Engineering UK 2013

The state of engineering

EngineeringUK

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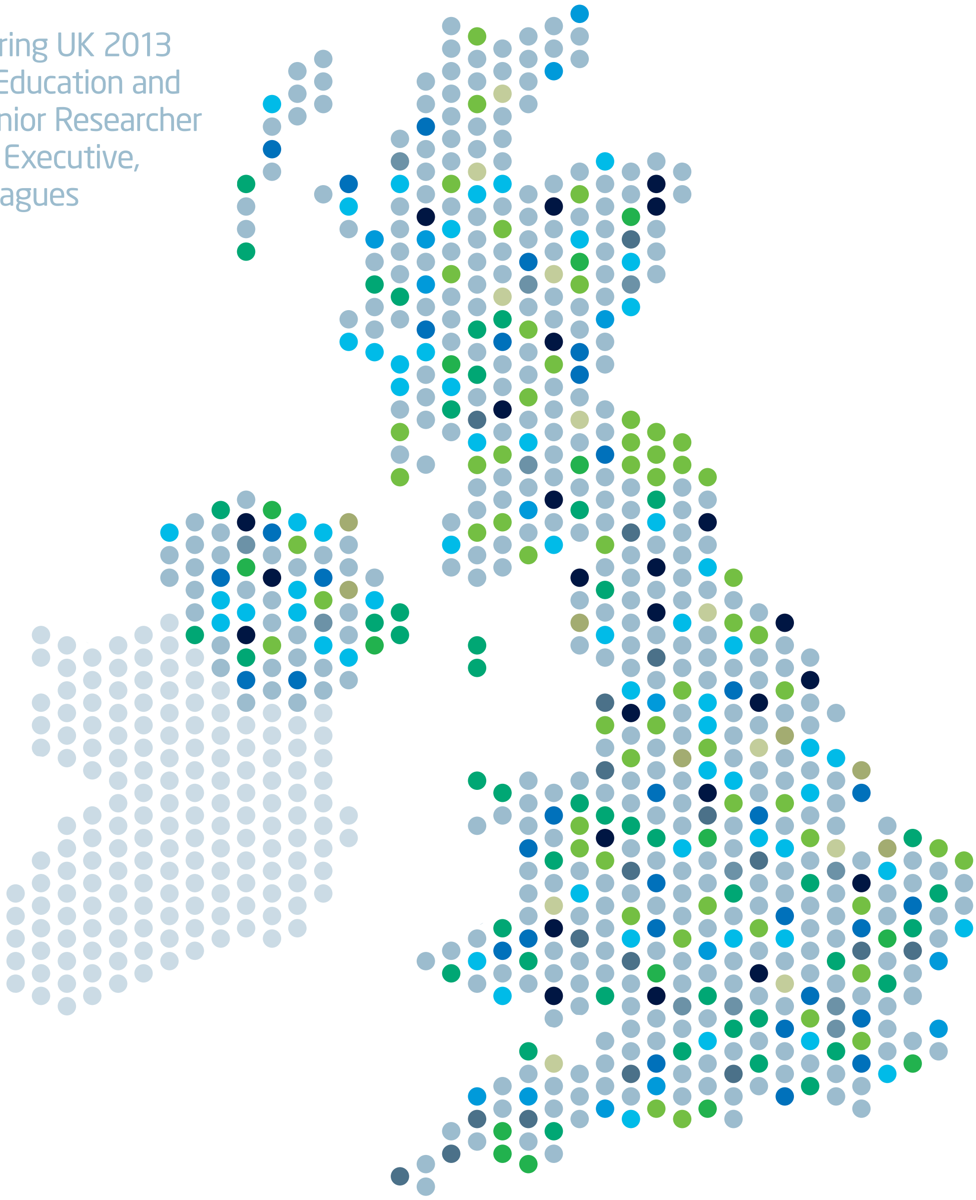

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Foreword
The Rt. Hon Dr Vince Cable MP

Engineering is central to manufacturing growth, and with manufacturing contributing £150bn to the UK economy, engineering skills are clearly vital to growth and rebalancing the economy.

It is, of course, something we are very good at.

Last June at the Royal Academy's annual MacRoberts Awards I was struck by the scope and richness of our native engineering talent. Whether it is the design and production of a specialised digital camera for scientific imaging at 20 nanometres, the manufacture of a lightweight car chassis, or the use of supercomputing for modelling weather and climate, engineering gives us a competitive edge in world markets.

Engineers with their highly adaptive skills are valuable across the whole economy.

Engineers therefore are the ones to watch. That is why I take a close interest in the findings of the 2013 EngineeringUK Annual Report. The Report shows encouraging trends across the sector, with many engineering and manufacturing businesses performing well.

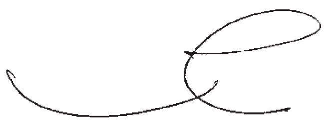
However, it also reveals that the age profile in the industry is high and that currently not enough young people are coming forward with the right skills and aspirations to meet the anticipated demand from industry.

The Government is very active in all policy areas from schools, apprenticeships, higher education and talent retention. Investing in the sector is vital to attract the most talented people into rewarding and well-paid careers. We're doing this in a number of ways:

- Our seven Catapults. These are centres of excellence that bridge the gap between business, academia, research and government, with the aim of increasing commercialisation of the world class research we already do.
- At the Manufacturing Summit in February 2012, I announced the extension of the See Inside Manufacturing programme to additional sectors. The aerospace & defence and food & drink sectors joined the automotive sector to give future engineers the chance to see the inspirational face of modern manufacturing.
- The Big Bang Fair and our own Make It In Great Britain initiative are encouraging young people to experience first hand the true excitement of science and engineering.

Apprenticeship starts are another positive sign of skills growth. In 2010/11 there were 48,970 starts in manufacturing and engineering, up 30 per cent on the year before.

But there is much more to do if we are to have the highly-skilled workforce the industry needs today, and in the future. The Government will continue to work closely with industry and the engineering community to identify and address the barriers between demand and supply of skills. But to make the right decisions it is vital to have quality information and analysis, and I applaud EngineeringUK's ongoing efforts to deliver thorough and insightful information to guide us in ensuring the industry has the skills it needs. In this way engineering will make the contribution to the economy it has the potential to, and will continue to offer rich and diverse career opportunities.



Rt. Hon Vince Cable MP
Secretary of State for Business, Innovation and Skills

EngineeringUK
About us

Our aim is to raise awareness of the vital contribution that engineers, engineering and technology make to our society and economy, and inspire people at all levels to pursue careers in engineering and technology.

Britain's economy needs a vibrant, innovative and successful engineering sector. Our vision is a society that understands the value of engineering and the opportunities that engineering provides. Our goal is to improve the supply of engineers through interventions with potential future engineers, the learners, and those who influence them, their parents, the media, education professionals and policy makers. We work in partnership with business and industry, Government, education and skills providers, the professional engineering institutions, the Engineering Council, the Royal Academy of Engineering and the wider science, technology, engineering and mathematics (STEM) community. Together, we pursue two strategic goals:

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

All of our activities are underpinned by thorough research and evaluation. This has helped to establish the not-for-profit organisation as a trusted, authoritative voice for the engineering community with influencers, policy makers and the media. *Engineering UK*, our annual review of the state of UK engineering, is our flagship publication, providing the engineering and wider STEM sectors, policy makers and the media with a definitive source of information, analysis and evidence.

You can view *Engineering UK* by theme on the EngineeringUK website www.engineeringuk.com

We focus our activity on two core programmes:

The Big Bang

The Big Bang programme exists to show young people the range and number of exciting and rewarding opportunities available to them with the right experience and qualifications. A unique collaboration by Government, business and industry, education, professional bodies and the wider STEM community, The Big Bang brings to life the exciting possibilities that exist for young people with science, technology, engineering and mathematics backgrounds. The programme is made up of:

The Big Bang UK Young Scientists and Engineers Fair, the largest celebration of science, technology, engineering and mathematics for young people in the UK. The Fair plays host to the finals of the National Science & Engineering Competition, which recognises the country's brightest and best young scientists and engineers. Led by EngineeringUK and delivered in partnership with over 150 organisations with the shared aim of inspiring the next generation of scientists and engineers, The Fair welcomed 56,000 people through its doors in its third year.

The Big Bang Near Me events take place across England, Northern Ireland, Scotland and Wales, providing young people across the UK with the opportunity to experience, close to home, the excitement and opportunities available through STEM. In 2012, over 20,000 people took part in The Big Bang Near Me.

We expect 65,000 people to attend The Big Bang Fair in 2013 and our ambition for 2020 is that 100,000 children and young people each year will experience The Big Bang for themselves. Our ultimate goal is that every child in the UK should know someone involved with it.

Tomorrow's Engineers

Tomorrow's Engineers is a careers programme led by EngineeringUK and the Royal Academy of Engineering. It is delivered through a broad partnership between business and industry, the engineering profession, activity delivery organisations and schools, working together to inspire learners and their influencers. Our long-term objective is to reach every state-funded secondary school in the UK in order to:

- improve awareness about engineering and what engineers do among pupils, their teachers and parents
- enthuse young people about engineering and the career opportunities available
- encourage young people to make the subject choices that keep open the routes into a career in engineering

To help achieve these objectives, Tomorrow's Engineers:

- funds a variety of experienced delivery partners, who provide a wide range of practical enhancement and enrichment activities delivered to targeted schools
- implements a common independent evaluation for activities that measures participants' learning about engineering and engineering careers, the impact on their perceptions, and their likely future subject and career choices
- provides careers information resources that help to engage pupils and teachers in understanding engineering career opportunities and routes into those careers

Careers information and resources are integral to our Big Bang and Tomorrow's Engineers programmes. We are working with the professional engineering institutions to develop unified, consistent careers messaging across the community for young people and those who influence them.

Our communications strategy ensures that not only those involved in our programmes, but the wider population, understand that studying science and mathematics subjects at school, college and university can open up a whole range of exciting and rewarding careers opportunities.

At EngineeringUK we believe that working in partnership with stakeholders is the only way to fully embed the engineering agenda in UK society. If you feel the same way, please visit www.engineeringuk.com and follow our activities on twitter.com/_EngineeringUK

Paul Jackson,
Chief Executive
EngineeringUK

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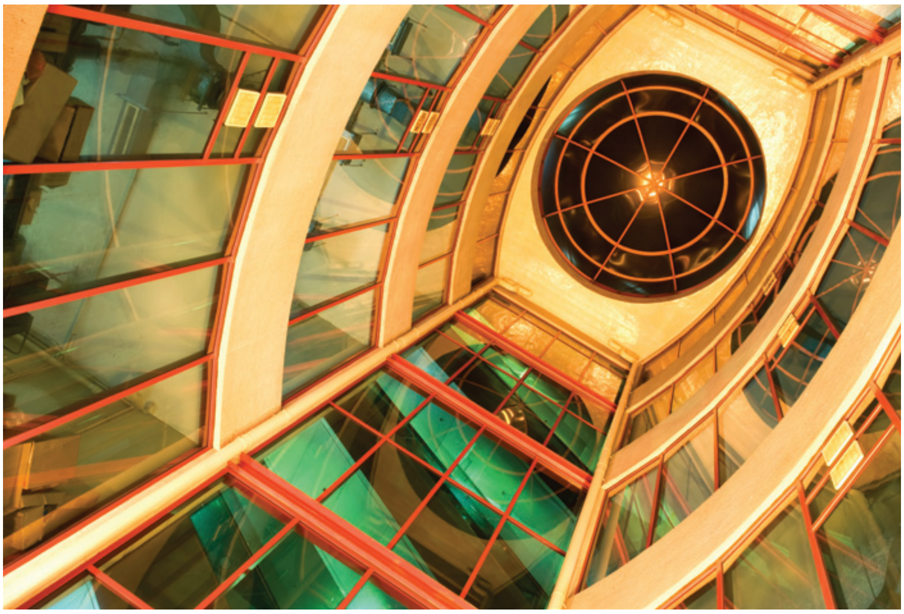
Executive Summary and Recommendations



Public understanding and perception of engineering and engineers are rising. And it is clear that the engineering sector has a crucial role to play in delivering growth for the UK, in building our capacity to compete in a rapidly growing global market and in shaping our ability to cope with mounting pressure on the world's resources. The building blocks are there and the signs are positive. We need to attract a greater talent pool into engineering, with joined-up action to ensure we seize the opportunities at a national level.

The Market

Turnover of UK engineering enterprises remains substantial, at £1.06 trillion in the year ending March 2011: that's 23.9% of the turnover of all UK enterprises and over three times the size of the retail sector. The sector employs 5.4 million people across 542,440 engineering companies. Between 2010 and 2020 these companies are projected to have 2.74 million job openings. UK manufacturing is very much alive and well: ranking ninth in global output, it makes up almost half (46%) of UK exports, employs 2.5 million people, and accounts for 72% of UK business R&D. Far from a manufacturing decline, output has risen by 148% from 1948 to 2011 and is more valuable to the UK than ever.

The UK is currently acknowledged as a world leader in several sectors: universities, automotive, renewable energy, space, low carbon, aerospace, creative industries, utilities, agri-food and bioscience. And **we have a powerful SME sector which employs 42% of the UK workforce**, represents 99.9% of all enterprises and makes a significant contribution to the economy at £1.5 trillion turnover.

Building Blocks

There is an undisputed need to increase both the absolute numbers and the rate of growth of young people in schools and colleges who are studying and progressing in the relevant academic and vocational science, technology, engineering and mathematics (STEM) subjects. We have firm foundations on which to build. **Entrants to the individual GCSE science subjects, physics, chemistry and biology have more than tripled from 2003 to 2012.** This growth is particularly significant for physics which, along with maths, is a key subject for those wishing to study engineering at university. However, whilst physics uptake increased by 5% last year, it only accounted for 3% of all GCSEs taken in 2012.

The positive trends continue at A level for England, Wales and Northern Ireland. The numbers of A level STEM entrants increased in 2012, with 85,714 pupils choosing maths (+3.3%), 34,509 choosing physics (+5.0%) and 49,234 choosing chemistry (+2.4%). **The increase in physics needs to be sustained** at least at this level if we are to increase the numbers of students studying engineering degrees. In terms of vocational progression routes, there are similar positive trends in growth: the numbers of students taking a BTec First in engineering in 2010/11 rose 30.4% from the previous year to 14,736. Similarly, the number of people starting Apprenticeship Programmes in England in 2010/11 for engineering and manufacturing technologies rose to 48,970, a 29.3% increase from the previous year, and the number successfully achieving them at 27,040, was up 3.6% from 2009/10. The picture in Scotland across different qualifications is more complicated, but the underlying requirement for growth in physics and apprenticeships is the same.

Over the last 10 years, accepted applicants from UK engineering and technology students have grown by 21.5%, reaching 21,344 in 2010/11. Only 10.8% of these applicants came from women. Overall in 2010/11, engineering and technology was the second largest STEM subject area (behind biological sciences) for qualifiers, with 22,905, or 6.2%, of all degree qualifiers.

Challenges

Between 2010 and 2020, engineering companies are projected to have 2.74 million job openings across a diverse range of disciplines. And yet by 2035, numbers of 20- to 64-year-olds – the most economically-active sector of our population – will gradually decline, whilst the proportion of the population aged over 65 will increase. When it comes to growing our capacity, we will need to expand our horizons in order to ensure that we have the pool of future engineering talent we need.

We do not need to look too far to recognise that the talent is there. The under-representation of women within engineering has been long recognised. And whilst the majority of young people succeed in education and make a positive transition to adult life and the world of work, we still face a very real challenge in terms of opportunities for young people. In particular, the 150,000 16- to 17-year-olds who are not in employment, education or training (NEET) may need additional opportunities or support to re-engage in education or training.

Our research shows that enjoyment is as important as attainment in terms of a pupil's likelihood to pursue a subject later, particularly when it comes to maths and science. The impact of high quality teachers is significant. A growing body of evidence shows that **variation in teaching quality has a major impact on outcomes** and that, all other things being equal, the difference between having an 'excellent' and a 'bad' teacher is equivalent to one GCSE grade. There are significant variances in the provision of the key engineering facilitating subjects of maths and physics at different educational levels. For example, only 73% of teachers of mathematics to years 7-13 held a relevant post-A level qualification while physics is hampered by the fact that, out of a target workforce of around 10,000 specialist physics teachers in England, there is a shortage of between 4,000 and 4,500.

In order to significantly increase the numbers of students studying engineering, **we need to substantially increase the numbers of young people studying both maths and physics** combinations from GCSE onwards, as well as those studying engineering and engineering-related vocational courses. In 2010, only 18% of pupils were entered for triple science (individual physics, chemistry and biology) GCSEs. This is important because students in England who study triple science at GCSE are three times more likely to study physics A level than those who studied core and additional science and are more likely to attain one grade higher in those A levels. This constriction of supply is further compounded by the fact that only 43% of physics students who achieved an A* at GCSE level progress onto AS level physics. In terms of equality and growing capacity, analysis of the national pupil database shows that 49% of state co-educational schools in England did not send any girls to study physics at A level in 2011, compared with only 14% for boys.

The lack of available engineering-related apprenticeships, coupled with the low numbers of training providers, potentially restricts the future growth, choice and local availability for students who want to take up engineering apprenticeships.

For degrees in physics and engineering, the primary pool of potential students comprises those with A levels in physics and mathematics. It has been shown that **the principal destination of students with A level physics is engineering**, and that almost everyone who passes goes onto a STEM-related course at university. The pool of students taking physics is two and a half times smaller than that taking maths: the emphasis must be on increasing the pool of students taking A levels in physics if we are to grow the degree numbers. Even with a 5% compound growth in the number of students studying A level physics for the next 10 years, the numbers of physics students would still be below those currently studying A level maths.

Labour market and salaries

Those who graduate in engineering have good employment prospects.

In 2010/11, 85.0% of engineering graduates went into either paid work or were undertaking further study within six months of graduating, with almost two thirds of those who went into employment going to work for an employer whose primary activity was engineering and technology. Analysis of the HESA Longitudinal Destination of Leavers data shows that engineering and technology degrees provide long term employability prospects: of those who graduated in 2006/07, 83.3% were in full-time employment in 2010, compared with an average for all subjects of 72.3%.

The salaries enjoyed by engineering graduates and technicians are also very good. Whilst medicine and dentistry graduates achieved the highest graduate starting salary, they were followed by engineering and technology graduates: at £25,762, their average starting salary is 15.7% more than the mean for all graduates. **For those engineering and technology graduates going to work for an engineering company, the average mean salary was £27,415**, a fifth higher than the mean salary for those who went to work for non-engineering companies. The same is true for technicians: engineering technicians, with an average salary of £34,018, top the list of STEM technician salaries versus the national mean average of £26,871.

Despite this, two in five (42%) of those employers who take on staff with STEM skills still have difficulties in finding the STEM talent they need. In manufacturing, nearly a third (30%) of firms are reporting difficulties in recruiting technicians.

Future job prospects are also very good. Between 2010 and 2020, engineering companies are projected to have 2.74 million job openings across a diverse range of disciplines. This represents 19.8% of all job openings across all industries and represents a 50% churn of the entire workforce currently employed in engineering enterprises (5.4 million). Of these, 1.86 million will be workers who are likely to need engineering skills. Pro-rata, that's 1.488 million jobs over the next eight years. Within this, the demand for people with level 4+ (HNC/D, Foundation Degree, undergraduate or postgraduate and equivalent) qualifications is projected at 865,100 over the ten-year period: an average demand of approximately 87,000 recruits per year. Worryingly, only around 46,000 people qualify at this level each year in the UK. There will also be a demand for approximately 690,000 people qualified at level 3 (BTec National, S/NVQ level 3, advanced diploma, Advanced Apprenticeship) – an average demand of 69,000 per year. Yet only around 27,000 UK apprentices a year qualify at level 3.

Prospects for the future

Whilst the expected post-recession upturn has not yet materialised to any significant level, either within the UK or the EU, the future trend paints a very different and more optimistic picture. Reports project that annual global output will more than double in two decades, from $78 trillion to $176 trillion. Three-fifths of that extra output will come from emerging or developing economies.

The force behind this growth is the growing purchasing power of the middle classes, particularly in Brazil, Russia, India and China (the BRIC countries) and other emerging economies. Today, India and China account for a mere 5% of global middle class consumption, while Japan, the United States and the European Union account for 60%. By 2025, those numbers are expected to equalise. By 2050, they will have flipped.

Supporting economic prosperity is not the only crucial role the engineering sector has to play in our future. Global population reached seven billion during 2011 and the United Nations predicts it could be as high as 11 billion by 2050. In the richest parts of the world, per capita material consumption is far above the level sustainable for a population of seven billion or more. Science and technology will play a vital role in seeing us through this critical period in the Earth's history.

This may seem daunting, but the glass is half full. While the UK does not have the capability or the resources to succeed in every emerging technology, it does in some: **synthetic biology, energy-efficient computing, energy harvesting (from the environment), graphene (the thinnest material possible), life sciences, nanotechnology and digital technologies.** In this last field, we have strengths in systems and software engineering, the development of advanced 3G and 4G mobile products and services, interface design and intelligent systems, and high performance computing.

At the grass roots level if we are to attract the future engineering talent pool, **we need to reach young people, their parents and teachers with messages about 21st century engineering** and the career opportunities available at all levels. We are making progress. Our 2012 *Engineers and Engineering Brand Monitor* (EEBM) survey shows that improvements in perceptions have been achieved. The proportion of 12- to 16-year-olds expressing some knowledge of what people working in engineering do has almost doubled, from 11% to 19.8% this year, and the likelihood of 12- to 16-year-olds seeing a career in engineering as being desirable has also increased year-on-year, from 29% to 38%. Equally significant is that we are influencing the influencers, with the majority (74%) of parents saying they would recommend a career in engineering to their children.

Through working together and proactive concerted action, the partners involved in EngineeringUK's two main programmes, The Big Bang Fair and Tomorrow's Engineers, are making a difference. Evaluating the impact of these programmes on their participants against the *Engineers and Engineering Brand Monitor* helped us to benchmark perceptions. In 2011, 29% of 12- to 16-year-olds surveyed in the EEBM said a career in engineering was desirable. In comparison, 45% of secondary school students who took part in the Tomorrow's Engineers programme and **54% of 12- to 19-year-olds who took part in The Big Bang Fair thought a career in engineering was desirable.**

There remain significant opportunities for increased involvement. Our research has shown that whilst nine out of ten STEM teachers are aware of enhancement and enrichment activities, only 46% got involved in them. And while 87% of teachers agree that providing careers guidance is part of their role, eight out of ten would base that guidance on their own knowledge and experience and around a fifth of them think a career in engineering is undesirable.

Young people in the UK experience a prominent and consistent dip in their motivation and performance in the middle years of compulsory education (ages 11-14). This dip becomes more pronounced just after the stage of transfer from lower to upper secondary school, with the most evident dips in more traditional academic subjects including science and maths. It is therefore crucial to the future engineering talent pipeline that there is support for schools, teachers and young people to enable students to make informed choices from an early age.

Recommendations

The engineering sector calls for:

- A two-fold increase in the number of engineering graduates. This is vital to meet the demand for future engineering graduates and to meet the shortfall in physics teachers and engineering lecturers needed to inspire future generations of talented engineers.
- A doubling of the numbers of young people studying GCSE physics as part of triple sciences and a growth in the numbers of students studying physics A level to match those studying maths.
- A two-fold increase in the numbers of pre-19-year-olds students studying vocational level 3 qualifications. In particular, increasing the number of apprentices studying the Advanced Apprenticeship frameworks in engineering and manufacturing technology frameworks, construction planning and the built environment and information and communications technologies.
- The provision of (face-to-face) robust and consistent careers information advice and guidance for all 11- to 14-year-olds that promotes the diversity of engineering careers available and the variety of routes to those careers, and includes opportunities to experience the workplace.
- Support for teachers and careers advisors in delivering careers information so that they understand the range of career paths, including vocational/ technician, and have the opportunity to experience a 21st century engineering workplace for themselves.

This programme is best achieved if Government works in partnership across the engineering industry, professional bodies and third sector.

Part 1 – Engineering in Context
1.0 Capacity for growth

On current trends, annual global output will more than double in two decades from US$78 trillion to US$176 trillion (at today's prices), with three-fifths of that extra output coming from emerging or developing economies.[1]

The over-riding topic of conversation in the corridors of power right now is delivering growth, with the Coalition Government firmly focused on the four key ambitions of its Plan for Growth agenda.[2] It wants to create the most competitive tax system in the G20. It aims to make the UK one of the best places in Europe to start, finance and grow a business. It wants to encourage investment and exports as a route to a more balanced economy. And it intends to create a more educated workforce that is the most flexible in Europe.

The central questions in this year's report is do we have the capacity for growth? Will the UK deliver? Other nations have the same preoccupation with growth and, whilst this is more of a marathon than a sprint, we are, nevertheless, in a race.

Events – specifically the London Olympics 2012 – demonstrated convincingly that when the UK really sets its mind on a challenge, it does have the capacity to deliver. Not only did we achieve our highest ever post-War result, with 29 gold medals in the Olympics and 34 in the Paralympics, but we delivered the impressive technological and engineering feat that is the Olympic Park.

The Olympic Park transformed 2.5 square kilometres of derelict land – making it Europe's largest construction site at the time. Despite including the most extensive tunnelling operation since the Channel Tunnel, it was delivered on time and within the £8.1 billion budget. It harnessed the skills of 46,000 people – 8,500 from the host boroughs. Almost half these people (4,000) were previously unemployed and became employable and 457 apprenticeships were set up.

With the size of global annual output forecast to grow to $176 trillion in the next two decades,[3] the opportunity for growth in engineering is on a far bigger scale than the Olympics. To capitalise on it, there's a pressing need for concerted action from the Government and UK's science, engineering and technology sectors.

The demand for engineering technicians and graduates is certainly there. Our unique analysis shows that, by 2020, engineering enterprises will need to recruit an additional 1.86 million workers with engineering skills – approximately one third of the entire 5.4 million workforce who currently work in engineering enterprises.[4]

So we have the opportunity. The abundance of Government strategy, policy and funding streams show that we have the desire. But do we have the capacity for truly sustainable growth? Do we have the will, leadership and consensus at the scale required to deliver?

The rest of this report delves into detail to provide reliable and robust data, trend analysis and commentary for policy makers, businesses, researchers, educators, the skills sector and media, to help them make informed decisions. This, in turn, will help support the growth of the science, engineering and manufacturing sectors within the UK and rebalance and grow the UK economy.

1.1 Challenges to growth

This section presents some key obstacles that will need to be overcome if we are to ensure that we have the capacity to meet future skills demands and deliver economic growth.

1.1.1 Economic challenges

The push for growth has been hampered by many stops and starts. This is because the expected post-recession upturn has not yet materialised to any significant and sustainable level, particularly within the EU. Indeed, the Greek and Spanish bail-outs have thrown into doubt many economists' assumptions. The UK has still not recovered from the 2008 recession. The recovery has been even slower than that following the Great Depression.[5] Lee Hopley, Chief Economist, EEF says, *"UK economic data has been complicated by a number of one-off events so far this year. However, the underlying trend appears to be flat activity. While there are pockets of growth in some sectors, a weak first half of the year combined with significant on-going challenges in the world economy has led most forecasters to pull down their expectations for growth in both 2012 and 2013. The consensus forecast for GDP this year is a modest contraction with the economy moving back to modest growth in 2013."*

The IPPR's *State of the Economy* report[6] makes the persuasive observation that UK growth must be less reliant on debt-fuelled consumer spending and based more on exports and business investment. It must be less reliant on a few sectors of the economy, like finance, and more broad-based across sectors. And it must be less focused in the South East and more regionally spread.

1 *When two worlds meet: How high-growth market companies are changing international business,* UKTI, 2011, page 4 **2** http://cdn.hm-treasury.gov.uk/2011budget_growth.pdf **3** *When two worlds meet: How high-growth market companies are changing international business,* UKTI, 2011, page 4 **4** See section 2 for details on the number of workers currently employed in engineering companies. **5** *Youth unemployment: the crisis we cannot afford;* AVECO, 2012, p32 **6** *The State of the Economy,* Tony Dolphin, David Nash, Amna Silim, IPPR, November 2011, p9

This position is exemplified by Table 1.0 which shows the scale of investment into various UK sectors. It shows that we are still able to attract foreign investment: the manufacturing sector is most successful in this, with a 2008 contribution of 43.2%. We need to consolidate this favourable foreign investment position and, to this end, we can look forward optimistically, according to Ernst & Young. Its 2011 survey once again named the UK as the most attractive destination in Europe for foreign direct investment projects and associated jobs.[7]

1.1.2 Skills challenges

Workforce skills are critical to the success of the UK economy in the long term and remain an on-going challenge. As mentioned in section 1.0, one of the four objectives of the Government's Plan for Growth is: *"To create a more educated workforce that is the most flexible in Europe."* [8]

The case for addressing the UK skills challenge is clear. Over the last 25 years, around a fifth of UK economic growth can be attributed solely to increased workforce skills,[9] while a one percentage point increase in productivity or employment would generate an additional £10 billion of GDP each year.[10]

Our own research shows that by 2020 engineering enterprises in the UK[11] will need to recruit 2.74 million new workers. This huge demand – around a fifth of the demand for all industries – raises huge challenges in making sure we have the STEM (science, technology, engineering and maths) skills supply chain to meet it.

UKCES produced two key reports into labour demand and workforce skills in 2011: *Working Futures 2010-2020* and the *UK Employer Skills Survey*. These highlight three key issues, described below.

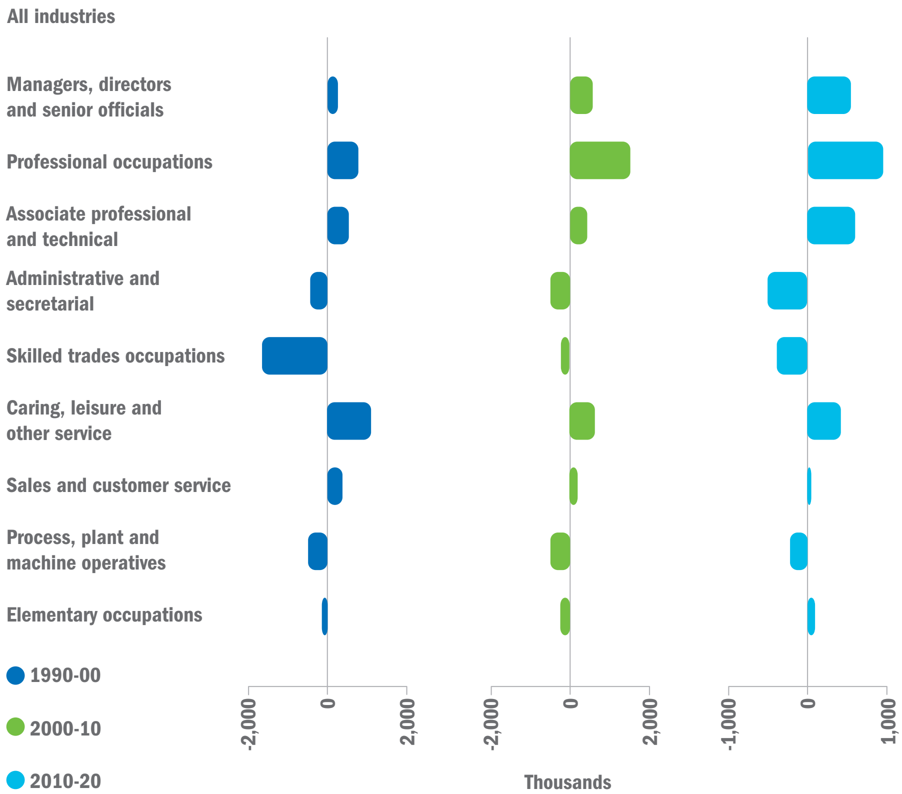
Firstly, *Working Futures 2010-2020* [12 13] provides a very illuminating picture of the changing occupational nature of the UK. Figure 1.0[14] shows that there will be an increase in demand for managers, directors and senior officials as well as for staff in professional, associate professional and technical occupations. It points to the need for the UK to grow its capacity of skilled people across all industries by increasing the supply of more highly qualified people.

Table 1.0: Total investment (millions) by UK and foreign-owned companies by sector type (2007-2008) – UK

		Manufacturing investment (million)	Services investment (million)	Other investment (million)	Total investment (million)
Foreign-owned	**2007**	4,649	11,674	7,504	23,828
	2008	4,755	10,148	9,232	24,135
UK-owned	**2007**	7,701	52,774	16,529	77,004
	2008	6,249	54,574	19,314	80,137
Total (foreign and UK-owned)	**2007**	12,350	64,448	24,033	100,832
	2008	11,003	64,722	28,547	104,272
Percentage (foreign-owned)	**2007**	37.6%	18.1%	31.2%	23.6%
	2008	43.2%	15.7%	32.3%	23.1%

Source: Department of Business, Innovation and Skills regional economic performance indicators

Fig. 1.0: Changes in occupational employment structure (1990-2020)



Source: IER estimates, MDM Revison 7146

Secondly, the reports highlight that UK industries are projected to need a staggering 13.9 million people between 2010 and 2020: 12.3 million to replace those leaving the labour market, plus 1.6 million additional jobs.[15]

7 *Destination UK: sustaining success in the new economy – Ernst & Young's 2011 UK Attractiveness Survey,* Ernst and Young, 2011, p2 8 http://cdn.hm-treasury.gov.uk/2011budget_growth.pdf 9 *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p12 10 *Big challenges bring big rewards The big picture narrative,* UKCES, March 2012, p7 11 For more details see section 15 12 *Working futures 2010 – 2020,* UKCES, December 2011 13 *Working Futures 2010-2020* is the most detailed and comprehensive set of UK labour market projections available. It focuses on a ten year horizon, providing a picture of the labour market for 2020. Its core purpose is to inform policy development and strategy around skills, careers and employment. 14 *Working futures 2010 – 2020,* UKCES, December 2011, p80 15 Bespoke analysis of Working Futures 2010-2020 16 *UK Commission's Employer Skills Survey 2011: UK Results, Evidence Report 45,* UKCES, May 2012, page 146 17 *Horizon Scanning and Scenario Building: Scenarios for Skills 2020, A report for the National Strategic Skills Audit for England 2010, Evidence Report 17,* UKCES, March 2010 18 In the UK, Generation Y is represented by the population centred around the age of 24 that will replace the retiring baby boomers. 19 *Horizon Scanning and Scenario Building: Scenarios for Skills 2020, A report for the National Strategic Skills Audit for England 2010, Evidence Report 17,* UKCES, March 2010, p92

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Thirdly, the UK Employers Skills Survey shows that skills gaps, Skills Shortage Vacancies and Hard-to-Fill Vacancies are still prevalent (Table 1.1).[16]

Finally, UKCES also undertook a project aimed at addressing the key question: *"What will be the drivers and impact of change on the employment and skills landscape in England by 2020; what are the challenges and opportunities for Government and employers?"* In short, the report[17] concluded that, *"the main changes to the skills landscape in 2020 are likely to be globalised markets, a new paradigm for training, Generation Y,[18] the renewal of UK infrastructure and the need for up-skilling and multi-skilling."* Whilst the full report goes into much more depth, the 23 most significant drivers are shown in the box for convenience.

Table 1.1: UKCES England legacy time series – key figures

	2011	2009	2007	2005
Vacancies and Skill Shortage Vacancies				
% of establishments with any vacancies	15%	12%	18%	17%
% of establishments with any Hard-to-Fill Vacancies	5%	3%	7%	7%
% with SSVs	4%	3%	5%	5%
% of all vacancies which are SSVs	16%	16%	21%	25%
Number of vacancies	533,400	358,700	619,700	573,900
Number of Hard-to-Fill Vacancies	115,500	85,400	183,500	203,600
Number of Skill Shortage Vacancies	85,500	63,100	130,000	143,100
Skills gaps				
% of establishments with any staff not fully proficient	18%	19%	15%	16%
Number of skills gaps	1.32m	1.70m	1.36m	1.26m

Source: Skills surveys: 2011 – UKCESS 2011; 2009 – NESS09; 2007 – NESS07; 2005 – NESS05

Drivers of the UK employment and skills landscape in 2020[19]

Economic and globalisation drivers

- **Economic growth in the UK** is a key uncertainty over the next 10 years. This will have substantial effects on the employment and skills landscape.
- Technology and a **knowledge economy** may lead to a polarisation of jobs between the highly skilled and low skilled.
- The challenge for Government-sponsored training services will be how to meet **growing consumer (quality) expectations** and how to grow demand for training.
- Replacement and enhancement of **infrastructure** will be a big driver of employment, and therefore skills, and its rate of introduction is highly dependent on future economic conditions.
- At predicted rates of growth, the **economy of China** will overtake that of the USA by around 2025. When adjusted for purchasing power parity, China may overtake the USA as soon as 2017. China (and other countries with large/ rapidly developing economies) will have an increasing impact on the UK economy.
- **New industries and new jobs** will be stimulated by Government policy, consumer demand and by the development of new technologies, methods and materials requiring training on their adoption.
- **Existing industries** will play a majority part in the employment landscape in 2020. They will have to adapt and improve to survive. Training will play a major part.

Technology drivers

- The bio-, nano- and cognitive sciences will lead to new technologies and products. Low carbon products, information and communications technology (ICT), and other **new technologies** will change industry and services and hence demand for training.
- Britain is strong in **design and media** and it is likely to be important to maintain this lead in the future, so training in this sector should not be undervalued.

Demographic change drivers

- **Migration** is a key driver of the skills landscape. In the past, it has provided a solution to labour shortages in the UK, especially for less skilled jobs. But outward migration is also likely to increase in importance.
- The main demographic issue is an **ageing workforce**. People may work longer, and they will need lifelong training to help them do so.
- Those born in the years leading up to the new millennium, **Generation Y**, have been shaped by growing up with instant communication technologies, new media and social networking.

Environmental change drivers

- **Reducing carbon dioxide emissions** will require skills in design, installation and maintenance of equipment and materials to generate low carbon energy and reduce energy consumption. In addition, low-carbon working practices will need to be generally adopted.
- As world consumption continues to grow, there is a growing risk of **resource shortages** (or price hikes in anticipation) in a wide range of commodities. New jobs in recycling and resource conservation will emerge.

Values and identity drivers

- International and internal **security concerns** have increased in recent years and are likely to be a significant concern for years to come, providing new jobs and influencing the location of investments.

Regulation and multi-level governance drivers

- **Regulation** across society is generally expected to increase, although with substantial differences in intensity and target in different scenarios. This will have a significant impact on training for certification and to meet regulatory norms.
- **School education** is crucial in all scenarios but is it delivering the right product for the future?
- The growth of EU markets and the **liberalisation of international trade** are important drivers of growth and will impact on the UK's industrial landscape.
- **Government** directly funds much training and also has an impact on the demand and supply of training through the effect of other policies.

We are not alone

On the other hand, the fight for skills is not unique to the UK. Across the globe, ambitious countries are taking stock of their skills inventories and matching them to their growth ambitions. By and large, most are predicting shortages.

We made the point last year[20] that talent-driven labour was identified as the number one driver for global manufacturing competitiveness.[21] This year, we are able to report on Manpower's 2012 survey,[22] which researched the views of more than 38,000 employers in 41 countries and territories. The report finds that, against the backdrop of the slow-paced recovery in the global economy, around one in three employers (34%) continue to experience difficulties filling vacancies due to lack of available talent.

Talent supply and demand issues are generally more acute in the Asia Pacific and the Americas regions than in Europe, the Middle East and Africa. The highest proportion of employers reporting difficulty filling jobs is in Japan, where 81% indicate that this is an issue. Notable shortages are also reported in other Asia Pacific markets, including Australia (50%), India (48%) and New Zealand (48%). In the Americas, the most urgent talent shortage is reported in Brazil, where 71% of employers identify difficulty sourcing employees with the relevant profile. In the US, 49% of employers report difficulties filling jobs.

It should be noted that the second most in-demand category globally is engineering staff – up from fourth place in 2011[23] (Figure 1.1). Mechanical, electrical and civil engineers are most often identified as in short supply by employers. This finding continues to highlight the lack of focus on developing STEM skills in many economies around the world.

When President Obama addressed the US on the issue of science and maths skills, he said, *"American students will move from the middle to the top of the pack in science and math over the next decade. For we know that the nation that out-educates us today will out-compete us tomorrow."*[24]

Fig. 1.1: Top 10 jobs employers are having difficulty filling globally

1	Skilled trades workers	**6**	Accounting and finance staff
2	Engineers	**7**	Drivers
3	Sales representatives	**8**	Management/executives
4	Technicians	**9**	Labourers
5	IT staff	**10**	Secretaries, PAs, administrative assistants and office support staff

Source: Manpower Group, The 2012 Talent Shortage Survey

The President's Council of Advisors on Science and Technology (PCAST)[25] found that economic forecasts pointed to a need for producing approximately one million more college graduates in STEM fields over the next decade than expected under current assumptions. They also found that fewer than 40% of students who enter college intend to major in a STEM field or complete a STEM degree. The Council has proposed that merely increasing the retention of STEM majors from 40% to 50% over the next decade would generate three-quarters of the targeted one million additional STEM degrees.[26]

1.1.3 Teaching quality

One of the main growth constraints for the UK is the rate at which it can grow its STEM supply chain directly from its educational establishments. And one of the main factors in growing its STEM supply chain is the quality and quantity of its teaching profession.

The impact of high quality teachers is significant. A growing body of evidence[27] shows that variation in teaching quality has a major impact on outcomes and that, all other things being equal, the difference between having an 'excellent' and a 'bad' teacher is equivalent to one GCSE grade.[28] It is therefore concerning that there is such a shortage of secondary mathematics teachers with specialist knowledge (eg a maths degree). It is estimated that up to one in six secondary mathematics teachers have transferred from another subject and 25% of maths teachers have no post A-level qualification in related subjects.[29]

This issue has been recognised by the European Commission. In 2010, it agreed to include education and training as a key element in Europe 2020,[30] its strategy for smart, sustainable and inclusive growth over the coming decade.

The Eurydice report on education in Europe[31] shows that, according to the latest Programme for International Student Assessment (PISA) results, many students are being hindered by a lack of qualified teachers in the core subjects: language of instruction, mathematics and science. In Germany, the Netherlands and Turkey, the percentages are high not only for the core subjects but also for other school subjects.[32]

The report also shows that, on average, around 15% of all 15-year-old students in participating European countries were taught in schools where the head reported that teaching was, at least to some extent, hindered by a lack of qualified science and mathematics teachers.[33]

The percentages were nearly 80% in the case of mathematics teachers in Luxembourg and teachers in all three subjects in Turkey. These countries were followed by Belgium (German-speaking and Flemish Communities), the Netherlands, the United Kingdom (England, Wales and Northern Ireland), Iceland and Liechtenstein, where between 20 and 40% of students have school heads who reported a lack of qualified science, mathematics or language of instruction teachers.

If that were not enough, demographic changes in the European Union (including an ageing population) are also affecting many professions, including teaching. This may be

20 *Engineering UK Report 2012 – the state of engineering, EngineeringUK,* December 2011, p33. 21 *2010 Global Manufacturing Competitiveness Index,* Deloitte and the U.S. Council on Competitiveness, 2010. Available at: http://www.deloitte.com/view/en_GX/global/industries/manufacturing/a1a52c646d069210VgnVCM200000bb42f00aRCRD.htm 22 *Talent Shortage Survey Results,* Manpower Group, 2012. Available at: http://www.manpowergroup.co.uk/ 23 *2012 Talent Shortage Survey Research Results,* Manpower Group, p5 24 US President Barack Obama address to the National Academy of Sciences in April 2009 25 The President's Council of Advisors on Science and Technology (PCAST) is an advisory group of the nation's leading scientists and engineers, appointed by the President to augment the science and technology advice available to him from inside the White House and from cabinet departments and other Federal agencies. 26 *Report To The President Engage To Excel: Producing One Million Additional College Graduates with Degrees In Science, Technology, Engineering, And Mathematics,* PCAST, February 2012 27 *Solving the maths problem: international perspectives on mathematics education, RSA,* January 2011, p12 28 *Room for improvement: IPPR's response to the schools white paper,* Clifton, J. and Muir, R, IPPR, 2010 29 *A world-class mathematics education for all our young people,* Vorderman, C, Conservative Party, 2011 30 http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm 31 *Key Data on Education in Europe 2012,* Eurydice, February 2012 32 *Key Data on Education in Europe 2012,* Eurydice, February 2012, p113 33 *PISA 2009,* OECD

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one of the reasons for the lack of qualified teachers in some countries.[34] The Eurydice report throws up the following data:

- In Germany, Italy and Sweden, nearly half of all teachers in primary education are in the 50+ category and therefore approaching retirement age.[35]
- The largest age group for teachers in Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Finland and Liechtenstein is 40- to 49-year-olds.
- In Belgium, Ireland, Cyprus, Luxembourg, Malta and the United Kingdom, primary school teachers are relatively young, with more than 20% of teachers being under 30 or in the 30- to 39-year-old category.
- In the majority of countries, teachers in secondary education are older than those in primary education. The most strongly represented age group at this educational level is the 50 and over group.[36]
- In Germany and Italy, teachers aged 50 and over account for more than 50% of all teachers.

The issue of teacher quantity and quality in the UK has also been highlighted by the Pearson report[37] which found that:[38]

- Recruitment to both undergraduate and postgraduate training courses has declined in the 2012 recruitment round. This is partly because of stricter degree qualifications imposed on applicants by the Government. But it's also likely to be because of the increase in fees for these courses: in some subjects where generous bursaries are available for trainees, such as physics, chemistry and languages, recruitment is better in 2012 than it was in 2011.
- Primary Initial Teacher Education (ITE) recruitment has notably declined. Yet demand for primary teachers is set to increase rapidly in the imminent future, especially in some parts of the country.
- Some subject areas are experiencing shortfalls in ITE recruits. These include key areas such as English, the sciences and mathematics.

1.1.4 The maths skills gap

Mathematics is a key underpinning subject for all STEM subjects and is one of the core key skills required by employers.[39] Mathematics is compulsory for all students in general education in 13 countries, and for all students in vocational education in nine countries. However, it is not compulsory in England, Wales and Northern Ireland,[40] and consequently fewer than one in five students study any mathematics after the age of 16. In 18 of the 24 countries, more than half of students in the 16– to 18-year-old age group study mathematics. In 14 of these, the participation rate is over 80%. And in eight of these, every student studies mathematics. When it comes to the mathematics education of its upper secondary students, the UK is out on a limb.

This has not gone unnoticed in the UK. The recent House of Lords report *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects*[41] makes a key recommendation:

"We recommend that, as part of their National Curriculum review, the Government make studying maths in some form compulsory for all students post-16. We recommend also that maths to A2 level should be a requirement for students intending to study STEM subjects in HE."[42]

This report also crucially recognises an issue that EngineeringUK is extremely passionate about. That is, to ensure that young people receive good STEM careers information, advice and guidance, so that they are able to make informed subject and/or careers choices. Without this, we will not grow the STEM supply regardless of whatever other interventions are introduced. The report says:

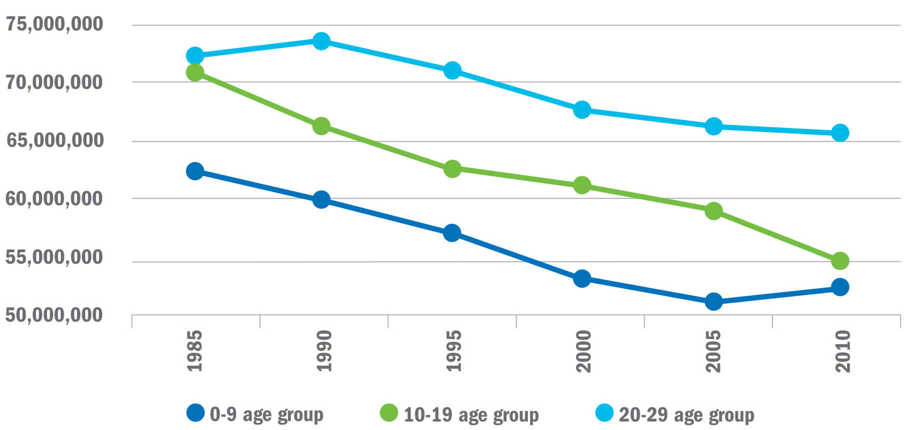
"We recommend that the Government should direct the new National Careers Service to ensure that appropriate advice is given to young people about the following: STEM subject choice at school and its possible consequences for future study and careers; the choices available within STEM subjects at HE level and beyond and the advantages of pursuing a STEM degree; and, relevant careers advice that highlights the jobs available to STEM graduates both within STEM and in other industries."[43]

1.1.5 Demographics

The assumption that we can simply turn on the supply tap in order to increase our capacity is questionable when you consider the variation in age cohorts[44] across the EU's 27 member states (Figure 1.2).

All the age groups analysed here show an overall decline during this period. The most significant decrease can be seen in the 10-19 age group (22%). This is the same cohort that will supply technicians and graduates over the next 10 years. This decline is followed by the 0-9 age group (16%), whilst the 20-29 age group is still declining, albeit at the lowest rate (8.7%).

Fig. 1.2: Population variation in the 0-9, 10-19 and 20-29 age groups in the EU-27 (1985-2010)



Source: Eurostat, Population statistics[45] (data extracted July 2011)

34 *Key Data on Education in Europe 2012,* Eurydice, February 2012, p123 **35** *Key Data on Education in Europe 2012,* Eurydice, February 2012, p123 **36** *Key Data on Education in Europe 2012,* Eurydice, February 2012, p125 **37** *The Future Teacher Workforce: quality and quantity, A Report for the Pearson Think Tank,* Professor John Howson, Pearson, August 2012 **38** *The Future Teacher Workforce: quality and quantity, A Report for the Pearson Think Tank,* Professor John Howson, Pearson, August 2012, p7 **39** Employers want to see primary schools concentrating on the key enabling skill of numeracy (61%) for those in the 14-19 age group (45%). *Education and skills survey 2012,* CBI/Pearson, p22 **40** *Is the UK an outlier? An international comparison of upper secondary mathematics education,* Nuffield Foundation, 2010, p5 **41** *2nd Report of Session 2012–13 Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects,* House of Lords, Select Committee on Science and Technology, 24th July 2012. http://www.publications.parliament.uk/pa/ld201213/ldselect/ldsctech/37/37.pdf **42** Ibid, para 32 **43** Ibid, para 46 **44** *Key Data on Education in Europe 2012, Eurydice,* February 2012, figure A1 **45** The population is that of 1 January in the reference year. The population is based on population registers or data from the most recent census adjusted by the components of population change produced since the last census.

In section 4.0 we are able to look specifically at the projected number of 0- to 29-year-olds in the UK between 2012-2035. This is broken down further into 0- to 9-year-olds, 10- to 19-year-olds, and 20- to 29-year-olds.[46] A key finding is that the number of young people aged 0-9 is expected to rise steadily in the ten year period – from 7,616,000 in 2012 to 8,356,000 by 2022 – then decline steadily to 8,008,000 by 2035.

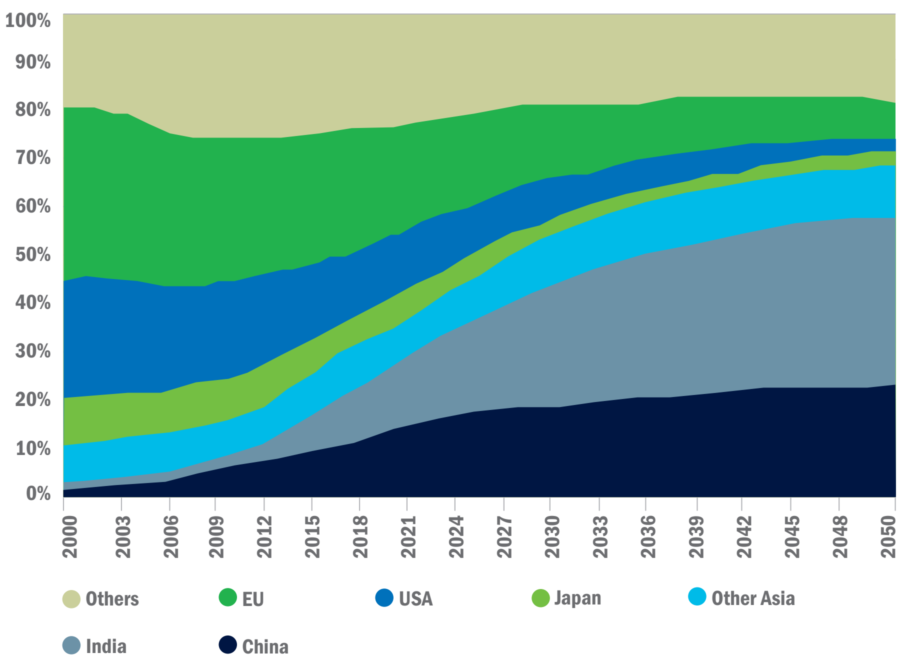
1.1.6 The middle classes

On the surface, this section may seem a strange addition to a report that describes the challenges and issues faced by the engineering sector. Several reports, however, have commented on the fact that the global economy will be driven by the purchasing power of the middle classes, particularly in Brazil, Russia, India and China (the BRIC countries) and other emerging economies.

As the BRIC and other emerging economies become richer, they will not just fuel the competition for low-cost and low value-added manufacturing. They will also provide a growing consumer market and potential market for exports.[47] McKinsey[48] estimates that between now and 2020 approximately 900 million people in Asia will enter the middle class, with a disposable income that will enable them to look overseas for luxury goods and services. The Chinese Government is already responding to this, with a five-year plan aimed at rebalancing the economy towards domestic consumption and developing domestic services. As a result, the type and level of demand will change.

Today, India and China account for a mere 5% of global middle class consumption, while Japan, the United States, and the European Union account for 60%.[49] By 2025, those numbers are expected to equalise; by 2050, they will be flipped (Figure 1.3).[50]

Fig. 1.3: Share of global middle class consumption (2000-2050)



Source: Kharas, H. (2010) Available at: www.oecd.org/dev/44457738.pdf Pg. 28-9

1.2 Government ambition and intent

Government's actual STEM ambitions and funding are always in a state of motion, so this section does not claim to present a definitive catalogue.[51] Rather, it illustrates the breadth, depth and intent of interventions aimed at increasing the UK's capacity for growth in STEM.

The Government's *Plan for Growth*[52] makes clear the UK's ambition to grow trade and inward investment – ensuring we remain one of the top destinations for foreign direct investment (FDI) – increase exports to key target markets, and deliver an increase in private sector employment, especially in UK regions outside London and the South East.

In this regard, the UKTI (UK Trade and Investment)[53] has listed the sectors that it sees as being the priority areas for attracting overseas investment (Figure 1.4).[54]

There is growing consensus around the need for an 'Industrial Strategy', a matter that Vince Cable spoke on at Imperial College, London.[55] The research paper[56] launched by the Department for Business, Innovation and Skills to coincide with this speech provides a useful analysis and exposition of Government thinking on industrial strategy and how it can support existing and emerging sectors. Briefly, the paper reviews a range of evidence on which sectors could make the greatest contribution to future economic growth and employment in the UK, and then considers where Government action could add most value. It concludes that, given variations in market conditions by sector, and the need for Government to engage across the economy, it is clear that intervention should operate on a spectrum. This would run from a horizontal approach with certain sectors, to one where Government is involved in shaping the sector's development. To this end, it suggests four levels of support: light touch, action, sustained dialogue and strategic partnership.[57]

Other initiatives illustrate Government's ambitions:

46 Section 4.0, Figure 4.1 47 *The State of the Economy,* Tony Dolphin, David Nash, Amna Silim, IPPR, November 2011, p17 48 *From austerity to prosperity: Seven priorities for the long term,* McKinsey Global Institute, 2010 49 *The Emerging Middle Class in Developing Countries. OECD Development Centre, Working Paper,* Kharas, H, 2010. Available at: http://www.oecd.org/dataoecd/12/52/44457738.pdf
50 *The Future of Manufacturing Opportunities to drive economic growth,* A World Economic Forum Report in collaboration with Deloitte Touche Tohmatsu Limited, April 2012
51 For up-to-date information go to the Department for Business, Innovation and Skills, http://www.bis.gov.uk/ or HMT, http://www.hm-treasury.gov.uk/ 52 *Plan for Growth,* HM Treasury, March 2011
53 *Britain open for business – growth through international trade and investment,* UKTI, 2011 54 *A Review of Business–University Collaboration,* Professor Sir Tim Wilson, February 2012, p79
55 http://www.bis.gov.uk/news/speeches/vince-cable-industrial-strategy-september-2012 56 *Industrial Strategy: UK Sector Analysis,* Department for Business, Innovation and skills Economics Paper No. 18, September 2012 57 *Industrial Strategy: UK Sector Analysis,* Department for Business, Innovation and Skills Economics Paper No. 18, September 2012, p30

Fig. 1.4: UKTI priority sectors

Advanced manufacturing	Defence and security	Infrastructure	Healthcare and life sciences	Services
Aerospace Agri-food Automotive Chemicals Energy	Defence Security	Construction Environment and water Transport (airports, railways, logistics, marine, ports)	Healthcare Industrial biotechnology Pharmaceuticals and medical biotechnology	Creative industries Education, skills and training Financial services Professional and business services Retail
Technology				
Low carbon				

Source: UKTI

On 15 November 2011, Government launched the **Make it in Great Britain**[58] campaign, a major new initiative to highlight and celebrate the UK's world class manufacturers. The campaign aimed to transform outdated views of UK manufacturing among investors and young people. Make it in Great Britain culminated in an exhibition at the Science Museum, coinciding with the 2012 Olympic and Paralympic Games, which showcased innovate UK manufacturing. It included a Make it in Great Britain Challenge, a national competition to find the most promising and cutting edge, pre-market products or processes.

On 17 November 2011, the **Queen Elizabeth Prize for Engineering**[59] was launched. The £1 million biennial prize will recognise and celebrate the best of modern engineering and illuminate the excitement around it. It will provide a high profile opportunity to demonstrate how engineers and engineering are making a real difference across the world.

Funding announcements:

The Regional Growth Fund is designed to encourage growth and jobs in the private sector and support regions that are overly dependent on the public sector. Through the first two rounds, £1.4 billion has already been allocated to 176 businesses, which are expected to create and protect up to 328,000 jobs across the country. The third round has generated 409 projects which, altogether, have bid for £2.68 billion funding.[60]

However, the House of Commons Committee of Public accounts September report[61] has not been complimentary stating that 'It has taken far too long for the Regional Growth Fund to get off the ground' and citing that only £60 million has been spent on front-line projects. As a result only 5,200 jobs can be claimed as having been created or safeguarded in projects where the offer of funding has been finalised, against targets of 36,800 over the lifetime of these projects.

Under the **UK Guarantees**[62] scheme, up to £40bn of funding will be underwritten for infrastructure projects that have been put on hold following difficulties in raising money from private investors.

A new £80 million package aims to keep the UK at the forefront of advances in aerospace and advanced manufacturing.[63] The Government is investing £25 million, with business – led by Rolls-Royce – providing a further £40 million, for a series of collaborative research and technology projects. SAMULET II (Strategic Affordable Manufacturing in the UK through Leading Environmental Technology) will investigate new manufacturing processes aimed at increasing productivity and making the best use of resources. The Government will separately invest £15 million in new capital equipment for the **High Value Manufacturing Catapult**[64] – part of a network of technology and innovation centres created to support projects such as these across the advanced manufacturing sector.

Since 2011, £200 million has been investing in aerospace. This includes £120 million new funding[65] for **aerospace research and technology**, announced alongside a new vision for the sector which will help UK aerospace firms win billions of pounds worth of contracts over the next 15 to 20 years.[66] It will see Government and industry working together – under the guise of the Aerospace Growth Partnership (AGP) – to secure the future for UK aerospace.

In January 2012, the Technology Strategy Board announced it will establish a new **Catapult centre in Satellite Applications.**[67] The technology and innovation centre will help UK businesses develop new satellite-based products and services and stimulate growth across the UK economy. The proposed expansion plans will provide an estimated 100,000 new jobs in the UK. To meet this demand, our schools and universities will need industry support to raise awareness of the opportunities afforded by a career in the Space sector.

58 http://makeitingreatbritain.bis.gov.uk/ **59** http://www.raeng.org.uk/prizes/qeprize/ **60** *Press Release, 19 June 2012 13:35,* Department for Business, Innovation and Skills. http://news.bis.gov.uk/Press-Releases/Businesses-compete-for-Regional-Growth-Fund-67b84.aspx **61** Website accessed on 11 October 2012 (http://www.publications.parliament.uk/pa/cm201213/cmselect/cmpubacc/104/104.pdf) **62** http://www.bbc.co.uk/news/business-18880354 **63** *Press Release, 21 June 2012 10:30,* Department for Business, Innovation and Skills. http://news.bis.gov.uk/Press-Releases/Lift-off-for-aerospace-and-manufacturing-projects-67ba5.aspx **64** For the up-to-date list of all Catapults Centres go to: https://catapult.innovateuk.org/ **65** *Press Release, 10 July 2012 10:30,* Department for Business, Innovation and Skills. http://news.bis.gov.uk/Press-Releases/Plan-launched-to-keep-UK-aerospace-flying-high-67cc0.aspx **66** *Press Release, 21 June 2012 10:30,* Department for Business, Innovation and Skills. http://news.bis.gov.uk/Press-Releases/Lift-off-for-aerospace-and-manufacturing-projects-67ba5.aspx **67** *A UK Space Innovation and Growth Strategy 2010 to 2030,* http://www.ukspacedirectory.com/uk-space-innovation-and-growth-strategy/

In the past year, a number of new initiatives have been launched, new schemes funded, and existing schemes given additional funding. Several such examples are highlighted and listed below. The overall picture is clear: even in times of austerity, Government recognises that science, technology, engineering and manufacturing are the sectors that will help drive the UK's future sustainability and economic prosperity.

1.3 UK manufacturing

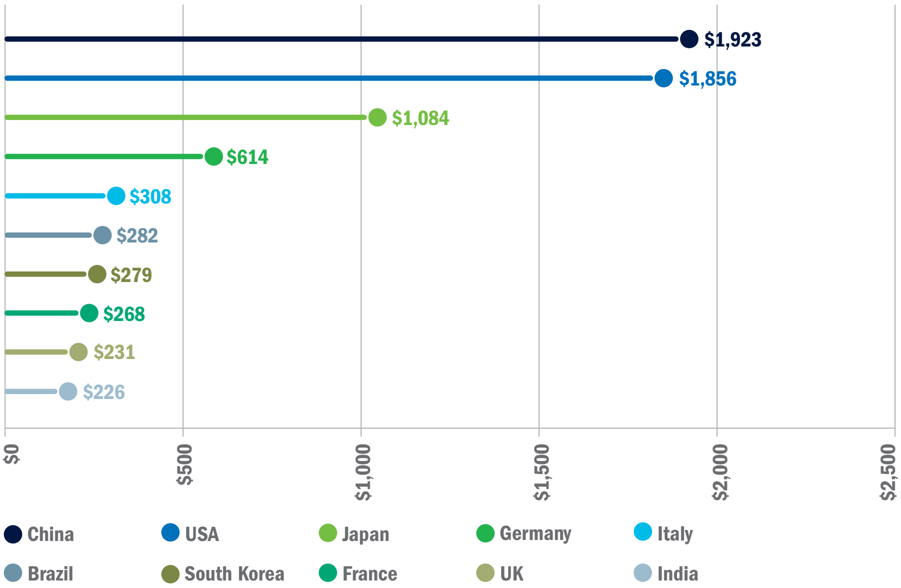
UK manufacturing is a tale of two sectors. The UK has a cluster of highly successful firms in innovative high-technology segments. But there is also a long tail of low value-added manufacturing firms that compete largely on price.[68]

As the Fact Card from EEF (the manufacturing organisation)[69] highlights, UK manufacturing is very much alive and well. Manufacturing accounts for almost half (46%) of UK exports, employs 2.5 million people, contributes 10% GVA (Gross Value Added)[70] and accounts for 72% of UK business R&D. It contributes over £6.7 billion to the global economy[71] and ranks ninth in output globally (Figure 1.5).

As for the view that UK manufacturing has had its heyday, then we should consider the chart below (Figure 1.6). This shows that manufacturing output has risen consistently by 148% from 1948 to 2011. Far from a manufacturing decline, the value that we get from manufacturing has continued to increase.[72]

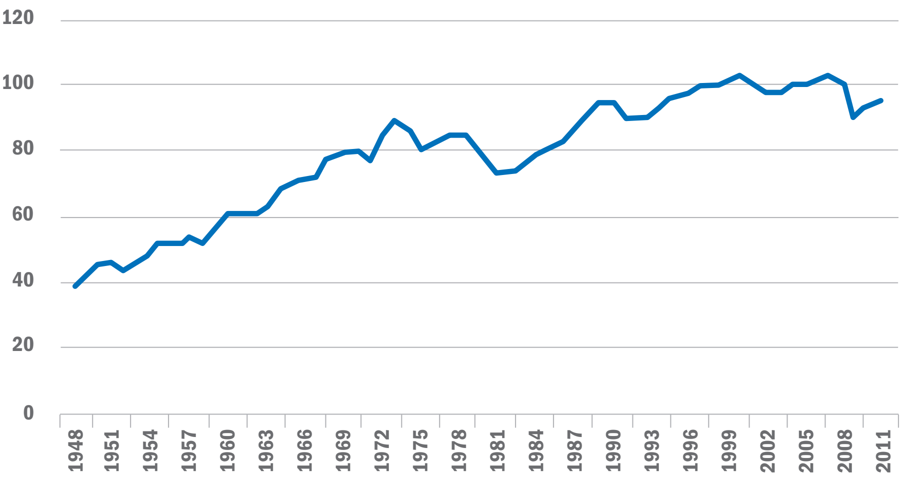
In addition, research from Harvard and MIT by Ricardo Hausmann and César Hidalgo[73] provides a compelling case that manufacturing does indeed matter. In their research, economic complexity is directly related to manufacturing knowledge and capabilities. They demonstrate that, once a country begins to manufacture goods, thus building knowledge and capabilities, its path to prosperity becomes much easier. Furthermore, they show that the more complex the goods and the more advanced the manufacturing process, the greater the prosperity.[74]

Fig. 1.5: Manufacturing output ($ billion – current prices)



Source: UN Statistics Division

Fig. 1.6: Manufacturing output (1948-2011)

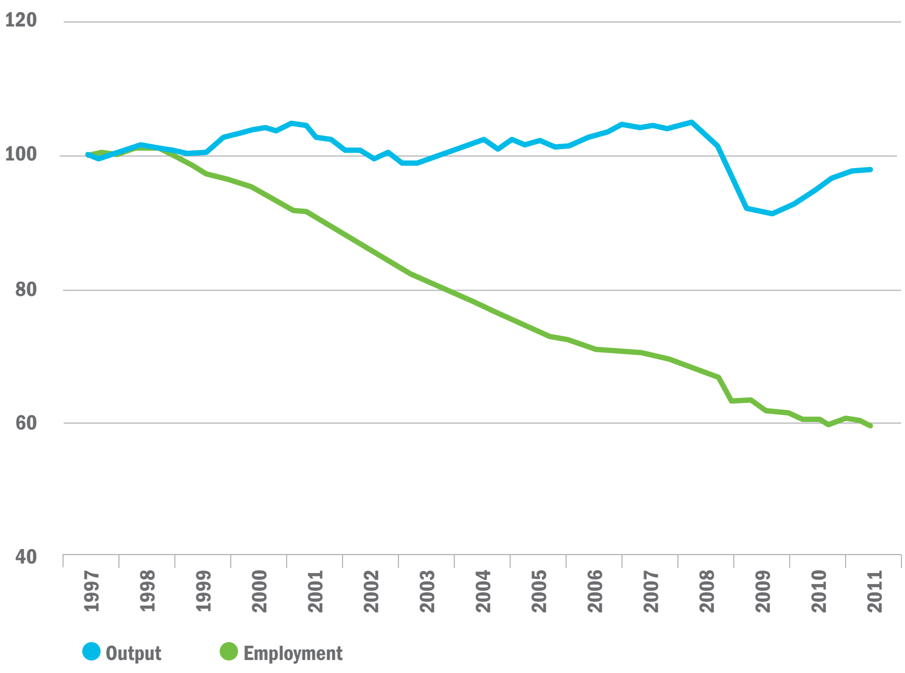


Source: High Value Manufacturing Strategy 2012-2015, Technology Strategy Board, May 2012

Figure 1.7, produced by The Institute for Public Policy Research (IPPR), from ONS data, in its *The State of the Economy* report, shows the growing gap between output and employment trends in manufacturing. It shows a rapid increase in productivity in the sector over the last 15 years, with many companies boosting productivity through greater use of technology. IPPR also stresses that some of the increase in aggregate productivity is simply the result of low-productivity companies closing down because they have been unable to compete with low-cost producers overseas.[75] Taken as a whole, the report points out that the most important driver behind these changes can be attributed to technological advance.[76]

68 *Manufacturing prosperity Diversifying UK economic growth,* Steve Coulter, SMF, March 2011 69 http://www.eef.org.uk 70 *UK National Accounts,* ONS 4 71 *United Nations Statistics Division,* United Nations National Accounts Main Aggregates Database, Value added by Country, 2010 72 *Growth Bulletin 18,* Centre for Policy Studies, May 2012 73 *The Atlas of Economic Complexity: Mapping Paths to Prosperity,* Hausmann, R., Hidalgo, C.A. et al., 2011. Available at: http://www.hks.harvard.edu/centers/cid 74 *The Future of Manufacturing Opportunities to drive economic growth,* A World Economic Forum Report in collaboration with Deloitte Touche Tohmatsu Limited, April 2012 75 *The State of the Economy,* Tony Dolphin, David Nash, Amna Silim, IPPR, November 2011, p13 76 ibid, p15

Fig. 1.7: Manufacturing output and employment (Q1 1997 = 100)



Source: ONS

1.3.1 The future of UK high value manufacturing

Advanced Manufacturing describes businesses which use a high level of design or scientific skills to produce technologically complex products and processes. Because of the specialised requirements involved, these are usually goods and associated services of high value.[77]

The arguments for why high value manufacturing should be a key strategic national priority are no longer needed: recognition of its value and future potential is well and truly embedded in Government and with policy makers.[78]

The UK is a major competitor in the £6.5 trillion global manufacturing economy. High value manufacturing (HVM) is the application of leading edge technical knowledge and expertise to the creation of products, production processes and associated services. It has the potential to bring sustainable growth and major economic benefits to the UK.[79]

However, at the same time as many international policymakers look towards production-based industries to help rebalance their economies, manufacturing itself is undergoing significant changes. The Institute for Manufacturing's (IfM) review of international approaches to manufacturing research identified five key drivers of change that governments wishing to grow their manufacturing capacities need to be aware of:[80]

- **Globalisation –** Internationally distributed value chains and new competition from emerging economies are influencing manufacturing research priorities.
- **Sustainability –** There is increasing acknowledgment that sustainable manufacturing goes beyond the production stage of the value chain. It extends across a product's lifetime and addresses the entire system of integrated components, energy, and transportation required to assemble the final product and deliver it to customers.
- **Manufacturing timescales –** Time is an increasingly critical factor in today's manufacturing environment. More efficient and flexible supply chains, technological advances and changing patterns of demand among buyers and customers are driving ever shorter product development cycles and accelerating the delivery of individualised products and value-added services.
- **Emerging science and technologies –** The accelerating pace of science and technology innovation is also transforming manufacturing. Advances in information-, nano-, bio- and other technologies are creating opportunities for significant economic and social benefit.
- **Emerging industries and the manufacturing base –** There is an increasing awareness of the interdependent nature of manufacturing and innovation. A knowledge economy that loses interaction with its production base may lose the ability to innovate. Novel science- and technology-based products often rely on manufacturing skills and infrastructure. Without close connection between the research base and real-world manufacturing, it may be difficult to innovate and, ultimately, participate in important emerging science- and technology-based industries.

In the UK, the Technology Strategy Board (TSB) has defined five cross-cutting strategic themes[81] from its report, *A landscape for the future of high value manufacturing* report:[82]

1. **Resource efficiency –** Securing UK manufacturing technologies against scarcity of energy and other resources
2. **Manufacturing systems –** Increasing the global competitiveness of UK manufacturing technologies by creating more efficient and effective manufacturing systems
3. **Materials integration –** Creating innovative products, through the integration of new materials, coatings and electronics with new manufacturing technologies
4. **Manufacturing processes –** Developing new, agile, more cost-effective manufacturing processes
5. **Business models –** Building new business models to realise superior value systems

77 *Advanced Manufacturing*, Department for Business, Innovation and Skills, July 2002, p1 **78** *High Value Manufacturing Strategy 2012-2015*, Technology Strategy Board, May 2012 **79** *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012 **80** *A review of international approaches to Manufacturing Research*, IfM, March 2011, p7-8 **81** *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012, p11 and p23 **82** *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012, p16

The study focused on an initial set of HVM sectors chosen for their potential to capitalise on high value product and service opportunities that might be viable in or around the 2025 timescale. The sectors identified (Table 1.2), which are all customer facing, fast growing, and research and development intensive, were seen to provide the UK with potential technological advantage.

In parallel, the UK Government has been very active in supporting high value manufacturing. It has developed a high value manufacturing strategy for 2010 to 2015, launched the new manufacturing advisory service, injected funds to help supply chains and, through Foresight, commissioned a long term view of manufacturing to 2050. These initiatives are briefly described below:

The Advanced Manufacturing Supply Chain Initiative[83] aims to help existing UK supply chains grow and achieve world class standards while encouraging major new suppliers to come and manufacture here. The new £125 million fund will support innovative projects in established UK advanced manufacturing sectors such as aerospace, automotive and chemicals. It will also target newer growth areas where the UK is well placed to take a global lead, such as energy renewables and other low carbon sectors.

Table 1.2: Key HVM sectors and significant process and service technologies

The key sectors emerging from this initial study were, in no particular order[84]	The most significant process and service technologies identified[85]
• food • biotechnology • chemicals • pharmaceuticals • medical • aerospace, defence and space • automotive • rail • marine (including under sea) • nuclear • energy • oil and gas • mining • built environment • electronics • retail, entertainment and consumer goods • digital economy (including infrastructure), communications and security	• additive manufacturing • net shape manufacturing • robotics and automation • customisation • small run technologies (including distributed manufacture and 'batch size of one') • micro- and nano-manufacturing processes • end of life activities: recycling, re-use, renewing and re-lifing • surface engineering (finishing and coating processes) • link design and manufacturing more closely • integrating technologies and processes • bioprocessing for new/replacement materials/ fuels • ICT and enabling ICT structures. • materials and materials science (excluding composites) • low carbon technologies • lightweight materials • biomaterials • sensor technologies • integrated technologies • nanotechnologies • energy storage • hydrogen fuel cells • robots • integrated products and services • new composites • nanomaterials

Source: Technology Strategy Board

The new **Manufacturing Advisory Service (MAS)** was launched in January 2012[86] and is now available to all manufacturing businesses across England. It will be delivered by the Manufacturing Advisory Consortium, which comprises Grant Thornton, Pera, WM Manufacturing Consortium Ltd and SWMAS Ltd. It has been estimated that the new MAS will help to generate £1.5 billion in economic growth, 23,000 jobs and safeguard 50,000 jobs.

The High Value Manufacturing Strategy 2010- 2015[87] was outlined by the Technology Strategy Board, whose aim is to make sure that high value manufacturing is a key driver of UK economic success. It will help accelerate businesses on their innovation journey, from concept to commercialisation, by doubling the direct investment in high value manufacturing innovation to around £50m a year. (The Board will also invest in manufacturing innovation specific to a number of other target areas, such as advanced materials, biosciences, transport and energy.) Investment will focus on the most attractive technologies and market sectors where the UK can become an important player in large global markets.

A new **Foresight project** investigating the future of manufacturing to 2050[88] launched in December 2011. The two-year project will call on industry and academic expertise from the UK and abroad to look at the long-term picture for the manufacturing sector, investigating global trends and drivers of change. It will explore how the UK can maximise opportunities and provide an evidence base to help policy-makers navigate a challenging and uncertain future.

Finally, the findings of Donald Hepburn's study, *Mapping the World's Changing Industrial Landscape,*[89] put future challenges into perspective. He highlights the global shift in manufacturing over the past 20-plus years. He attributes changes, in part, to the rise of domestic industries in developing countries, as well as the relocation of

83 *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012, p16 84 *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012, p16 85 *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012, p20 and p25 86 *A landscape for the future of high value manufacturing in the UK*, Technology Strategy Board, February 2012, p20 and p25 87 *High Value Manufacturing Strategy 2012-2015*, Technology Strategy Board, May 2012 88 *Press Release, 10:30,* Department for Business, Innovation and Skills. 10 July 2012, http://news.bis.gov.uk/Press-Releases/Plan-launched-to-keep-UK-aerospace-flying-high-67cc0.aspx 89 *Mapping the World's Changing Industrial Landscape.* Chatham House, Hepburn, D., 2011. Available at: http://www.chathamhouse.org/sites/default/files/0711bp_hepburn.pdf

industries from the developed world, as multinationals seek low-cost labour to provide them with a cost advantage in global markets. On the whole, shares of world manufacturing value added have moved towards developing countries, at the expense of industrialised countries (Table 1.3).

Table 1.3: Share of world manufacturing value added (%)

	1995	2000	2005	2008e[90]
Industrialised countries	80.2	79.1	74.6	72.2
Developing countries	19.8	20.9	25.4	27.8

Source: UNIDO

1.3.2 Knowledge-based business services – the silent success story

In last year's report,[91] we described the development and growth of manu-services. While manu-services is still an important contributor to the UK economy, this year we are exploring the importance of knowledge-based business services.

The Work Foundation indicates[92] that knowledge-based business services have been responsible for 38%[93] of all economic growth in the UK since 1970, and have created 1.8 million jobs[94] over that period. By contrast, financial services contributed 15% to economic growth over the same period, and created just 300,000 new jobs.

Knowledge-based business services provide professional and technological support to other businesses, helping these companies to function effectively. The business services sector covers a wide range of activities, from lawyers and accountants to IT and data specialists. Despite this diversity, knowledge-based business services share a key distinguishing feature: they trade primarily in knowledge and information. These services are unique because their outputs are almost exclusively intangible. They do not involve any physical processes, but involve the *creation, accumulation or dissemination*[95] of knowledge or information. This stands in contrast to the rest of the UK economy, where companies produce some form of tangible output, whether a manufactured good or service.

The contribution of knowledge-based business services to the UK economy can be summed up in four areas:[96]

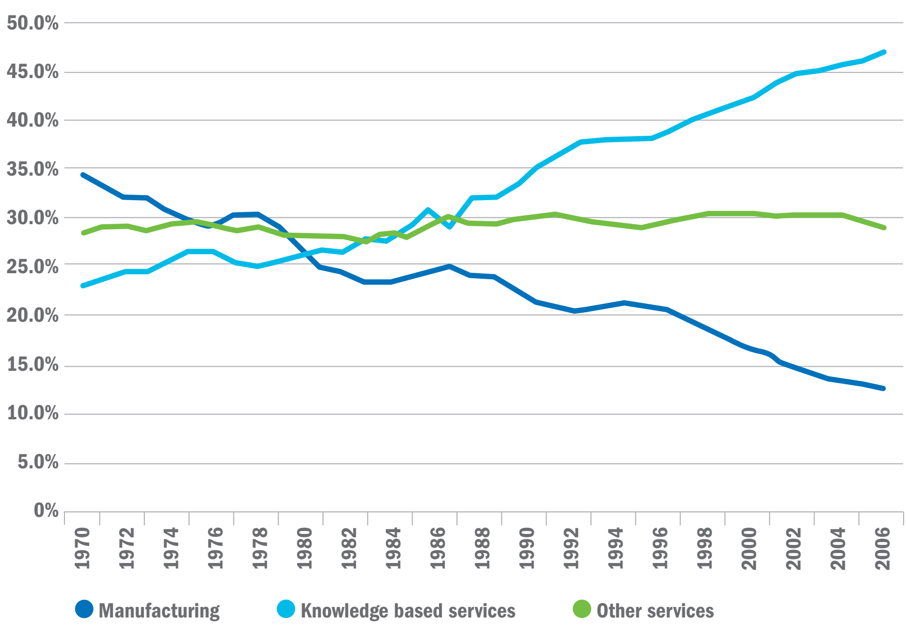
- They account for over 20% of UK GDP, making them comfortably the largest sector of the UK economy.[97]
- They employ 3.175 million people, 11.4% of the UK total, much of it high value and knowledge intensive work.[98]
- In 2010, the business services sector generated exports of around £55 billion and had a trade surplus of almost £21 billion, making a significant positive contribution to the UK's balance of payments position.[99]
- They form the infrastructure of the knowledge economy, helping knowledge and ideas to move around the economy, and allowing UK businesses to exploit the full potential of new technologies and ideas.

The report stresses that the Government has set out some important steps towards boosting the business services sector in its *Plan for Growth.* However, it should view the business services sector alongside manufacturing as a key anchor of the UK economy, helping to re-balance it and drive the recovery.

Figure 1.8 illustrates how the UK economy has restructured towards the growing knowledge-based services sector in the past thirty years. The knowledge economy has also become central to how the UK pays its way in the global economy: between 1987 and 2006, the value of the UK's knowledge-based service exports grew from less than £13 billion to just under £90 billion. We not only use knowledge to power our own industries. We sell it to the world.[100]

We know that tiny minorities of dynamic high growth firms are disproportionately responsible for the majority of job creation

Fig. 1.8: Economy restructures towards knowledge-based services, Gross Value Added (1970-2007)



Source: EU KLEMS Database[101]

90 e = estimate 91 *Engineering UK Report 2012 – the state of engineering,* EngineeringUK, December 2011, p27-28 92 *Britain's Quiet Success Story – Business services in the knowledge economy,* A Knowledge Economy programme report, Andrew Sissons, The Work Foundation, May 2011 93 ONS Blue Book data for 1979 to 2009. Real GVA attributed to renting and business services stood at £307.2billion in 2009, equivalent to 23.8% of UK GDP. However, the classification used in these figures does not exactly match the preferred definition of knowledge-based business services used in this paper. 94 ONS Workforce Jobs data for 1979 to 2009 95 *Knowledge-intensive services: users, carriers and sources of innovation,* Miles et al., 1995 96 *Britain's Quiet Success Story – Business services in the knowledge economy, A Knowledge Economy programme report,* Andrew Sissons, The Work Foundation, May 2011 97 ONS Blue Book. GDP in Renting and Business Services (Broad Industrial Groups L and M) had a GDP of £299 billion in 2009, equal to 23.8% of UK GDP 98 Figures derived from the Business Register and Employment Survey, 2009, using their exact definition of knowledge-based business services. 99 ONS Balance of Payments first release data. All figures in 2010 prices. 100 *A plan for growth in the knowledge economy, A Knowledge Economy programme paper,* Charles Levy, Andrew Sissons and Charlotte Holloway, Work Foundation, June 2011, p4 101 Knowledge-based services based on OECD definitions includes communications, financial services, business services, education and health. All other services include retail, hospitality, transport, public administration and other community, social and personal services. Manufacturing includes both knowledge-based and other sectors.

within the private sector, and that small enterprises appear to be critical to the performance of our knowledge economy. Figure 1.9 shows that SMEs in knowledge-intensive industries appear to be of growing importance. Ensuring that firms with the potential to be high growth can achieve will be absolutely central to achieving a lasting and sustainable recovery.[102]

1.4 UK industry sector strengths

This section highlights sectors where the UK has proven strength and is demonstrating the capacity for growth and competitiveness. The section ends by highlighting emerging technologies that the Department for Business, Innovation and Skills (BIS) has identified as strategically important in its Innovation and Research Strategy for Growth.[103] BIS emphasises that these technologies offer huge potential in global markets and we need to position ourselves to exploit them.

1.4.1 Existing sector strengths

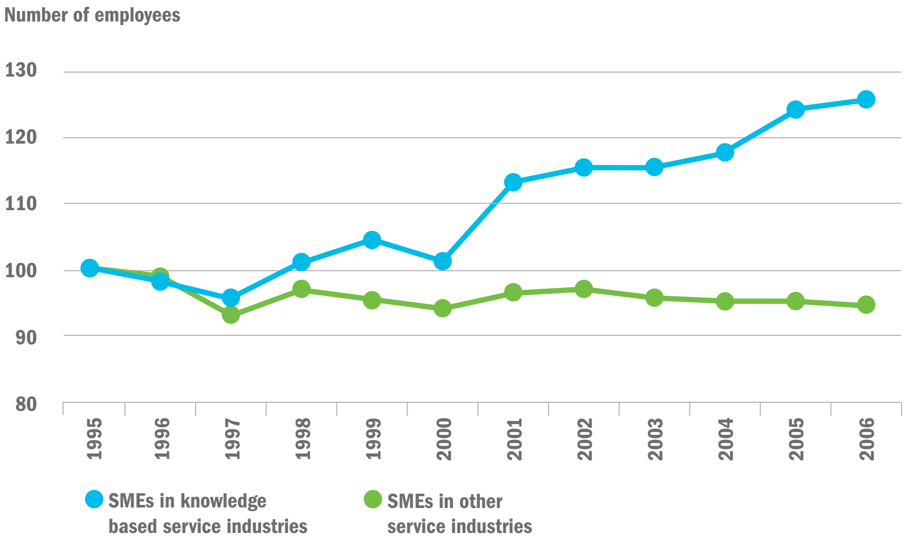
Universities

Our universities are often not recognised as a strength in their own right. And yet they are an integral part of the supply chain to business — a supply chain that has the capability to support business growth and therefore economic prosperity.[104]

The sector employs more than 1% of the UK's total workforce and for every 100 full-time jobs within universities, more than 100 other full-time equivalent jobs are generated through knock-on effects.[105] For every £1 million of university output, a further £1.38 million of output is generated in other sectors of the economy.[106]

As an export industry, Higher Education (HE) contributed £7.9 billion in 2009. This figure is expected to rise to £16.9 billion by 2025. The market for internationally mobile students is expected to reach seven million students by 2020, from a baseline of 3.7 million in 2009.[107]

Fig. 1.9: SMEs in knowledge-based services and other sectors



Source: BERR, Work Foundation Estimates

In 2010-11, 268 new businesses were set up based on the world-class research carried out by UK universities, bringing the total number of active spin-off companies to 1,262. These companies employed around 18,000 people and turned over nearly £2.1 billion during the year.[108]

Automotive

Vehicle manufacturing in the UK is once again growing and has a strong export element. The three largest Japanese vehicle companies have their main European manufacturing operations here, and BMW, Ford and GM are heavily committed to the UK in terms of vehicle and engine production. Jaguar Land Rover is now profitable and has the backing of the giant Tata group of India.

The UK automotive sector typically generates around £50 billion in annual turnover and around £10 billion in net valued added to the economy.[109]

The automotive sector is the largest UK sector in terms of exports, generating around £24 billion in revenue.

Renewable energy

The UK's £12.5 billion renewable energy industry supports 110,000 jobs across supply chains, and is likely to support 400,000 jobs by 2020.[110]

The sector's overall rise in market value was 11% year-on-year in 2010-11, far outpacing economic growth of 1.4% for the same 12-month period.

If the UK was to meet its renewable energy targets, the use of fossil fuels would be reduced by an average of £60 billion by 2020, giving a much-needed boost to the UK's balance of trade.[111]

Space

The UK space sector contributes £7.5 billion to the economy and directly employs 24,000. A further 80,000 jobs are supported by this sector.

The value added per employee is three times the UK average, and it is six times more R&D intensive than the UK economy as a whole. By 2020, it is predicted to be worth £14.2 billion a year and be supporting 115,000 more jobs.

102 *A plan for growth in the knowledge economy, A Knowledge Economy programme paper,* Charles Levy, Andrew Sissons and Charlotte Holloway, Work Foundation, June 2011, p9 **103** *Innovation and Research Strategy for Growth, Department for Business,* Innovation and Skills, December 2011 **104** *A Review of Business–University Collaboration,* Professor Sir Tim Wilson, February 2012 **105** *Beyond bricks and mortar boards: universities and the future of regional economic development,* IPPR North, February 2012 **106** *The impact of universities on the UK economy,* Universities UK, 2009 **107** *Driving Economic Growth: Higher Education – a core strategic asset to the UK,* Universities UK, December 2011 **108** http://www.hefce.ac.uk/pubs/year/2012/201218/ **109** *The UK Automotive Industry – Invest now, A report prepared by AutoAnalysis,* Ian Henry, March 2011 **110** http://www.egovmonitor.com/node/49449 **111** ibid

The Innovation and Growth Strategy (IGS) for space[112] outlines a 20-year plan. Its overarching ambition is to see the UK's space sector grow from around 6% (£9.6 billion) of the world space economy – which was worth £160 billion in 2008 – to 10% of a space economy likely to be worth £400 billion by 2030.

Low carbon

Research by the Confederation of British Industry (CBI)[113] has revealed that the UK grew its share of the £3.3 trillion global green goods and services market by 2.3% in real terms in 2010/11, reaching £122 billion and accounting for around 8% of UK GDP.

It predicted the market for low carbon goods and services could be contributing £20 billion in additional annual income to the GDP by 2015.

Aerospace

The UK has 17% of the global market for aerospace. This makes us the largest aerospace industry in Europe – globally, second only to the United States. The sector provides over 100,000 direct jobs and indirectly supports many more across the UK. It generated £24.2 billion UK revenue in 2011 – 75% of which was exported.[114]

It is forecast that nearly 27,000 new large civil airliners (with a market value of $3.2 trillion) will be needed by 2030 and, by 2020, there will be a global market for around 9,500 civil helicopters (worth around $50 billion).[115]

Creative industries

Britain's creative industries represent the fastest growing sector of the UK's economy, with annual revenues in excess of £70 billion.

Crossing many sectors (such as music, publishing, advertising and the arts), the creative industries employ many people. This is also an area in which the UK has a significant and distinctive international reputation, exporting to global markets.[116]

Utilities

The energy and water industries make an important contribution to the UK economy. In 2009, the UK water market contributed £15 billion of UK GVA.

The energy industries (electricity and gas) contributed around £21 billion, with over 150,000 people employed across both industries.[117]

Agri-food

The agri-food sector includes all industries that are involved in the production, processing and inspection of food. Agri-food makes a significant contribution to the national economy and is the largest manufacturing sector in the UK.

It has an annual output of £129 billion, and employs around 3.7 million people. The global market in agriculture and agricultural supply, food production, distribution and retail exceeds $1 trillion. In 2010, UK agri-food exports were worth £16.1 billion, which was an increase of 36% on 2007.[118]

Bioscience

Biopharmaceuticals account for over 30% of R&D spend (over £5 billion), the largest of any sector in the UK. Bioscience companies had a turnover of £5.5bn in 2010, an increase of 18% in just one year.[119] The Bioscience sector provides highly skilled employment for 36,000 people.

The value of biological medicines in development in the UK is worth around £24 billion, against a global value of biological medicines in development of £200 billion.[120]

1.4.2 Emerging technologies

As well as investing in areas of existing sector strength, the UK needs to position itself to exploit new technologies emerging from the knowledge base. As the speed with which technologies are commercialised increases, the UK's competitiveness will depend on our ability to identify new opportunities at an early stage and mobilise skilled people and investment capital to exploit them.

The UK does not have the capability or the resources to succeed in every emerging technology. However, several key emerging areas have been identified and are briefly recorded and described below:

- **Synthetic biology** is the design and engineering of novel biologically-based parts, devices and systems, or the redesign of existing biological systems for useful purposes. Estimates put the world market at around $100 billion by 2020. The UK produced 14% of all global research papers between 2005 and 2010. The potential applications include bacteria that feed on pollutants, new biofuels, and drought- and disease-resistant crops. The UK has leading companies in these sectors.[121]
- **Energy-efficient computing** is the design of hardware and software to reduce energy consumption by reducing power demands or operating times. The global market could be $50 billion by 2020. The UK produces around 7% of global research papers and 1.6% of global patents. Almost a third of European chip design companies are based in the UK and we also have strengths in hardware and software.[122]
- **Energy harvesting** is the use of low levels of energy obtained from the environment, from temperature, movement or pressure, to enable electronic devices to power themselves independently. Markets include wireless sensors, building controls and consumer devices. The global market for energy harvesting could grow to $4.4 billion

112 http://www.bis.gov.uk/assets/ukspaceagency/docs/igs/space-igs-exec-summary-and-recomm.pdf 113 http://www.cbi.org.uk/media/1552876/energy_climatechangerpt_web.pdf 114 http://www.bis.gov.uk/assets/biscore/business-sectors/docs/r/12-954-reach-skies-strategic-vision-uk-aerospace 115 ibid 116 *Innovation and Research Strategy for Growth,* Department for Business, Innovation and Skills, December 2011 117 ibid 118 *United Kingdom Food Supply Chain,* Improve Food and Drink Skills Council, 2011. Available at http://improveltd.co.uk/industry-report/uk-food-supply-chain 119 http://www.bioindustry.org/about/the-uk-bioscience-sector/ 120 http://www.bioindustry.org/about/the-uk-bioscience-sector/ 121 *Innovation and Research Strategy for Growth,* Department for Business, Innovation and Skills, December 2011 122 *Innovation and Research Strategy for Growth,* Department for Business, Innovation and Skills, December 2011

by 2020. The UK has capability in sensors and instrumentation, electronics and design to exploit these technologies.[123]

- **Graphene** is the thinnest material possible, while still being impermeable to gases or liquids. It is the strongest material ever measured – around 200 times stronger than structural steel – and a record conductor of heat and electricity. Potential applications include ultrafast transistors and high-performance materials that are used to build aircraft. It could potentially revolutionise the semi-conductor industry by replacing silicon.[124]
- **Life sciences** are strong in the UK, with a pharmaceutical and biotechnology sector that accounts for nearly a third of all business R&D investment. The UK is a world leader in fields such as stratified medicine, the targeting of treatments on populations based on genetic type and cell therapy which will enable the growth of new tissue to treat damaged or partially-functioning organs or systems within the body.[125]
- **Nanotechnology** is a growth field, with over 200 companies creating wealth through the theoretical development, design, the scaling up of new manufacturing technologies for specific materials. The UK has strengths in the development of coatings, composite materials and nanomaterials such as graphene, medical technologies, and displays and sensors.[126]
- **Digital technologies** continue to be important to the UK. We have strengths in systems and software engineering, the development of advanced 3G and 4G mobile products and services, interface design and intelligent systems, and high performance computing, which increases the number of operations computers can carry out per second and enables the modelling of complex systems and processes in sectors such as the life sciences.[127]

1.5 The UK on the global stage

Where will growth come from in the future and how will the UK compete on the global; stage? The IPPR report, *The third wave of globalisation,* provides a very good treatise on this issue.[128]

It states that prosperity in the decades ahead for the advanced market economies in Europe, North America and Asia will rest more than ever before on their ability to generate and apply knowledge to provide the world's consumers with high-value-added goods and services. This will need to be a journey of perpetual movement up the value chain.[129]

It goes on to summarise three recent reports by PricewaterhouseCoopers,[130] Citigroup[131] and Goldman Sachs,[132] which make projections about the global economy in 2050. Each report suggests a fundamental realignment over the next four decades. Some of these changes having already taken place: China is now the world's second-largest economy, Brazil is larger than Italy, and India is larger than Canada. By 2050, even the most cautious of the three reports suggests that, of the current G7 countries, only the US, UK and Japan will remain in the global top seven (Table 1.4).[133]

It goes on to note that the third wave of globalisation will be dominated by non-western growth, notably but not exclusively, in Asia. In 2009, China alone contributed 18% to global growth, compared with 14% from the US. China is now the world's largest exporter of goods and the second-largest importer. International Monetary Fund (IMF) data shows that, in terms of the whole economy's purchasing power, China may overtake the US as the world's largest economy as soon as 2016. Allowing for all the uncertainties associated with such predictions, it seems likely that this will happen by 2030.

Interestingly, the report also points out that while China's scale makes it the one to watch, its growth trend is paralleled across many so-called 'emerging markets'. From 2001 to 2010, the 'Growth 8'[134] countries contributed the same additional output to world GDP as the G7 group of rich nations.[135] By 2020, their share of global GDP will be virtually the same.

Looking specifically at the UK, the report highlights that there are a number of sectors where global demand is on the rise and where Britain has a comparative advantage. Aerospace, pharmaceuticals and financial services are often mentioned in this regard. In addition to these, there are other business

Table 1.4: Ranking of global economies to 2050, according to PwC, Citigroup and Goldman Sachs

		2050 rank, according to...		
Rank	**Today**	**PwC (2011)**	**Citigroup (2011)**	**Goldman Sachs (2009)**
1	**US**	China	India	China
2	**China**	India	China	US
3	**Japan**	US	US	India
4	**Germany**	Brazil	Indonesia	Brazil
5	**France**	Japan	Brazil	Russia
6	**UK**	Russia	Nigeria	UK
7	**Brazil**	Mexico	Russia	Japan
8	**Italy**	Indonesia	Mexico	France
9	**India**	Germany	Japan	Germany
10	**Canada**	UK	Egypt	Italy

123 *Innovation and Research Strategy for Growth,* Department for Business, Innovation and Skills, December 2011 124 ibid 125 ibid 126 ibid 127 ibid 128 The third wave of globalisation, Will Straw and Alex Glenni, IPPR, January 2012 129 ibid, p82 130 The World in 2050: The accelerating shift of global economic power: challenges and opportunities, PricewaterhouseCoopers, 2011 131 Global Growth Generators: Moving beyond "Emerging Markets" and "BRIC"', Global Economics View, Buiter W and Rahbari, Citi Investment Research and Analysis 2011 132 The Long-Term Outlook for the BRICs and N-11 Post Crisis, Global Economics paper no 192, O'Neill J and Stupnytska A., Goldman Sachs, 2009 133 The third wave of globalisation, Will Straw and Alex Glenni, IPPR, January 2012, p39 134 The 'Growth 8' refers to the following fast-growing countries that make up more than 1% of global GDP: China, India, Brazil, Russia, Korea, Mexico, Indonesia, and Turkey. 135 *Challenges as the World Economy Adjusts,* O'Neill J, Goldman Sachs Asset Management, 2011

services, such as accountancy and legal services, education services (particularly Higher Education and vocational skills), health services, retail, architecture and design, creative industries and tourism. In the manufacturing sector, we would include high-tech and electronic, marine industries and some forms of green energy, such as car batteries. (See also section 1.4 – UK industry sectors' strengths). Figure 1.10 illustrates the sectors where Britain has the potential to enhance its performance and market share. It maps a selection of sectors on a matrix showing the extent of Britain's comparative advantage against expected global demand, each measured on a scale from 1 (low) to 5 (high).[136]

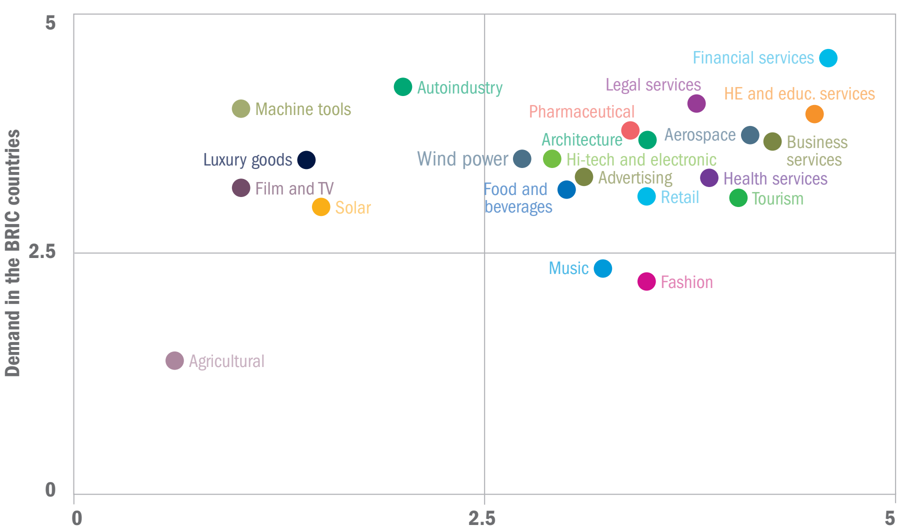
We should therefore remain optimistic, and be buoyed by the KPMG report,[137] which shows that even China is losing its edge as the world's cheapest place to manufacture goods. It states that Indonesia and Bangladesh are benefiting most as rising costs in China force firms to switch production. This is because the minimum wage levels in China are now four times greater than other places in South and South East Asia.

Within the UK, cities have been identified and targeted as drivers for economic growth. The report by the Centre for Cities[138] points out that Great Britain's cities are already home to 58% of our private sector employment and 54% of our population,[139] while accounting for only 9% of our land mass. Cities[140] will be critical to increasing private sector growth in the future when public sector growth will be limited at best. However, the UK and its cities will increasingly need to compete in higher-value, knowledge-intensive markets.

The report highlights that many of these higher-value businesses in both the public and private sector cluster together in certain cities that offer access to specialist skills and proximity to key markets and suppliers – so-called 'agglomeration benefits'. These benefits apply to a range of sectors – including publishing, media, IT, universities and financial and business services.[141]

It also highlights that some cities have more employment in these businesses than others, and therefore stand to play a bigger role in driving national economic growth. Larger cities like London, Manchester and Bristol combine this strength with scale. Others like Cambridge, Reading and Brighton are smaller and have particular niche strengths.

Fig. 1.10: Britain's comparative advantages in a global context



Source: IPPR analysis

The role of cities will remain important in the future. The World Economic Forum[142] predicts that the global population is projected to reach over nine billion people by 2050.[143] Due to continuing urbanisation, the proportion of the population living in cities will increase from 50% at present to almost 70% by 2050.[144]

Finally, whilst we are looking to our strengths, we should not overlook the fact that our small to medium enterprises (SMEs) make a very significant contribution to the UK economy. They represent 99.9% of all enterprises and 42.0% of all employment, with approximately £1.5 trillion turnover.[145] The challenge in the context of economic growth is the identification of those companies that have the capability, the capacity and the motivation to grow. This issue has been the subject of a number of reports by NESTA,[146] Experian,[147] The Work Foundation[148] and the CBI.[149]

1.6 Sustainable consumption and resource efficiency – a new perspective for global opportunities?

We are living in a resource constrained world in which we need to look at fundamentally new business models. This platform is not about rhetoric, it's about action.

Mark Parker, Chief Executive Officer, Nike

In the four years since the World Economic Forum's Sustainable Consumption Initiative[150] started, an estimated 450 million people have been lifted out of poverty,[151] and the number of households in the emerging and developed world living on an income of more than $3,000 per annum has increased by 28%.[152] At a global level, this encouraging progress has come at the cost of higher resource consumption, continued environmental degradation, and greater social and health imbalances.

Over the same period, about 21 million hectares of forest were lost,[153] 9.1 billion tonnes of municipal solid waste were

136 *The third wave of globalisation,* Will Straw and Alex Glenni, IPPR, January 2012, p51 **137** http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Press-releases/Pages/china-beyond-sourcing.aspx **138** *Cities Outlook 2012,* Centre for Cities, January 2012 **139** When their wider commuting areas are taken into account, this rises to 74% of the population and 78% of jobs. Source: Data for 2008, from DCLG (2010) *Updating the evidence base on English Cities.* Data for cities relates to Primary Urban Areas; for hinterlands includes travel to work areas (TTWA) **140** The eight-largest English cities outside London are: Birmingham, Bristol, Leeds, Liverpool, Newcastle, Nottingham, Manchester and Sheffield. **141** Ibid, p7 **142** *More with Less: Scaling Sustainable Consumption and Resource Efficiency,* World Economic Forum, January 2012 **143** *World Population Prospects – The 2010 Revision,* United Nations Population Division, 2010 **144** *World Population Prospects – The 2009 Revision,* United Nations Population Division, 2009 **145** *Statistical release: Business population estimates for UK and Regions,* Department of Business, Innovation and Skills, 2011 **146** http://www.nesta.org.uk **147** http://www.experian.co.uk/insight-reports/index.html **148** http://www.theworkfoundation.com/ **149** http://www.cbi.org.uk **150** The World Economic Forum is an independent international organisation committed to improving the state of the world by engaging business, political, academic and other leaders of society to shape global, regional and industry agendas. **151** *Poverty in Numbers: The Changing State of Global Poverty in Numbers from 2005 to 2015,* Brookings Institution, 2011 **152** Economist Intelligence Unit (2011), $ values are at market exchange rates and current prices. **153** *Global Forest Resources Assessment and Accenture analysis (net forest loss),* Food and Agriculture Organisation, 2010

generated[154] and some 50 billion tonnes of fossil fuels were consumed.[155] This pattern of economic growth and development cannot continue indefinitely.

The World Economic Forum's *More with Less – Sustainable Consumption and Resource Efficiency* report[156] reveals the opportunities that exist for countries and companies to act. At least $2 trillion economic output could potentially be protected in 2030 if the world adapts more rapidly to an increasingly resource-constrained economy. The 'size of the prize' in economic terms, therefore, is large.

Within this report, Oxford Economics analysed the economic impact of existing emission reduction commitments and a possible resource scarcity scenario in some of the world's largest economies: the US, the EU, BRIC countries and Japan.[157] It found the following:

Resource efficiency – A 'peak metals' scenario could put $2 trillion (1.7% of GDP) of economic output at risk in 2030 if major global economies fail to respond to shortages in the supply of steel and iron. To meet projected steel demand under such a scenario, the recycled content of world steel would need to increase from 38% to 51% by 2030.

Energy efficiency – The costs associated with agreed and necessary regulatory constraints around carbon could be up to $1.8 trillion across major global economies (US, EU, Japan and BRICs) in 2030. However, with faster innovation, more investment in technology and greater deployment of advanced technology in emerging economies, $1 trillion of these losses could potentially be avoided.

This in turn means that in the consumer-focused industries and along their value chains, individual companies will need to consider making resource efficiency and environmental competitiveness a core element of their strategy and business models. This will bring new capabilities and stimulate innovation with far-reaching implications for efficiency and future growth. The analysis by Oxford Economics[158] suggests the following mitigating actions:

- **Resource efficiency –** Under the 'peak metals' scenario, more resource-efficient approaches to manufacturing and increased recycling rates would deliver savings of as much as $46.9 billion in 2030, equivalent to a more than 50% reduction in steel costs.
- **Energy efficiency –** If consumer goods companies took action to increase their energy efficiency to match that of companies in Canada (considered the most energy efficient in the world) they could save $37 billion in 2030: equivalent to 1% of projected sector output in that year. With a 50% increase in energy costs, the 2030 figure could be as high as $55.5 billion.

Clearly, sustainable consumption and resource efficiency not only offers a new perspective on future opportunities. It also offers innovative businesses and economies huge economic and environmental benefits.

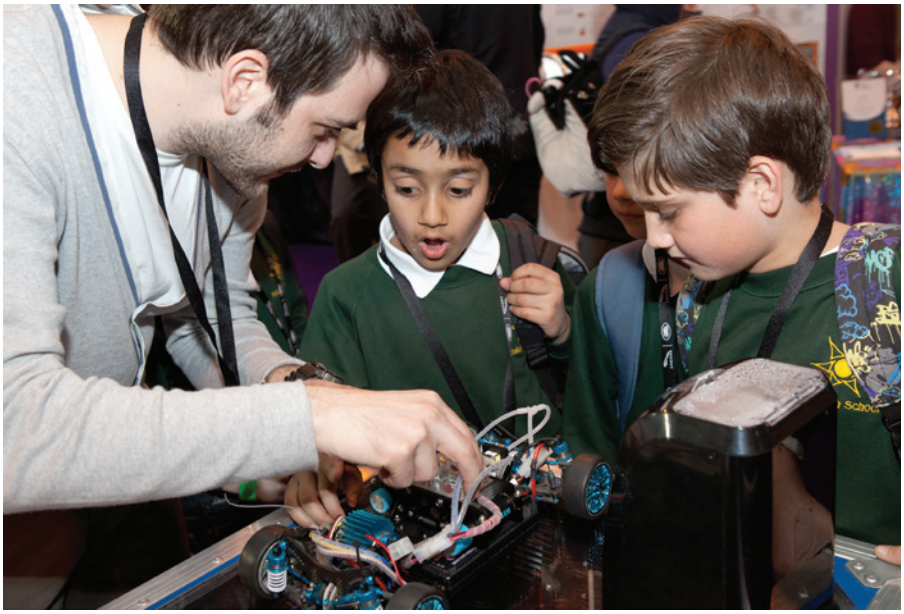
Finally, here are two additional perspectives on future global competitive advantage:

Data: the new oil? Companies must begin treating data as an enterprise-wide corporate asset, while also managing it locally within business units. This enables sharing of data about customers and products, which often provides opportunities to up-sell, cross-sell and create customer service and retention plans that are aligned with a customer's true value to the organisation. Sharing product data can open up opportunities to create new and innovative products across lines of business. In combination, an enterprise-wide understanding of customer behaviour, products, and transactions enables advanced analytics.[159]

The 'pure' service sector represents three quarters of the developed world's economy. Forty per cent of manufacturing firms sell services as well as products. In some cases, 'traditional' manufacturing firms generate over 50% of their revenues from services. It is clear that service offers companies significant opportunities to create and capture economic value. Underlying this shift to service is a change in the nature of service. Increasingly, firms are focusing on how they can deliver services that help their customers deliver value to their stakeholders. In essence, service providers are shifting from being 'doers' to becoming 'problem solvers', capable of orchestrating the delivery of complex services.[160]

154 *Developing Integrated Solid Waste Management Plans,* United Nations Environmental Programme, 2009 **155** *Statistical Review of World Energy,* BP, 2011 **156** *More with Less: Scaling Sustainable Consumption and Resource Efficiency,* World Economic Forum, January 2012 **157** *More with Less: Scaling Sustainable Consumption and Resource Efficiency,* World Economic Forum, January 2012, p5 **158** *More with Less: Scaling Sustainable Consumption and Resource Efficiency,* World Economic Forum, January 2012, p6-7 **159** Forbes – http://www.forbes.com/sites/perryrotella/2012/04/02/is-data-the-new-oil/ **160** *From Processes to Promise: How complex service providers use business model innovation to deliver sustainable growth,* Cambridge Service Alliance, Cambridge University, September 2011

Part 1 – Engineering in Context
2.0 Engineering and manufacturing in the UK



In the UK, recovery from the 2008 recession is proving even slower than after the Great Depression.[161] Lee Hopley, Chief Economist, EEF says, *"UK economic data has been complicated by a number of one-off events so far this year. However, the underlying trend appears to be flat activity. While there are pockets of growth in some sectors, a weak first half of the year combined with significant on-going challenges in the world economy has led most forecasters to pull down their expectations for growth in both 2012 and 2013. The consensus forecast for GDP this year is a modest contraction with the economy moving back to modest growth in 2013."*

In the *Engineering UK Report 2012,*[162] we stated that Government was seeking to devolve power to the regions by establishing partnerships with regional and local bodies who could promote investment, skills, employment, efficiency, innovation and competitiveness in their area. The Regional Growth Fund[163] was a key element of this initiative. Through the first two rounds, £1.4 billion has already been allocated to 176 businesses, which are expected to create and protect up to 328,000 jobs across the country. The third round has generated 409 projects which, altogether, have bid for £2.68 billion funding.[164]

However, the House of Commons Committee of Public accounts September report[165] has not been complimentary stating that, *"It has taken far too long for the Regional Growth Fund to get off the ground"* and citing that only £60 million has been spent on front-line projects. As a result only 5,200 jobs can be claimed as having been created or safeguarded in projects where the offer of funding has been finalised, against targets of 36,800 over the lifetime of these projects.

2.1 Number of engineering enterprises in the UK

This section examines the size of the engineering sector, based on the engineering footprint,[166 167] as defined by EngineeringUK. The data used in this section comes from the Inter-Departmental Business Register (IDBR)[168 169] and is split by home nations and English regions.

In March 2011, there were 542,440 engineering enterprises in the UK (Table 2.0). This was only down 1.6% on 2010 and translates to 9,080 fewer enterprises.

Only two regions have bucked the trend and shown positive growth in the number of engineering enterprises in the last year. These are London, which grew by 0.7% to reach 79,190 enterprises, and Scotland which also grew by 0.7% to reach 36,180. However, Scotland is the only home nation to have experienced growth over the past two years, with 36,180 engineering enterprises in 2011 compared with 36,125 in 2009.

The North West had the largest decline. The number of engineering enterprises fell by 1,875 from the previous year. Three other regions also showed a decline: the West Midlands lost 1,470 engineering enterprises, the East of England lost 1,435 and Yorkshire and The Humber lost 1,055.

161 *Youth unemployment: the crisis we cannot afford;* AVECO, 2012, p32 162 *Engineering UK Report 2012 – the state of engineering in the UK,* EngineeringUK, December 2011, p22 163 http://www.bis.gov.uk/rgf/ 164 *Press Release, 19 June 2012 13:35,* Department for Business, Innovation and Skills. http://news.bis.gov.uk/Press-Releases/Businesses-compete-for-Regional-Growth-Fund-67b84.aspx
165 Website accessed on 11 October 2012 (http://www.publications.parliament.uk/pa/cm201213/cmselect/cmpubacc/104/104.pdf) 166 The engineering footprint is defined in SIC 2007. For further details see Table 17.7 in the Annex (http://www.engineeringuk.com/what_we_do/education_&_skills/engineering_uk_12.cfm) 167 Data was purchased from the ONS, using IDBR, based on the engineering footprint. 168 The IDBR collects data on VAT and/or PAYE registered businesses. 169 The IDBR is the official Government statistics on the number of businesses.

In contrast to the growth in Scotland, Northern Ireland showed a decline of 2.7% and Wales was down 2.3%.

The IDBR does not collect data on companies which are not VAT and/or PAYE registered. However, research by the UK Commission for Employment and Skills (UKCES)[170] shows that 13% of the workforce is self-employed and that only one in five self-employed people have any employees. It is therefore possible that there are additional, very small, engineering enterprises that are not recorded in Table 2.0.

Table 2.1 shows the total number of enterprises (engineering and non-engineering) by region and home nation. The table shows that overall there was a decline of 0.9% in the total number of enterprises in 2011. This is lower than the 1.6% decline experienced by engineering enterprises, showing that engineering has been hit slightly harder by the recession.

Reflecting the situation with purely engineering enterprises, only two areas showed growth in the total number of enterprises: London (up 0.9%) and Scotland (up 0.1%). The region with the steepest decline was the West Midlands (down 2.2%).

Wales also experienced a decline – 2.2% – in 2011. The decline was less severe in Northern Ireland, falling by just 0.8%.

Figures 2.0 and 2.1 highlight that most engineering enterprises in the UK are small[172] or micro[173] businesses. In fact, 89.1% of all firms have fewer than 10 employees. Northern Ireland is the home nation with the smallest percentage of firms with fewer than five employees (73.2%), while England has the highest percentage (78.3%). Within England, 83.7% of engineering enterprises in London have fewer than five employees.

Table 2.0: Number of VAT and/or PAYE registered engineering enterprises (2009-2011) – UK[171]

Home nation/ English region	2009	2010	2011	One year change (whole numbers)	One year change (percentage)
North East	15,545	15,010	14,545	-465	-3.1%
North West	55,315	53,240	51,365	-1,875	-3.5%
Yorkshire and The Humber	40,080	38,825	37,770	-1,055	-2.7%
East Midlands	40,600	39,050	38,075	-975	-2.5%
West Midlands	48,380	46,415	44,945	-1,470	-3.2%
East	63,625	61,930	60,495	-1,435	-2.3%
London	81,680	78,640	79,190	550	0.7%
South East	98,005	95,500	94,535	-965	-1.0%
South West	52,415	51,105	50,355	-750	-1.5%
England	495,645	479,715	471,275	-8,440	-1.8%
Wales	21,375	20,595	20,115	-480	-2.3%
Scotland	36,125	35,920	36,180	260	0.7%
Northern Ireland	15,860	15,290	14,870	-420	-2.7%
Total	**569,005**	**551,520**	**542,440**	**-9,080**	**-1.6%**

Source: ONS/IDBR

Table 2.1: Number of VAT and/or PAYE registered enterprises (2009-2011) – UK

Home nation/ English region	2009	2010	2011	One year change (whole numbers)	One year change (percentage)
North East	57,425	55,865	54,770	-1,095	-2.0%
North West	211,915	204,990	201,060	-3,930	-1.9%
Yorkshire and The Humber	152,475	148,855	146,605	-2,250	-1.5%
East Midlands	147,980	143,310	140,940	-2,370	-1.7%
West Midlands	177,195	171,410	167,585	-3,825	-2.2%
East	217,925	213,635	210,845	-2,790	-1.3%
London	339,185	331,535	334,395	2,860	0.9%
South East	337,380	330,375	328,015	-2,360	-0.7%
South West	202,550	197,935	196,605	-1,330	-0.7%
England	1,844,030	1,797,910	1,780,820	-17,090	-1.0%
Wales	92,005	89,370	87,430	-1,940	-2.2%
Scotland	145,745	144,565	144,650	85	0.1%
Northern Ireland	70,620	68,525	67,960	-565	-0.8%
Total	**2,152,400**	**2,100,370**	**2,080,860**	**-19,510**	**-0.9%**

Source: ONS/IDBR

170 *Skills for self-employment,* UKCES, August 2011, pi 171 Data in IDBR was taken on the 28th March 2011. 172 10-49 employees 173 1-9 employees and turnover less than £2 million

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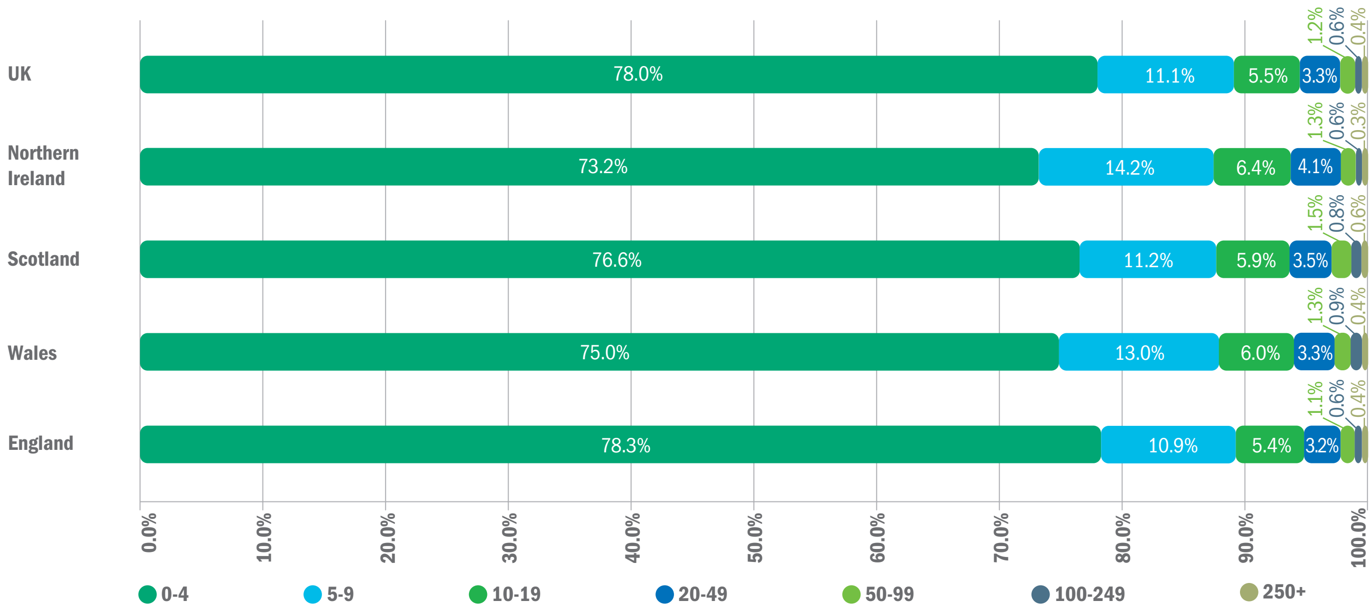
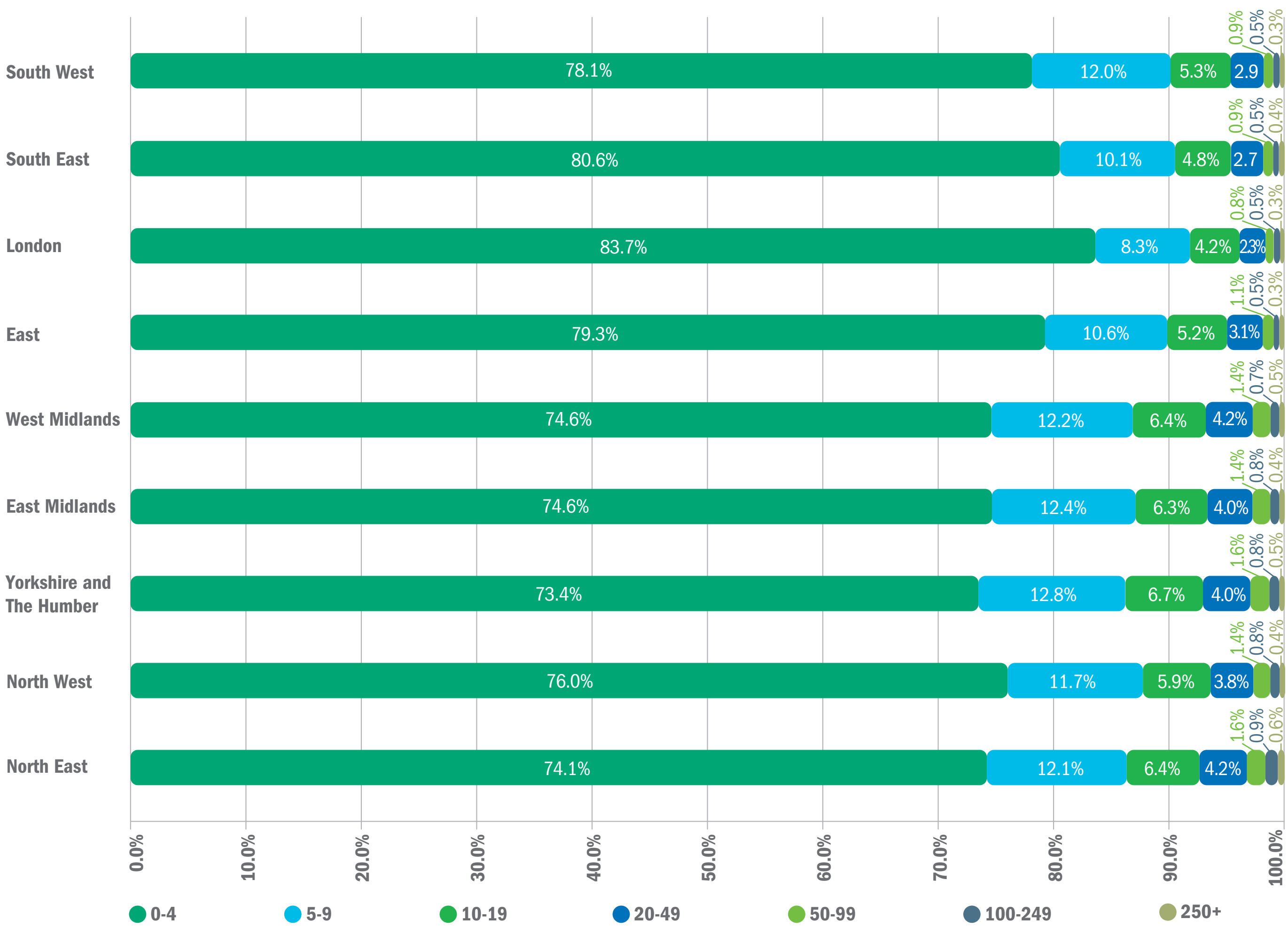
Fig. 2.0: Share of VAT and/or PAYE registered engineering enterprises by number of employees and by home nation (2011)



Source: ONS/IDBR

Fig. 2.1: Share of VAT and/or PAYE registered engineering enterprises by number of employees and by English region (2011)



Source: ONS/IDBR

2.2 Employment in engineering in the UK

Table 2.2 shows that in March 2011 the number of people working in engineering enterprises had fallen to 20.1% of all UK workers, or 5.4 million people.[174 175] The percentage decline in the number of workers in engineering enterprises is more than double the percentage decline in the number of engineering enterprises identified in Table 2.0. According to the IDBR data, the percentage decline in employment for all enterprises, was 2.1%. This implies that the engineering sector has been hit harder than the rest of the UK economy.

This is concerning because in section 15 our unique analysis shows that, by 2020, engineering enterprises will need to recruit an additional 1.86 million workers with engineering skills approximately one third of the entire 5.4 million workforce who currently work in engineering enterprises.[176]

The only home nation or region to show growth in employment for engineering enterprises was London, where employment grew by 7,000.

The greatest contraction within English regions was in the North West, where 51,000 jobs were lost. Employment fell significantly in the North East too, where 16,000 jobs were lost.

In the other home nations, the largest decline in employment was in Northern Ireland, where engineering employers shed 19,000 employees. Although Table 2.0 showed that the number of engineering enterprises in Scotland had grown, employment fell by 5,000. Wales also saw a decline of 2,000 jobs.

Although only 0.4% of engineering enterprises employ more than 250 people, they are responsible for 43.7% of all those employed by engineering enterprises (Figure 2.2). However, looking at the importance of large businesses by home nation shows that the proportion of staff employed in the largest businesses varies considerably. In Scotland, 44.7% of those in employed in engineering enterprises work for employers with at least 250 staff, as do 44.3% of those in England. By comparison, just over a quarter (27.2%) of those employed by engineering enterprises in Northern Ireland were employed by the largest businesses. In Northern Ireland, nearly as many people were employed by engineering enterprises with fewer than 10 employees (26.4%) than were employed by the largest engineering enterprises (27.2%).

Just over half (51.9%) of those employed by engineering enterprises in the South East of England worked for enterprises with at least 250 workers (Figure 2.3). By comparison, large enterprises accounted for only 34.8% of employees in the North West, 35.1% in the East Midlands, 36.7% in Yorkshire and the Humber, and 37.1% in the North East. This emphasises the valuable contribution made by engineering SMEs in these four regions.

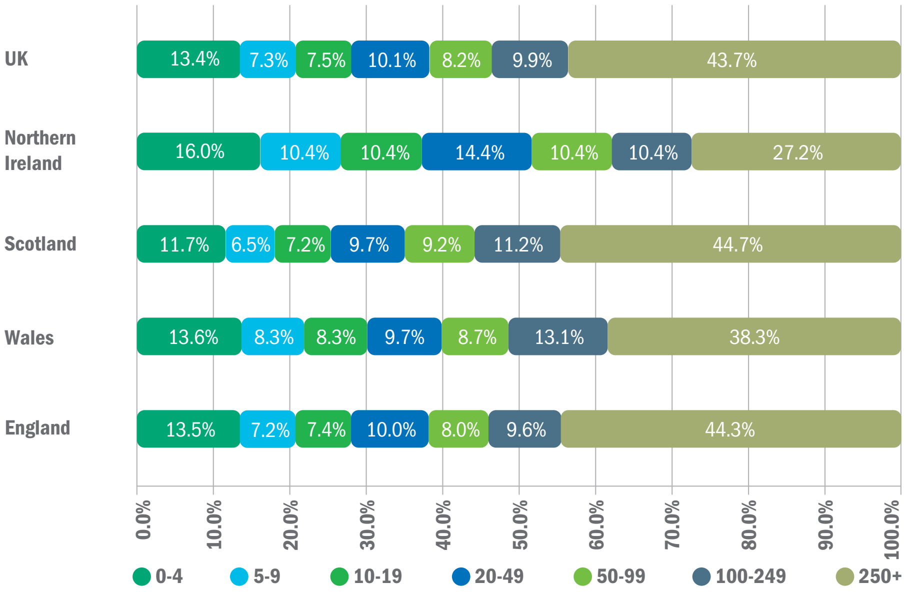
Table 2.2: Employment in VAT and/or PAYE registered engineering enterprises (2009-2011) – UK

Home nation/ English region	2009	2010	2011	One year change (whole numbers)	One year change (percentage)
North East	189,000	175,000	159,000	-16,000	-9.1%
North West	559,000	540,000	489,000	-51,000	-9.4%
Yorkshire and The Humber	462,000	423,000	403,000	-20,000	-4.7%
East Midlands	427,000	399,000	382,000	-17,000	-4.3%
West Midlands	550,000	519,000	497,000	-22,000	-4.2%
East	657,000	633,000	607,000	-26,000	-4.1%
London	717,000	661,000	668,000	7,000	1.1%
South East	1,018,000	1,000,000	961,000	-39,000	-3.9%
South West	505,000	497,000	491,000	-6,000	-1.2%
England	5,084,000	4,848,000	4,657,000	-191,000	-3.9%
Wales	223,000	208,000	206,000	-2,000	-1.0%
Scotland	435,000	408,000	403,000	-5,000	-1.2%
Northern Ireland	153,000	144,000	125,000	-19,000	-13.2%
UK	5,895,000	5,608,000	5,391,000	-217,000	-3.9%

Source: ONS/IDBR

174 The IDBR dataset is not the official source of statistics on employment and these figures are indicative. The Business Register Employment Survey is the official statistics on employment. Employment statistics have been rounded to the nearest thousand. 175 Website accessed 20th August 2012 (http://www.ons.gov.uk/ons/rel/bus-register/business-register-employment-survey/2010/stb-bres-2010.html)
176 See section 2 for details on the number of workers currently employed in engineering companies.

Fig. 2.2: Share of employment in VAT and/or PAYE registered enterprises by enterprise size and home nation (2011)



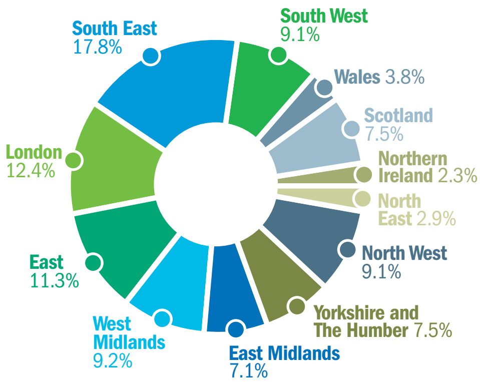
Source: ONS/IDBR

Fig. 2.3: Share of employment for VAT and/or PAYE registered enterprises by enterprise size and English region (2011)

Source: ONS/IDBR

Figure 2.4 shows the distribution of employment by engineering enterprises in the regions and home nations. It shows that 17.8% of those employed in engineering work in the South East, with a further 12.4% working in London and 11.3% in the East of England. Of the other home nations, Scotland had the largest proportion of people employed by engineering enterprises (7.5%), followed by Wales (3.8%) and Northern Ireland (2.3%).

Fig. 2.4: Share of employment for VAT and/or PAYE registered enterprises by home nation and English region (2011)



Source: ONS/IDBR

2.3 Turnover of engineering enterprises in the UK

Table 2.3 shows the turnover of engineering enterprises. It shows that turnover fell by 7.6% in the year ending March 2011, to £1.06 trillion.[177] Engineering now accounts for 23.9% of the turnover of all enterprises in the UK, down from 24.9% in 2010.[178] This decline affected all regions and home nations. The worst regional decline was in the North East, where turnover fell by nearly a quarter (24.4%) in one year. Despite a modest growth in the number of engineering enterprises, London had the second largest decline in turnover, at 11.0%. The smallest decline in turnover was in the South West, which fell by 2.7%.

Looking at the home nations, there was decline in turnover of 9.2% in Wales, 8.0% in Scotland and 6.7% in Northern Ireland.

Figure 2.5 shows the breakdown of turnover by English region and home nation. It shows that over a fifth (21.7%) of all the turnover of engineering enterprises is generated by enterprises in the South East, with a further fifth (19.6%) coming from London. This, along with other data in this section, emphasises the importance of London and the South East to the engineering sector. With just 2.6% of turnover, the North East's engineering enterprises made the smallest contribution.

In the other home nations, Scottish engineering enterprises contributed 9.3% of turnover, Welsh firms contributed 3.0% and those in Northern Ireland contributed 1.7%.

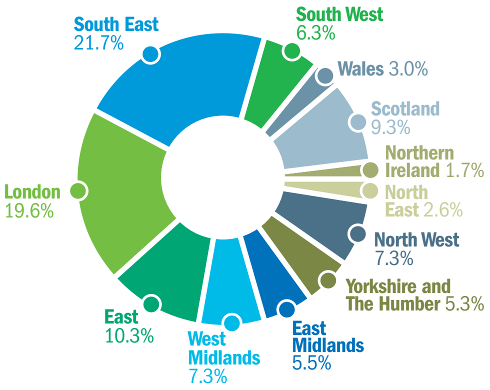
In terms of employment and turnover, it is interesting to compare the size of the engineering sector with the size of the retail sector.[179] The turnover of the engineering sector is 3.2 times the turnover of the retail sector (£331 billion[180]). In addition employment in the engineering sector is 1.8 times that in the retail sector (3.0 million[181]).

Table 2.3: Turnover (millions) in VAT and/or PAYE registered engineering enterprises (2009-2011) – UK

Home nation/ English region	Turnover (millions) 2009	Turnover (millions) 2010	Turnover (millions) 2011	One year change (millions)	One year change (percentage)
North East	38,171	35,807	27,065	-8,742	-24.4%
North West	82,209	85,323	77,817	-7,506	-8.8%
Yorkshire and The Humber	64,580	62,709	56,371	-6,338	-10.1%
East Midlands	60,270	62,046	58,742	-3,304	-5.3%
West Midlands	93,612	82,572	77,024	-5,548	-6.7%
East	109,521	117,366	109,177	-8,189	-7.0%
London	198,958	232,880	207,274	-25,606	-11.0%
South East	211,568	237,578	230,367	-7,211	-3.0%
South West	65,936	69,162	67,289	-1,873	-2.7%
England	924,826	985,443	911,125	-74,318	-7.5%
Wales	35,082	35,412	32,139	-3,273	-9.2%
Scotland	94,329	107,388	98,805	-8,583	-8.0%
Northern Ireland	19,357	19,377	18,082	-1,295	-6.7%
UK	1,073,594	1,147,619	1,060,151	-87,468	-7.6%

Source: ONS/IDBR

Fig. 2.5: Share of turnover of VAT and/or PAYE registered engineering enterprises by home nation and English region (2011)



Source: ONS/IDBR

177 The IDBR dataset is not the official source of statistics on turnover and these figures are indicative. The official statistics on turnover are the Annual Business Survey. **178** *Engineering UK 2012 – the state of engineering in the UK,* EngineeringUK, December 2011, p43 **179** The retail sector has been defined as division 47 (Retail trade, except of motor vehicles and motorcycles) using the Standard Industrial Classification 2007. **180** Total turnover taken from the Annual Business Survey **181** Total employment – average during the year taken from the Annual Business Survey.

2.4 Manufacturing and construction in the UK

According to UNESCO data,[182] the UK was the world's seventh[183] largest manufacturing economy in 2010. However, more recent data from EEF suggests the UK has slipped to ninth in the world. Table 2.4 shows the UNESCO data for the value of the UK manufacturing sector over a 10-year period and its share of manufacturing in the European Union[184] and the world. In 2010, the value of UK manufacturing rose by 3.6%, although the longer term trend has been downwards, with a 10-year decline of 8.8%. Over 10 years, the UK's share of world manufacturing has slipped from 4.1% to 2.8%. The UK's share of manufacturing in the EU has also declined over 10 years, from 13.4% to 11.8%.[185]

However, high value UK manufacturing accounted for 35% of all UK exports in 2010, a contribution of £151 billion to the UK balance of payments.[186] The Index of Production shows that manufacturing output has consistently risen since the late 1940s: by 2011, it was 148% higher than in 1948.[187]

The pattern for construction is different to manufacturing. Over the last year, the UK's share of world construction rose from 4.7% to 4.8%, although it is still below its peak of 5.3% in 2003 and 2004. Within the European Union, the UK's share of construction fell to 11.8% in 2010, down from 12.2% the previous year.

Table 2.4: Value of manufacturing and construction sectors, at constant 2005 prices, in million US Dollars (2001-2010) – United Kingdom, EU-27 and the world

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change over one year	Change over 10 years
United Kingdom	Manufacturing (ISIC D)	270,551	264,689	264,009	269,738	269,297	273,499	274,828	266,991	238,304	246,853	3.6%	-8.8%
	Construction (ISIC F)	111,436	115,774	121,660	125,707	127,033	128,310	131,744	130,809	116,965	125,071	6.9%	12.2%
Total for EU-27	Manufacturing (ISIC D)	2,023,730	2,012,187	2,024,835	2,083,183	2,121,330	2,218,160	2,297,523	2,245,316	1,945,722	2,085,096	7.2%	3.0%
	Construction (ISIC F)	706,048	708,422	715,426	729,403	743,194	766,381	789,566	784,525	731,690	724,044	-1.0%	2.5%
World	Manufacturing (ISIC D)	6,648,140	6,775,045	7,032,727	7,429,870	7,702,487	8,179,335	8,647,846	8,655,855	8,329,259	8,741,104	4.9%	31.5%
	Construction (ISIC F)	2,266,641	2,275,672	2,286,895	2,364,384	2,425,096	2,491,460	2,505,959	2,531,586	2,497,998	2,590,193	3.7%	14.3%
UK share of EU-27	Manufacturing (ISIC D)	13.4%	13.2%	13.0%	12.9%	12.7%	12.3%	12.0%	11.9%	12.2%	11.8%	-3.3%	-11.9%
	Construction (ISIC F)	15.8%	16.3%	17.0%	17.2%	17.1%	16.7%	16.7%	16.7%	16.0%	17.3%	8.1%	9.4%
UK share of world	Manufacturing (ISIC D)	4.1%	3.9%	3.8%	3.6%	3.5%	3.3%	3.2%	3.1%	2.9%	2.8%	-3.4%	-31.7%
	Construction (ISIC F)	4.9%	5.1%	5.3%	5.3%	5.2%	5.2%	5.3%	5.2%	4.7%	4.8%	2.1%	-2.0%

Source: UNESCO

182 Website accessed on 27 July 2012 (http://unstats.un.org/unsd/snaama/dnllist.asp) **183** The top six manufacturing economies are the United States of America, China, Japan, Germany, South Korea and Italy. **184** For a list of European Union countries please go to http://europa.eu/about-eu/countries/index_en.htm **185** All data for the European Union has been calculated using the list of member countries in 2012. **186** High value manufacturing is here defined as high and medium-high technology manufacturing as defined by the OECD (SIC codes 20, 21, 25.4, 26, 27, 28, 29, 30.2, 30.3, 30.4, 30.6). Exports of these goods totalled £151bn in 2010 – 66% of total UK manufacturing exports (at £228bn in 2010) and 35% of total UK exports of goods and services (£437bn in 2010). Sources: UK Trade in Goods Analysed in Terms of Industry (ONS) and UK Balance of Payments: The Pink Book 2010 (ONS) **187** *Growth Bulletin,* Centre for Policy Studies, 18 May 2012

Part 1 – Engineering in Context
3.0 UK engineering research and innovation

"Rapid and widespread changes in the world's human population, coupled with unprecedented levels of consumption present profound challenges to human health and wellbeing, and the natural environment."

Paul Nurse, President of the Royal Society

3.1 Importance of research and innovation

The 21st Century is a critical period for people and the planet. The global population reached seven billion during 2011 and the United Nations predicts it could be as high as 11 billion by 2050. Human impact on the Earth raises serious concerns: in the richest parts of the world, per capita material consumption is far above the level that can be sustained for everyone in a population of seven billion or more. This is in stark contrast to the world's 1.3 billion poorest people, who need to consume more in order to be raised out of extreme poverty.[188]

The demographic changes and consumption patterns described above lead to three pressing challenges.[189]

1. The world's 1.3 billion poorest people need to be raised out of extreme poverty.
2. In the most developed and the emerging economies unsustainable consumption must be urgently reduced.
3. Global population growth needs to be slowed and stabilised, but this should by no means be coercive.

There is an implicit view that scientific, engineering and technological innovations will help address and mitigate many of these pressing challenges. But in terms of global competitiveness, who will be the winners and who will be the losers? For example, China[190] is predicted to overtake the US as the world's largest economy by 2016. Its research spend has trebled since 2005 to £70 billion and spending is planned to increase by a further 2.2% of GDP by 2015. [191]

The UK, however, is also well placed: it has the fourth highest concentration of the world's top 1,400 international companies for R&D expenditure. In 2010, UK businesses spent £16.1 billion on non-defence R&D, a 3.7% increase in cash terms compared with 2009. Overall, employment in R&D increased by 4,000 staff in 2010. Indeed, in contrast to previous recessions, business investment in R&D has been maintained throughout the economic downturn, in contrast to previous recessions, providing a foundation for future economic growth. [192]

We also have a strong base of research-active universities, with four of the top 20 universities in the world, and 32 universities in the top 200.[193]

The importance of Research and Development (R&D) for Europe has also been recognised. R&D spend is one of the five strategy targets in the Europe 2020 plan and is also recognised as a key driver of its three thematic priorities.[194]

188 *People and the Planet*, The Royal Society, April 2012 189 *People and the Planet*, The Royal Society, April 2012, p15 190 *World Economic Outlook*, IMF, April 2011 191 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011, p69 192 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011
193 Times Higher Education World University Rankings (2011-12) 194 Presented by Anne Glover Chief Scientific Adviser to the President of the European Commission at; Science and Innovation 2012 – Driving Economic Growth, London, 27 June 2012

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Europe 2020 targets[195]

1. Employment
   - 75% of 20- to 64-year-olds to be employed
2. R&D
   - 3% of the EU's GDP to be invested in R&D
3. Climate change/energy
   - Greenhouse gas emissions 20% (or even 30%, if the conditions are right) lower than in 1990
   - 20% of energy from renewables
   - 20% increase in energy efficiency
4. Education
   - Reducing school drop-out rates below 10%[196]
   - At least 40% of 30- to 34–year-olds completing third level education[197]
5. Poverty/social exclusion
   - At least 20 million fewer people in or at risk of poverty and social exclusion

Thematic priorities of the Europe 2020 strategy

1. Smart growth – development of an economy based on knowledge and innovation
2. Sustainable growth – development of a more efficient, greener and competitive economy
3. Inclusive growth – development of an economy that ensures high employment rates and social and spatial cohesion

3.2 UK Government interventions[198]

The Government recognises that research and innovation, and the skills to exploit them, are essential components that will allow the UK economy to prosper and grow. That is why, despite a difficult fiscal situation, the Government's most recent Spending Review (SR) protected the £4.6 billion a year that has been ring-fenced for science and research programmes for the 2011-15 period. And, in addition to £1.9 billion capital funding announced in the SR, Government has since announced a further £595 million investment in science and innovation capital. This recognises the critical role of the UK's world-class research base as one of the key components in promoting economic growth.[199]

Table 3.0 provides an abbreviated but informative picture of the net Government expenditure on science, engineering and technology (SET) by department over the past 10 years.

Through its innovation and research strategy for growth,[200] the Government places great emphasis on the role that innovation will play. It defines innovation as, *"The development of new products, services and processes which may be based on cutting edge research. Improving the UK's innovation performance is an essential component of the Government's growth plan."*[201] It clearly sees innovation as a growth factor, that will drive the competitiveness of UK businesses in the global economy. In technology-based sectors, research is a primary driver of innovation, and research can also discover and exploit new technologies, sometimes giving rise to new industries. In other sectors, the rapid adoption of technologies and the development of intangible assets are essential to innovate, sometimes transforming existing industries.[202]

Table 3.0: Net Government expenditure on SET by departments in cash (2000/01 – 2009/10) – UK

		£ million									
		2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Research Councils	**Total**	**1,514**	**1,707**	**1,947**	**2,259**	**2,408**	**2,871**	**3,014**	**2,742**	**3,024**	**3,165**
Higher Education Funding Councils	**Total**	**1,276**	**1,474**	**1,626**	**1,665**	**1,804**	**1,928**	**2,085**	**2,252**	**2,247**	**2,403**
Civil departments	**Total**	**1,664**	**1,776**	**2,043**	**2,140**	**1,866**	**1,965**	**1,918**	**2,312**	**r[203] 2,378**	**2,681**
Defence											
MoD	Development	1,673	1,500	2,218	2,153	1,937	1,921	1,492	1,505	1,406	1,175
	Research	566	557	516	524	639	598	632	635	584	567
	Total	**2,240**	**2,057**	**2,734**	**2,677**	**2,576**	**2,519**	**2,124**	**2,139**	**1,991**	**1,742**
Indicative UK contribution to the EU R&D budget		**399**	**391**	**440**	**390**	**325**	**365**	**374**	**374**	**r 593**	**650**
Grand total		**7,093**	**7,404**	**8,791**	**9,130**	**8,980**	**9,649**	**9,515**	**9,819**	**r 10,232**	**10,642**

Source: ONS Government R&D Survey

195 Website accessed on the 30th August 2012 (http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm) 196 Refers to numbers of pupils who drop out before the end of secondary education. 197 Undergraduate degree level education 198 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011, Detailed list of all relevant activities via the Government's Innovation and Research Strategy and how they will be Monitoring the UK's Innovation Performance on p91–96 199 *Following Up the Wilson Review of Business – University Engagement*, Department for Business, Innovation and Growth, June 2012, p22 200 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 201 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 202 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 203 r = revised

Government does, however, note the need to remain vigilant, as fast-growing economies like China, Brazil and India are rapidly raising their game. China, for instance, is set to become the second largest recipient of foreign direct investment in the world and is already the second largest investor in R&D after the USA.[204] In the BRIICS countries (Brazil, the Russian Federation, India, Indonesia, China and South Africa), high-technology manufacturing now represents 30% of total manufacturing trade. This compares with 25% for the Organisation for Economic Co-operation and Development (OECD) area. New scientific hubs have been created over the last decade, for instance in Shanghai and Sao Paulo. Some universities in Asia, such as the Hong Kong University of Science and Technology, are emerging as leading research institutions.[205]

Nevertheless, it is worth heeding the World Economic Forum's report which points out that, whilst R&D is clearly an important element, it is not the sole driver of innovation. Other factors such as the quality of educational systems, infrastructure and policy environment are critical factors to national innovation effectiveness.[206]

Through the TSB, the Government has embarked on developing and launching a series of technology and innovation centres under the name 'Catapult'. These facilities will help commercialise innovation and research, to make them competitive on the world stage. Briefly, the key role of Catapult centres is to[207]:

- create a critical mass for business innovation in technology areas where there is strong UK capability to exploit global markets worth billions of pounds each year
- strengthen and embed supply chains within the UK
- provide open access for business to equipment and technology expertise that would otherwise be inaccessible
- conduct applied research collaboratively, with business and under contract
- act as the hubs of clusters and networks, facilitating open innovation through the development of new collaborations between businesses and external partners
- support the training and development of applied engineering skills and facilitate the movement of skilled individuals between the knowledge base and business
- encourage the diffusion of knowledge and techniques between different sectors
- help businesses access new funding streams, including European funding programmes, and attract inward investment by promoting UK capabilities and the Catapult brand

At the time of writing, the High Value Manufacturing Catapult centre had been launched in 2011, and the Cell Therapy and Offshore Renewable Energy centres launched in 2012. The Satellite Applications, Connected Digital Economy, Transport Systems and Future Cities Catapult Centres are scheduled for launch in 2013.

In addition to building infrastructure and innovation networks, the Government recognises the value of **R&D Tax Credits** to innovative companies. R&D Tax Credits offer relief from Corporation Tax and provide the single biggest Government incentive for business R&D. They incentivise companies in all sectors, from innovative start-ups through to large multinational companies, to undertake more R&D.[208]

The Chancellor made a commitment in the 2011 Autumn Statement to introduce an Above the Line (ATL) credit in 2013 to encourage R&D activity by larger companies.[209]

The Government's aim is for an ATL credit that works well for all businesses and provides the best mechanism for supporting UK R&D investment, in a way that is consistent with fiscal sustainability, simplicity and ease of administration within the tax system.

This is in addition to increasing the level of the Small Company R&D Tax Credit from 175% to 225% in April 2012. The Government, however, is not proposing to change the existing SME R&D Tax Credit to an ATL credit, and the level of support under the small business scheme will not be reduced as a result of these changes.

These interventions make the R&D Tax Credit the largest programme of support for business innovation. In the financial year ending 31 March 2010, company claims totalled over £1 billion, enabling over £11 billion of R&D investment by business.[210]

With 99.6% of UK enterprises being SMEs,[211] and the fact that tiny minorities of dynamic high-growth firms are disproportionately responsible for the majority of job creation within the private sector,[212] it is important that they are not overlooked. Therefore, Smart and Innovation vouchers – the intervention to increase SME innovation support – are to be commended.

As part of an SME Innovation Package announced in the 2011 Autumn Statement, the Government will invest an additional £75 million over three years through the TSB to support innovative small businesses. The new funding allows for the rebranding of grants for R&D back to their original and popular brand name of Smart. Smart was introduced in 1988 and was a long-running programme that corrected the recognised failure of the market to provide private finance for high-risk and potentially high-reward technologically innovative projects carried out by SMEs. The new funding package for Smart[213] enables the TSB to expand support for innovative technology SMEs across the whole of the UK.[214]

The **Innovation voucher** programme[215] supports SMEs in collaborating with knowledge-based institutions across the public or private sectors. These can be an effective means of building innovation capability in SMEs. Recent voucher programmes in the UK, run in a number of regions or by NESTA, have shown a positive impact. Innovation vouchers:

- encourage first contact between SMEs and the knowledge base

204 OECD Science, Technology and Industry Scoreboard (2011) **205** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 **206** *The Future of Manufacturing Opportunities to drive economic growth*, A World Economic Forum Report in collaboration with Deloitte Touche Tohmatsu Limited, April 2012, p58 **207** Website accessed 30 August 2012 (https://catapult.innovateuk.org/) **208** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 **209** Press Release, issued 27 March 2012, open date 27 March 2012, close date 29 June 2012. http://www.hm-treasury.gov.uk/consult_above_line_credit_rd.htm **210** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 **211** Source: ONS/ IDBR **212** *A plan for growth in the knowledge economy, A Knowledge Economy programme paper*, Charles Levy, Andrew Sissons and Charlotte Holloway, Work Foundation, June 2011, p9 **213** Website accessed 30 August 2012 (http://www.innovateuk.org/deliveringinnovation/smart.ashx) **214** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 **215** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011

- introduce innovation processes into businesses
- raise awareness and recognition within SMEs of the services the knowledge base can provide
- encourage on-going collaboration with the knowledge base beyond the expiry of the voucher, generated by satisfaction with project outcomes and services provided by the knowledge base

Working in partnership with business, the TSB and Local Enterprise Partnerships (LEPs),[216] the Government will implement the new innovation voucher programme during 2012/13.[217] The programme will initially focus on geographical areas and sectors which, to date, have had relatively low levels of private sector innovation and growth.

If we raise our eyes above the horizon and look to our export strategy, we will see that UK Trade and Investment (UKTI) launched its five-year strategy in May 2011,[218] setting out four pathways to growth:

1. Focus on high growth and innovative SMEs:

   UKTI has helped over 20,000 SMEs to export and break into new high-growth markets, and its target is to double its client base to 50,000 companies a year by 2015. In November 2011, it launched a National Export Challenge to get 100,000 more companies exporting by 2020.

2. Focus on high-value opportunities (HVOs):

   Through the identification of HVOs, UKTI has supported UK businesses in securing more than £800 million of successes overseas.

3. Focus on targeted inward investment:

   UKTI is working to maintain Britain's position as one of the top three destinations for inward investment.

4. Focus on building strategic relationships:

   UKTI has introduced 'key account management', a systematic approach to managing strategic relations between the UK's top exporters and the most significant inward investors.

In addition, the Foreign and Commonwealth Office (FCO) has made promoting Britain's prosperity central to its wider foreign policy agenda.[219]

Slight reservations

Looking at this section alongside the funding interventions outlined in section 1.2, the intent to build our capacity seems clear. However, there are two independent studies that question some aspects of the scale of funding.

The report by the House of Lords Select Committee titled *Nuclear Research and Development Capabilities* investigated whether or not the Government is doing enough to maintain and develop UK nuclear R&D capabilities, along with the expertise needed to ensure that nuclear energy is a viable option for the future.[220] Unfortunately, the Committee concluded that the Government is not. In particular, it did not believe that the UK has sufficient R&D capabilities and associated expertise to be able to cope with the current nuclear programme up to 2050, let alone a significantly extended programme. This is because the UK's current R&D capability is, to a significant extent, based on an ageing pool of experts and built on past investments in R&D. This means that in a few years' time, there will be crucial gaps in capabilities.[221]

The full report makes 14 key recommendations, including establishing a Nuclear R&D Board and developing an R&D Road Map.[222]

The second study comes from new analysis by the Campaign for Science and Engineering (CaSE). This revealed an alarming decline in UK science and engineering funding, despite political pledges to protect such investment.

CaSE's paper *Public Funding of UK Science and Engineering: Putting Government Rhetoric to the Test* shows that, by 2014-15, the research base will be £1.7 billion worse off in cash terms, as a result of funding decisions taken since the Spending Review last year. Inflation will lead to a further erosion of investment available for science and engineering.[223]

The report goes on to state that, although the Coalition Government pledged that the science budget would be *"protected at £4.6bn a year"*, this pledge was made possible by redefining what the term 'science budget' meant. For instance, although 'capital' funding for research equipment and facilities was slashed by almost half, such spending no longer counts towards the official science budget.

216 http://www.bis.gov.uk/policies/economic-development/leps **217** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Growth, December 2011 **218** *Trade and Investment for Growth White Paper; Progress and Achievements in Year One*, Department for Business, Innovation and Growth, February 2012 **219** Website accessed 30 August 2012 (http://www.fco.gov.uk/en/global-issues/economy/commercial-diplomacy/business-charter) **220** *Nuclear Research and Development Capabilities*, House of Lords Select Committee on Science and Technology, 3rd Report of Session 2010–12, 22 November 2011 **221** *Nuclear Research and Development Capabilities*, House of Lords Select Committee on Science and Technology, 3rd Report of Session 2010–12, 22 November 2011, p92 **222** *Nuclear Research and Development Capabilities*, House of Lords Select Committee on Science and Technology, 3rd Report of Session 2010–12, 22 November 2011, p92-97 **223** Public Funding of UK Science and Engineering: Putting Government Rhetoric to the Test http://sciencecampaign.org.uk/?p=7144

3.3 Engineering research on the world stage

The UK does have a successful UK research base:

- Eleven UK universities are in the World Universities Ranking Top 100 (second only to the US).
- The UK attracts 15% of all international doctoral students (second only to US).
- The UK is third in the G8 (behind US and Germany) for production of PhD qualifiers.
- The UK produces more publications and citations per pound spent on research than other G8 nations.
- With 1% world population, we produce 6.9% of world publications, receive 10.9% of citations and 13.8% of citations with highest impact.[224]

In addition, it has robust innovation strategies and programmes in place, as illustrated by Figure 3.0.[225]

3.3.1 International comparative engineering performance

The most recent *International Comparative Performance of the UK Research Base* report[226] shows that, while the UK has far fewer researchers than larger countries such as the US and China, as a country, it is far more efficient in terms of output per researcher. Of the top five research nations based on article output in 2010 (US, China, UK, Japan, Germany), UK researchers generate more articles per researcher, more citations per researcher, and more usage per article authored, as measured by global downloads of UK articles.[227]

The UK Gross Expenditure on Research and Development (GERD) is reported as increasing but remains below that of several key comparator countries – both proportionally and in absolute terms.[228] The latest figures show that:

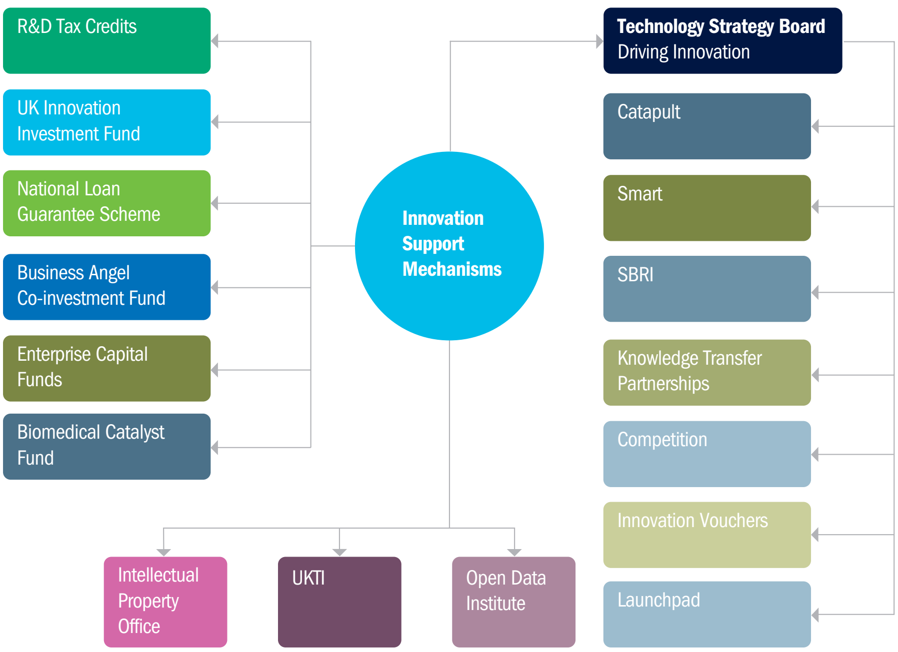
- The UK's GERD in 2010 was $32.2 billion.[229]
- The UK's R&D intensity (GERD as a share of GDP) – which is a long-standing and widely-used metric for comparing the level of investment in research between countries – was 1.8% in 2010.
- While growing modestly, the UK's R&D intensity remains below that of several key comparator countries and international benchmarks. In 2010 for example, the UK ranked fifth among the G8 comparator group, below the G8 average of 2.4%. And among all OECD countries, the UK ranked 16th, below the OECD average of 2.7%.
- In the period 2006-2010, the UK's R&D intensity increased on average by 1.1% per year, higher than the G8 average of -0.2%. This was due mainly to a large decline in Japan. However, this figure was below the annual growth average of 1.5% across the EU-27 and 4.6% for the OECD countries.

Furthermore, the report highlights that, in terms of value for money, the UK punches well above its weight. Figure 3.1, which shows the number of citation per billion dollars GDP,[230] and Figure 3.2, which shows the number of citations per million dollars Higher Education R&D (HERD),[231 232] both show the UK first in the world G8, emphasising the high productivity of the UK.

Looking more specifically at engineering (Figure 3.3), the UK is fourth in the world in engineering citations. With a 6.51% world share in 2010 (256,366 citations), it sits behind USA, China and Japan.[233]

The production of the R&D Scoreboard has been stopped. Please refer to the Engineering UK 2012 report for the last set of data published. [234]

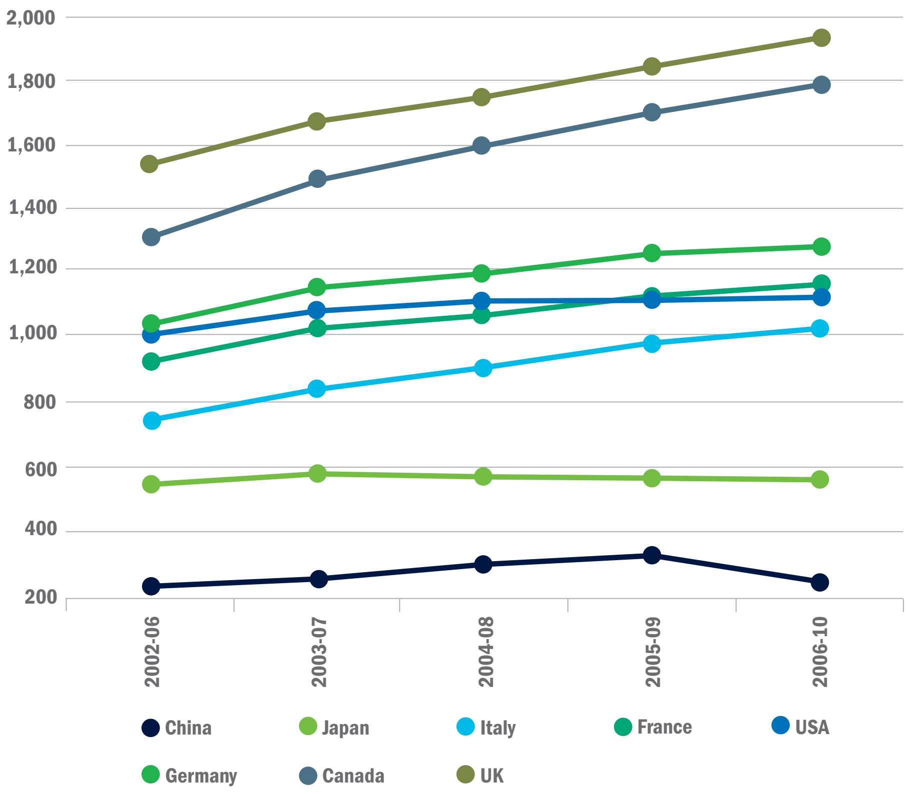
Fig. 3.0: UK innovation support mechanisms



Source: Department for Business, Innovation and Skills

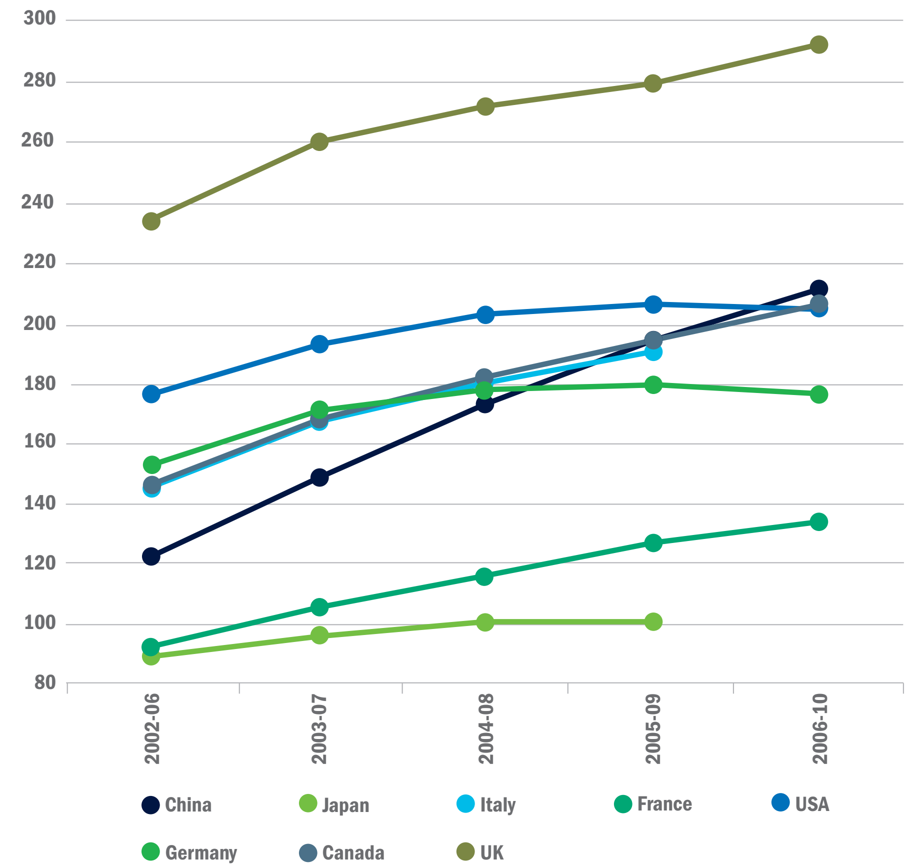
224 Data presented by David Sweeney Director (Research, Innovation and Skills) at Science and Innovation 2012 – Driving Economic Growth, London, 27 June 2012 225 Figure presented by John Dodds Director of Innovation Department for Business Innovation and Skills UK at Science and Innovation 2012 – Driving Economic Growth, London, 27 June 2012 226 *International Comparative Performance of the UK Research Base – 2011*, Department of Business, Innovation and Skills, 2011, p1 227 This report has been commissioned by the UK's Department of Business, Innovation and Skills (BIS) to assess the performance of the United Kingdom's research base compared with seven other research-intensive countries (Canada, China, France, Germany, Italy, Japan, and the US), and, where data is available, with the EU-27, the Organisation for Economic Co-operation and Development (OECD) member countries' groups, and three other fast growing nations (Brazil, Russia and India). 228 *International comparative performance of the UK research base – 2011*, Department of Business, Innovation and Skills, 2011, p10 229 Financial data are given in constant $ at 2000 prices and corrected for Purchasing Power Parity (PPP), allowing comparability over time and between countries. 230 *International comparative performance of the UK research base – 2011*, Department of Business, Innovation and Skills, 2011, p112 231 University sector citations are those where at least one author listed on the cited article is affiliated with a degree-granting institute that also engages in research, eg Harvard University. 232 *International comparative performance of the UK research base – 2011*, Department of Business, Innovation and Skills, 2011, p117 233 *International comparative performance of the UK research base – 2011*, Department of Business, Innovation and Skills, 2011, p66 234 *Engineering UK Report 2012 – the state of engineering, EngineeringUK*, December 2012, p52-55

Fig. 3.1: Citations per billion dollars GDP – UK and comparator countries



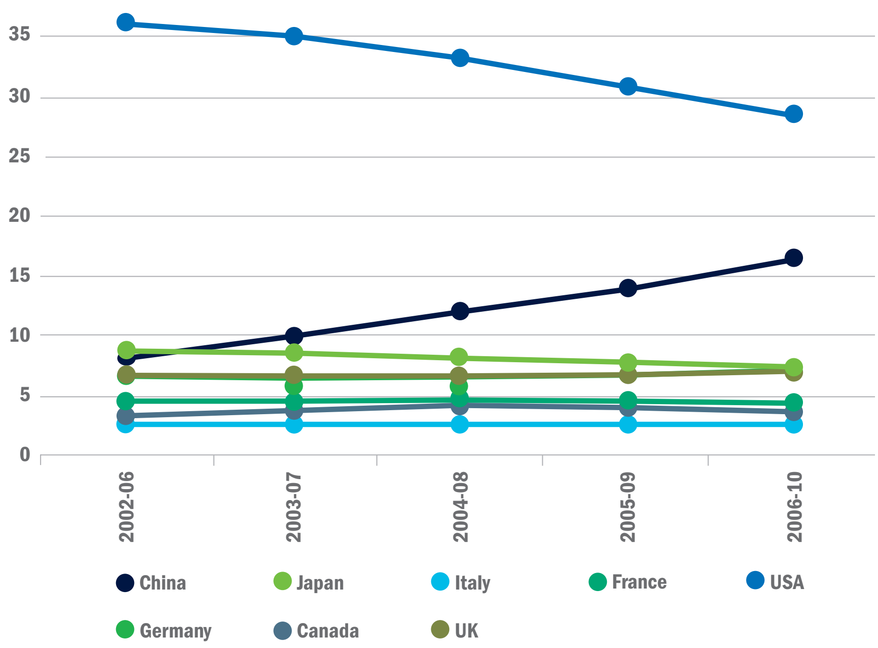
Source: Scopus and OECD MSTI

Fig. 3.2: Citations per million dollars HERD – UK and comparator countries



Source: Scopus and OECD MSTI

Fig. 3.3: Citation share (world) – engineering



Source: Scopus

3.4 Research excellence

3.4.1 Research Assessment Exercise (RAE)

The last formal Research Assessment Exercise was back in 2008. Nevertheless, in *Engineering UK 2009/10*,[235] we analysed the state of engineering R&D within UK Higher Education Institutions (HEIs), based on the 2008 RAE, and found it to be in excellent shape. Within the engineering subject area, 59% to 71% of research assessed for the sub-disciplines was classed as being internationally excellent.

3.4.2 Research Excellence Framework (REF)

The Research Excellence Framework (REF)[236] is the new system for assessing the quality of research in UK HEIs. It will replace the RAE and be completed in 2014.

The four UK Higher Education funding bodies will be responsible for the REF. The exercise will be managed by the REF team based at the Higher Education Funding Council for England (HEFCE) and overseen by the REF Steering Group, consisting of representatives of the four funding bodies.

The primary purpose of the REF is to produce assessment outcomes for each submission made by institutions. From 2015/15, the funding bodies will use this information to inform the selective allocation of their research funding to HEIs. The assessment will produce evidence of the benefits of public investment in research, while the outcomes will provide benchmarking information and establish reputational yardsticks.

So far, the REF has enjoyed its fair share of controversy and debate – particularly over the exact definition of the "Impact" element of the framework. This has now been clarified:

235 *Engineering UK Report 2012 – the state of engineering, EngineeringUK*, December 2012, p31 236 Website accessed on the 30 August 2012 (http://www.ref.ac.uk/)

Impact: definition for the REF

The REF defines an impact as an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia. Impact includes an effect, change or benefit to:

- the activity, attitude, awareness, behaviour, capacity, opportunity, performance, policy, practice, process or understanding
- of an audience, beneficiary, community, constituency, organisation or individuals
- in any geographic location whether locally, regionally, nationally or internationally

It excludes impacts on research or the advancement of academic knowledge within HE, and impacts on teaching or other activities within the submitting HEI.

3.5 Immigration

As highlighted in Engineering UK 2012,[237] the full ramifications of the Government's drive to curb immigration have yet to be realised. But the potential unintended consequences for UK R&D have been subject to much debate and lobbying activity, led by CaSE.[238]

Briefly,[239] a range of changes were made to the points-based visa system in April 2010 that aimed to ensure the UK can attract and retain the talent it needs:

- The new Entrepreneurs Visa allowed prospective foreign entrepreneurs to seek entry to the UK. In recognition of the contribution entrepreneurs make to growth, they can apply for accelerated indefinite leave to remain in the UK if they have built a business with a turnover of £5 million or created 10 jobs in three years.
- The truly world-class can come through the Exceptional Talent route in Tier 1, even without a job offer.
- Other scientists with a job offer can apply through the Tier 2 visa route. If the monthly visa allocation limit is reached, PhD level jobs are awarded additional points to recognise the high level of qualification these jobs require.
- To tackle the hurdles that institutions can face in bringing foreign academics over as guest lecturers and external examiners, the terms of the Tier 5 Government Authorised Exchange Scheme have been expanded.

In its report on Higher Education in science, the House of Lords Select Committee noted that these immigration reforms were intended principally to tackle 'bogus colleges' and students who use the student visa system simply to gain access to the UK.[240] To that extent, the Committee supported the Government's efforts to address a problem that gives a bad name to our HE system and to bona fide overseas HE students who intend to return to their countries of origin after their studies.

However, the report concluded that: *"We are concerned that changes to the immigration rules may reduce the number of overseas students coming to study to the UK and, therefore, the income that HEIs derive from these students to support other activities. This may result in a general reduction of provision of STEM courses that rely on this income to make them viable.[241] A moot point when you consider that the value to the UK of non-EU students studying at UK HEIs was £2.6 billion (section 11)."*

It appears that, one year on, the debate continues apace and that the actual ramifications on either the UK's R&D capacity or its economic prosperity are not yet evident.

3.6 Intellectual property rights – a strategic national asset

Intellectual Property (IP) is a significant factor for growth for many companies. Innovative companies that use intellectual property rights are associated with significantly better chances of firm survival[242] and company growth.[243] Evidence shows that use of patents is associated with greater knowledge creation, better use of knowledge within firms[244] and higher transfer rates of knowledge between firms and universities.[245] Trade mark use is similarly associated with higher firm productivity and innovation.[246] However, in protecting their innovation, SMEs lag behind large firms. While 13% of large firms seek to protect their intellectual property through patents, only 6% of SMEs do so and therefore may miss opportunities to seize the full value of their ideas.[247] This is often because smaller firms do not always understand the value of their IP and are unlikely to seek specific protection within wider business advisory discussions.[248]

In the *Engineering UK Report 2012*, we highlighted the economic importance of IP rights and, in particular, the comments of Baroness Wilcox who stated in the Hargreaves report: [249]

"Intellectual property is a key UK export, and global trade in IP licences alone is worth more than £600 billion a year. UK businesses need to have confidence in the international IP framework so they are able to create and exploit value from their ideas."

The Hargreaves review published its findings in May 2011, setting out the main concerns for businesses – particularly SMEs – in accessing the right advice to allow them to use their IP to maximum effect.[250]

In response to the review,[251] the Government has announced plans to support economic growth by modernising UK intellectual property laws. Ministers have accepted the recommendations which estimate the potential to deliver up to £7.9 billion to the UK economy.

237 *Engineering UK Report 2012 – the state of engineering, EngineeringUK*, December 2012, p58-59 **238** Website accessed on the 30 August 2012 (http://sciencecampaign.org.uk/?tag=immigration) **239** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Skills, December 2011 **240** *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects*, House of Lords, Select Committee on Science and Technology, 2nd Report of Session 2012–13, 24 July 2012, p216 **241** *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects*, House of Lords, Select Committee on Science and Technology, 2nd Report of Session 2012–13, 24 July 2012, p225 **242** *Innovation and Survival of New Firms across British Regions*, Economics Series Working Papers 416, Helmers and Rogers, University of Oxford, Department of Economics, 2008 **243** *The Value of Intellectual Property Rights to Firms, Economics Series Working Papers 319*, Greenhalgh and Rogers, University of Oxford, 2007 **244** *Global engagement and the innovation activities of firms*, NBER Working Papers 11479, Criscuolo, Haskel and Slaughter, National Bureau of Economic Research, Inc, 2006 **245** *Productivity growth, knowledge flows and spillovers*, Crespi, Criscuolo, Haskel and Slaughter Centre for Economic Performance, London School of Economics, 2007 **246** *Trade Marks and Productivity in UK firms*, Economics Series Working Papers 300, Greenhalgh and Rogers, University of Oxford, Department of Economics, 2005 **247** *The Impact of the Patent System on SMEs*, Hughes and Mina, CEBR, 2010 **248** *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Skills, December 2011 **249** *Engineering UK Report 2012 – the state of engineering, EngineeringUK*, December 2012, p60 **250** Digital Opportunity: A Review of Intellectual Property and Growth, Hargreaves, IPO, 2011 **251** Website accessed on the 30 August 2012 (http://www.ipo.gov.uk/ipresponse-full.pdf)

Specifically, the Intellectual Property Office (IPO) has undertaken a programme of work designed to improve the offering to business in this area. This includes:

- raising IP capability for business advisers
- establishing a register of advisers
- carrying out IP audits
- resolving disputes

The strategic importance of IP rights has recently been further endorsed by the Government's acceptance of recommendations[252] in a report on open access by Dame Janet Finch titled *Accessibility, Sustainability, Excellence: How to Expand Access to Research Publications*.[253] In response, the Government has announced that it will make publicly-funded scientific research available for anyone to read for free.

Currently, most formally published research is only available behind restricted paywalls. Reforms will see publications opened up to a greater audience, providing more opportunities for research and development across a range of sectors. Universities, businesses and the public will therefore have better access to British scientific research and academic papers by 2014.

Science Minister David Willetts said: *"Removing paywalls that surround taxpayer-funded research will have real economic and social benefits. It will allow academics and businesses to develop and commercialise their research more easily and herald a new era of academic discovery."* He added that, *"This development will provide exciting new opportunities and keep the UK at the forefront of global research to drive innovation and growth."* [254]

Looking overseas, we should note that some countries are making IP a national strategic priority. For example, Singapore has a national IP office to coordinate the IP aspects of different ministries. Its IP system has boosted inward investment in areas such as nanotechnology and biotechnology.[255]

3.7 Predicting the future

"Prediction is very difficult, especially if it's about the future."

Niels Bohr

In section 1.4, we outlined some of the strengths of UK industry sectors. In this section, we highlight emerging technologies that have been identified by the Government Office for Science's Foresight Horizon Scanning Centre[256] as being potentially important from a research and innovation perspective.

Its report[257] on UK growth opportunities it highlights some emerging technologies with a potentially huge market size by the middle of the 2020s: for example, up to $100 billion for nanomaterials, over $200 billion to build a European smart grid, £150-£350 billion globally for industrial biotechnology, £100-£150 billion for plastic electronics. The report also recognises that the UK holds a strong position in many of these areas, with every opportunity to play a major part in servicing these markets.[258]

The report takes the 53 identified individual technologies[259] and groups them into 28 clusters.[260] From these, the report identifies seven cross-cutting areas which are likely to be particularly important to the UK in the 2020s, regardless of how far individual technologies mature in that timescale. Three clusters in particular were identified as potentially transformative, in that they would provide platforms for innovation across a wide range of other technology areas, and their combined impact would be felt in many different areas of UK society and business. These are:

- **A manufacturing revolution**, fuelled by new technologies, tools and materials, with local, bespoke manufacturing-on-demand based on 3D printing and a move to product *plus* service commercial models, dubbed 'servicisation' (see section 1.3.2).
- **Smart infrastructure:** this could include a smart electric grid, increased use of sensor networks, and 'cannibalisation' of existing infrastructure.
- **A second internet revolution, which may see the emergence of a 'web of data'** adding structure and meaning to the data and text of the web, thereby transforming its value.

In addition, we would also highlight the following key technologies from those identified:

Internet

The pace of innovation in web technologies is high, and shows no signs of stopping. The industry that has developed around the Internet is thriving, with minimal direct public support, and generates remarkable social and economic benefits. So it might be considered that this is one area public policy should leave alone. All the more so since the principle of bottom-up, 'emergent' collaboration and innovation, which governments are keen to foster in a wide range of industries and communities, has been hugely boosted by the Web. New business models – such as open source software – which have their origins in internet software, are now being successfully applied in fields such as pharmaceuticals and green technology.

The Energy transition

By the mid-2020s, the UK plans to generate a much-increased proportion of its electricity from renewables, with wave and tidal power, microgeneration and biofuels joining wind as the main contributors. This will require profound changes, such as the ability to store electricity in a more distributed system relying on intermittent generation. New battery technologies and fuel cells as well as a smart grid may be needed.

The smart electricity grid

This might be the first new transformational infrastructure of the 21st century. It has been argued that it will be a prerequisite for an electricity system that meets the carbon reduction requirements of the UK to 2050.

To supplement intermittent electricity supply from renewable as a further low-carbon source of energy, nuclear generation is anticipated to see resurgence over the next

252 Website accessed on the 30 August 2012 (http://www.bis.gov.uk/assets/biscore/science/docs/l/12-975-letter-Government-response-to-finch-report-research-publications.pdf) **253** Website accessed on the 30 August 2012 (http://www.researchinfonet.org/wp-content/uploads/2012/06/Finch-Group-report-FINAL-VERSION.pdf) **254** Website accessed on the 30 August 2012 (http://www.bis.gov.uk/news/topstories/2012/Jul/Government-to-open-up-publicly-funded-research) **255** *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*, Foresight Horizon Scanning Centre, Government Office for Science, 2010 **256** Website accessed on the 30 August 2012 (http://www.bis.gov.uk/foresight) **257** *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*, Foresight Horizon Scanning Centre, Government Office for Science, 2010 **258** *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*, Foresight Horizon Scanning Centre, Government Office for Science, 2010, p4
259 The full list of 53 technologies is contained within the Technology Annex. http://www.bis.gov.uk/assets/foresight/docs/general-publications/10-1252an-technology-and-innovation-futures-annex.pdf
260 Full list of the 28 technology clusters *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*, Foresight Horizon Scanning Centre, Government Office for Science, 2010, p25 – 34

decade. New generation reactors with increased capacity, lower fuel and waste usage and increased safety are now available, and current research suggests further improvements are on the horizon.

Carbon Capture and Storage (CCS) technology

However, fossil fuels will still constitute a large part of the UK's energy mix throughout the 2020s and beyond. Carbon Capture and Storage (CCS) technology will be essential is the UK is to meet its emission targets. The UK is an early mover in both the development and application of CCS technology, and should be well placed to export elements of it into a market with a massive global potential:[261] it is estimated that this could be worth a potential £1-£2 billion/year to the UK by 2020 and £2-£4 billion/year by 2030.[262]

New materials

The developments in new materials over the next 20 years are potentially as fruitful as the increased variety of plastics in the earlier 20th century. One aspect of these materials is their potential importance in helping reduce energy use and CO_2 emissions. New, lower cost and high performance fibrous composite materials are expected to become significant over the next decade – as materials for road and footbridges, for example. Self-healing active surfaces on materials, such as concrete and paint, would increase building durability and longevity, saving energy and reducing emissions.[263]

Regenerative medicine

This refers to treatments designed to restore the function of diseased or damaged tissues or organs. This could potentially lead to significant improvements in the treatment of chronic diseases and generate economic benefits for the companies that develop therapies and related infrastructure.[264] Stem cells – the area of regenerative medicine in which the most significant breakthroughs are expected – are already demonstrating their potential. NHS patients are routinely being cured with adult stem cells for damaged corneas and over 250,000 patients (mainly in the USA) have received tissue-engineered

skin.[265] The ultimate promise of cell-based therapeutics is widely recognised. The global market is today estimated at around $100-200 million, potentially growing to $8.5 billion over the next decade.[266]

All 53 technologies are fully described in the separate Technology Annex.[267]

3.8 Does it pay?

So does investment in innovation actually pay dividends? According to NESTA's 2009 report *The vital 6 per cent – How high-growth innovative businesses generate prosperity and jobs*,[268] it most certainly does.

Its report showed that about 6% of innovative, high-growth companies created 40% of new private sector jobs in the UK between 2002 and 2008. NESTA defined high-growth companies as those who experience annual average growth in employment of 20% or more over three years and identified them as the driver of UK economic prosperity.

Moreover, this finding has not gone unnoticed. The Government has referenced it and stated its commitment to providing support through the tax system as well as enabling such businesses to access more diverse sources of finance, including debt and equity.[269]

261 Pike Research estimates up to $221.5 billion by 2030 262 *Future Value of Coal Carbon Abatement Technologies to UK* Industry, AEA 2009 263 *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*, Foresight Horizon Scanning Centre, Government Office for Science, 2010 264 *Technology and Innovation Futures: UK Growth Opportunities for the 2020s*, Foresight Horizon Scanning Centre, Government Office for Science, 2010, p3 265 *Regenerative medicine cell therapies: numbers of units manufactured and patients treated between 1988 and 2010.* Mason C. and Manzotti E. Regenerative Medicine. 2010, 5(3), p307-313 266 PearlDriver Technologies forecast 2008 267 Website accessed on 30 August 2012 (http://www.bis.gov.uk/assets/foresight/docs/general-publications/10-1252an-technology-and-innovation-futures-annex.pdf) 268 Website accessed on 30 August 2012 (http://www.nesta.org.uk/areas_of_work/economic_growth/assets/features/the_vital_6_per_cent) 269 *Innovation and Research Strategy for Growth*, Department for Business, Innovation and Skills, December 2011

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Part 1 – Engineering in Context
4.0 Population changes

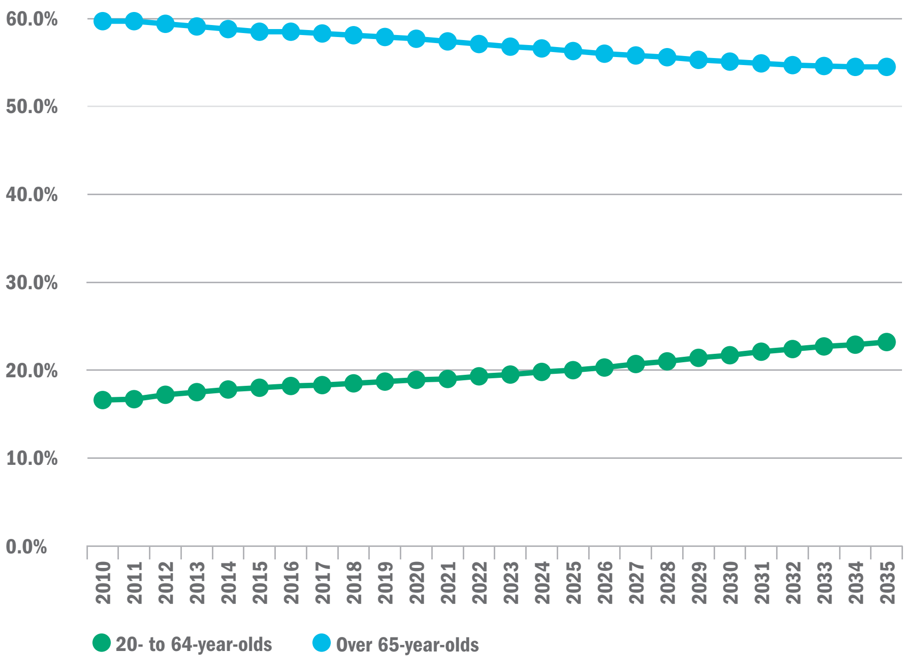
The National population projections for the UK are produced by the Office for National Statistics (ONS) in consultation with the statistical offices of the different home nations. ONS has published projected population statistics from 2010 to 2035, and for selected years beyond 2035; the projections are filtered by age or age group and are further broken down by gender.

The UK population is projected to increase by 4.9 million over the next ten years, from an estimated 62.3 million in 2010 to 67.2 million in 2020. In addition to growing, the population is ageing, with the median average age rising from 39.7 years in 2010 to 39.9 years in 2020 and 42.2 by 2035.[270]

In 2010, there were 1.4 million people in the UK aged 85 and over. This number is projected more than double over 25 years, increasing to 1.9 million by 2020 and to 3.5 million by 2035.

Figure 4.0 looks at the proportion of 20- to 64-year-olds and over 65-year-olds as part of the total population between 2012 and 2035. The 20-64 cohort, which is considered to be the most economically active, will experience a gradual decline, whilst the proportion of those aged over 65 will increase. In 2012, the estimated proportion of 20- to 64-year-olds was 59.4%, declining to 57.1% by 2022 to 54.5% by 2035. On the other hand, the number of over 65-year-olds is projected to increase from 17.2% in 2012 to 19.1% by 2022. By 2035, those aged over 65 will be almost a quarter (23.2%) of the UK population.

Fig. 4.0: The proportion of 20- to 64-year-olds and over 65-year-olds as part of the total population (2012-2035) – UK[271]



Source: ONS

270 Based national population projections, principle projections and key variants, Office of National Statistics, 2010 **271** 2010 base year

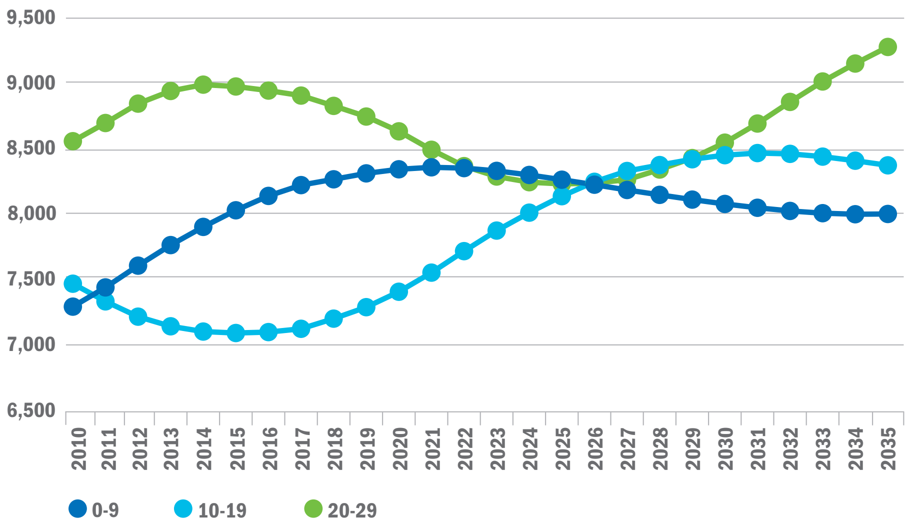
Figure 4.1 looks at the projected number of 0- to 29-year-olds between 2012 and 2035, broken down into 0- to 9-, 10- to 19- and 20- to 29-year-olds. The number of 0- to 9-year-olds is expected to rise steadily in the first ten-year period, from 7,616,000 in 2012 to 8,356,000 by 2022. This increase puts pressure on Government to make sure there are enough primary and junior school places and teachers. Between 2022 and 2035, numbers in this cohort are expected to fall steadily to 8,008,000.

The number of young people aged 10-19 years is expected to see a decline until 2015, from 7,229,000 in 2012, down to 7,105,000. After 2015 it will increase rapidly, reaching 7,418,000 in 2020 and 8,454,000 by 2030 and finally declining slightly to 8,377,000 by 2035.

The projected number of young people aged 20 to 29 years is expected to increase from 8,845,000 to 8,989,000 by 2014, and then gradually decline to 8,235,000 by 2025. After that, a steep rise to 9,275,000 is expected by 2035.

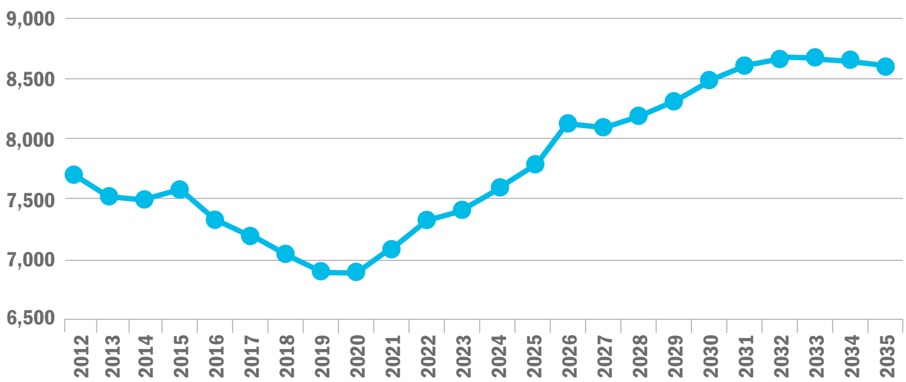
Figure 4.2 looks at the projected number of 18-year-olds from 2012 to 2035: from 2012 to 2020, the numbers will decline annually from 772,500 to 688,700, with the exception of a slight increase in 2015. As a result, there will be fewer young people completing education, going into Higher Education and, ultimately, joining the engineering workforce. However, from 2020 onwards, the number of 18-year-olds is expected to steadily increase, reaching 862,500 by 2035.

Fig. 4.1: Projected 0- to 29-year-old population in thousands (2012-2035) – UK[272]



Source: ONS

Fig. 4.2: Projected 18-year-old population in thousands (2012-2035) – UK[273]



Source: ONS

272 2010 base year 273 2010 base year

Part 1 – Engineering in Context

5.0 Understanding and influencing target audiences

"There is no truth. There is only perception".

Gustave Flaubert

In section 15, we show that between 2010 and 2020 engineering companies will need to attract 1.86 million workers with engineering skills approximately one third of the entire 5.4 million workforce who currently work in engineering enterprises.[274] If the UK is to meet this large demand, we need to make sure that all young people receive good careers advice and guidance (CIAG) while in education, so that they can make informed subject and/or career choices. Alongside this, the engineering sector needs to ensure that engineering and engineering careers are actively promoted as the attractive, well-paid, exciting and technologically advanced activities they are.

5.1 Influencing perceptions of STEM

To attract young people into engineering or STEM careers, we need to do two crucial things. Firstly, we must build a better understanding of their perceptions of STEM through robust research. Secondly, we need to develop appropriate programmes, activities or interventions which will positively influence their perceptions of STEM.

When the Wellcome Trust looked at attitudes to science,[275] it found that nearly all young people thought it was important *for their parents* that they do well in school science. In the same report,[276] the Wellcome Trust showed that young people expressed a preference for being taught science via practical, hands-on activities, which they believed made science learning more interesting and easier to understand. They also found that young people would be more engaged with science if it was more relevant to contemporary life.[277]

In terms of engineering, research[278] shows that it is an important driver of the STEM agenda outside of schools. However, inside many secondary schools, STEM is seen as a proxy for science. This means that engineering suffers, as it does not form an identifiable part of the school curriculum. Similarly, technology is seen as just being design and technology with no understanding or its wider links to the STEM agenda.

Looking at perceptions of engineering at an international level by analysing the Programme for International Student Assessment (PISA) data, the OECD has determined that in OECD countries only 5% of girls and 18% of boys expect a career in engineering and computing. Within the UK, our own research[279] shows that 91% of women effectively rule themselves out of a job in engineering by not choosing triple science at age 14.

Finally, looking at perceptions of maths, 45% of 14- to 16-year-olds stated unprompted that maths should be relevant to real life and involve practical scenarios,[280] indicating that students see a disconnection between the maths they learn at school and the maths they think they need outside of school.

5.1.1 The importance of STEM enrichment and enhancement activities

An important way of changing young people's perceptions of STEM is through enrichment and enhancement activities. Research by the Wellcome Trust[281] has shown that a majority of young people said school trips made science more interesting and increased their understanding of the issues. But they also said that trips needed to support classroom learning or else it would just be a nice day out of the classroom.

Our own research[282] has shown that over nine out of ten (91%) STEM teachers are aware of enhancement and enrichment activities, but only 46% got involved in them. It also identified that nearly a quarter (23%) of

274 See section 2 for details on the number of workers currently employed in engineering companies. **275** *Exploring young people's views on science education*, Wellcome Trust, September 2011, p25 **276** *Exploring young people's views on science education*, Wellcome Trust, September 2011, p6 **277** *Exploring young people's views on science education*, Wellcome Trust, September 2011, p6 **278** *Good Timing Implementing STEM careers strategy in secondary schools*, Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011, p11 **279** *An investigation into why the UK has the lowest proportion of female engineers in the EU*, EngineeringUK, April 2011, p17 **280** *Ways into Work: Views of children and young people on education and employment*, City and Guilds, May 2012, p17 **281** Exploring young people's views on science education, Wellcome Trust, September 2011, p43 **282** *STEM Teachers Careers Information Survey*, EngineeringUK, August 2011, p1 those aware of enrichment and enhancement activities would like to get involved.

In the study *Good Timing Implementing STEM careers strategy in secondary schools*,[283] it was identified that some of the best STEM activity occurs in informal learning contexts. However, while STEM enrichment and enhancement is seen as a mechanism for increasing interest in STEM subjects, it is not seen as a route for promoting careers, information, advice and guidance (CIAG). The Royal Society has also identified that schools don't understand the range of enrichment and enhancement opportunities available to them and that there needs to be a greater level of co-ordination.[284]

National multi-partner co-ordination of enrichment and enhancement activities is something EngineeringUK is developing through its two core programmes The Big Bang Fair and Tomorrow's Engineers.

Independent evaluation of The Big Bang Fair 2012[285] showed that the 49,000 visitors who attended over the three days were enthused about the content, variety, scale and atmosphere of the event. The event also achieved its desired outcome of improving young people's and adults' knowledge and perceptions of STEM. In addition, a majority of teachers said they would incorporate activities, ideas and materials into future lessons.

The impact of our two main programmes can also be demonstrated by our evaluation of activities against the benchmark of perceptions in the UK.[286] In 2011, 29% of 12- to 16-year-olds surveyed in the *Engineers and Engineering Brand Monitor* said a career in engineering was desirable. But 45% of secondary school students who took part in the Tomorrow's Engineers programme and 54% of 12- to 19-year-olds who took part in The Big Bang Fair thought a career in engineering was desirable.

Similarly, in 2012 only 19.8% of 12- to 16-year-olds questioned for the brand monitor survey said they knew what engineers did. The comparable figure for those taking part in the Tomorrow's Engineers programme was 34.7%, while 41.0% of 12- to 16-year-olds attending The Big Bang Fair said they knew what engineers did.

5.2 Measuring perceptions in engineering – The Engineers and Engineering Brand Monitor

Each year, EngineeringUK commissions the *Engineers and Engineering Brand Monitor* survey.[287] The results from the 2012 survey show, that compared with 2011, there are positive changes in secondary school aged students – an important age group for influencing perceptions.

Two key statistically significant improvements have been identified. Firstly, the proportion of 12- to 16-year-olds expressing a 'top two box' knowledge of what people working in engineering do has almost doubled, moving from 11% in 2011 to 19% this year. Secondly, the likelihood of young people seeing a career in engineering as being desirable has also increased year-on-year, from 29% to 38% amongst 12- to 16-year-olds. A similar knowledge increase – from 62% to 68% – is evident amongst the 20+ age group.

This increase in knowledge of engineering and its perceived desirability may be explained in part by the raised awareness and possible influence of teachers: their 'top two box' knowledge of engineering rose from 60% to 69% this year. It may also be explained by the fact that teachers were more likely to say that they think a career in engineering is desirable for their students (62% compared with 47% in 2011), and because 74% of respondents aged over 20 who have children say that they would recommend to their children that they consider a career in engineering.

5.3 Careers information advice and guidance

In April 2012, the Government in England launched the National Careers Service. This publicly-funded careers service for adults and young people aged 13 or over brings together elements of previous publicly-funded careers services for adults and young people, including Connexions and Next Steps.[288]

The National Careers Service provides information, advice and guidance on learning, training, career choice, career development, job search, and the labour market. It can be accessed online and by telephone. Face to face services are provided for people aged 19 and over by the National Careers Service, whilst schools have become responsible for the provision of face-to-face services for 11- to 19-year-olds. From September 2012, schools have a new duty to secure access to independent careers guidance for pupils in years 9-11 (14- to 16-year-olds). Head teachers, school staff and governing bodies must have regard to the statutory guidance which sets out how this new duty could be fulfilled.[289]

There is no specific budget allocated for the provision of these services or a legal requirement for careers guidance to be provided by a professional careers adviser. So many organisations providing information about specific career paths have voiced concerns regarding both the quality of advice and information that is likely to be provided by schools. There is an expectation that in some cases young people will simply be offered the website and helpline services, and the likely result will continue to be ill-informed careers choices.

There are a growing number of websites, organisations and individuals providing CIAG that schools may decide to use to fulfill their new duty. However, the quality of existing information about science and engineering careers is at best patchy. Sector Skills Councils, institutes and professional bodies are doing their best to work together to provide up to date information about careers in science and engineering. However, providing this information to the rising numbers of individuals and organisations now advising young people will become increasingly difficult.

There is already low awareness of the roles and routes to science and engineering careers,[290] and there is a possibility that this policy change and the potential resulting fragmentation and lack of quality CIAG available in schools will perpetuate this trend. In fact, our own research has shown that 91% of girls effectively rule themselves out of a career in engineering by not choosing to study triple science at age 14.[291]

283 *Good Timing Implementing STEM careers strategy in secondary schools*, Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011, p6 **284** *Shut down or restart? the way forward for computing in UK schools*, The Royal Society, January 2012, p11 **285** *The Big Bang Fair – Executive summary of research evaluating The Big Bang Fair 2012*, FreshMinds Research, May 2012, p1 **286** *The Engineers and Engineering Brand Monitor* provides a benchmark against which those engaging with our two main programmes can be compared. **287** *Engineers and Engineering Brand Monitor*, FreshMinds Research, August 2012 **288** Website accessed on 14 September 2012 (https://nationalcareersservice.direct.gov.uk/Pages/Home.aspx) **289** http://www.education.gov.uk/aboutdfe/statutory/g00205755/statutory-careers-guidance-for-young-people **290** Website accessed on 14 September 2012 (http://www.derby.ac.uk/files/icegs_stem_careers_awareness_timelines.pdf) **291** *An investigation into why the UK has the lowest proportion of female engineers in the EU*, EngineeringUK, April 2011

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Research conducted by City and Guilds in 2012[292] has shown that nearly two thirds (64%) of 14- to 18-year-olds receive careers advice from teachers, but that only 14% rated it as very useful. This is reinforced by research conducted by EngineeringUK,[293] which showed that nearly nine out of 10 (87%) teachers agreed that providing CIAG was part of their role. This research also identified that 79% of these respondents would answer pupils' questions based on their own knowledge and experience. In our brand monitor research,[294] we showed that 17% of STEM teachers thought a career in engineering was undesirable, and they based this perception on negative and outdated beliefs. This therefore raises some very important concerns about the quality of CIAG in relation to engineering.

In the report *Good Timing Implementing STEM careers strategy in secondary schools*,[295] it was identified that careers education doesn't usually have a high status in schools and that there is often a weak or non-existent link between careers provision and individual subject departments.

Furthermore, research by the Wellcome Trust[296] has shown that young people would like to see a greater emphasis on careers guidance and the use/value of science at an earlier stage of their schooling.

There is an emerging body of research which explores the importance and impact of work placements on providing effective CIAG to pupils. In its *Ways into Work: Views of children and young people on education and employment* report,[297] City and Guilds identified that the most useful advice on employment and careers came from visiting an employer, with 44% of 16- to 18-year-olds rating this as very useful. The Education and Employers Taskforce[298] have also shown that work experience plays an important, sometimes essential role in determining admission to university courses.

However, the same two research reports also identified barriers to young people going on work placements. The Education and Employers Taskforce[299] showed that around half of work placements are sourced directly, either by the young person or their families, which means that, *"work experience is under-utilised as a means to stretch the career horizons of young people"*. It also means the work experience might not be a good fit with the realities of demand in the labour market. Meanwhile, City and Guilds[300] identified that only 26% of 16- to 18-year-old respondents to its survey had actually visited an employer.

It is also worth considering that young people who had contact with an employer at least four times, were five times to be more likely to be in education, employment or training than their peers who could recall no such contacts.[301]

5.4 Employers' engagement with schools

Section 5.3 shows that employer visits are a very important element of CIAG. However, research with employers shows that there are a number of obstacles for businesses when it comes to offering work experience and engaging with schools.

Research by the UK Commission for Employment and Skills (UKCES)[302] has identified a number of barriers employers face when trying to engage with schools. These fall into three main categories:

Businesses and schools working together

- It can be difficult for small businesses to 'get a foot in the door' with schools, which tend to find it easier to work with larger businesses.
- Some schools do not recognise the role that businesses can play in working with them to enhance and enrich the education experience for their students.
- Some schools are focusing on areas that relate to performance tables, such as exam results, and do not see working with businesses as a priority.
- Businesses have constraints on the time and resources they can provide to work with schools.

Work experience

- Businesses may have to turn schools away due to the volume of demand and the timing being too prescriptive for work experience placements – most schools request work experience placements in the summer term.
- Poor planning of the work experience can lead to poor quality placements or placements that do not meet the needs of the student.

Awareness of and access to guidance and support

- Schools and businesses may not know where to start, due to a lack of access to clear guidance, information and support.
- Misinformation and misunderstanding around the areas of regulation such as insurance, health and safety and Criminal Records Bureau (CRB) checks was cited by both schools and businesses.

Ofsted[303] has also indicated that schools asking for placements at the same time of year meant the number of placements they could accommodate was restricted. The British Chambers of Commerce has also shown that two thirds (65.4%) of employers offered some sort of work-related learning activity, with work placements being the most popular form. This is corroborated by the Confederation of British Industry (CBI),[304] which said that 70% of its employers provide work experience for pupils. The CBI research also indicated that half (51%) provided careers advice and/or careers talks.

Finally, on the positive side, UKCES is calling for every UK business to adopt a youth policy.[305] It states that the most successful businesses recognise the value of growing their own talent, and asks that most companies should do at least one thing for young people in their community – from offering apprenticeships, hosting some form of work experience, visiting schools to give talks, offering teachers or college lecturers a workplace visit or mentoring a young person.

292 *Ways into Work: Views of children and young people on education and employment*, City and Guilds, May 2012, p2 293 STEM Teacher Careers Information Survey, EngineeringUK, April 2011, p3 294 *Engineers and Engineering Brand Monitor*, FreshMinds Research, August 2012 295 *Good Timing Implementing STEM careers strategy in secondary schools*, Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011, p6 296 *Exploring young people's views on science education*, Wellcome Trust, September 2011, p7 297 *Ways into Work: Views of children and young people on education and employment*, City and Guilds, May 2012, p2 298 *Work Experience: impact and delivery – insights from the evidence*, Education and Employers Taskforce, April 2012, p5 299 *Work Experience: impact and delivery – insights from the evidence*, Education and Employers Taskforce, April 2012, p5 300 *Ways into Work: Views of children and young people on education and employment*, City and Guilds, May 2012, p2 301 *Ways into Work: Views of children and young people on education and employment*, City and Guilds, May 2012, p2 302 *Business and schools building the world of work together*, UKCES, April 2012, p5 303 *Apprenticeships for young people*, Ofsted, April 2012, p5 304 *Learning to grow: what employers need from education and skills Education and Skills survey 2012*, CBI, June 2012, p29 305 *The youth employment challenge*, UKCES, July 2012

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Part 1 – Engineering in Context
6.0 Mining the talent pool – capacity and equity

The large numbers of young people who are NEET (not in employment, education or training) is one of the most serious social problems facing the country. Almost a million young people in England are NEET, more than one in every seven 16- to 24-year-olds. While this in part reflects the impact of the recession, the number of NEETs was rising before this; the recession simply exacerbated the problem. The growing number of NEETs is a source of major concern and it represents a large economic and social cost.[306]

In the *Engineering UK report 2012*, section 6 – *Mining the talent pool*,[307] we comprehensively bought to the reader's attention the various disparities in educational provision and progression due to a range of factors – social, financial, type of school or poor careers advice – which, actively or passively, hindered young people, creating a cohort of NEETs. Much of what was reported still remains true,[308] so this year's section concentrates on highlighting and presenting only new data and new insights that serve to help address the on-going serious challenges and unfairness.

It is worth stating at the outset that the majority of young people do succeed in education and make a positive transition to adult life and the world of work. But, with just under one million (954,000) 16- to 24-year-olds in England classifying as NEET, we still face a very real challenge in terms of opportunities for young people.

In its *Building Engagement, Building Futures*[309] paper, the Government sets out its entire strategy for improving opportunities for young people, so that they gain the skills they need to secure an apprenticeship or employment. This strategy includes radical reforms to schools, vocational education, skills and welfare provision.

The strategy highlights that attainment at 16 is the single most important factor in securing young people's participation and future achievement. It sets out plans for achieving full participation of 16- to 17-year-olds and 18- to 24-year-olds in education and training and plans for supporting 18- to 24-year-olds into employment. It also looks at how it can support 18-24 year olds on inactive benefits and those in disadvantaged groups. In short, it maps out a plan of action for the entire 16-24 cohort.

6.1 Our untapped capacity for growth

Our analysis of *Working Futures 2010-2020* in section 15, shows that we will need to recruit 1.86 million workers with engineering skills approximately one third of the entire 5.4 million workforce who currently work in engineering enterprises.[310] So it falls on UK policy makers to make sure we make the most of our capacity, so that we can meet this future demand and retain our engineering and manufacturing competitiveness.

We need look no further than Table 6.0 which clearly shows that the capacity in our 16- to 24-year-olds remains stubbornly untapped. The latest figures for this cohort show that there were just under one million NEETs (954,000) in quarter one of 2012.

306 Lost in transition? The changing labour market and young people not in employment, education or training, Paul Sissons and Katy Jones, The Work Foundation, May 2012 **307** Engineering UK 2012 the state of engineering, EngineeringUK, December 2011, p70-79 **308** Building Engagement, Building Futures: Our Strategy to Maximise the Participation of 16-24 Year Olds in Education, Training and Work, HMGovernment, December 2011 **309** Website accessed on the 3rd September 2012 (http://media.education.gov.uk/assets/files/pdf/building%20engagement%20building%20futures.pdf) **310** See section 2 for details on the number of workers currently employed in engineering companies.

Table 6.0: Number of young people classed as NEET, by age[311] and gender (2000-2011) – England

	16- to 24-year-olds			16- to 18-year-olds		
	All (thousands)	**Male (thousands)**	**Female (thousands)**	**All (thousands)**	**Male (thousands)**	**Female (thousands)**
Q4 2000	629	240	389	151	84	67
Q4 2001	664	273	391	172	85	86
Q4 2002	660	271	389	177	95	82
Q4 2003	669	275	394	177	96	81
Q4 2004	748	314	434	188	105	83
Q4 2005	840	377	463	217	132	85
Q4 2006	810	362	448	197	114	84
Q4 2007	783	338	446	192	110	82
Q1 2008	**811**	**358**	**453**	**193**	**101**	**92**
Q2 2008	840	351	489	209	110	99
Q3 2008	971	415	557	256	124	131
Q4 2008	853	361	492	206	108	98
Q1 2009	**929**	**434**	**495**	**220**	**123**	**97**
Q2 2009	954	444	509	234	127	107
Q3 2009	1,074	510	565	262	146	117
Q4 2009	896	403	492	178	98	79
Q1 2010	**928**	**425**	**502**	**195**	**108**	**87**
Q2 2010	872	380	493	197	103	93
Q3 2010	1,026	439	587	265	138	127
Q4 2010	939	433	506	162	92	70
Q1 2011	**925**	**431**	**495**	**159**	**88**	**71**
Q2 2011	979	434	545	186	99	87
Q3 2011	1,163	532	632	267	151	116
Q4 2011	958	462	496	178	108	69
Q1 2012	**954**	**460**	**494**	**183**	**109**	**74**
Percentage change from Q4 2000	**51.7%**	**91.7%**	**27.0%**	**21.2%**	**29.8%**	**10.4%**

From 2015, as the Raising the Participation Age legislation comes into force, **all** young people up to the age of 18-19, will be required to be in education, training or work-based learning. As a result, 16- to 19-year-old NEETs will disappear from the official statistics. Research will be needed to track this cohort and evaluate if Government policy has indeed been successful and to make sure that those aged 16-19 are fully engaging with the learning opportunities available. As a result, the NEET issue will be economically and socially more pronounced and detrimental for 19- to 24-year-olds than for 16- to 19-year-olds.

In response to this vital issue, the UK Commission for Employment and Skills (UKCES) is calling for every UK business to adopt a youth policy,[312] stating that the most successful businesses recognise the value of growing their own talent. It asks that most companies should do at least one thing for young people in their community – from offering apprenticeships, hosting some form of work experience, visiting schools to give talks, offering teachers or college lecturers a workplace visit or mentoring a young person.

311 Age refers to academic age, which is defined as the age of the respondent at the preceding 31 August 312 *The youth employment challenge*, UKCES, July 2012

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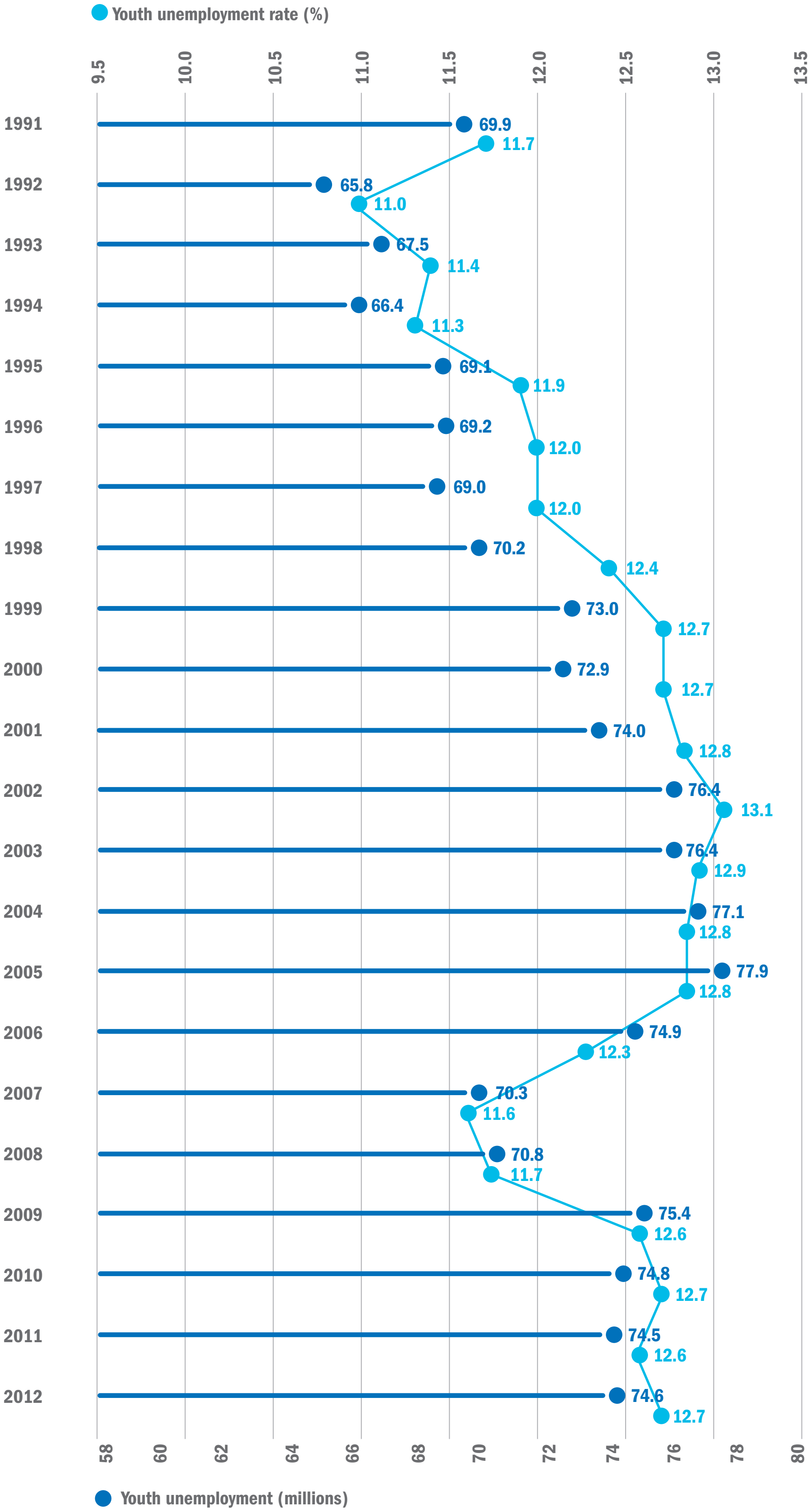
6.1.1 We are not alone

Unfortunately, our youth unemployment issues are shared across the globe: Figure 6.0 shows that we are not alone when it comes to global youth unemployment.

At 12.6% in 2011 and projected at 12.7% in 2012, the global youth unemployment rate[313] remains at least a full percentage point above its level in 2007. Nearly 75 million youth are unemployed around the world, an increase of more than 4 million since 2007. Medium-term projections (2012–16) suggest little improvement in youth labour markets. By 2016, the youth unemployment rate is projected to remain at the same high level.

Fig. 6.0: Global youth unemployment and unemployment rate (1991-2012)



Source: ILO, Trends Economic Models, April 2012

313 *Global Employment Trends for Youth 2012*, ILO, May 2012, p14 http://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/publication/wcms_180976.pdf

6.1.2 What do the statistics tell us?

Below the surface number of 954,000 NEETs, Figure 6.1 (taken from the *Building Engagement, Building Futures report*[314]) shows us that:

- 150,000 are 16- to 17-year-olds who may need additional opportunities or support to re-engage in education or training.
- 523,000 are 18- to 24-year-olds who are unemployed, not in education, and looking for work. Of those, 249,000 have been unemployed for over six months and may need significant help to find work.
- 490,000 are 18- to 24-year-olds who are economically inactive. Of these, 371,000 are looking after family or home, or are sick or disabled. The remaining 119,000 are inactive for a wide range of other reasons.

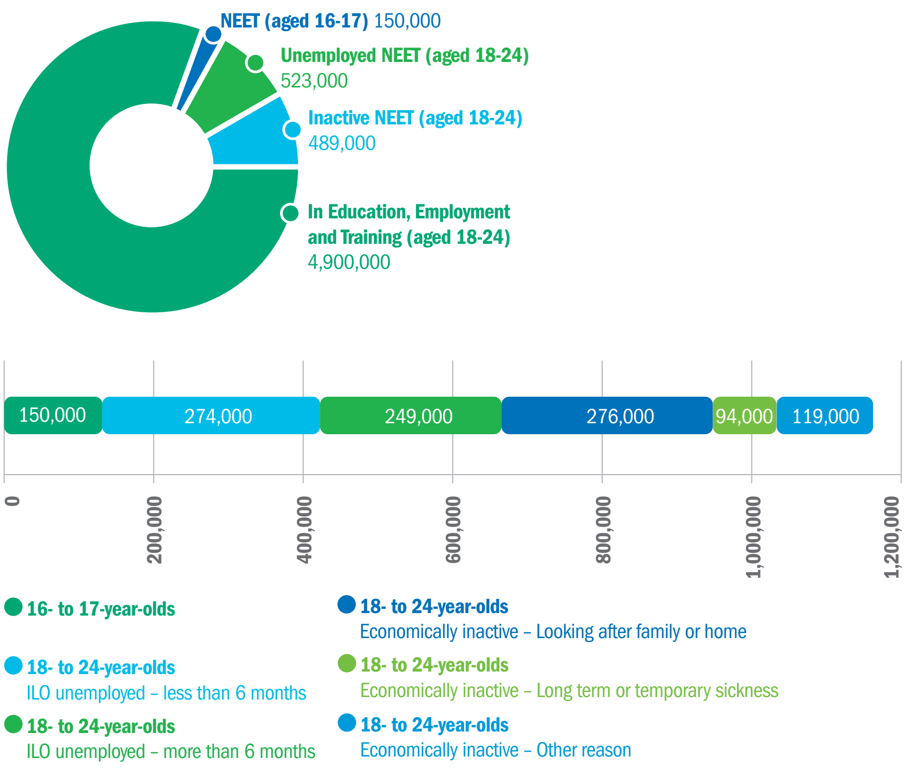
Table 6.1 breaks down the NEET cohort by age and supports the point that the issue is economically and socially more pronounced and detrimental for 19- to 24-year-olds than for 16- to 19-year-olds.[315]

Recent facts and figures which illustrate the current inequalities within both our society and educational systems are:

Children eligible for free school meals (FSM) are still only half as likely as other children to achieve five good GCSEs, including English and maths,[316] and fewer than 4% achieve the English Baccalaureate. The gaps in achievement between rich and poor actually widens during the school years.[317]

Attainment at 16 and the qualifications achieved by an individual are the most important factors in determining later participation and attainment. By the age of 18, 45% of those with no reported qualifications had spent more than a year NEET, compared with 4% of those with 5-7 GCSEs at A*-C.[318]

Fig. 6.1: Breakdown of 16- to 19-year-old NEETs



Source: Labour Force Survey, Quarter 3 2011

Table 6.1 NEETs by age group (2011)

Age (years)	Percent in total
16	6
17	4
18	8
19	11
20	14
21	13
22	14
23	15
24	15

Source: Labour Force Survey

An estimated[319] 13% of maintained school pupils who received FSM entered Higher Education in 2005/06. This rose steadily to an estimated 17% in 2008/09. The estimated progression rate for pupils not receiving free school meals also increased, but with a smaller increase, from 33% to 35%. The gap between FSM and non-FSM rates is therefore estimated to have fallen slightly, to 18 percentage points (Table 6.2).

The Department for Education[320] has also shown that students on FSM are less likely than those not on FSM to take up A level maths and science (for maths FSM students were one quarter as likely to study the subject and for physics it was one third as likely). Students on FSMs are also less likely to achieve A and B grades at A level than their non-FSM counterparts reflecting both a shortage in FSM students progressing into A level maths and physics and an attainment gap.

Two reports have provided some evidence-based thinking on avenues for intervention, namely careers information, advice and guidance (CIAG) and employer engagement:

Firstly, an encouraging finding by the Institute of Education[321] sheds new light on the matter. Analysis of the Longitudinal Study of Young People in England (LSYPE) showed that, while those in the top income quintile group are more likely than those in the

314 *Building Engagement, Building Futures: Our Strategy to Maximise the Participation of 16-24 Year Olds in Education, Training and Work*, HM Government, December 2011, p4, Figure 1 **315** *Lost in transition? The changing labour market and young people not in employment, education or training*, Paul Sissons and Katy Jones, The Work Foundation, May 2012 **316** *GCSE and Equivalent Attainment by Pupil Characteristics in England 2009/10,Statistical First Release*, Department for Education 2010 **317** *Children's educational attainment: how important are attitudes and behaviours?* Joseph Rowntree Foundation, 2010 **318** *Youth Cohort Study and Longitudinal Study of Young People in England: The Activities and Experiences of 18 year olds*, Department for Education, July 2010 **319** *Widening Participation in Higher Education: Analysis of progression rates for young people in England by free school meal receipt and school type*, Department for Business, Innovation and Skills, August 2011 **320** *Maths and science education: the supply of high achievers at A level*, Department for Education, January 2011, p123 and p130 **321** *What's the link between household income and going to university?* Jake Anders, DoQSS Working Paper No. 12-01, IOE, March 2012

Table 6.2: Estimated percentage of maintained school pupils aged 15, by Free School Meal status who entered HE by age 19 Academic UK Higher Education Institutions and English Further Education Colleges (2005/06-2008/09)

	Estimated % who entered HE FSM [1]	Non-FSM [1]	Gap (percentage points) [2]	All
2005/06	13%	33%	19%	30%
2006/07	14%	33%	19%	31%
2007/08	15%	33%	18%	31%
2008/09	17%	35%	18%	33%

[1] FSM and Non-FSM refer to whether pupils were receiving Free School Meals or not.

[2] Gap is the difference between FSM and non-FSM expressed in percentage points. Percentage figures are rounded; gap figures are calculated from un-rounded data and therefore may not correspond to the gap between rounded percentages.

Source: Education and Employers Taskforce.

bottom quintile group to attend university (66% vs. 24%), much of this gap is explained by earlier educational outcomes. Their paper also examines admissions decisions in more detail, separating applying from attending. That analysis yields results suggesting most of the difference in participation rates is driven by the application decision. The attendance gap conditional on having applied is much smaller (85% vs. 68%).

It therefore seems that if we can inspire and support NEETs to study the appropriate STEM subjects and apply to university, they have a high likelihood of actually attending. This finding reinforces the key role that good CIAG can play if provided at the 'right' times which, from our own research,[322] appears to be between the ages of 12 and 14 years old.

Secondly, evidence[323] from the Employers and Education Taskforce shows statistically significant positive relationships exist between the number of employer contacts (such as careers talks or work experience) that a young person experience in school between the ages of 14 and 19 and:

- their confidence (at 19-24) in progression towards ultimate career goals
- the likelihood of them being NEET at 19-24
- their earnings if salaried

The 7% of young adults surveyed who recalled four or more activities while at school were five times less likely to be NEET and earned, on average, 16% more than peers who recalled no such activities. The findings are not linked to highest level of qualification. This reinforces the key role that forward thinking employers could play and the difference they could make.

It is interesting to note that the type of sector in which young people work has been changing.[324] Table 6.3 looks at changes in the industries that young people worked in between 1981 and 2011. It is evident that there has been a sharp decline in the importance of manufacturing for young people in the last three decades, from almost a quarter of total employment to just 8%.

Table 6.3: Employment of 16- to 24-year-olds by industry (1981 and 2011)

	1981	2011
Agriculture, forestry and fishing	2%	1%
Energy and water	7%	1%
Manufacturing	24%	8%
Construction	7%	7%
Distribution, hotels and restaurants	24%	39%
Transport and communication	5%	5%
Banking and finance	11%	13%
Other services	19%	27%

Source: Labour Force Survey[325]

The data also show the considerable importance of employment in distribution, hotels and restaurants for young people, with almost 40% employed in these industries in 2011.

The employers' survey undertake by UKCES[326] showed that, contrary to popular belief, employers do still recruit young people from school and, in the main, they are well prepared for work. Around a quarter (24%) of UK establishments had recruited at least one person straight from education in the two to three years before the survey. Most employers found these education leavers to be well prepared for work, with this proportion increasing with the recruit's age and / or education level (up to 82% for university leavers). Where recruits were considered poorly prepared for work, this was most often put down to a lack of experience (of the world of work or, more generally, life experience or maturity), or to personality (poor attitude, or a lack of motivation).

In England, Northern Ireland and Wales,[327] most employers found recruits to be well prepared for work, with this figure increasing with age and educational level:

- 59% among those recruiting 16-year-old school leavers
- 64% of those recruiting 17- to 18-year-olds from school
- 72% of those recruiting 17- to 18-year-olds from Further Education
- 82% of those recruiting from Higher Education establishments

In Scotland, the proportion finding education leavers well-prepared followed a similar pattern:

- 68% of those employing Scottish school leavers
- 82% employing those leaving a Scottish FE college
- 86% employing those leaving a Scottish university

322 http://www.engineeringuk.com/_db/_documents/Int_Gender_summary_EngineeringUK_04_11_.pdf 323 *It's who you meet: why employer contacts at school make a difference to the employment prospects of young adults*, Dr Anthony Mann, Education and Employers Taskforce, 2012 324 *Lost in transition? The changing labour market and young people not in employment, education or training*, Paul Sissons and Katy Jones, The Work Foundation, May 2012 325 Because of changes in the classification columns are not directly comparable. 1981 data are Standard Industrial Classification (SIC) revision 1980; 2011 data are SIC 2007 326 *UK Commission's Employer Skills Survey 2011: UK Results*, UK Commission for Employment and Skills, May 2012 327 *UK Commission's Employer Skills Survey 2011:* UK Results, UK Commission for Employment and Skills, May 2012, p28

6.2 Cost to the economy

It is well known that in addition to the social costs caused by the NEET situation, there are also real financial costs to the UK economy.

At its current rates, youth unemployment will cost the Exchequer £4.8 billion in 2012 – more than the budget for Further Education for 16- to- 19-year-olds in England – and cost the economy £10.7 billion in lost output.[328] But the costs are not just temporary. The scarring effects of youth unemployment at its current levels will incur future costs of £2.9 billion per year for the Exchequer (equivalent to the entire annual budget for Jobcentre Plus) and £6.3 billion a year for the economy in lost output. Therefore, the net present value of the cost to the Treasury, even looking only a decade ahead, is approximately £28 billion.[329]

At an individual level, the Work Foundation has estimated that the average total cost to public finances of each 16- to 18-year-old who is currently NEET is £56,000 over the course of their lifetime.[330]

6.3 Government action

"No one should be prevented from fulfilling their potential by the circumstances of their birth. What ought to count is how hard you work and the skills and talents you possess, not the school you went to or the jobs your parents did."[331]

On 25 November 2011,[332] the Government announced that it will spend almost £1 billion over the next three years to provide unemployed young people with extra help. This 'youth contract'[333] is part of its participation strategy, *Building Engagement, Building Futures*, which aims to provide a strong, rich offer of further learning from age 18. The Department for Work and Pensions (DWP) has listed the key measures of this contract, which are described in the box.

Cash payments to encourage employers to recruit young people. There will be 160,000 job subsidies available worth up to £2,275 each for businesses who take on an 18– to 24-year-old from the Work Programme: enough to cover an employer's National Insurance contributions for a year.

An extra 250,000 Work Experience places over three years, taking the total to at least 100,000 per year. This will come with an offer of a Work Experience place for every 18- to 24-year-old who wants one, before they enter the Work Programme.

At least 20,000 extra incentive payments worth £1,500 each for employers to take on young people as apprentices, taking the total number of payments available to 40,000 in 2012.

Extra support through Jobcentre Plus in the form of weekly, rather than fortnightly, signing-on meetings, more time to talk to an adviser and a National Careers Service interview.

A new £150 million **programme to provide support to vulnerable 16- to 17-year-olds** who are NEET. This will provide vital support to help them to get back into education, an apprenticeship or a job with training.

The programme will take a **payment-by-results approach**, providing payments on the basis of young people sustainably engaging in education or training through full-time education, an apprenticeship or work with training. This approach is ever more essential in light of the raising of the compulsory participation age in education to 17 from 2013.

Finally, in its *Opening Doors, Breaking Barriers* strategy paper,[334] the Government shed some light on its key goal in this area stating that: *"We are primarily concerned with intergenerational social mobility – breaking the transmission of disadvantage from one generation to the next. Children must be free to succeed whatever circumstances they are born into."*

Social mobility is a measure of how free people are to improve their position in society. There are two key distinctions that shape the Government's approach to social mobility. Intergenerational versus intragenerational social mobility:

- Intergenerational social mobility is the extent to which people's success in life is determined by who their parents are.
- Intragenerational social mobility is the extent to which individuals improve their position during their working lives, irrespective of where they started off.

6.4 One size doesn't fit all

Research over the past year supports what we suspected we know all along but were unable to lay down in precise terms. That is, when it comes to NEETs and youth unemployment, a one-sized approach doesn't fit all!

Segmentation analysis undertaken by the National Foundation for Educational Research (NFER)[335] has very usefully identified three discrete sub-categories of NEETs:

- 'Open to learning' NEETs (41% of NEET group) – young people most likely to re-engage in education or training in the short term and with higher levels of attainment and better attitudes towards school than other NEET young people.
- 'Sustained' NEETs – (38% of NEET group) – young people characterised by their negative experience of school, higher levels of truancy and exclusion, and lower academic attainment than other NEET young people. They are most likely to remain NEET in the medium term.
- 'Undecided' NEETs (22% of NEET group) – young people similar in some respects, such as their attainment levels, to those who are 'open to learning' NEET, but dissatisfied with available opportunities and their inability to access what they want to do.

Complimentary research by the Audit Commission,[336] and Gracey and Kelly[337] provide the following insightful points about these sub- categories.

328 *Youth unemployment: the crisis we cannot afford*, ACEVO, 2012, p4 **329** *Lost in transition? The changing labour market and young people not in employment, education or training, Paul Sissons and Katy Jones*, The Work Foundation, May 2012, p11 **330** *Lost in transition? The changing labour market and young people not in employment, education or training, Paul Sissons and Katy Jones*, The Work Foundation, May 2012, p11 **331** *Opening Doors, Breaking Barriers: A Strategy for Social Mobility*, HM Government, April 2011, p5 **332** http://www.cabinetoffice.gov.uk/ **333** http://dwp.gov.uk/youth-contract/key-initiatives/ **334** *Opening Doors, Breaking Barriers: A Strategy for Social Mobility*, HM Government, April 2011, p15 **335** *A review of career professional's involvement with schools in the UK*, NFER, May 2012 **336** *Against the Odds: Re-engaging Young People in Education, Employment or Training*, Audit Commission 2010 **337** *Changing the NEET Mindset: Achieving More Effective Transition Between Education and Work*. Learning and Skills Network, Gracey, S. and Kelly, S. 2010

- The ‘open to learning’ (or unable to find work) group have few barriers to engagement and may simply be waiting for a course to begin or to find employment. They are likely to engage in the short to medium term and require only low-level or no support. They represent a large component of the NEET group, and are a ‘savings target’ for councils. Fiscal incentives to employers, such as tax breaks or subsidies, may also help to open up opportunities for this group.
- The ‘sustained’ (or disengaged) group face multiple barriers and require high-cost targeted support.
- The ‘undecided’ (or unsure) group need appropriate and timely CIAG and resilience building to help develop a sense of determination, focus and direction.

The Government’s *Opening Doors, Breaking Barriers: A Strategy for Social Mobility* report usefully summarises additional categories that differentiate NEETs and, in turn, its approach to addressing social mobility issues:[338]

Gender, race, disability and other characteristics also influence life chances. Some groups – especially disabled people, some ethnic groups and some religious groups – are over-represented among the less well-off.[339]

Different groups are affected, for better and for worse, in different ways. This means that our approach to social mobility will need to be sensitive to these other influences. The impact of these characteristics has been documented at length elsewhere.[340] Some important findings include the following:

- FSM eligibility appears to have little impact on the GCSE performance of children from Chinese origins, but white British and black Caribbean boys eligible for FSM perform poorly.
- Participation in Higher Education by white British teenagers is lower than for many ethnic minorities, particularly in the middle of the attainment range. However, ethnic minority graduates are under-represented in the graduate recruitment of large organisations.
- Women outperform men throughout the education system yet do not do as well in the labour market, with pay not reflecting their qualification levels. There is a persistent labour market penalty associated with becoming a mother.
- Some ethnic groups – particularly Pakistani and Bangladeshi women – have relatively low employment rates.
- There are large differences in employment rates and wages between those who are disabled and those who are non-disabled and the gap appears to have grown in the last 25 years.

Clearly we can see that the parlous state of affairs with NEETs in the UK has been recognised and concrete steps have been put into place. Nevertheless, the statistics speak for themselves and we have a long way to go. NFER offers some sobering words: *“However, it is unlikely that youth inactivity levels will begin to fall within the current economic climate unless there is a major macroeconomic, fiscal stimulus, or an enhancement of opportunity through national youth training offers, or through the commitment and engagement of local employer communities.”*[341]

On a final, positive note the last part of this section describes a pro-active and successful initiative aimed at recruiting highly talented graduates to teach STEM subjects in schools where the majority of pupils come from low-income neighbourhoods.

6.5 Closing the science talent gap

Authored by Katherine Richardson, Senior Data and Impact Officer, Teach First

In 1958, a typical future engineer was born into a household 8% richer than average. By 1970, they were born into a household 16% richer than average.[342] We are seeing increasing inequality in the way in which children grow up to realise their career aspirations, a trend which is mirrored across most professions. This is a moral issue for everyone who wants to live in a fair society. It is also an economic call to action, because raising the achievement of children from low socio-economic backgrounds to the national average would add 3.9% (£140 billion per year) to GDP by 2050.[343] When two-fifths of employers have difficulty recruiting staff with STEM skills,[344] and an A level maths qualification attracts a £136,000 premium in lifetime income,[345] it is simply not smart to waste the talent of more than a million children growing up in low-income neighbourhoods – especially in these times of economic uncertainty.

Teach First is an educational charity with the vision that no child’s educational success should be limited by their socio-economic background. In the ten years since we were founded, we have learned a lot about the

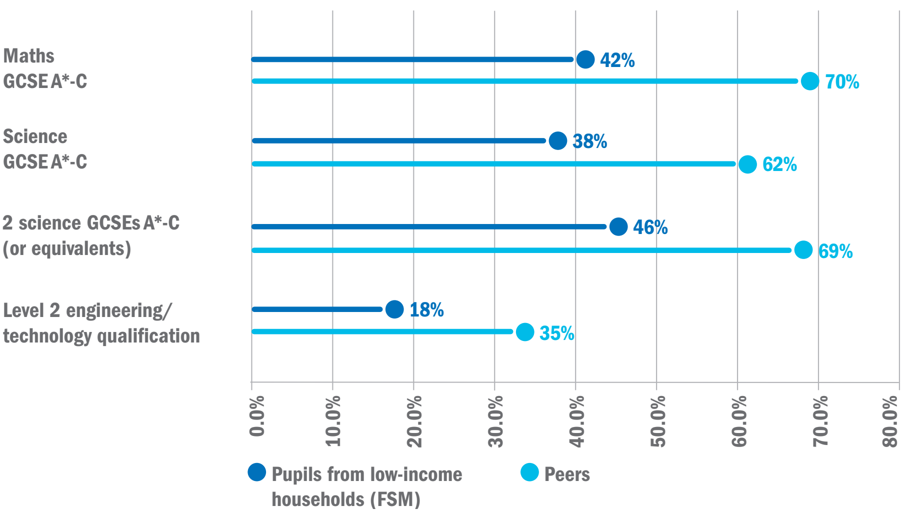
338 *Opening Doors, Breaking Barriers: A Strategy for Social Mobility*, HM Government, April 2011, p21 **339** National Equality Panel, *An Anatomy of Economic Inequality in the UK*, Government Equalities Office, 2010 **340** National Equality Panel, *An Anatomy of Economic Inequality in the UK*, Government Equalities Office, 2010 **341** *Approaches to supporting young people not in education, employment or training – a review*, Julie Nelson and Lisa O’Donnell, NFER, 2011, p18 **342** *Social Mobility and the Professions*, Centre for Market and Public Organisations, 2009 **343** *The Mobility Manifesto*, Sutton Trust, 2010 **344** *Education and Skills Survey 2011*, CBI, 2011 **345** *The Value of Mathematics*, Reform, 2008 symptoms of educational disadvantage, especially the barriers to accessing STEM degrees and, eventually, related careers. We know that the gap in educational success opens early. By age 14, children from low-income households are on average more than a year behind their peers in maths and science (0.8 and 0.7 National Curriculum levels respectively).[346] At age 16, they are less likely to achieve benchmark grades of A*-C in maths, science, and engineering/ technology (Figure 6.2), and these gaps get even bigger when GCSE-equivalent qualifications such as BTec are excluded.[347] Each percentage point of these gaps represents around 1,000 children from low-income households who are not succeeding at the expected level.[348] In the case of maths GCSE, raising these pupils' achievement to the level of their peers would mean almost 30,000 extra pupils from low-income households achieving an A*-C grade, opening doors to future education and employment. We also know that achievement is a huge stepping stone, but not a guarantee of progression. Even when young people from low-income households do achieve as highly as their peers at age 16, they are less likely to study two or more A levels in maths and science,[349] a key route to Higher Education and employment opportunities in STEM.

What causes these persistent gaps in achievement and progression within STEM subjects? The causes and consequences of educational disadvantage are multi-faceted and complex, and are certainly not limited to the STEM subjects. However, we can pinpoint one major factor which systematically disadvantages children from low-income households, limiting the opportunities, resources and expectations available to these pupils. This is the quality of teaching experienced by children from low-income backgrounds.

High quality teaching is the strongest school-based factor in ensuring that children from low-income backgrounds achieve at the same level as their peers. However, well-qualified STEM teachers have been in short supply for more than 25 years,[350] and these shortages have been most severe for schools where the majority of pupils come from the country's poorest neighbourhoods. Highly-qualified teachers are less likely to teach in schools serving students from low-income backgrounds. When they do, they are less likely to teach the lower sets, in which students from low-income backgrounds are over-represented.[351]

A full complement of qualified and effective STEM teachers also enables schools to offer a full range of courses to their students. At present, many schools do not offer courses which support achievement and progression in STEM subjects, including further maths and triple science. Some schools do not offer any GCSE science courses to their pupils.[352]

Fig. 6.2: Percentage of students achieving benchmark STEM qualifications (2010)



Source: London Skills Commission

Teach First works to directly address the shortage of high-quality teaching experienced by children from low-income backgrounds. We target high calibre, motivated graduates who would not normally consider a career in teaching, and support them to become effective and inspirational teachers, raising the achievement and access to opportunity of children from low-income backgrounds, and supporting them to realise their aspirations. All of our teachers work in schools where the majority of pupils come from low-income neighbourhoods. Through this work, we are also developing a movement of future leaders with a life-long commitment to ending inequality in education from both inside and outside the classroom. We believe this movement is crucial to achieving the scale of change needed at the level of pupils, schools, and the whole system.

In the last ten years, we have made teaching in schools in challenging circumstances one of the most prestigious career options for top graduates: the charity is now the 4th most prestigious graduate employer according to the *Times Top 100 Graduate Employers*, making it the highest ranking charity in the history of the survey.

We have attracted a cadre of highly-qualified teachers: almost all Teach First trainees have a degree class of 2.1 or above, compared with just half of all secondary teacher trainees in maths, science, design and technology and ICT. Teach First teachers are also assessed against specific competencies such as problem-solving, resilience and leadership, which we believe are critical to their success.

We have placed large numbers of STEM teachers each year to meet the demand from our partner schools. We currently have 500 secondary participants teaching STEM subjects, including over 450 teaching maths or science, as well as a growing number of participants teaching across the curriculum in primary schools. We will have trained almost 9% of the maths teachers, almost 6% of the science teachers, almost 3% of the ICT and 1% of the design and technology teachers who will be joining schools as Newly Qualified Teachers in September 2012.

346 *Influences on students' attainment and progress in Key Stage 3*, Department for Education, 2012 347 *Technicians and Progression*, Skills Commission, 2011 348 15.9% of secondary students were eligible for Free School Meals in 2011. 349 *A level subject choice in England: patterns of uptake and factors affecting subject preferences*, Cambridge Assessment, 2007 350 *Preparing for the transfer to STEM Higher Education*, Royal Society, 2011 351 *Mathematics and Science in Secondary Schools: the Deployment of Teachers and Support Staff to Deliver the Curriculum (DfES Research Report 708)*. DfES, 2006
352 *Successful Science*, Ofsted, 2011

Ten years since the charity was launched, we are seeing the signs of impact. Our teacher training provision, delivered in collaboration with our university partners, was rated as 'outstanding' in all 44 categories assessed by Ofsted last year. We have seen hundreds of our teachers take on middle leadership roles in schools and over 50 take on senior leadership roles. Three of our teachers have been appointed as head teachers or principals of schools.[353]

Working in partnership, we have seen the difference that we can make for individual pupils, schools and communities: for example, improved attainment of pupils at GCSE in schools which partner with Teach First, above and beyond similar schools.

Yet we also know that there are still many pupils from low-income households across the country who do not have the opportunities, resources and expectations provided for their peers from wealthier backgrounds, and who are not experiencing the same educational success.

So in the next ten years, we want to see a change in these national patterns. We want to see a significant reduction in the gaps in achievement at primary and secondary school. We want to see a significant shift in the proportions of young people from low-income backgrounds who go on to Further and Higher Education or employment, including in STEM subjects and related careers. Ultimately, we want to see a significant change in society, so that all young people are equipped and supported to realise their aspirations for their life, whatever their background.

353 *Teach First Maximum Impact Evaluation*, University of Manchester, 2010

Part 2 - Engineering in Education and Training
7.0 GCSEs

The education sector has, and is, continuing to go through significant transformation since the Coalition Government came to power. In July 2010, under the Academies Act,[354] all primary, secondary and special schools became eligible to convert to Academy status. In addition to the existing school types, this has resulted in a myriad of school types being available to young people.

By September 2012, there were 2,309 Academy schools of different types,[355] some of which are sponsored by external organisations. Some converting schools operate autonomously, while others are formed into chains of Academy schools. Free Schools are Academy schools which have been opened to meet parental demand,[356] while University Technical Colleges (UTCs) and Studio Schools are also Academy schools, but they have opened to meet employer demand.[357] All Academy schools are outside of the control of Local Authorities and get their funding direct from the Department for Education.[358]

UTCs are Academies aimed at 14- to 19-year-olds.[359] Two UTCs are currently open: these are the JCB Academy in Staffordshire and the Black Country UTC in Walsall. UTCs are likely to expand quite rapidly: 32 are in the pre-opening stage and, by 2014, there are expected to be 24 UTCs teaching 20,000 pupils.[360] These new UTCs have the support of around 200 national and local employers.

Studio Schools offer academic and vocational qualifications, taught using practical and project-based methods. This includes placements with local and national employers who are involved in the school.[361] Like UTCs, Studio Schools are aimed at 14- to 19-year-olds. The first two schools opened in September 2010 and by September 2013 the Government expects there to be 30 Studio Schools open.

Please see box overleaf for further details on different types of schools.

In *the Engineering UK Report 2012*[362] we discussed the English Baccalaureate. The English Baccalaureate is not a qualification in its own right but recognises academic success by being awarded to those who get a grade C or above in six core academic subjects:

- English
- mathematics
- history or geography
- The sciences (including core and additional science and subjects within triple science)
- a language

The Government has recently announced a review of Key Stage 4 examinations with the introduction of the English Baccalaureate Certificates, proposing first teaching of new certificates in English, maths and the sciences in September 2015 with other subjects following.[363] What impact this English Baccalaureate Certificate will have on take up of maths and science subjects or progression to A level can't yet be determined.

In April 2012, the Government in England launched the National Careers Service. This publicly-funded service for adults and young people aged 13 or over brings together elements of previous publicly-funded careers services for adults and young people, including Connexions and Next Steps.[364]

Schools have become responsible for the provision of face-to-face services for 11- to 19-year-olds. From September 2012, schools have a new duty to secure access to independent careers guidance for pupils in years 9-11 (14- to 16-year-olds). Head teachers, school staff and governing bodies must follow the statutory guidance which sets out how this new duty could be fulfilled.[365] But there is no specific budget allocated for the provision of these services, or a legal requirement for careers guidance to be provided by a professional careers adviser.

In addition, the Coalition Government has also decided to remove the duty on schools to provide every young person with work-related learning at Key Stage 4, with effect from the 1 September 2012.[366] However, schools are free to continue to offer work-related learning, if they choose. The removal of the duty on schools to provide work-related learning may impact on pupils developing employability skills, which 71% of businesses said was an education priority for 14- to 19-year-olds.[367]

In the autumn statement,[368] the Government announced a number of initiatives to improve education and skills in the UK. This included:

- an additional £1.2 billion for capital investment in schools in England, made up of £600 million to fund 100 additional Free schools (including new specialist maths Free schools for 16- to 18-year-olds) and £600 million to support those Local Authorities with the greatest demographic pressures
- £4.5 million over the next two years to support work experience
- £10 million over five years (starting in 2013-14) for Project Enthuse, matched by investment from the Wellcome Trust, to improve the quality of science teaching in schools

At the time of writing, the Government announced that school qualifications face a shake-up in England, with end-of-course exams and single exam boards.[369]

354 *Academies annual report 2010/11,* Department for Education, 2012, p10 **355** Website accessed on 5 October 2012 (http://www.education.gov.uk/inthenews/inthenews/a00213703/huge-increase-in-academies-takes-total-to-more-than-2300) **356** At the time of going to print there were 24 Free schools already open and 55 scheduled to open in September 2012 (http://www.bbc.co.uk/news/education-19460927) **357** *Academies annual report 2010/11,* Department for Education, 2012, p9 **358** *Academies annual report 2010/11,* Department for Education, 2012, p9 and p40 **359** Website accessed on 29 August 2012 (http://www.education.gov.uk/schools/leadership/typesofschools/technical/a00198954/utcs) **360** Website accessed on 29 August 2012 (http://www.education.gov.uk/schools/leadership/typesofschools/technical/a00198983/utcs-opening) **361** Website accessed on 29 August 2012 (http://www.education.gov.uk/schools/leadership/typesofschools/technical/a0077819/about) **362** *Engineering UK Report 2012 – the state of engineering,* EngineeringUK, December 2012, p80 **363** Website accessed on 11 October 2012 (http://www.education.gov.uk/inthenews/inthenews/a00213908/oral-statement-ks4-exam-reform) **364** Website accessed on 14 September 2012 (https://nationalcareersservice.direct.gov.uk/Pages/Home.aspx) **365** http://www.education.gov.uk/aboutdfe/statutory/g00205755/statutory-careers-guidance-for-young-people **366** *Consultation on removing the duty to delivery work related learning at Key Stage 4,* Department for Education, p6 **367** *Learning to grow: what employers need from education and skills Education and Skills survey 2012,* CBI, June 2012, p25 **368** *Autumn statement,* HM Treasury, November 2011, p36-37 and p61 **369** Website accessed on 17 September 2012 (http://www.bbc.co.uk/news/education-19620075)

Academy

Academies are independent, state-funded schools, which receive their funding directly from central Government, rather than through a local authority.

They have more freedom than other state schools over their finances, curriculum, length of terms and school days and do not need to follow national pay and conditions for teachers.

Free school

Free schools are set up by groups of parents, teachers, charities, businesses, universities, trusts, religious or voluntary groups, but are funded directly by central Government.

They can be run by an 'education provider' – an organisation or company brought in by the group setting up the school – but these firms are not allowed to make a profit.

The schools are established as Academies, independent of local authorities and with increased control over their curriculum, teachers' pay and conditions, and the length of school terms and days.

Grammar school

Grammar schools are state schools that select their pupils on the basis of academic ability. Pupils in their final year of primary school sit an exam known as the 11-plus which determines whether or not they get a place. There is no central 11-plus exam, with papers being set on a local basis.

They are funded in much the same way as other maintained schools. Central Government allocates funds, largely on a per pupil basis, to Local Authorities. A local funding formula then determines how much each school receives.

Maintained school

Maintained schools are funded by central Government via the Local Authority, and do not charge fees to students. The categories of maintained school are community, community special, foundation (including trust), foundation special (including trust), voluntary aided and voluntary controlled. There are also maintained nursery schools and pupil referral units.

Maintained faith school

A Maintained Faith school is a Foundation or Voluntary school with a religious character. It has a foundation which holds land on trust for the school – and which may have provided some or all of the land in the first place – and which appoints governors to the school. In many cases, the land is held on trust for the specific purposes of providing education in accordance with the tenets of a particular faith.

Decisions on the establishment of Maintained Faith schools are taken under local decision-making arrangements – either by the Local Authority or the Schools Adjudicator, following a statutory process. If proposals are approved to establish a Maintained Faith school, a further application will be needed to the Secretary of State to designate the school with a religious character.

Maintained Faith schools are like all other Maintained schools in a number of ways. They must:

- follow the National Curriculum
- participate in National Curriculum tests and assessments
- be inspected by Ofsted regularly
- follow the School Admissions Code

Trust school

Trust schools are state-funded Foundation schools that receive extra support (usually non-monetary) from a charitable trust made up of partners working together for the benefit of the school. Achieving trust status is one way in which maintained schools can formalise their relationship with their partners. Trust status can help schools ensure that their partners are committed to the success of the school for the long term, helping to shape its strategic vision and ethos.

Any Maintained school – primary, secondary or special schools (but not maintained nursery schools) can become a Trust school. Trust schools remain Local Authority-maintained.

Trust status will help schools to:

- raise standards through strengthening new and existing long-term partnerships between schools and external partners
- broaden opportunities and increase aspirations for pupils, support children's all-round development, and tackle issues of deprivation and social exclusion
- strengthen overall leadership and governance
- give business foundations and other organisations the opportunity to be more involved in their local community
- engage with parents – schools will need to consult parents before entering a trust
- bring a renewed energy and enthusiasm to the way they work by learning from other schools and external partners
- create a distinctive, individual or shared ethos

University Technical Colleges (UTC)

The best-known model of Technical Academies, they specialise in subjects that need modern, technical, industry-standard equipment – such as engineering and construction – and teach these disciplines alongside business skills and the use of ICT. Each UTC is sponsored by a university and industry partner and responds to local skills needs. They provide young people with the knowledge and skills they need to progress at 19 into Higher or Further Education, an apprenticeship or employment.

Studio School

These are innovative new schools for 14- to 19-year-olds, delivering project-based, practical learning alongside mainstream academic study. Students will work with local employers and a personal coach, and follow a curriculum designed to give them the skills and qualifications they need in work or to continue in education.

Technical Academy

While there is no single definition or model for a Technical Academy, it is likely to be a new institution with no pre-existing school for secondary age pupils and to offer a curriculum combining academic with technical and/or vocational learning.

Finally, Table 7.0 shows that in the UK there are 4,073 secondary schools teaching 3.9 million students. Of these, 3,268 (80%) are in England, while 367 are in Scotland, 222 in Wales and 216 in Northern Ireland. Overall, all primary, secondary, special and independent schools teach 9.6 million pupils.

Table 7.0: Number of schools and pupils taught by home nation and school sector (2011-2012) – UK

Year	Country	Number	Primary	Secondary	Special	Total primary, secondary and special	Total independent	Total primary, secondary, special and independent
Jan-12	England	Schools	16,818	3,268	1,039	**21,125**	2,420	**23,545**
		Pupils	4,217,000	3,234,875	95,915	**7,547,790**	577,445	**8,125,235**
Dec-11	Scotland	Schools	2,081	367	158	**2,606**	74	**2,680**
		Pupils	366,429	297,109	6,973	**670,511**	31,425	**701,936**
Jan-11	Wales	Schools	1,435	222	43	**1,723**	66	**1,789**
		Pupils	259,189	201,230	4,181	**464,600**	9,088	**473,688**
Feb-12	Northern Ireland	Schools	854	216	43	**1,113**	15	**1,128**
		Pupils	164,812	146,747	4,740	**316,299**	681	**316,980**
Jun-12	Total UK	Schools	21,188	4,073	1,283	**26,567**	2,575	**29,142**
		Pupils	5,007,430	3,879,961	111,809	**8,999,200**	618,639	**9,617,839**

Source: Department for Education

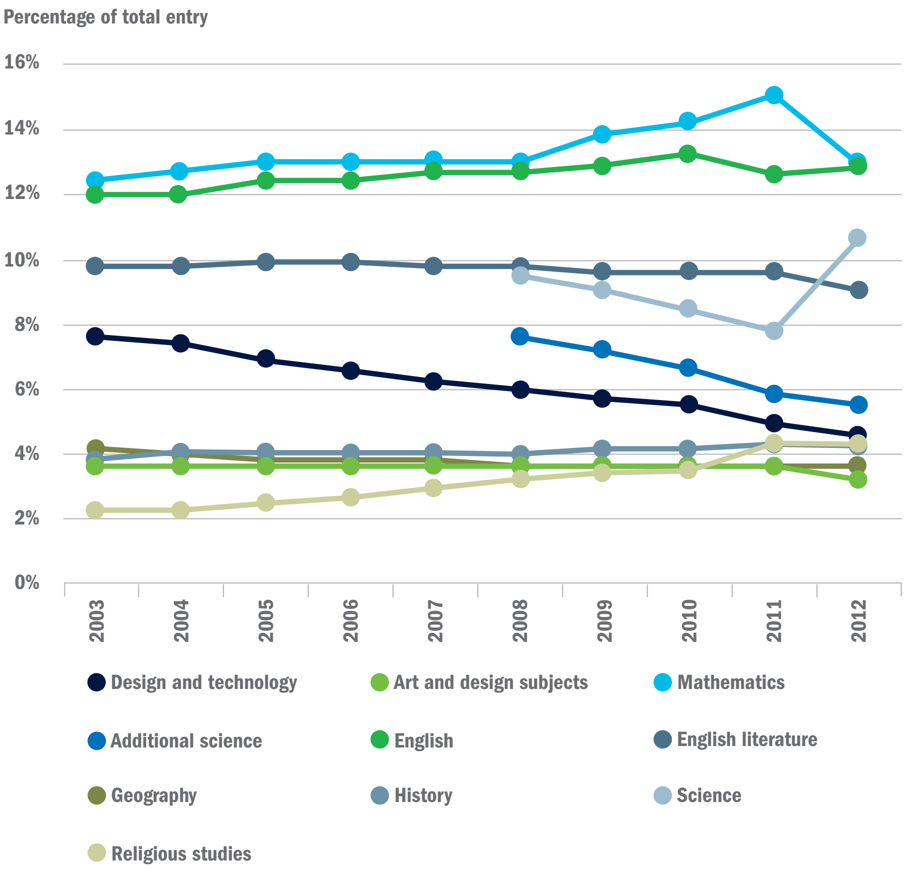
7.1 GCSE entrant numbers

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. It can also be taken with other awards, such as the National Vocational Qualification (NVQ) and BTec Firsts.

The number of entries for GCSE in the core subjects (English, mathematics and science, and Welsh in Wales) is determined by the statutory requirements of the National Curriculum in England, Northern Ireland and Wales. Most pupils studying these subjects will go on to take GCSEs in them.

Figure 7.0 shows that the GCSE subject with the largest number of entries in 2012 was mathematics: with 675,789, this represented 12.9% of all GCSE subject entries. However, this was down on the 10-year high of 772,944, which was achieved in 2011. Science had the third highest number of entries in 2012, at 552,504. This represented

Fig. 7.0: Top 10 GCSE subjects (2003-2012) – all UK entrants



Source: Joint Council for Qualifications (JCQ) just over one in ten (10.6%) of all entries. Additional science came fifth with 289,950 entries. The only other STEM-related subject feature in the top ten was design and technology, a non-compulsory subject, which came sixth with 240,704 entries. It has also been identified by E4E[370] that 1 in 12 students in 2010 weren't entered for a science qualification at GCSE level.[371]

It is disappointing to note that none of the science subjects within the triple science combination of physics, chemistry and biology made it into the top 10 subjects. However, it is not surprising considering the fact that only 70% of secondary schools (excluding independent schools) in England in 2010 offered triple science,[372] although at the time of going to print a survey by Ipsos MORI showed this has risen to 93% in 2012. The fact that such a large cohort doesn't offer triple science has a significant impact on the overall STEM supply chain. Analysis by the National Audit Office (NAO)[373] has shown that students who studied double science at GCSE attain, on average, one grade lower in A level science than those who had studied triple science at GCSE. Furthermore, it has been shown that pupils who study triple science at GCSE are more likely to progress to A level and degree level science.[374] Additionally, the Department for Education has identified that students who study triple science at GCSE are three times more likely to study physics A level than those who studied core and additional science. Since physics A level is a major pre-requisite to studying engineering at university, this finding is significant.

The provision of triple science, unsurprisingly, is higher among schools with a science specialism. Ninety six per cent of science specialist schools offer triple science, compared with only 66% of independent schools.

In its analysis,[375] the NAO identified that provision of triple science is less widely available in deprived areas of the country. In addition, schools with a specialism in science, technology, engineering or maths and computing[376] have higher numbers of pupils taking and passing GCSE science and A level science and maths. However, as these types of specialist schools are less likely to be located in deprived areas of the country, this further disadvantages pupils from these areas. At this point it is also worth noting that only 35.1% of students on Free School Meals achieved an A*-C grade in both English and maths in 2011, compared with 62.5% of students not on Free School Meals.[377]

The triple science issue is discussed in more detail in section 7.5, via an externally-authored case study.

There is an incorrect assumption that pupils make links between curriculum knowledge and their future careers. However, research by the University of Warwick[378] has shown that students don't make this link and need to know that, for some STEM careers, studying triple science is either desirable or essential. Links between the curriculum and future careers need to be made more explicit.

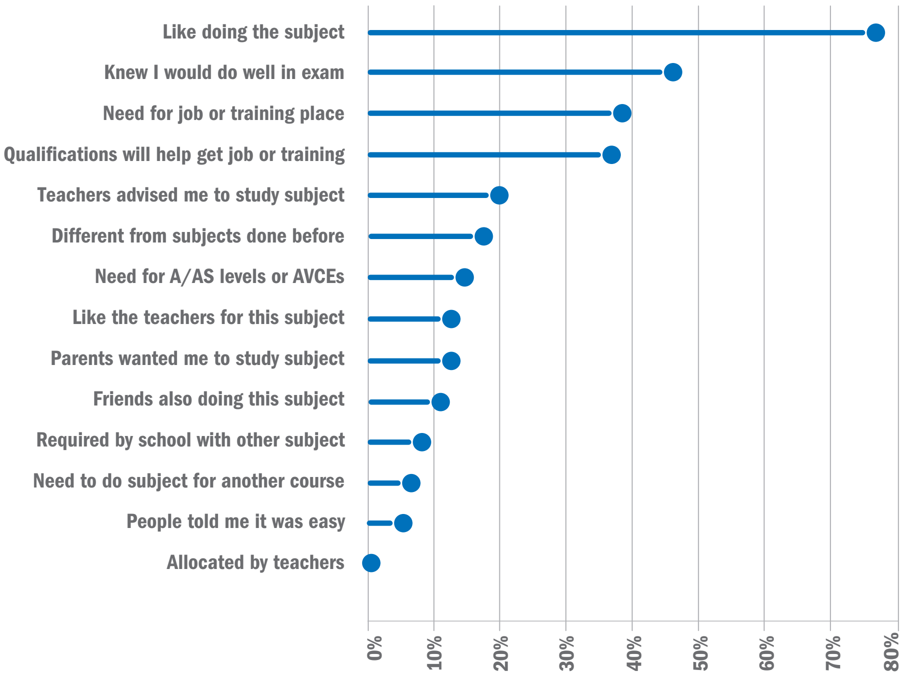
Furthermore, it is interesting to note research reported by the Department for Education[379] on why learners make subject choices (Figure 7.1). The research found that the key factor driving subject choices at Key Stage 4 was whether the learner liked doing the subject.

According to the Department for Education,[380] 53.8% of students achieved an A*-C grade in both English and mathematics and 91.1% of students were entered for both qualifications in 2009/10. Nearly a quarter of students (22.0%) were entered for all the components of the English Baccalaureate and 15.6% achieved it. Fewer than half of pupils (48.5%) achieved an A*-C grade in minimum science GCSEs and mathematics in 2010, which is the normal requirement for progressing onto engineering degrees.[381]

Table 7.1 shows the 10-year trend in the number of entries to different STEM courses. Science has increased by more than a third (36.1%) in just one year. Individual subjects within triple science have had significant growth over 10 years: physics has grown by 228.2%, chemistry by 226.1% and biology by 224.8%. All three subjects have grown by 12.3% in 2012, which compares very well to the average growth for all subjects (1.4%).

Mathematics is the STEM subject with the largest number of entries. However, maths entries fell by 12.6% in 2012, resulting in a small decline in the 10-year trend. The largest percentage decline in entries in 2012 was for additional mathematics, which fell 74.1% to just 3,436 entries. Despite this sharp fall in the last year, its 10-year trend is still showing growth of 7.2%. Statistics also had a one-year decline, in

Fig. 7.1: Reasons for Key Stage 4 subject choice decisions (as reported in Year 10)



370 E4E are an alliance of engineering organisations who work to inform education policy and practice. Further details can be found at http://www.educationforengineering.org.uk/default.htm **371** *Analysis of Key Stage 4 science and mathematics attainment in England 2010,* E4E, 2012, p1 **372** *Maths and science education: the supply of high achievers at A level,* Department for Education, January 2011, p165 **373** *Educating the next generation of scientists,* National Audit Office, November 2010 **374** *Uncovering the real level of science skills at school and university,* Policy Exchange, 2009 **375** *Educating the next generation of scientists,* National Audit Office, November 2010 **376** *Educating the next generation of scientists,* House of Commons Committee of Public Accounts, January 2011 **377** *Opening doors, Breaking barriers: A strategy for social mobility,* Her Majesty's Government, May 2012, p24 **378** *Good Timing Implementing STEM careers strategy in secondary schools,* Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011, p11 **379** *Subject and course choices at ages 14 and 16 in England: Insights from behavioural economics,* Department for Education, October 2011, p25 **380** *Statistical release GCSE equivalent results in England 2009 – 10,* Department for Education, January 2011, p1-2 **381** *Analysis of Key Stage 4 science and mathematics attainment in England 2010,* E4E, 2012, p1

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Table 7.1: GCSE full STEM courses entries (2003-2012) – all UK candidates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Change over one year	Change over 10 years
Science double award – halved to allow comparison	519,575	527,017	494,450	479,789	478,028	8,433	-	-	-	-	-	-
Science double award	1,039,150	1,054,034	988,900	959,578	956,056	16,866	-	-	-	-	-	-
Science	-	-	-	-	57,316	537,606	493,505	453,757	405,977	552,504	36.1%	864.0%
Additional science	-	-	-	-	-	433,468	396,946	352,469	306,312	289,950	-5.3%	-33.1%
Mathematics	712,830	741,682	741,422	750,570	760,299	738,451	754,738	762,792	772,944	675,789	-12.6%	-5.2%
Design and technology	439,617	437,403	396,668	371,672	354,959	332,787	305,809	287,701	253,624	240,704	-5.1%	-45.2%
Biology	51,156	53,389	56,522	60,082	63,208	85,521	100,905	129,464	147,904	166,168	12.3%	224.8%
Chemistry	48,802	51,225	53,428	56,764	59,219	76,656	92,246	121,988	141,724	159,126	12.3%	226.1%
ICT	92,054	98,833	103,400	109,601	99,656	85,599	73,519	61,022	47,128	53,197	12.9%	-42.2%
Physics	47,953	50,404	52,568	56,035	58,391	75,383	91,179	120,455	140,183	157,377	12.3%	228.2%
Science single award	71,184	74,095	89,348	96,374	98,485	-	-	-	-	-	-	-
Statistics	-	39,666	51,432	68,331	82,682	86,224	77,744	69,456	53,400	50,620	-5.2%	27.6%
Mathematics (additional)	-	3,205	3,256	3,282	9,793	16,973	18,765	17,183	13,282	3,436	-74.1%	7.2%
Engineering	-	-	-	-	-	-	-	-	1,850	2,128	15.0%	-
All subjects	5,733,487	5,875,373	5,736,505	5,752,152	5,827,319	5,669,077	5,469,260	5,374,490	5,151,970	5,225,288	1.4%	-8.9%

Source: Joint Council for Qualifications (JCQ)

this case of 5.2%. Section 7.6 addresses concerns over the continuing weaknesses in mathematics, a key facilitating subject which provides a platform for progression within all the STEM subjects.

The largest decline over 10 years has been for design and technology, an optional GCSE subject. Over 10 years, entries have declined by 45.2%. They also fell by 5.1% in 2012. Despite the fall in entrant numbers, it should be noted that there were still 240,704 entries in 2012.

ICT showed growth of 12.9% in 2012, but over 10 years has actually declined by 42.2%. However, it should be noted that 212,900 students completed an OCR National qualification in computing in 2011, an increase of 261.5% on 2008.[382]

In 2011, engineering was introduced as a new GCSE. In 2012, entries rose 15.0% to reach 2,128. Research by the Centre for Education and Industry[383] has shown that most secondary schools lack a clear strategy for teaching engineering and, where teaching and learning does occur, it is in schools with an engineering specialism or is restricted to extra curricula activities which only reach a proportion of students.

In 2010, a quarter (25%) of the mathematics cohort (152,000 pupils)[384] was made up of pupils entered early for the exam.[385] According to CASE,[386] the big increase in students studying science in 2012 is due to students being entered early for the subject. This is an area of concern, as research by the Department for Education has shown that early entry candidates, many of whom were higher achievers at Key Stage 2, perform worse statistically in their GCSE exams than those who did not enter the exam early.[387] It also showed that in 2010, 68% of early entrants went on to retake their exams at the end of year 11, but less than half (45%) achieved a higher grade at their retake,[388] and only 19% who had not gained a grade C or above in year 11 succeeded in doing so in the November of year 12.[389] Other research by the Department for Education[390] has shown that only 3% of A level maths entrants manage to progress from grades of B or lower at GCSE to an A or B at A level.

The Department for Education has also conducted a detailed statistical analysis of progression from GCSEs to A levels.[391] Its research shows that for all subjects, pupils obtaining a higher grade at GCSE are more likely to study the same subject at AS level.[392] The impact of grades on progression to AS level is highest for maths, with high progression from those with A*-A grades but low progression from those with B and C grades. Therefore, early entry could be seen as a risk to the engineering supply chain, because previous

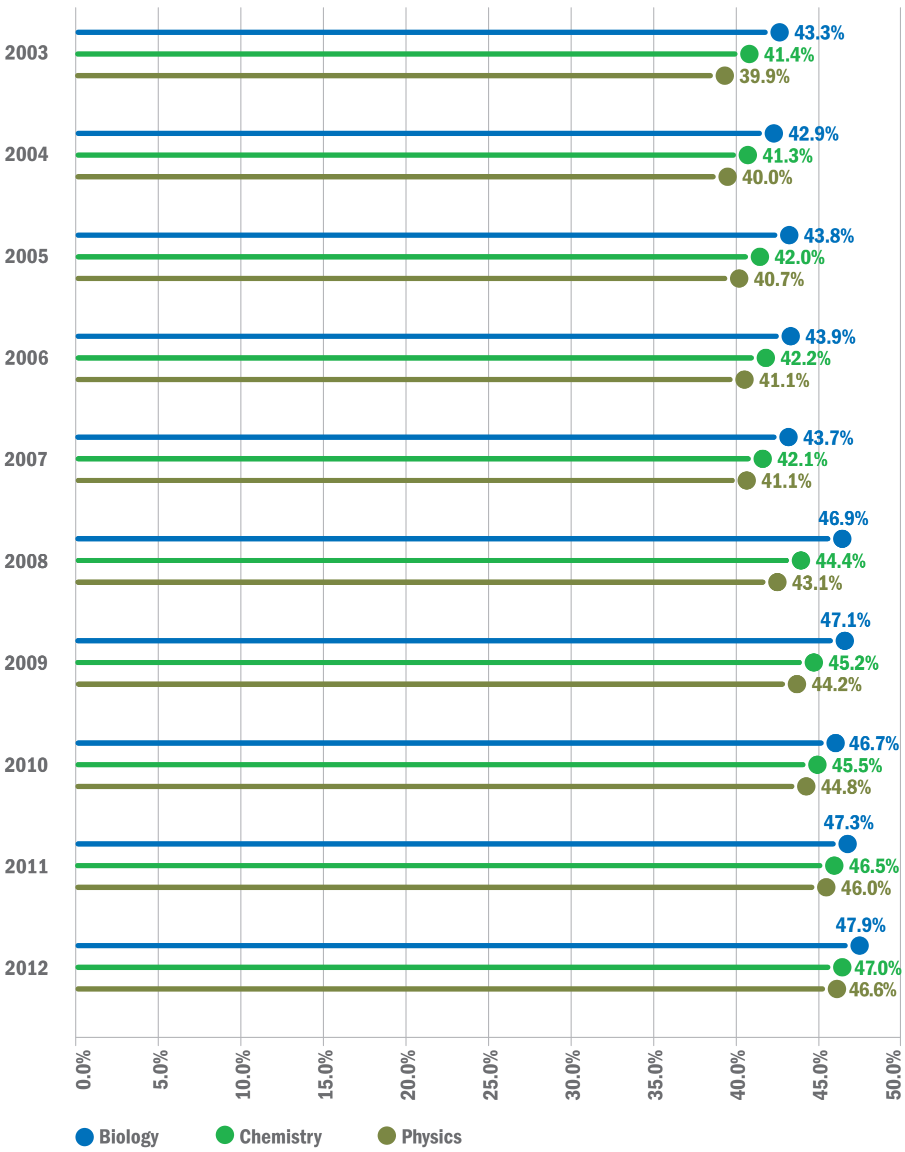
382 *ICT in schools 2008-11,* Ofsted, December 2011, p20 **383** *Good Timing Implementing STEM careers strategy in secondary schools,* Centre for Education and Industry, University of Warwick, the International Centre for Guidance Studies, University of Derby and Isinglass Consultancy Ltd, November 2011, p6 **384** *Early entries to GCSE examinations,* Department for Education, 2011, p5 **385** *Early entries to GCSE examinations,* Department for Education, 2011, p3 **386** Website accessed on 30 August 2012 (http://sciencecampaign.org.uk/?p=10664) **387** *Early entries to GCSE examinations,* Department for Education, 2011, p2 **388** *Early entries to GCSE examinations,* Department for Education, 2011, p3 **389** *Mathematics for all Post-16,* Mathematics in Education and Industry, December 2011, p4 **390** *Maths and science education: the supply of high achievers at A level,* Department for Education, January 2011, p4 **391** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012 **392** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012, pi high fliers in science and maths perform poorly in their early-entry GCSE exams and then don't continue their studies at AS level.

The proportion of female entrants to each subject within triple science has increased over 10 years (Figure 7.2). For physics, the proportion of female entrants has risen from 39.9% to 46.6%, while the comparable figures for biology are 43.3% and 47.9%, and for chemistry they are 41.4% and 47.0%. In each of the 10 years, physics has had the lowest proportion of female entrants.

However, the gap between physics and the other two science subjects is closing.

Ofsted[393] has shown that, at age 16, girls achieve better educationally than boys. In section 11, we show that maths and physics at A level are the key qualifications for progressing onto an engineering degree. Therefore, the lower proportion of women studying GCSE physics, compared with other science subjects, could represent a loss of potential female engineering talent in the future.

Fig. 7.2: Proportion of female entrant numbers to separate science GCSEs (2003-2012) – all UK candidates



Source: Joint Council for Qualifications (JCQ)

7.2 A*-C[394] achievement rate

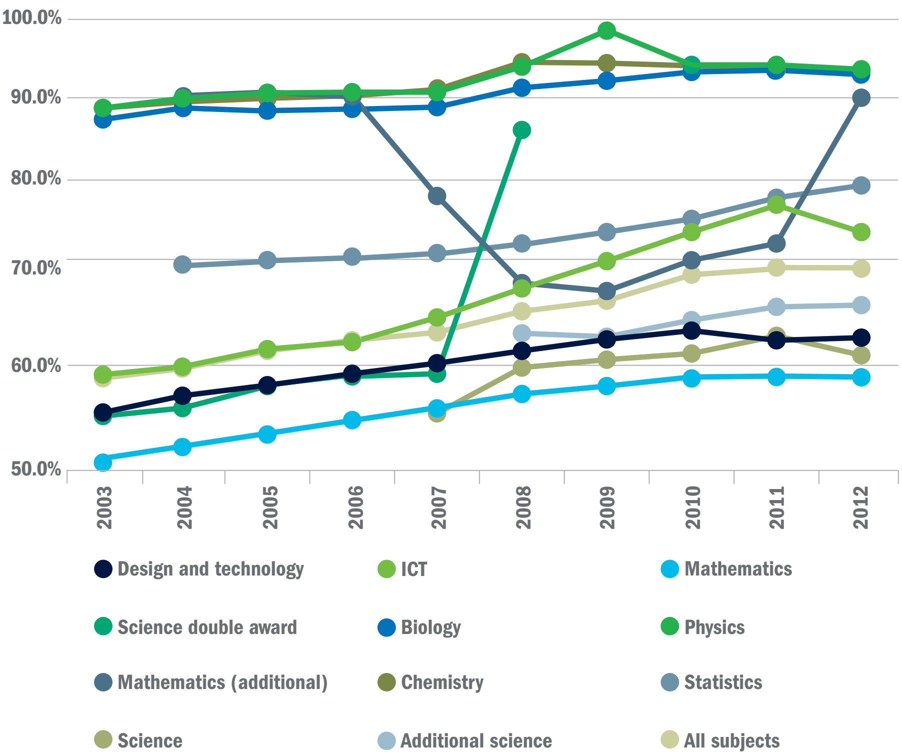
The 10-year trend in A*-C pass rates for different STEM subjects is shown in Figure 7.3. The STEM subject with the lowest A*-C pass rate in each of the 10 years was maths, which didn't manage to reach 60% in any year. In 2012, the A*-C pass rate for maths was 58.4%, below the average of all subjects (69.4%). The pass rate for maths had been increasing year on year until 2011. However, in 2012, there was a slight decline in the pass rate. Maths is a compulsory subject,[395] and as such is taken by students with a wide range of ability and aspiration. This will go some way to explaining why the A*-C pass rate for maths is below the average for all courses. Statistics[396] show that around 6% of 11 year-olds leave primary school with a maths level equivalent to the average 7- to 8-year-old. City and Guilds[397] has shown that 45% of 14- to 16-year-olds feel that maths should be more relevant to real life. The Confederation of British Industry (CBI)[398] starkly laid out the cost of poor numeracy in its report *Making it all add up: Business priorities for numeracy and maths,* when it pointed out that the cost to the taxpayer of students leaving school with poor maths skills was estimated to be around £2.4 billion per year.

In Table 7.1 we showed the number of entrants to additional maths fell by 74.1% in 2012, but the pass rate increased from 73.4% in 2011 to 90.5% in 2012. Statistics had a more modest increase in its A*-C pass rate, rising from 78.6% to 80.0% in 2012.

Both science and additional science have had below average pass rates each year since they were introduced. In 2012, the pass rate for science was 60.7%, a decrease on the previous year's 62.9%. As mentioned earlier, there was a large increase in the number of entrants to science, driven by a large number of early entrants. We also mentioned that early entrants are statistically more likely to get a lower mark than those who are not early entrants. It is therefore possible that this decrease in the pass rate for science is driven by the early entrant effect. This theory is supported by the fact that there was not a large increase in the number of entrants for additional science in 2012, and the pass rate was 66.4% – slightly above that achieved in 2011.

393 *Girls career aspirations,* Ofsted, April 2011, p4 **394** Grades A*-G are passes within GCSEs. However, we purposely only analyse/the A*-C, pass rate as this is the range of grades frequently required for entry into AS level courses. **395** For a list of compulsory subjects see http://www.direct.gov.uk **396** *Long term costs of numeracy difficulties,* Every Child a Chance Trust, 2009, p8 **397** *Ways into Work: Views of children and young people on education and employment,* City and Guilds, May 2012, p17 **398** *Making it all add up: Business priorities for numeracy and maths,* CBI, August 2010

Fig. 7.3: GCSE A*-C pass rates (2003-2012) – all UK candidates



Source: Joint Council for Qualifications (JCQ)

For the last five years, the pass rate for each subject in triple science has been above 90%. In 2012, the highest pass rate was for physics, at 93.2%, followed by chemistry (93.0%) and biology (92.6%). In fact, all of the subjects within triple science were in the top three for A*-C pass rate in 2012.

Design and technology is the most popular of the non-compulsory STEM subjects. However, its pass rate is only 62.7%, below the average for all subjects (69.4%). In fact, the pass rate for design and technology has been below the average pass rate for each of the 10 years considered.

For each of the 10 years considered, the pass rate for ICT has been above average and the rate of improvement in the pass rate has outpaced that for all subjects. In 2003, the pass rate for ICT was 58.5%, just slightly above the 58.1% for all subjects. In 2012, the ICT pass rate had increased to 74.7%, compared with 69.4% for all subjects.

7.3 BTec Firsts

In 2010, a Department for Education White Paper[399] identified that the number of vocational qualifications rose by 3,800%, from 15,000 to 575,000, between 2004 and 2010. BTec First is equivalent to a GCSE A*-C. Table 7.2 shows that over the period 2006/07 to 2011/12, the number of completions in engineering BTec Firsts went up 204.1%. However, when you look at the domicile status of the students, you notice that completions among international students fell by 20.5%. Within international students, diploma students fell 53.1% but extended certificates rose 63.4%. Conversely, completions for UK-domiciled students rose by 222.6 % over six years and by 30.4% in 2012 alone. In fact, in 2012, 142.5% more UK students completed a certificate, and 41.9% more completed an extended certificate, although completions fell by 2.1% for those on a diploma course.

In 2011/12, a total of 14,736 UK-domiciled students completed a BTec First in engineering (Table 7.3). Of these, over half (7,614) were doing an extended certificate in engineering (QCF). The largest percentage growth over one year was for a certificate in engineering (QCF). Of the selected engineering sub-disciples, the only one to show a fall in numbers in 2011/12 was the diploma in engineering – down 84.7%.

399 *The importance of teaching: The schools white paper 2010,* Department for Education, 2010, p17

Table 7.2: Completions for engineering BTec Firsts (2006/07-2011/12) – all domiciles

	QCF Size	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
International	Certificate	275	261	181	138	59	129	118.6%	-53.1%
	Extended certificate	101	113	-	76	43	165	283.7%	63.4%
	Diploma	-	-	-	-	-	5	-	-
International Total		**376**	**374**	**181**	**214**	**102**	**299**	**193.1%**	**-20.5%**
UK	Certificate	2,940	3,801	4,626	5,115	4,889	4,788	-2.1%	62.9%
	Extended certificate	1,628	2,630	3,862	4,597	5,569	7,904	41.9%	385.5%
	Diploma	-	-	-	-	843	2,044	142.5%	-
UK Total		**4,568**	**6,431**	**8,488**	**9,712**	**11,301**	**14,736**	**30.4%**	**222.6%**
Grand Total		**4,944**	**6,805**	**8,669**	**9,926**	**11,403**	**15,035**	**31.9%**	**204.1%**

Source: Edexcel

Table 7.3: Completions for engineering BTec Firsts by selected sub-discipline (2006/07-2011/12) – UK domicile

QCF size	Course name	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
Certificate	Engineering (QCF)	-	-	-	-	843	2,044	142.5%	-
Diploma	Engineering	1,096	1,825	2,345	2,905	1,332	204	-84.7%	-81.4%
Diploma	Engineering (electronics) (QCF)	-	-	-	-	227	294	29.5%	-
Diploma	Engineering (manufacturing) (QCF)	-	-	-	-	206	354	71.8%	-
Diploma	Engineering (QCF)	-	-	-	-	1,775	3,262	83.8%	-
Diploma	Vehicle technology	159	187	336	469	381	291	-23.6%	83.0%
Diploma	Vehicle technology (maintenance and repair)	112	287	221	237	211	151	-28.4%	34.8%
Diploma	Vehicle technology (motorsports)	169	215	229	233	242	119	-50.8%	-29.6%
Extended Certificate	Engineering	1,628	2,630	3,862	4,597	3,939	271	-93.1%	-83.4%
Extended Certificate	Engineering (QCF)	-	-	-	-	1,630	7,614	367.1%	-
Total of all BTec First courses		**4,568**	**6,431**	**8,488**	**9,712**	**11,301**	**14,736**	30.4%	222.6%

Source: Edexcel

7.4 Year 11 diplomas

Diplomas were first taught in England in 2008.[400] The diploma can be taught at one of three levels:

- Foundation – level 1
- Higher – level 2
- Progression/advanced – level 3

Diplomas are offered in 14 subjects which have been rolled out in three stages (in 2008, 2009[401] and 2010).[402] In September 2008, learners could enrol on one of five diplomas:

- Construction and built environment
- Creative and media
- Engineering
- Information technology
- Society, health and development

14-19 diplomas are modular courses, available in England only, which combine theoretical study with practical experience in the chosen subject, as well as core training via functional skills and personal learning.[403]

Those who enrolled in September 2008, were typically on a two-year diploma and graduated in 2010.[404]

400 *Outcomes for the first cohort of Diploma learners,* Department for Education, October 2011, p1 401 Diplomas which became available in 2009 were business administration and finance, environment and land based studies, hair and beauty studies, hospitality plus manufacturing and product design. 402 Diplomas which became available in 2010 were public services, retail business, sport and active leisure plus travel and tourism. 403 *Statistical release Diploma learning, England 2010 – 11,* Department for Education, November 2011, p2 404 *Outcomes for the first cohort of Diploma learners,* Department for Education, October 2011, p1

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Since it took office, the Coalition Government has announced that the planned diploma entitlement would not come into force and schools and colleges would be allowed to choose how many and which diploma subjects they want to offer.[405] In addition, the rules around offering a diploma have been modified so that schools and colleges no longer have to be part of a consortium in order to offer the qualification. The Government also stopped the development of the final three diplomas, which would otherwise have started enrolling pupils in September 2011.[406]

Table 7.4 provides a breakdown of the number of students completing the four different engineering diplomas in 2010/11. It shows that in total 9,754 students completed the diploma. A fifth (20%) of all diploma completions were in engineering, a further 15% of completions were in information technology while 6% were in construction and the built environment. Only 1% of diploma completions were in manufacturing and product design, which became available for the first time in September 2009.

Table 7.5 gives a gender breakdown for the different diploma subjects. It shows that 46% of students completing a diploma were female. The engineering subject with the highest proportion of female students was information technology with 27%. By comparison, only 8% of completers for construction and the built environment and 7% of completers for engineering were female.

Table 7.4: Number of Year 11 learners completing diploma subjects (2010/11) – England[407]

	Number of learners	Percentage of all learners
Construction and the built environment	585	6%
Engineering	1,951	20%
Information technology	1,463	15%
Manufacturing and product design	98	1%
All students	**9,754**	

Source: Department for Education

Table 7.5: Diploma subjects completed by gender (2010/11) – England[408]

	Number of female students	Total number of students	Percentage female
Construction and the built environment	45	585	8%
Engineering	135	1,951	7%
Information technology	315	1,463	27%
All students	**4,494**	**9,754**	**46%**

Source: Department for Education

7.5 Opportunity or ability - a study of participation and attainment in science and mathematics qualifications at Key Stage 4 in England

Authored by Dr Rhys Morgan, Head of Secretariat to E4E, Royal Academy of Engineering

In August 2012, Education for Engineering, the body which represents the professional engineering community on education and skills matters, published the first in a series of reports on Key Stage 4 science and maths in England.[409]

Progression in many science, engineering and technology roles invariably requires a minimum requirement of A*-C grades in at least two science GCSEs (or equivalent qualifications) and A*-C in mathematics GCSE. These qualifications are also likely to be expected for any person wishing to enter into *professional technician* roles across science, engineering and technology (SET).

Particular attention was also paid to young people studying triple science (individual science GCSEs in physics, chemistry, biology), since high attainment in these subjects is known to be a strong indicator of likelihood to pursue a career in SET.

The E4E research set out to provide a detailed picture of participation and attainment in combinations of science and mathematics at GCSE and equivalent vocational qualifications at level 2 across England in 2010. The aim was to provide the engineering community with a snapshot of the potential pool from which the economy can draw its science, engineering and technology future workforce.

The findings, based on these requirements, give cause for concern:

The following is a summary of the findings of the first report:

National participation and attainment in science and mathematics

- Only 80% of the cohort was entered for the minimum requirement (two or more science qualifications at the end of Key Stage 4). This means that one in five children were entered for fewer than the minimum required number of science qualifications to enable them to immediately progress to further study or a career in science, engineering or technology.
- One in twelve pupils (8%) was not entered for any science qualification.
- Only half the pupils in the cohort achieved A*-C grade in a combination of the *minimum* requirement for progression: two science GCSEs (or equivalent qualifications) plus A*-C in mathematics GCSE.
- Eighteen per cent of pupils were entered for triple science (individual physics, chemistry and biology) GCSEs. The vast majority of this group went on to achieve A*-C in triple science as well as A*-C in mathematics GCSE.
- Thirty-nine per cent of pupils did not achieve A*-C in GCSE Mathematics.

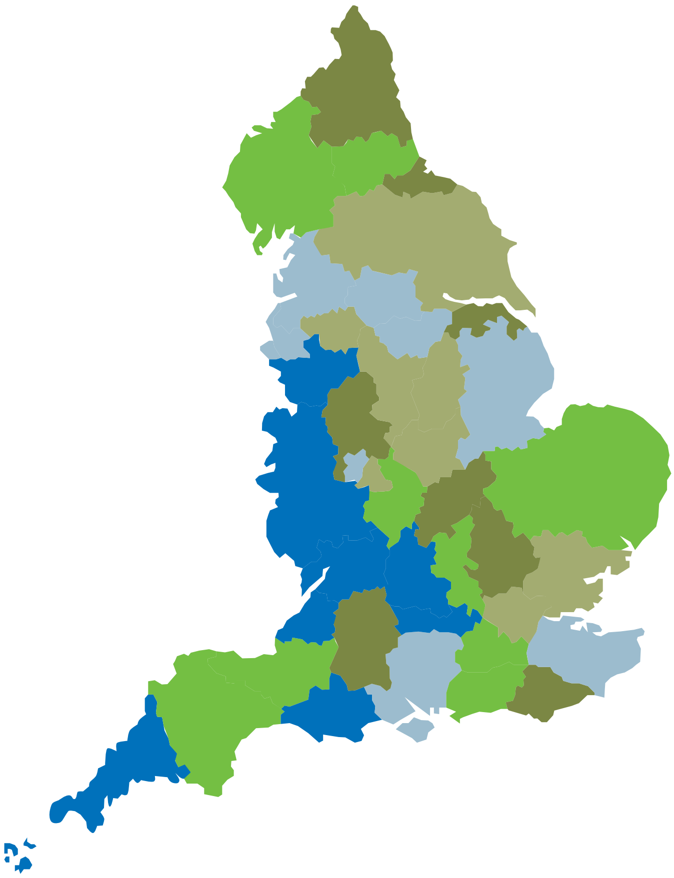
The study also examined regional variations in participation and attainment compared with the national average. E4E found significant variation across the regions of England, sub-divided into 41 smaller sub-regions, and by a finer local authority division (Figure 7.4).

The study found the following regional variations for participation:

- The sub-regions of England with the highest number of entries to triple science were around the South West and the M4 corridor. There is a 16% variation in the proportion of

405 Website accessed on 21 June 2012 (http://www.education.gov.uk/schools/teachingandlearning/qualifications/diploma/a0064056/diploma-announcements) **406** The three diplomas which were cancelled were humanities, science and languages. **407** Data has been abstracted from *Statistical release Diploma learning, England 2010 – 11,* Department for Education, November 2011, p7 **408** Data has been abstracted from *Statistical release Diploma learning, England 2010 – 11,* Department for Education, November 2011, p8 **409** The full report *Opportunity or Ability?* can be found at: http://www.educationforengineering.org.uk/reports/

Fig. 7.4: Proportion of pupils who achieved A*-C grade in at least two science GCSEs (or equivalent vocational qualifications) and A*-C grade in mathematics GCSE at Key Stage 4 across the 41 sub-regions (2010) – England[410]



53-69% 50-53% 48-50% 45.5-48% 42-45%

Source: E4E

pupils entered for triple science across England. The highest was Bournemouth, Dorset and Poole with 27.7%. The lowest, North and North-East Lincolnshire with 11.7%.

- The national average for the proportion of pupils not entered for any science qualification was 8%. The sub-regions with the lowest participation were Lincolnshire and Rutland (at 23%) and Merseyside (at 17%).
- Looking deeper at the Local Authority level, there was an even greater (36%) variation in entry to triple science, ranging from 39.5% of the cohort in Sutton, Greater London to 3.5% in Knowsley, Merseyside. Encouragingly, however, localised excellence could be found across all of England.
- In four Local Authorities, over a quarter of pupils were not entered for any science qualification.

The key finding for attainment were as follows:

- Higher proportions of pupils attained science and mathematics GCSEs with A*-C grades in the south of England, particularly in the South West.
- The sub-regions with the lowest proportions of students achieving A*-C grades in two sciences and mathematics GCSEs were north and north-east Lincolnshire (32%) and Merseyside (37%).
- Trafford in Greater Manchester had the highest participation and attainment in science and mathematics of all Local Authorities in England, with 67% of pupils achieving A*-C in at least two science subjects and A*-C in mathematics GCSE.
- Blackpool was the poorest performing Local Authority in England for combinations of science and mathematics. Only 31% of pupils achieved two or more science GCSEs combined with mathematics GCSE at grades A*-C.

The research also investigated differences in participation in triple science GCSEs (physics, chemistry, biology) between state-maintained and independent schools and found some surprising results:

- Forty-four per cent of all schools in both state-maintained and independent sectors did not enter any pupils for triple science GCSEs.
- School size was a critical factor: 87% of schools with fewer than 50 in the Key Stage 4 cohort did not enter any pupils for triple science. This is almost 1,400 secondary schools.
- Girls-only schools had a much higher rate entry to triple science, but independent schools had fewer entries (52%) than girls-only state-maintained schools (67%).
- Similarly, boys-only state-maintained schools had a higher entry to triple science (43%) than boys-only independent schools (30%).

The E4E analysis by region and participation by school type and size suggests that pupils' entry and attainment in triple science is often not based on the ability of pupils. Given that participation and attainment in triple science GCSEs is a strong indicator of progression in science subjects,[411] children's potential to progress in science, engineering and technology is heavily determined by opportunity rather than ability.

410 The national average was 50%. **411** *Maths and science education: the supply of high achievers at A level,* Department for Education, January 2011

7.6 World class skills and world class economic performance

Authored by Barry Brooks, Strategy and Partnerships Director, Tribal plc

Introduction

"Mathematics is essential for everyday life and understanding our world. It is also essential to science, technology and engineering, and the advances in these fields on which our economic future depends."[412]

During times of austerity, one of the most important elements of economic and fiscal policy must be to prepare for the post-austerity world. In the knowledge economy, the most important resource available to a nation is its human capital and, therefore, a key policy driver must be to ensure that all individuals are able to realise their full potential. This axiom means ensuring that education and training are fundamental elements of the UK's economic as well as social policy.

Engineering and manufacturing are increasingly seen as key industries for economic growth and, as a consequence, science, technology, engineering and mathematics have been identified as priority subjects for development, to provide the launch-pad for sustainable economic recovery. The concern from employers and universities is that young people entering Higher Education and employment markets do not have the appropriate attitudes, aptitudes and skills necessary to keep UK plc in the vanguard of the world's engineering and manufacturing industries.

The Coalition Government has recognised that UK businesses need to offer progression routes that go beyond employment in the financial and services sectors. There is a growing concern that the UK's current education policies and practices are insufficient in both quality and quantity to meet the knowledge and skills requirements of the engineering and manufacturing industries – industries that are currently undergoing something of a renaissance. Pre-eminent among their concerns are the continuing weaknesses in mathematics: the key facilitating subject that provides the platform for progression within the STEM subjects and thereafter into successful and sustainable careers in engineering and manufacturing.

These concerns are not new. As early as 2004, Professor Adrian Smith's I*nquiry into Post-14 Mathematics Education, Making Mathematics Count,* reported: *"It is essential for teachers of mathematics to have sufficient subject knowledge to challenge and develop the full range of pupils they teach. Broadening and deepening mathematical knowledge and understanding are essential."*

Such concerns have seen unprecedented levels of investment in mathematics education. Since 2004, successive Government programmes and projects have focused on addressing the mathematical capabilities of the **flow** of young people into the workforce, and the **capacity** of the education sector to meet these demands, whilst at the same time improving the **quality** of the education on offer. These measurable, practical outcomes are dependent on ensuring that the **policies** in place actually work and will secure sustainable and irreversible change.

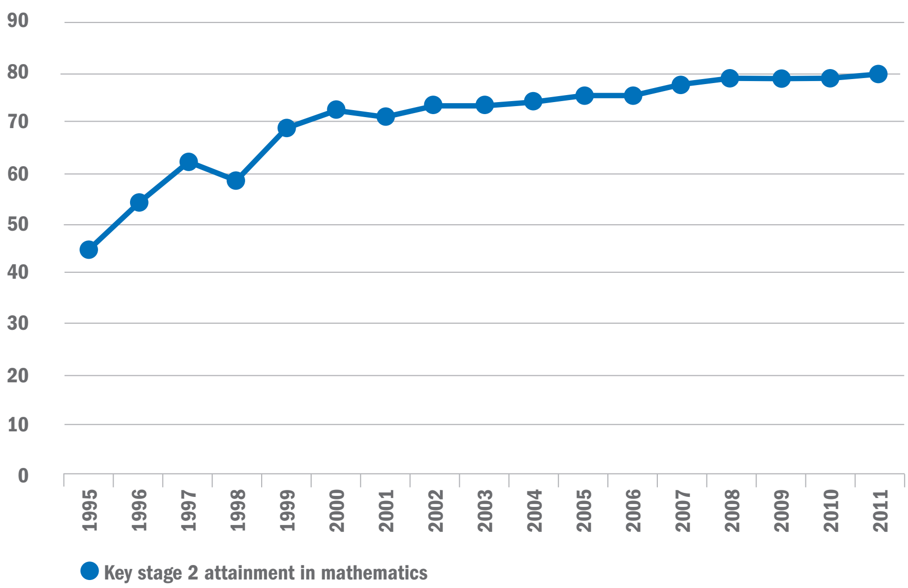
The flow

Irrespective of the age at which our children and young people enter the workforce, it is critical for both the economy and their own long-term employment security that they are confident, capable and proficient in mathematics. Successive governments have expressed their concern about the capability and levels of mathematics performance of our children and young people at all ages and stages of their educational journey, from primary through to secondary school. As a nation, we need confident mathematicians leaving school and entering the Further Education system, training or the work place. Further Education Colleges may seek to redress the balance, but the data in the Wolf Report suggests that only 4% of those without a GCSE mathematics qualification managed to go on and secure the benchmark during their two years of further study. Of even greater concern is that there are many, many more who do not undertake any further studies in Mathematics during this period.

At, 16 a qualification in GCSE mathematics is seen as the gold standard. Currently, only around 60% of school leavers manage to attain Grades A*-C level. Too many children's capability and confidence in mathematics are undermined long before they reach the GCSE watershed. As the data from the Key Stage tests in Figure 7.5 highlights, there has been gradual, incremental improvement in performance over time. The latest data for England confirms that 80% of boys and 80% of girls achieved level 4 or above in the 2011 Key Stage 2 tests. Nevertheless, the concern must be that 20% of children have fallen behind the expected norm by age 11.

Many of the seeds of failure are sown in the primary phase, as Figure 7.6 confirms. So it is not surprising that this lack of proficiency at the end of Key Stage 2 translates into disappointingly low levels of achievement by 16, accompanied by decreasing levels of participation in any form of mathematics education up to 18.

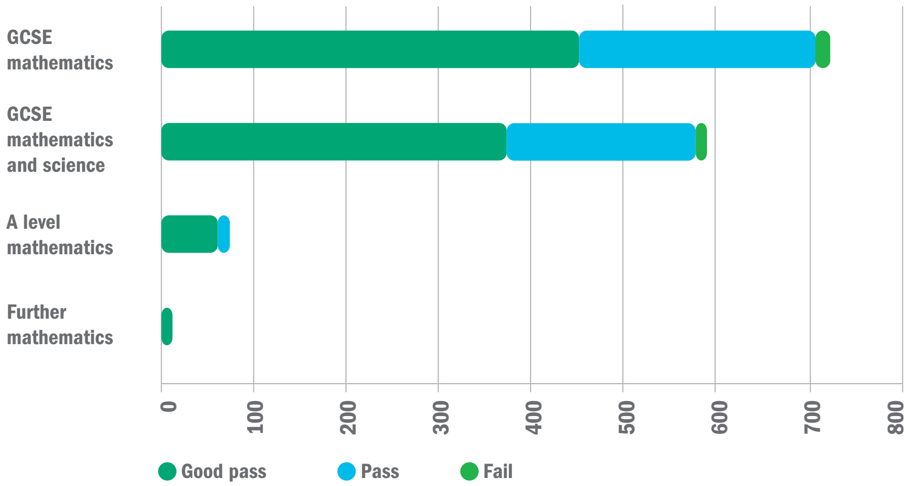
Fig. 7.5: Key Stage 2 attainment in maths at age 11 (in thousands)



Source: Department for Education: Education and Training Statistics for the United Kingdom -2011

412 *Mathematics: made to measure,* Sir Michael Wilshaw, Ofsted, May 2012

Fig. 7.6: Achievements (in thousands) for mathematics at Key Stage 4 and Key Stage 5, (2009/10) – UK



Source: Department for Education: Education and Training Statistics for the United Kingdom – 2011

When these numbers are looked at in more detail (Table 7.6), the most striking feature, other than the limited activity post-16, is the disappointing performance at the end of Key Stage 4: 37% of young people failed to secure a good pass at GCSE level after over ten years' studying the subject.

The capacity

The key element in raising outcomes and securing sustainable progress for mathematics students is to ensure that they have access to enough highly qualified and highly motivated teachers. The apparent intractable nature of raising standards seems to be causing fewer and fewer young people to see mathematics as a keystone of their careers. So it is not surprising that there are insufficient expert mathematics teachers entering and working within the education system.

This position is especially relevant to the primary sector, where the foundations of proficiency are established and the confidence to secure mastery in the subject is nurtured. As the Sir Peter Williams' *Review of Primary Mathematics* in 2008 noted, the main challenge in improving learning outcomes in mathematics was the capability of the teaching workforce, rather than the programme of learning. Williams recommended that there should be a mathematics specialist in every primary school but recognised the scale of this challenge and set a ten-year period for this to happen.

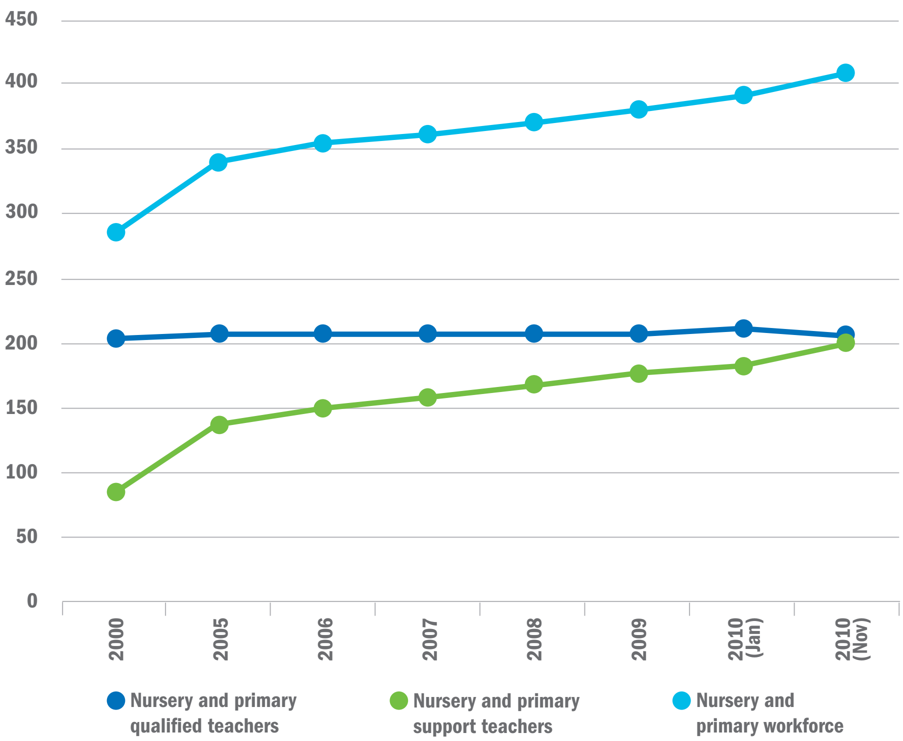
Although the wider workforce in the nursery and primary sector has grown, as Figure 7.7 highlights, the number of qualified teachers has remained reasonably stable at around 200,000. As Williams identified, the sector has a distinct lack of qualified teachers with a background in mathematics. This situation is of particular concern when, because of the way the curriculum is usually delivered, virtually every teacher in the primary sector has a responsibility for teaching the fundamentals of arithmetic and mathematics. Too many primary teachers currently lack the confidence and dexterity needed to engage and stimulate children's mathematical imagination. That said, as will be identified later, there is a major intervention programme currently being put in place to raise the capability and quality of mathematics teaching in the primary sector.

Table 7.6: Mathematics achievements Key Stage 4 and Key Stage 5 (2009/10)

Number of entrants (in thousands)	Achievement rates	
Key stage 4: mathematics GCSE or equivalent	A*-C	A*-G
724.3	63%	98%
Key stage 4: mathematics and science GCSEs or equivalents	A*-C	A*-G
589.2	62%	98%
Key stage 5: mathematics A level or equivalent	A-C	D-E
75.6	83%	16%
Key stage 5: further mathematics or equivalent	A-C	D-E
11.1	91%	8%

Source: Department for Education: Education and Training Statistics for the United Kingdom – 2011

Fig. 7.7: Growth of the nursery and primary workforce (in thousands), (2000-2010)



Source: Department for Education School: Workforce in England, November 2011

This lack of a pipeline of young mathematicians leaving school for university has led to a premium on graduates with degrees in mathematics. There are certainly not enough to satisfy the appetites of commerce and industry, let alone education. Education loses out, and so the potential mathematicians of tomorrow do not have access to the inspirational educators of today. This issue remains a major problem across the sector where, too often, mathematics is taught by teachers who are not subject experts. This means that many of our current teachers of mathematics have no background in numerical or statistical subjects. Our children deserve access to the very best mathematics educators that our system can develop, fund and provide.

Recent reforms have been introduced that are designed to improve teacher recruitment and training and raise the status of the teaching profession. As Table 7.7 suggests, these reforms include diversification of the methods by which mathematics graduates are trained to become expert practitioners. This diversification is designed to target and attract the best and the brightest mathematics graduates into the profession. As the figures below suggest, the numbers entering training are positive. But there is bound to be a lag between those entering training, impact in the classroom and examination performance. Retention within the teaching workforce remains a concern.

Within the secondary sector, where there is a tradition of subject expertise, mathematics is recognised as a core subject. But even here, many schools continue to struggle to ensure that every mathematics lesson is taught by an expert practitioner. According to the Department for Education's statistical release, *The School Workforce in England, November 2011:*

- Seventy-three per cent of teachers of mathematics to Years 7-13 held a relevant post A level qualification – which means that 27% did not.
- Eighty-four per cent of the total hours of taught mathematics to Years 7-13 were taught by a teacher who held a relevant post A level qualification – which means that 16% of taught hours were not.

What this information confirms is that our raw talent has historically been short-changed and intervention and reform is urgently required.

The quality

Even if we have sufficient qualified teachers of mathematics, we must ensure that all of those individuals who demonstrate a talent for mathematics remain sufficiently inspired and stimulated to study the subject beyond 16. And we need to make sure that those who fall behind at each and every stage are supported in their efforts to catch up. Ofsted is charged with the responsibility of monitoring, reporting and seeking to raise educational standards. As Figure 7.8 demonstrates, there is no place for complacency.

Ofsted recognises that in recent years there has been a dramatic increase in the take-up of A level and further mathematics, and also that our youngest children are improving. As earlier data suggest, there is also an incremental improvement in Key Stage, GCSE and A level results. That said, with over 40% of our primary and secondary schools at best delivering satisfactory mathematics provision, there are priority areas for improvement.

Ofsted's inspection evidence suggests that those children with the lowest ability are taught by the weakest teachers, rather than the most gifted and inspirational. In that context, should we be surprised that the 10% who do not reach the expected standard by age 7 doubles to 20% by age 11, and nearly doubles again by age 16. The stark reality is that if at first you don't succeed in mathematics, you don't succeed.

It is equally concerning that the brightest pupils may also not be realising their full potential when they reach secondary school. Data shows that 37,000 of the highest attaining primary school pupils achieved no better than a GCSE grade C some five years later. There is a parallel concern that children are being entered for GCSE mathematics too early, before the end of Key Stage 4, which is limiting their opportunities to realise their full potential. Fundamental to this situation, of course, is the clarity, consistency and focus of the teaching and learning. Ofsted is committed to raising ambitions for mathematics education. From 2012, inspection will place greater emphasis on:

1. how effectively schools tackle inconsistency in the quality of mathematics teaching
2. how well teaching fosters mathematical understanding
3. the development of pupils' skills in solving problems
4. challenging the extensive use of early and repeated entry to GCSE examinations

A further dimension that enhances the quality of learning is access to and use of technology: not as a crutch to avoid subject

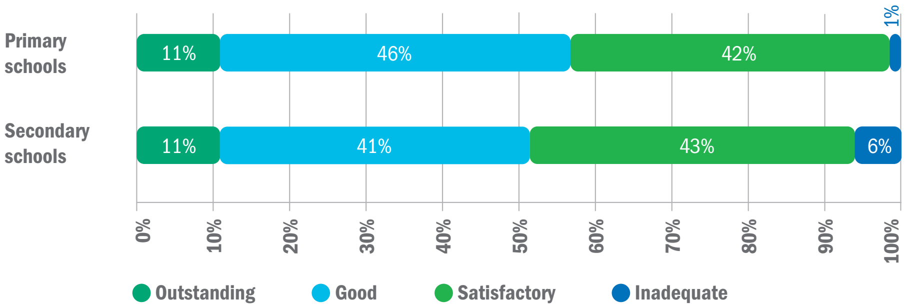
Table 7.7: Mathematics specialist trainees, DfE school workforce (November 2011) – England

Mainstream[413]			**Employer based initial teacher training scheme (EBITT)**				**Mainstream and EBITT[414]**		
2009/10	**2010/11**	**2011/12**	**2009/10**	**2010/11[415]**	**2011/12**		**2011/12**		
Registrations and forecast registrations			**Registrations**				**Registrations and forecast registrations**		
New entrants	New entrants	New entrants	New entrants	New entrants	New entrants (Autumn Term)	Teach First (Autumn term)[416]	Mainstream and EBITT registration (not TF)	EBITT forecast	Predicted outcomes
2,408	**2,324**	**2,232**	**479**	**445**	**542**	**159**	**2,615**	**72**	**2,687**

Source: 2010/11 and 2011/12 TDA Initial Teacher Training Census Data Summaries

413 Mainstream includes Higher Education Institutions and SCITTs. 414 Recruitment figures for 2011/12 are provisional and are subject to change. The data are correct as at the census date 12 October 2011. 415 2010/11 new entrants include July 2011 updates to the census. 416 Teach first numbers do not contribute to the DfE target for 2011/12 of 2,635 new mathematics teachers so they are not included in the calculations.

Fig. 7.8: Overall effectiveness of mathematics in the schools surveyed (percentages of schools)



Source: Mathematics: made to measure, Ofsted, May 2012

mastery, but to enable students to discover and explore and experiment with the laws of the subject. Technology can help to bring mathematical models to life and allow the creative and innovative individual to recognise the potential of the subject and the future opportunities available to them. It is important with mathematics never to lose sight of its potential to thrill and reward, as solutions are found and problems are solved.

The policies

The Coalition Government has recognised that to secure irreversible, sustainable change, there needs to be a step change in the quality of our teaching workforce. It has committed to making sure that every child, at every stage, and at every age, has access to the best teaching experience. This was made clear in the White Paper, *The Importance of Teaching*. As Michael Gove, Secretary of State for Education, made clear in the foreword: *"At the heart of our plan is a vision of the teacher as our society's most valuable asset. We know that nothing matters more in improving education than giving every child access to the best possible teaching. There is no calling more noble, no profession more vital and no service more important than teaching. It is because we believe in the importance of teaching – as the means by which we liberate every child to become the adult they aspire to be – that this White Paper has been written. The importance of teaching cannot be over-stated. And that is why there is a fierce urgency to our plans for reform."*

As the data presented here demonstrates, there is a measurable and tangible mathematical skills gap between where we are as a nation and where we need to be to remain an economic force. The current Government is relentless in its determination to overhaul all elements of the education and training system, in an effort to ensure that its policies secure this irreversible change. *The Importance of Teaching* addressed the capacity and quality of the teaching workforce: *"The best education systems in the world draw their teachers from among the top graduates and train them rigorously and effectively, focusing on classroom practice. They then make sure that teachers receive effective professional development throughout their career, with opportunities to observe and work with other teachers, and appropriate training for leadership positions."*

In order to realise these policy ambitions, a phalanx of inter-related and integrated policies is being rolled out. To this end, Government has invested in:

1. **Recruitment** by setting targets for specialist teachers in mathematics. The targets are to recruit 2,635 mathematics trainees into Initial Teacher Training (ITT) annually. This target was achieved for 2011/12 and there is confidence that this will be repeated in 2012/13. The Government has also invested heavily in Teach First, a programme designed to bring the best and most qualified graduates into teaching. Finally, during the academic year 2013/14, a number of ITT places will be allocated for trainees undertaking a specialist primary mathematics programme. The courses will be designated as Subject Specialist Primary ITT Programmes and will prepare teachers whose sole or main role is to teach mathematics in primary schools.
2. **Quality** through a range of Teaching Agency programmes to support the best candidates to apply to mathematics ITT. They include new financial incentives, with bursaries of up to £20,000 designed to incentivise better-quality graduates to enter the profession. Other programmes include Premier Plus, a package of support where candidates interested in teaching mathematics receive personalised one-to-one support; the School Experience Programme, which gives those considering a career in teaching the opportunity to spend one or more observation days in schools; and Subject Knowledge Enhancement courses, which provide potential trainees with in-depth subject knowledge before they begin teacher training.
3. **Professional development** to ensure that the stock of those already teaching have the opportunity to access development opportunities. The Department for Education has invested in a National Centre for Excellence in the Teaching of Mathematics (NCETM). NCETM has a remit to improve the quality of professional development available to serving mathematics teachers, by making sure that those who deliver professional development to teachers adhere to a nationally-recognised standard of professional development that is in line with the Government's expectations and policies.
4. **Curriculum reform** designed to provide teachers with the necessary framework and standards to raise achievement, by initiating the reform of the National Curriculum in the primary and secondary sectors. By prioritising the primary curriculum, ministers have sent out a strong message of their commitment to raise standards from the very beginning of the learning journey, to ensure that every one who is capable is mathematically proficient by the time they reach age eleven.
5. **The Further Mathematics Support Programme (FMSP),** to place momentum behind raising the performance levels of young people already partway through their mathematics education, and raise the numbers and quality of those studying A level and further maths in advance of entering university.
6. **National qualifications** designed to secure greater consistency and more reliable and robust assessments that are designed to raise standards and thereby increase credibility and currency of both GCSEs and A levels.
7. **Mathematics proficiency,** by making mathematics mandatory up to the age of 18 and making achievement of a level 2

qualification the benchmark for every young person in education and training. This policy will be facilitated by increasing the age of compulsory education to 17 during the academic year 2013-14 and to 18 during 2014-15.

8. **Mathematics for the workplace,** by providing free mathematics courses for adults wherever they are studying, training or working. This offer has an ambition for level 2, but recognises that there need to be certain high quality different approaches to build confidence and develop skills for those who have the longest learning journey or the lowest levels of self-belief and confidence.

Taken as a snapshot, the current picture on mathematics performance is one of improvement, with increasing numbers of young people studying A level mathematics and further maths and progressing to university. These numbers are still modest when compared with those of the UK's international competitors. The education and skills system's ability to provide commerce and industry with access to the talent it craves is far from ideal. However, seen in the context of a developmental, growth trajectory as a nation, and more specifically as an education and training system, the UK is now firmly committed to this ambitious journey. Whilst the scale of the challenge remains daunting, the improving statistics on teacher recruitment and learner performance, especially at the higher levels, suggest that the policies are the right ones. The developments now in place are positive. There is a commitment and determination at Government and practitioner level to secure irreversible, sustainable change and develop mathematics capability, confidence and proficiency in everyone, irrespective of who they are, where they live or where they work.

7.7 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 (Foundation, General and Credit) at which Standard Grade examinations can be taken.

New guidance for classroom teaching known as the Curriculum for Excellence was introduced into schools in September 2010. The Curriculum for Excellence is less prescriptive than the previous curriculum and emphases inter-disciplinary learning and personalisation.[417] This year, new qualifications called National 4 and National 5 were also introduced, and will replace Standard Grade General, Standard Grade Credit, Intermediate 1 and Intermediate 2. Standard Grade Foundation will be replaced by the revised Access 3. The New Access 4 and 5 will be introduced in 2013/14, as will the new Access qualifications. The new Higher will follow in 2014/15, while the new Advanced Higher will be available from 2015/16.[418]

New exams are due to be introduced in 2013 and in 2013/14 and existing exams will be revised to fit in with the new curriculum. The redevelopment of the curriculum and assessment system in Scotland was motivated by similar challenges to those faced in England, including the need to make learning more engaging and less orientated solely to the achieving of high grades; the need to provide clearer progression pathways through to vocational and Higher Education; and to ensure assessment and certification better meet the variety of learner needs.[419]

7.7.1 Standard Grades

The number of pupils taking STEM courses at Standard Grade fell by an average of 2.8% in 2012 and by a fifth (21.8%) over eight years (Table 7.8). However, there were still 107,401 entrants in 2012 – even with the eight-years of decline. Students taking STEM subjects as a proportion of all students studying Standard Grades has remained similar, at about a third in each of the eight years. Looking at the different STEM subjects, in 2012 only biology had an increase in the number of entrants, although this was marginal at 0.1%. The largest decline was for science, which fell by 11.9%. It has also had the largest decline over eight years, falling by two thirds (66.4%).

In 2012, mathematics and chemistry were only the STEM courses which were closest to having a gender parity,[420] with the proportion

Table 7.8: Trends in entries for each STEM subject at Standard Grade (2005-2012) – Scotland

Subject	2005	2006	2007	2008	2009	2010	2011	2012	Change over one year	Change over eight years
Mathematics	53,842	53,782	53,979	50,982	46,782	43,990	42,651	40,879	-4.2%	-24.1%
Biology	22,213	23,200	22,787	22,319	21,029	20,570	20,315	20,336	0.1%	-8.5%
Chemistry	20,876	20,688	20,078	19,773	19,475	18,906	19,020	18,747	-1.4%	-10.2%
Physics	16,917	17,064	15,940	15,299	14,780	14,571	14,442	14,227	-1.5%	-15.9%
Science	6,206	5,741	4,205	3,525	2,961	2,607	2,369	2,086	-11.9%	-66.4%
Computing studies	17,237	16,508	16,040	15,383	13,586	12,390	11,659	11,126	-4.6%	-35.5%
Total for all STEM entries	137,291	136,983	133,029	127,281	118,613	113,034	110,456	107,401	-2.8%	-21.8%
All students	411,324	416,052	404,850	387,085	358,728	339,426	330,873	319,986	-3.3%	-22.2%
Proportion of STEM entries	33.4%	32.9%	32.9%	32.9%	33.1%	33.3%	33.4%	33.6%	0.1%	0.1%

Source: SQA

417 *Curriculum for Excellence: Experiences and outcomes,* Scottish Government, 2008 418 Website accessed on 30 August 2012 (http://www.educationscotland.gov.uk/nationalqualifications/about/newqualifications/changes.asp) 419 *Curriculum for Excellence: Experiences and outcomes,* Scottish Government, 2008 420 Close to gender parity is defined as no gender representing more than 60% of the number of entrants.

of female students ranging from 46.9% for biology to 51.1% for chemistry (Table 7.9). Physics and computing studies, however, had a much higher proportion of males (70.4% and 67.3%) respectively. Biology was the subject with the highest proportion of female students with 64.9%, however, this figure has seen a noticeable decline in the last year, down by 13% since 2011.

Table 7.9: Standard Grade entry volumes by gender (2012) – Scotland

Subject	Percentage female	Percentage male
Mathematics	49.1%	50.9%
Biology	64.9%	35.1%
Chemistry	51.1%	48.9%
Physics	29.6%	70.4%
Science	44.9%	55.1%
Computing	32.7%	67.3%
All students	49.2%	50.8%

Source: SQA

7.7.2 Intermediate 1 and Intermediate 2

Intermediate 1 and 2 are qualifications for students who have completed Standard Grades or courses at Access 3. Intermediate 1 qualification is equivalent to a General Standard Grade, while the Intermediate 2 is equivalent to the Credit Standard Grade, and for some students is a stepping stone to Higher qualifications.

Entry volumes for intermediate 1 have increased by 97.6% over eight years, but by just 0.4% in 2012 (Table 7.10). All the STEM subject areas have shown growth over eight years. At 19.1%, computing studies has increased the least, compared with a rise of 1,312.1% for engineering skills (albeit from a very low base of 33 in 2008). Mathematics was the most popular STEM subject at Intermediate Level 1, with an entry volume of 13,115 in 2012.

The increase in entry volumes for Intermediate 2 has been lower than for Intermediate 1, with a growth of 60.8% since 2005. Three of the selected STEM subjects grew by more than average over the eight-year period. These were physics (85.6%), chemistry (70.9%) and engineering craft skills, which grew by 176.2% – although this was from a small base of 307 in 2005. Two of the STEM subject areas at Intermediate 2 showed a decline over the eight-year period: information systems declined by 55.1%, falling from 2,637 in 2005 to 1,184 in 2012, and technological studies declined by 22.3%, falling from 224 in 2005 to 174 in 2012. As with Intermediate 1, the largest STEM subject at Intermediate 2 was mathematics, with 23,536 entries.

Table 7.10: Trends in entries for each STEM subject at Intermediate 1 and 2 (2005-2012) – Scotland

Subject	2005	2006	2007	2008	2009	2010	2011	2012	Change over one year	Change over eight years
INTERMEDIATE 1										
Mathematics	7,799	10,317	11,446	12,650	12,082	12,737	12,843	13,115	2.1%	68.2%
Biology	3,295	3,975	5,146	5,699	5,750	5,718	5,873	6,358	8.3%	93.0%
Chemistry	1,602	1,929	2,479	2,824	3,058	2,934	2,986	3,157	5.7%	97.1%
Physics	1,555	1,845	2,092	2,379	2,558	2,609	2,721	2,769	1.8%	78.1%
Computing studies	1,674	1,552	2,024	2,403	2,294	1,981	1,681	1,994	18.6%	19.1%
Engineering craft skills	55	63	73	152	138	211	241	347	44.0%	530.9%
Engineering skills	-	-	-	33	455	493	574	466	-18.8%	1312.1%
Sub-total (all students at Intermediate 1)	36,653	45,174	53,840	60,267	65,735	69,510	72,174	72,427	0.4%	97.6%
INTERMEDIATE 2										
Mathematics	15,172	16,789	18,989	19,480	21,487	21,938	22,406	23,536	5.0%	55.1%
Biology	5,336	5,326	6,615	6,755	6,927	7,354	7,490	7,995	6.7%	49.8%
Chemistry	2,728	3,369	3,725	3,918	4,110	4,319	4,565	4,662	2.1%	70.9%
Physics	2,354	2,645	3,352	3,488	3,796	3,906	4,083	4,369	7.0%	85.6%
Computing	2,094	2,742	2,682	2,865	2,948	3,079	3,154	3,074	-2.5%	46.8%
Engineering craft skills	307	367	354	526	602	658	739	848	14.7%	176.2%
Information systems	2,637	2,263	1,993	1,846	1,765	1,547	1,366	1,184	-13.3%	-55.1%
Technological studies	224	197	207	155	213	173	131	174	32.8%	-22.3%
Sub-total (all students at Intermediate 2)	87,100	94,686	107,340	113,388	122,463	130,497	134,516	140,046	4.1%	60.8%
All students (Intermediate 1 and 2)	123,753	139,860	161,180	173,655	188,198	200,007	206,690	212,473	2.8%	71.7%

Source: SQA

Part 2 - Engineering in Education and Training
8.0 AS and A levels

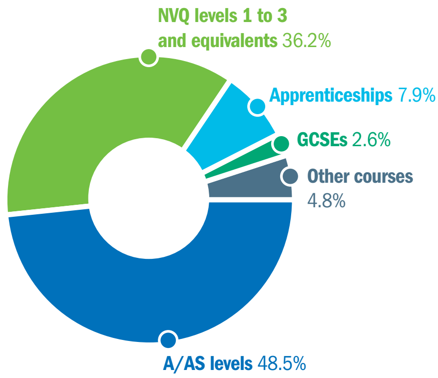
In section 7, we covered the wide range of changes affecting the pre-16 education system in England. This includes the introduction of the English Baccalaureate Certificate, the expansion of Academy schools, the introduction of Free schools and Studio schools, and the development of University Technology Colleges. The post-16 education system has not been immune to controversy and is also facing proposed radical changes.

Four years after A levels were last revised, Ofqual launched its latest consultation on A levels in June 2012,[421] with the aim of ensuring the qualifications 'command confidence'. The consultation will cover issues such as grade inflation and the design of A levels, from introducing a linear A level, and reducing the contribution of the AS to the overall mark, to separating AS and A levels completely.[422] It will also look at the purpose of A levels: are they primarily an entry qualification for Higher Education, or are they a signature qualification for the end of formal education? The intention is to run the consultation from September 2013 to September 2018.

The House of Commons Select Committee[423] has also reported on this issue in its July 2012 report, *The administration of examinations for 15- to 19-year-olds in England.* The report stresses concern over grade inflation, which it attributes to multiple competing exam boards. It therefore recommends the development of national syllabuses, accredited by Ofqual and developed by exam boards in conjunction with learned bodies, employer bodies and Higher Education Institutions.

Another change that will certainly affect post-16 education is the raising of the school leaving age to 17 in 2013 and 18 in 2015. With this statutory change, one would expect the number of A level students to increase. However, the increase in the number of students may be limited. Current analysis by the National Audit Office[424] shows that the number of 16- to 18-year-olds in education and training was over 1.6 million at the end of 2009, a participation rate of 83%. Of those in full-time education, nearly half (48.5%) were studying for A/AS Level qualifications and a third (36.2%) were studying for NVQs Level 1-3 (Figure 8.0).

Fig. 8.0: Type of education undertaken by 16- to 18-year-olds in full-time education[425]



Source: National Audit Office analysis of departmental data

The Department for Education looks at post-16 participation slightly differently to the National Audit office. According to its data, over a third of pupils leave the education system after the age of 16[426] and, amongst those who stay, the majority do AS/A levels. The Department has also identified that 14% of young people completing year 11 are

421 Website accessed on 14 September 2012 http://www.ofqual.gov.uk **422** Website accessed on 14 September 2012 http://www.ofqual.gov.uk **423** *The administration of examinations for 15–19 year olds in England,* House of Commons Education Committee, 12 June 2012 **424** *Getting value for money from the education of 16- to 18-year-olds,* National Audit Office, 2011, p4 **425** Full-time education only and excluding 18-year-olds in Higher Education **426** *Subject and course choices at ages 14 and 16 in England: Insights from behavioural economics,* Department for Education, October 2011, p4 prevented from studying their preferred subjects post-16 due to perceived barriers and constraints.[427] These mainly relate to finance, transport, availability of provision and their knowledge and awareness of the post-16 options available to them.

In the autumn statement,[428] the Chancellor announced changes that will impact on the post-16 education sector. From 2013, the Government will publish destination data at age 16 and 18. It will invest £4.5 million over two years to support post-16 work experience and will launch a review on the impact of work experience.

Finally, it is worth noting data from the Department for Education[429] which states that, in 2010, 81.5% of 19-year-olds were qualified to level 2 and just over half (54.2%) were qualified to level 3.

8.1 Progression from GCSEs to A levels

Research by the Department for Children, Schools and Families (DCSF)[430] identified that schools that had high levels of post-16 uptake of science, also had enthusiastic and specialist science teachers who engaged in continuous professional development (CPD) and team work, and had high expectations for their pupils. They also found pupils had a high level of enjoyment in learning science. This is reinforced by research by EngineeringUK,[431] which showed that enjoyment was as important as attainment in terms of a pupil's likelihood to pursue a particular subject later.

The Department for Education has conducted a detailed statistical analysis of progression from GCSEs to A levels.[432] This research shows that, for all subjects, pupils obtaining a higher grade at GCSE level are more likely to progress onto studying the same subject at AS level.[433] The impact of high grades on progression to AS level is highest for maths, with high progression from those with A*-A grades but low progression from those with B and C grades.

However, the report shows that only 43% of physics students who achieved an A* at GCSE level progress onto AS level physics.[434] This is lower than the comparable progression rate for chemistry (59%) and biology (51%). Furthermore, the IoP in their *It's Different for Girls report,* showed through an analysis of data from the national pupil database that 49% of state co-educational schools in England did not send any girls to study physics at A-level in 2011; this is in stark contrast to only 14% for boys.[435]

8.2 AS level entrant numbers

Table 8.0 shows the entrant numbers to different STEM subjects at AS level over a 10-year period. The biggest increase in entrant numbers, both in the last year and over 10 years, was for further mathematics which increased by 12.9% and 521.6% respectively – although this was from a relatively low base. It is also worth noting that the STEM subject with the second highest growth, in the last year and over 10 years, was mathematics, with increases of 5.1% and 132.7%. The rapid growth for maths means that it has overtaken biology and been the largest STEM subject every year since 2007. The increases for both of the maths subjects is very impressive when compared with the average for all subjects which fell by 4.4% in 2012 but grew 31.0% over 10 years.

Apart from maths and further maths, only two other STEM subjects grew in 2012 and over 10 years. These were chemistry, up 3.1% in 2012 and 76.9% over the 10-year period, and physics, which grew by 1.7% in 2012 and by 60.3% over 10 years.

Design and technology grew too, by 16.6% over 10 years. However, it fell by 10.5% in 2012.

Table 8.0: GCE AS level STEM subject entrant volumes (2003-2012) – all UK candidates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Change over one year	Change over 10 years
Biology	67,845	70,035	71,346	72,246	73,572	72,239	79,112	83,408	102,532	102,387	-0.1%	50.9%
Chemistry	46,586	48,166	49,951	50,855	52,835	54,157	58,473	62,232	79,874	82,390	3.1%	76.9%
Computing	14,075	11,722	10,247	9,208	8,719	7,821	7,564	7,223	8,097	7,719	-4.7%	-45.2%
ICT	28,833	25,558	23,444	21,790	20,422	19,266	19,696	19,910	21,100	18,961	-10.1%	-34.2%
Mathematics	63,841	62,098	68,178	70,805	77,387	84,613	103,312	112,847	141,392	148,550	5.1%	132.7%
Further mathematics	3,371	3,980	5,054	6,292	7,426	8,945	13,164	14,884	18,555	20,954	12.9%	521.6%
Physics	36,921	36,700	35,828	36,258	37,323	38,129	41,955	45,534	58,190	59,172	1.7%	60.3%
Other science subjects	8,941	8,892	9,053	9,801	9,343	9,529	6,947	6,873	7,064	6,550	-7.3%	-26.7%
Design and technology/ technology subjects	22,006	22,629	23,736	23,099	22,702	22,953	25,120	25,201	28,674	25,661	-10.5%	16.6%
All subjects	1,030,919	1,039,379	1,079,566	1,086,634	1,114,424	1,128,150	1,177,349	1,197,490	1,411,919	1,350,345	-4.4%	31.0%

Source: Joint Qualifications council (JCQ)

427 *Barriers to participation in education and training,* Department for Education. 2011, p4 **428** *Autumn statement,* HM Treasury, November 2011, p60-61 **429** *Level 2 And 3 Attainment By Young People In England Measured Using Matched Administrative Data: Attainment By Age 19 In 2010 (Provisional),* Department for Education, 31 March 2011, p1 **430** *Schools that make a difference to post-compulsory uptake of science: final project report to the Astra Zeneca Science Teaching Trust,* York: University of York, Department of Education, Bennett J, Hampden-Thompson G and Lubben F, 2011 **431** *An investigation into why the UK has the lowest proportion of female engineers in the EU,* EngineeringUK, 2011 **432** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012 **433** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012, pi **434** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012, p4 **435** http://www.iop.org/education/teacher/support/girls_physics/file_58196.pdf

Three STEM subjects have suffered declining entrant numbers, both in 2012 and over 10 years. Entrant numbers for both computing and ICT fell in 2012, 4.7% and 10.1% respectively. When you look at the 10-year trend, however, the decline in computing (45.2%) is higher than the decline in ICT (34.2%). The third STEM subject is the collective category 'other science subjects', which fell by 7.3% in 2012 and by 26.7% over 10 years. Since 2009 it has been the smallest of all the STEM subjects.

Table 8.1 shows the top eight AS level subjects by percentage increase in the number of entrants for 2011-2012. It shows that the number of entrants to further maths grew by 12.9% in one year, making it the subject with the largest percentage increase. Three other STEM subjects also made it into the top eight, with maths rising 5.1%, chemistry rising 3.1% and physics up 1.7%.

8.3 AS level A-C[436] achievement rates

The overall pass rate for all AS subjects has risen to 60.6%, the highest it has been for 10 years (Figure 8.1). This is a continuation of the upward trend over the last 10 years.

Of the different STEM subjects, only two (further maths and maths) had an A-C pass rate above the average for all subjects in 2012. The further maths pass rate was 82.6%, slightly up on the previous year but below the peak of 83.9% achieved in 2003. The maths pass rate was much lower at 66.0%, but this was still a rise from 64.4% in 2011.

Ofsted[437] has raised concerns about the readiness of GCSE students to study AS level maths. Its figures show that around 20% of students entered for AS maths and 10% for AS further maths fail their exams, despite a large majority of them having gained an A*-A grade at GCSE level.

Of the different STEM subjects, ICT and computing had the lowest pass rates. In 2012 the pass rate for computing was just 45.5%, while ICT was only marginally higher at 46.9%. It can also be seen that neither of these subjects has achieved a pass rate of 50% in the last 10 years.

All the different science subjects had an increase in their A-C pass rate in 2012. For chemistry the pass rate was 59.1%, while the comparable figure for physics was 58.1% and for biology it was 55.9%.

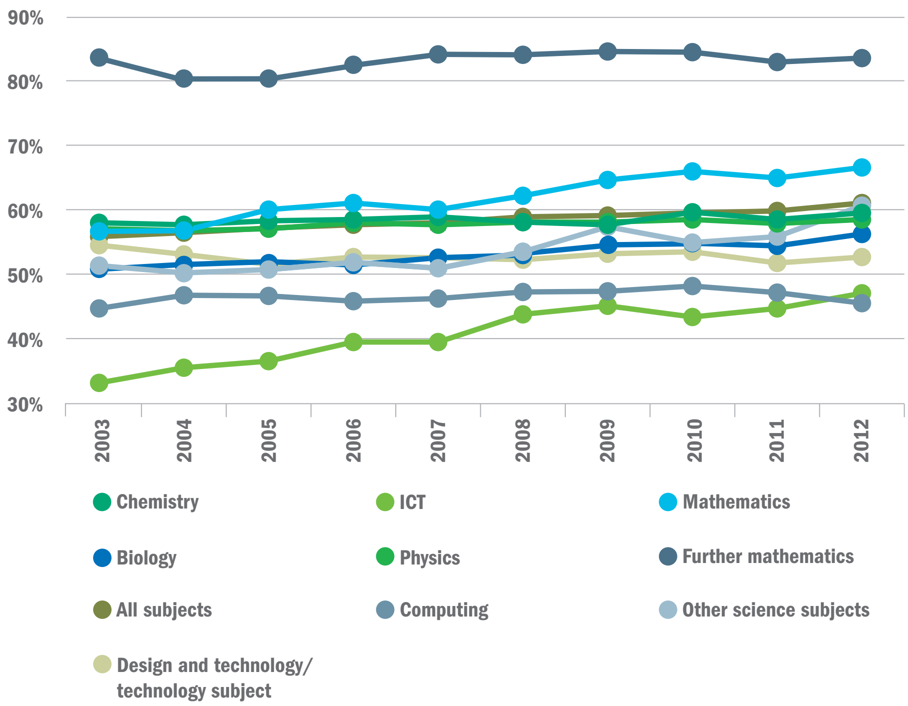
Design and technology had a pass rate of 52.4% in 2012, above the 51.5% in 2011. However, this was still below the total of 54.2% achieved in 2003.

Table 8.1: Top eight AS level subjects as percentage increase in the number of entrants (2011-2012) – all UK candidates

	2011	2012	Change over one year
Further mathematics	18,555	20,954	12.9%
Economics	35,184	38,386	9.1%
Mathematics	141,392	148,550	5.1%
Chemistry	79,874	82,390	3.1%
Spanish	11,433	11,781	3.0%
Physics	58,190	59,172	1.7%
Geography	45,302	45,923	1.4%
Classical subjects	8,611	8,614	0.3%

Source: Joint Qualifications council (JCQ)

Fig. 8.1: GCE AS level STEM subject A-C achievement rates (2003-2012) – all UK candidates



Source: Joint Qualifications council (JCQ)

436 Grades A-E are passes at AS level. However, we purposely only analyse/group passes at grades A-C, as these are generally the grades required for entry into STEM honours degree courses.
437 *Mathematics: Made to measure,* Ofsted, May 2012, p14

8.4 AS level gender balance

When you examine the proportion of females in different STEM subjects, a large amount of variation is evident (Figure 8.2).

Computing had the lowest proportion of female entrants, at just 8.2%. The STEM subject with the second worst proportion of females is physics with only a quarter (23.4%). This is in stark contrast to biology and chemistry, which are both close to gender parity.[438] For chemistry, nearly half (47.9%) of entrants are female while for biology women make up a majority (56.3%) of entrants. In fact, biology is the only STEM subject where women make up a majority of entrants.

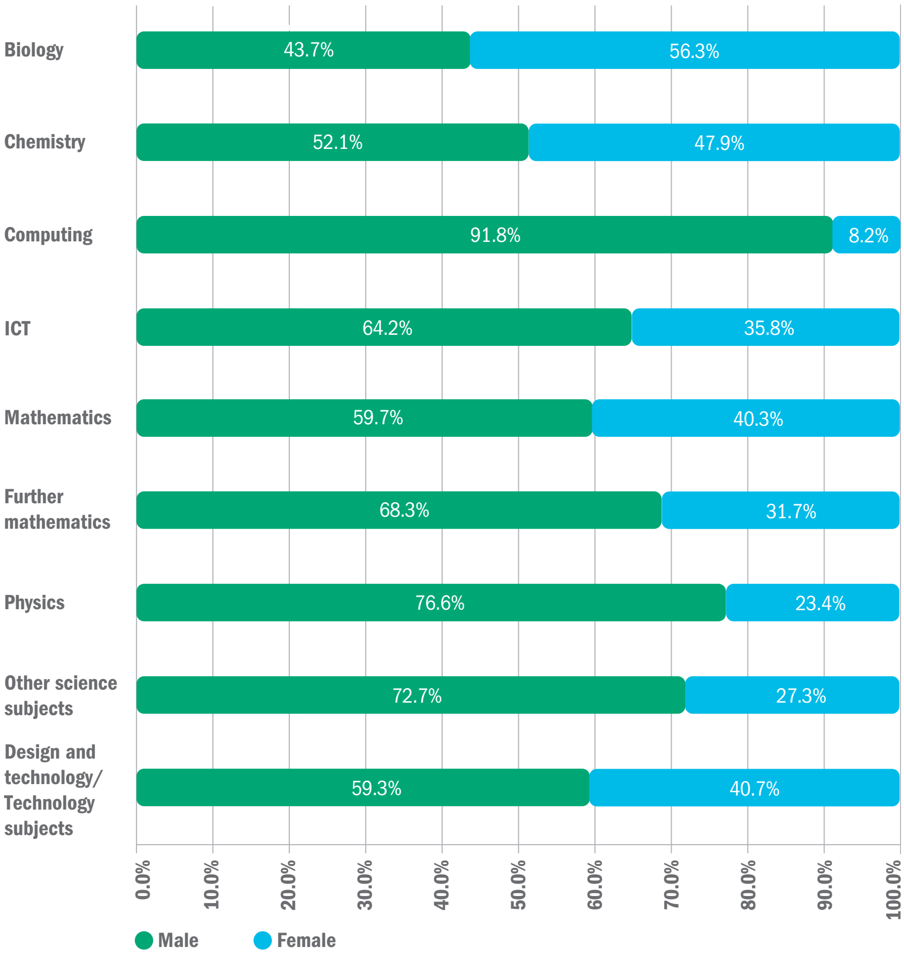
Although computing has the lowest proportion of female students, the proportion studying ICT is much higher, at 35.8%. The reasons ICT attracts a higher proportion of female students than computing is not known.

The proportion of women studying further maths is skewed towards male entrants, with only a third (31.7%) being female. However, the proportion of female entrants to maths is 40.3%.

Female entrants to design and technology made up 40.7% of the total cohort in 2012, making it the STEM subject with the third largest proportion of female entrants.

Table 8.2 shows the proportion of female entrants to different STEM subjects over a 10-year period. It shows that in 2003, only chemistry was close to gender parity. In 2012, four subjects were close to gender parity: biology, chemistry, maths and design and technology.

Fig. 8.2: AS level gender balance amongst entrants (2012) – all UK candidates



Source: Joint Qualifications council (JCQ)

Of the four subjects which were close to gender parity in 2012, biology has had a decrease in the number of female entrants over 10 years, from 60.9% in 2003 to 56.3% in 2012. Conversely, the proportion of female entrants to both maths and design and technology has increased over 10 years, bringing both subjects close to gender parity since 2005. Chemistry, the only subject to have been close to gender parity in each of the 10 years, has seen a fall female entrants, from 50.6% in 2003 to 47.9% in 2012.

Table 8.2: Percentage of female entrants to GCE AS level subjects (2003-2012) – all UK candidates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Biology	60.9%	59.7%	59.0%	58.8%	58.1%	57.2%	56.7%	56.1%	55.1%	56.3%
Chemistry	50.6%	50.2%	49.7%	49.5%	49.5%	49.0%	48.2%	47.9%	47.0%	47.9%
Computing	13.8%	12.5%	11.1%	11.3%	11.0%	11.1%	10.2%	9.5%	9.5%	8.2%
ICT	36.9%	37.0%	36.9%	37.3%	38.2%	37.6%	37.0%	36.9%	36.4%	35.8%
Mathematics	39.8%	39.8%	40.0%	41.0%	41.4%	41.7%	41.8%	41.0%	40.9%	40.3%
Further mathematics	32.4%	32.7%	33.6%	35.0%	33.8%	34.7%	35.3%	34.8%	32.8%	31.7%
Physics	24.3%	24.6%	24.6%	24.5%	24.7%	24.1%	23.6%	23.7%	23.3%	23.4%
Other science subjects	30.8%	31.3%	32.0%	32.5%	33.6%	34.8%	29.7%	29.3%	27.6%	27.3%
Design and technology/ technology subjects	37.3%	39.0%	40.5%	41.5%	41.5%	41.4%	42.4%	42.1%	42.2%	40.7%

Source: Joint Qualifications council (JCQ)

438 Close to gender parity is defined as no gender representing less than 40% of all entrants.

The proportion of females in computing and ICT in 2012 (8.7%) is below 2003 levels (13.8%). ICT numbers have declined only marginally, from 36.9% in 2003 to 35.8% in 2012.

Further maths and physics both had a slightly lower proportion of female entrants in 2012 (31.7% and 23.4% respectively) than they had in 2003 (32.4% and 24.3% respectively).

8.5 A level entrant numbers

Between 2011 and 2012, the number of entrants to all A level subjects decreased by 0.6% (Table 8.3). Against this background, it is positive to note that six of the nine STEM subjects had growth in their entrant numbers over the last year.

The STEM subject with the largest percentage growth in 2012 was further maths, which was 7.6% higher. Since 2004, the number of entrants to further maths has more than doubled to 13,223.

Maths also had an increase in entrant numbers in 2012, rising by 3.3%. At 85,714 entrants, maths is the largest STEM subject. It has also had the largest percentage increase over 10 years, rising 53.3% (although this is below the average for all subjects which was 284.2%).

Both of the IT-related STEM subjects (computing and ICT) saw entrant numbers fall, both over 10 years and in the last year. Specifically, entrant to computing have fallen by 86.5% over 10 years, and by 4.8% in the last year, to a low of 3,809. ICT had the largest decline in 2012, falling by 7.3% to 11,088 entrants.

Over 10 years, design and technology has grown very slightly, rising by just 0.1%. However, it had a sharp fall of 6.3% in 2012.

The three single science subjects (biology, chemistry and physics) have all seen growing entrant numbers over 10 years and in the last year. Of the three, physics had the highest growth in one year, rising by 5.0%. However, over 10 years it has had the lowest growth of the three single sciences, rising by 12.8%. By comparison, biology grew by 1.7% in 2012 and by 22.0% over 10 years, while chemistry grew by 2.4% in 2012 and by 36.3% over 10 years.

Analysis by the Department for Education[439] shows that physics has the lowest progression rate from AS level to A level, at just 67%. If we are to increase the number of pupils who are studying A level physics, then the reasons for this low progression rate need to be identified and intervention measures developed.

Table 8.4 shows the top 10 A level subjects, based on the percentage increase on the previous year. It shows that further maths had the largest increase, rising 7.6%, while physics was third with entrant numbers up 5.0%. Maths was fifth with a 3.3% rise, other sciences came seventh with a 3.0% rise, and chemistry was tenth with a 2.4% rise – meaning that half of the top 10 subjects were STEM subjects.

Table 8.4: Top 10 A level subjects as a percentage increase in the number of entrants (2011-2012) – all UK entrants

	2011	2012	Change over one year
Further mathematics	12,287	13,223	7.6%
Classical subjects	6,175	6,635	7.4%
Physics	32,860	34,509	5.0%
Communication studies	2,032	2,118	4.2%
Mathematics	82,995	85,714	3.3%
Religious studies	22,325	23,042	3.2%
Other sciences	3,277	3,375	3.0%
Political studies	14,848	15,260	2.8%
Geography	31,226	32,005	2.5%
Chemistry	48,082	49,234	2.4%

Source: Joint Qualifications council (JCQ)

Table 8.3: GCE A level STEM subject entrant numbers (2003-2012) – all UK candidates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Change over one year	Change over 10 years
Biology	51,716	52,264	53,968	54,890	54,563	56,010	55,485	57,854	62,041	63,074	1.7%	22.0%
Chemistry	36,110	37,254	38,851	40,064	40,285	41,680	42,491	44,051	48,082	49,234	2.4%	36.3%
Computing	28,175	8,488	7,242	6,233	5,610	5,068	4,710	4,065	4,002	3,809	-4.8%	-86.5%
ICT	-	16,106	14,883	14,208	13,360	12,277	11,948	12,186	11,960	11,088	-7.3%	
Mathematics	55,917	52,788	52,897	55,982	60,093	65,593	72,475	77,001	82,995	85,714	3.3%	53.3%
Further mathematics	-	5,720	5,933	7,270	7,872	9,091	10,473	11,682	12,287	13,223	7.6%	
Physics	30,583	28,698	28,119	27,368	27,466	28,096	29,436	30,976	32,860	34,509	5.0%	12.8%
Other science subjects	4,751	4,444	4,414	4,209	4,544	4,555	4,496	3,361	3,277	3,375	3.0%	-29.0%
Design and technology/ technology Subjects	17,091	17,261	17,914	18,684	17,417	17,396	17,442	18,417	18,249	17,105	-6.3%	0.1%
All subjects	224,343	766,247	783,878	805,698	805,657	827,737	846,977	853,933	867,317	861,819	-0.6%	284.2%

Source: Joint Qualifications council (JCQ)

439 *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012, p9

8.6 A level A*[440]-C[441] achievement rates

In 2012, the A*-C pass rate for all subjects was 76.6%, a slight increase on the previous year (Table 8.5). The A*-C pass rate has increased every year for our 10-year analysis. However, looking at specific STEM subjects, only three had an A*-C pass rate above the average for all subjects in 2012.

The highest pass rate was for further maths, at 89.4%. Since 2004, further maths has had the highest pass rate of all the STEM subjects, never falling below 86.5%. Maths had the second highest pass rate in 2012, at 81.6%. The maths pass rate had been increasing steadily until 2009 but, since then, it has slid back slightly.

The third STEM subject with an above average pass rate in 2012 is chemistry, at 79.1%. Like further maths and maths, chemistry has had an above average pass rate for each of the last 10 years.

In 2003, physics had an above average pass rate of 66.0%. Although the pass rate has increased to 74.0% over the 10-year period, it has been below average since 2005. Analysis by the Department for Education[442] shows that over 50% of pupils with a grade A in physics at GCSE level who go on to A level achieve a grade C or lower.

For each of the last 10 years biology has had a below average pass rate, although it has increased over this time to reach 73.7% in 2012.

The pass rate for design and technology has fallen slightly. It was 69.9% in 2012, compared with a highpoint of 70.2% in 2011. The pass rate for design and technology has been below average for each of the last 10 years.

Both computing and ICT have had large increases in the A*-C pass rate over the period of the analysis. Both subjects started with a pass rate below 50% (48.0% for computing in 2003 and 49.4% for ICT in 2004). However, since then there has been steady growth, with computing achieving an A*-C pass rate of 60.8% in 2012 and ICT achieving a pass rate of 62.8%. It should be noted that the 2012 A*-C pass rate for computing is below the 10-year high of 62.6% in 2011.

Research by the Department for Education,[443] shows that achievement at A level decreases as GCSE grades decrease and that only a small proportion of students achieve a better grade in a subject at A level than they did at GCSE level. Other research by the Department for Education[444] has shown that for those who achieve high grades at A level in maths and science there is, “a pattern of persisting dependence on strong prior attainment within subject from the end of primary education”. This emphasises the importance of good primary school education for the supply of students who achieve high grades in maths and science at A level.

The Department for Education[445] has also shown that students on Free School Meals (FSM) are less likely than those not on FSM to take up A level maths and science. FSM students were one quarter as likely to study maths and one third as likely to study physics as non-FSM students. Students on free school meals are also less likely to achieve A and B grades at A level than their non-FSM counterparts, reflecting both a shortage of FSM students progressing into A level maths and physics, and an attainment gap.

Table 8.6 shows the number of males and females achieving A*-C grades in both maths and physics. The table shows that the number of A level students achieving both of these qualifications has been rising each year to reach 16,624 in 2010. However, the proportion of female students has remained fairly static, fluctuating between a high of 22.5% in 2009 and a low of 21.0% in 2006.

Table 8.6: The number of students achieving A*-C grades in both A level maths and physics (2006-2010) – England

Year	Males	Females	Total	Percentage female
2010	13,059	3,565	16,624	21.4%
2009	11,738	3,408	15,146	22.5%
2008	11,112	3,032	14,144	21.4%
2007	10,446	2,871	13,317	21.6%
2006	9,977	2,658	12,635	21.0%

Source: Department for Education

Table 8.5: Proportion achieving grade A*-C at GCE level (2003-2012) – all UK candidates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Further mathematics		86.5%	86.6%	87.9%	88.5%	88.9%	88.9%	89.8%	89.5%	89.4%
Mathematics	75.0%	75.7%	77.9%	79.9%	80.7%	81.3%	81.8%	81.7%	81.8%	81.6%
Chemistry	72.0%	73.0%	73.1%	74.2%	75.2%	76.3%	76.2%	75.8%	78.2%	79.1%
Physics	66.0%	67.9%	68.1%	68.9%	70.2%	70.6%	70.8%	72.9%	73.5%	74.0%
Biology	62.0%	64.1%	65.0%	66.3%	67.7%	69.2%	70.2%	70.3%	73.3%	73.7%
Design and technology/ technology subjects	62.0%	63.5%	64.8%	67.6%	68.6%	68.6%	69.1%	69.6%	70.2%	69.9%
Computing	48.0%	55.6%	56.2%	57.8%	58.7%	59.0%	59.9%	61.3%	62.6%	60.8%
ICT	-	49.4%	49.0%	50.6%	53.0%	55.8%	56.9%	60.2%	60.6%	62.8%
Other science subjects	61.0%	63.4%	63.0%	64.9%	67.4%	66.2%	69.0%	76.3%	75.2%	76.4%
All subjects	64.0%	69.0%	69.9%	71.3%	72.8%	73.9%	75.1%	75.4%	76.2%	76.6%

Source: Joint Qualifications council (JCQ)

440 A new A* grade was introduced for A levels in 2010. **441** Grades A*-E are passes at A level. However, we purposely only analyse/group passes at grades A*-C, as these are generally the grades required for entry into STEM honours degree courses. **442** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012, p18 **443** *Subject progression from GCSE to AS Level and continuation to A Level,* Department for Education, February 2012, p12 **444** *Maths and science education: the supply of high achievers at A level,* Department for Education, January 2011, p95 **445** *Maths and science education: the supply of high achievers at A level,* Department for Education, January 2011, p123 and p130

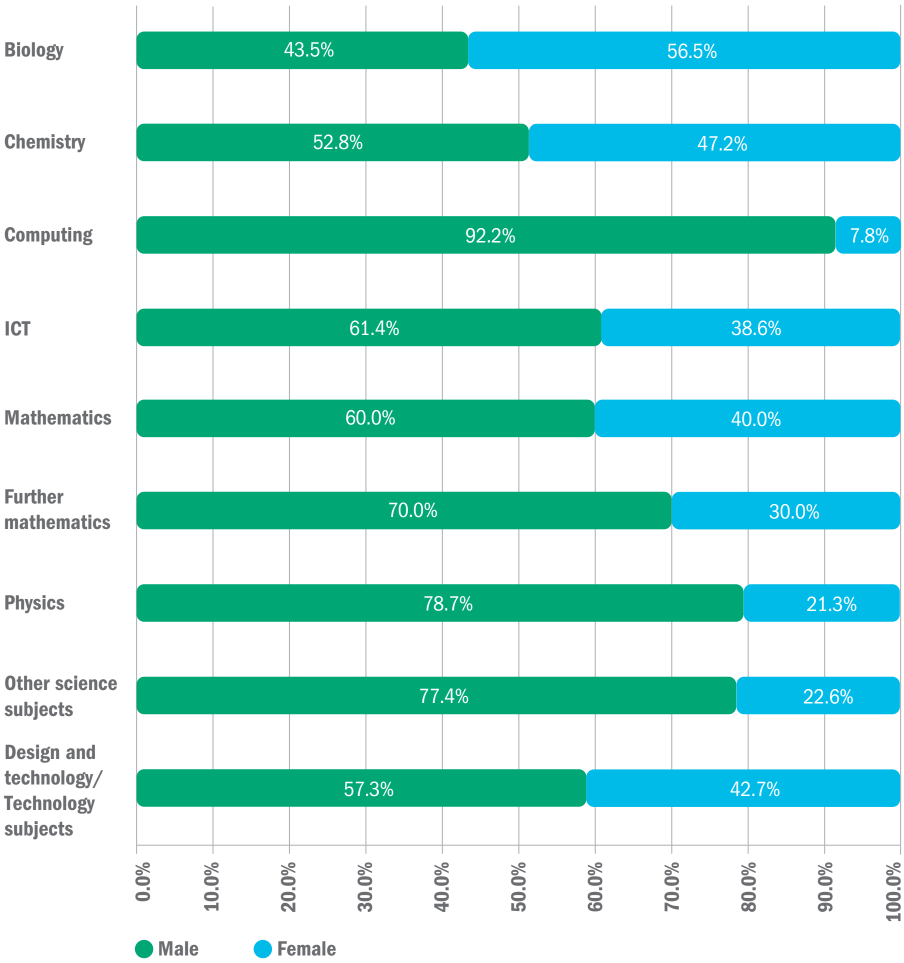
8.7 Gender balance within STEM A levels

The gender balance for different STEM A levels is shown in Figure 8.3. The pattern is broadly similar to AS level, with only four subjects being close to gender parity. These are biology, chemistry, mathematics and design and technology. The subject with the worst gender imbalance is computing, with only 7.8% female entrants.

Table 8.7 shows the 10-year trend in the proportion of female entrants to different STEM A level courses. It shows that in 2003 only one subject, biology, was close to gender parity. Computing, in 2012 the subject most skewed towards male entrants, had a quarter (26.5%) female entrants in 2003. But in 2012, this had fallen to 7.8%.

Four other STEM subjects had a lower proportion of female entrants in 2012 than they had in 2003: these were all science subjects (biology, chemistry, physics and other science subjects). Conversely, maths, and design and technology, had more female entrants in 2012 than they had in 2003.

Fig. 8.3: Gender balance within STEM A level (2012) – all UK candidates



Source: Joint Qualifications council (JCQ)

Table 8.7: Percentage of female entrants for STEM GCE A level courses (2003-2012) – all UK candidates

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Biology	61.4%	60.3%	59.1%	58.8%	58.7%	58.1%	57.3%	56.4%	56.6%	56.5%
Chemistry	51.5%	50.8%	49.4%	49.1%	49.8%	48.7%	48.4%	47.8%	47.3%	47.2%
Computing	26.5%	12.2%	11.3%	9.7%	10.2%	9.5%	9.6%	8.9%	7.5%	7.8%
ICT	-	34.9%	35.5%	36.3%	37.3%	38.0%	38.6%	38.1%	39.1%	38.6%
Mathematics	37.0%	38.7%	38.1%	39.1%	40.0%	39.4%	40.6%	40.6%	40.0%	40.0%
Further mathematics	-	28.4%	28.6%	29.8%	29.4%	30.4%	31.3%	31.9%	31.2%	30.0%
Physics	22.8%	22.3%	22.0%	21.8%	22.2%	21.9%	22.2%	21.5%	20.8%	21.3%
Other science subjects	30.0%	27.5%	26.9%	27.1%	27.7%	27.0%	27.8%	21.5%	22.8%	22.6%
Design and technology/ technology subjects	37.2%	37.7%	39.1%	40.7%	41.9%	41.3%	41.5%	43.7%	42.2%	42.7%

Source: Joint Qualifications council (JCQ)

8.8 Educational establishments offering A level qualifications

Table 8.8 shows that nearly half (48%) of 16-18 education providers are general Further Education Colleges, while a third (32%) are taught in school sixth forms. It should be noted, however, that cohort size varies quite significantly, with a general Further Education College having, on average, 2,662 16- to 18-year-old learners compared with just 222 in a school sixth form.

Figure 8.4 shows that just under 90% of schools and colleges offer A level maths, while physics is offered in less than 80% of establishments. This could mean that pupils who want to study A level maths and physics are denied the opportunity, as their local A level provider doesn't offer the qualification.

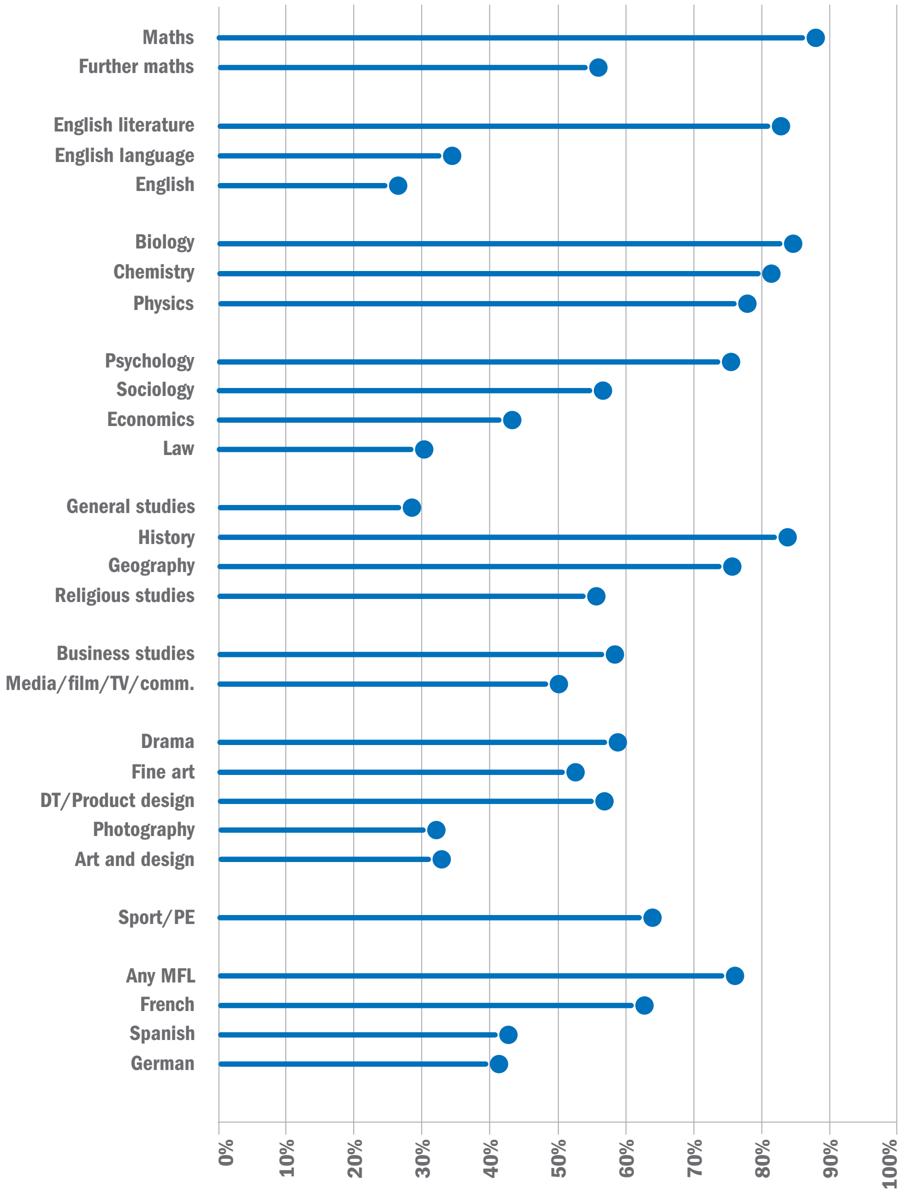
The Department for Education[448] has shown that Sixth Form Colleges generally offer the widest range of A level subjects – 38 on average. By comparison, Further Education Colleges offer only 20 A level subjects on average. Only 61% of FE Colleges offer A level maths, while for physics the comparable figure is only 50%.

Table 8.8: State funded 16-18 education providers (2009-2010)

	Number of providers	Average number of 16-18 learners per provider	Share of learners
School sixth forms (including academies)	1,888	222	32%
Sixth form colleges	92	1,629	11%
General Further Education Colleges[446]	235	2,662	48%
Specialist colleges	19	953	1%
Other providers[447]	334	327	8%

Source: National Audit Office

Fig. 8.4: Percentage of schools and colleges offering selected A level subjects (2009-2010) – England



Source: Department for Education[449]

446 Included tertiary colleges **447** Includes agricultural colleges and art, design and performing arts colleges. **448** *Maths and science education: the supply of high achievers at A level,* Department for Education, January 2011, p169 **449** *Subject and course choices at ages 14 and 16 in England: Insights from behavioural economics,* Department for Education, October 2011, p66

Table 8.9 shows that a majority of schools are teaching A level physics in class sizes of no more than 10 (73.7%), with nearly half (48.1%) being taught in classes of no more than five students. This implies that many schools would be able to increase the number of AS/A level physics students they are teaching without needing to increase the number of physics teachers. Section 8.10 describes some interventions from the Institute of Physics specifically aimed at growing the pool of young people studying physics.

Table 8.9 Number of pupils studying AS/A level physics by size of class[450]

Pupils studying A/AS or equivalent physics	Number of schools
1 to 5	1,583
6 to 10	844
11 to 15	384
16 to 20	223
21 plus	258
Total	3,292

Source: Institute of Physics[451]

8.9 Year 13 diplomas

In section 7 we described the introduction of diplomas for 14- to 19-year-olds into the English education system. These diplomas can be studied at level 3 (advanced or progression).[452] A progression diploma is worth 2.5 A levels, while an advanced diploma is worth 3.5.[453]

Table 8.10 shows that in 2010/11, a total of 1,718 learners completed either a progression or an advanced diploma. Of these, 35% were studying one of the three engineering diplomas. The most popular engineering diploma was information technology, with 275 awards, followed by engineering (241) and then construction and the built environment (86).

Table 8.10: Number of Year 13 learners completing diploma subjects (2010/11) – England[454 455]

	Number of learners	Percentage of all learners
Construction and the built environment	86	5%
Engineering	241	14%
Information technology	275	16%
All subjects	1,718	

Source: Department for Education

8.10 BTec Nationals

BTec Nationals are vocational qualifications which are equivalent to an A level. Table 8.11 shows that in 2011/12, 14,533 BTec Nationals were completed in engineering subjects. Of these, 13,610 were awarded to UK-domiciled students: an 8.3% rise in 2011/12 and an increase of 43.5% over six years. The number of completions from international students increased by 200.7% in 2011/12, to 923.

Table 8.12 shows that of the 13,610 UK students who completed a BTec National in 2011/12, 3,608 were studying for a subsidiary diploma in engineering. This was more than twice the number of completions for the extended diploma in engineering which, with 1.362 completions, was the second most-studied subject.

Table 8.11: Completions for engineering BTec Nationals (2006/07-2011/12) – all domiciles

	QCF Size	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
International	Subsidiary diploma	-	-	4	1	8	6	-25.0%	-
	Diploma	4	10	17	10	48	107	122.9%	2,575.0%
	Extended diploma	384	355	468	358	251	810	222.7%	110.9%
International Total		**388**	**365**	**489**	**369**	**307**	**923**	**200.7%**	**137.9%**
UK	Certificate	-	-	-	-	190	656	245.3%	-
	Subsidiary diploma	1,599	2,245	2,363	3,428	3,203	3,978	24.2%	148.8%
	90 credit diploma	-	-	-	-	-	52	-	-
	Diploma	5,026	5,281	6,030	6,256	5,165	4,837	-6.4%	-3.8%
	Extended diploma	2,859	3,107	3,057	3,254	4,012	4,087	1.9%	43.0%
UK total		**9,484**	**10,633**	**11,450**	**12,938**	**12,570**	**13,610**	**8.3%**	**43.5%**
Grand total		**9,872**	**10,998**	**11,939**	**13,307**	**12,877**	**14,533**	**12.9%**	**47.2%**

Source: Edexcel

450 This table only covers 27,161 A level passes, out of a total of 32,860 entrants. **451** *It's different for girls,* Institute of Physics, October 2012 **452** *Statistical release Diploma learning, England 2010 – 11,* Department for Education, November 2011, p1 **453** *Statistical release Diploma learning, England 2010 – 11,* Department for Education, November 2011, p2 **454** Data abstracted from *Statistical release Diploma learning, England 2010 – 11,* Department for Education, November 2011, p8 **455** Manufacturing and product design has been excluded from this table. The Department for Education didn't report on this diploma due to the low number of students.

Table 8.12: Completions for engineering BTec Nationals, by selected sub-discipline (2006/07-2011/12) – UK domicile

QCF Size	Title	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
Certificate	Engineering (QCF)	-	-	-	-	189	656	247.1%	
Diploma	Aeronautical engineering (QCF)	-	-	-	-	16	139	*[457]	
Diploma	Aviation operations	-	-	78	114	78	154	97.4%	
Diploma	Electrical/electronic engineering	1,189	1,378	1,478	1,425	1,150	115	-90.0%	-90.3%
Diploma	Electrical/electronic engineering (QCF)	-	-	-	-	115	993	763.5%	
Diploma	Engineering (QCF)	-	-	-	-	99	1,063	973.7%	
Diploma	Mechanical engineering (QCF)	-	-	-	-	7	520	*	
Diploma	Operations and maintenance engineering	532	689	812	930	703	126	-82.1%	-76.3%
Diploma	Operations and maintenance engineering (QCF)	-	-	-	-	44	689	1,465.9%	
Extended diploma	Aeronautical engineering (QCF)	-	-	-	-	1	290	*	
Extended diploma	Electrical/electronic engineering (QCF)	-	-	-	-	5	804	*	
Extended diploma	Engineering (QCF)	-	-	-	-	52	1,362	2,519.2%	
Extended diploma	Manufacturing engineering (QCF)	-	-	-	-	2	377	*	
Extended diploma	Mechanical engineering (QCF)	-	-	-	-	1	298	*	
Extended diploma	Vehicle technology	-	-	193	275	283	286	1.1%	
Extended diploma	Vehicle technology (motorsports)	-	10	176	181	229	224	-2.2%	
Subsidiary diploma	Aviation operations	-	177	184	212	130	117	-10.0%	
Subsidiary diploma	Engineering (QCF)	-				1,905	3,608	89.4%	
Subsidiary diploma	Vehicle technology	-	51	104	125	103	120	16.5%	
	Grand total	**9,482**	**10,816**	**12,025**	**13,540**	**12,570**	**13,610**	**8.3%**	**43.5%**

Source: Edexcel

8.11 Growing the pool

Authored by Peter Main, Director, Education and Science, Institute of Physics

There is universal acceptance of the need to increase the numbers of scientists and engineers emerging from the educational system. There is rather less agreement on the best way to achieve that goal, ranging from improved careers advice to participation in exciting outreach activities. Recent work shows that the best route towards solving the problem is probably the obvious one – by improving the quality of the day-to-day student experience in the classroom.

In this article, I shall concentrate mainly on routes into university, although much will also be relevant for other learners. For degrees in physics and engineering, the primary pool of potential students comprises those with A levels in physics and mathematics; of these, the bottleneck is the number taking physics. In a recent statistical analysis, the Institute of Physics (IOP) has shown[456] that the primary destination of students with A level physics is engineering, and that almost everyone that passes goes to university, the majority to pursue STEM subjects. What this observation implies is that, in order to grow the numbers, the emphasis must be on increasing the pool taking A levels in physics. Otherwise, all that happens is that students move from one STEM subject to another.

To increase the numbers taking A level physics, I will consider three main areas: improving the classroom experience; recruiting more specialist teachers; and understanding why students, particularly girls, make the choices they do. The three areas are not unrelated!

Improving the classroom experience means, in simple terms, getting better physics (and maths) teachers. Careful estimates show that, out of a target workforce of around 10,000 specialist physics teachers in England, there is a shortage of between 4,000 and 4,500. This means that for the short to medium term, at least, most teaching of physics to GCSE will be undertaken by a non-specialist, most likely a biologist. The problem is most acute in regions where the dominant model is to have schools that teach to GCSE with A levels offered in separate colleges. Such schools are much less likely to have specialist teachers, because most specialists want to teach A level. Whether this lack of specialists is the reason or not, the numbers moving on to take A level physics from these schools is much lower than for schools that teach up to A level. For example, girls are almost three

456 http://www.iop.org/publications/iop/2012/page_56469.html **457** The one year percentage change has not been published due to the low number of completions in 2010/11 times more likely to go on the do A level physics if they do their GCSEs in a school that also teaches A levels.

The Institute has spent a lot of its own money over the last ten years in developing resources to support non-specialists, both in terms of subject knowledge and pedagogical approaches. More recently, we have been fortunate enough to receive funding from Government for our *Stimulating Physics Network,*[458] the main thrust of which is to identify schools where we think we can make a difference. We then take our support into the school, working with whole teams, including technicians, to provide bespoke training to increase knowledge and, equally important, confidence and enthusiasm. To date, the results have been rewarding. In the schools where we have been working long enough to have made a real impact in the take up of A levels, we have seen increases of 50% in the number of boys and, encouragingly, 150% in the number of girls. It is entirely possible that the recent modest increases in the national A level physics numbers are due to the Network. If so, there is a lot more to come over the next few years. And, while the support for non-specialist teachers is not the only element of the programme, the figures do suggest that the quality of the teaching is a major factor in determining student progression.

Any long term solution to the teacher shortage involves improved recruitment and here too, there is optimism. We need to recruit around a thousand new teachers a year for 15 years to redress the situation. Until last year, the average recruitment was 400 a year, albeit with large fluctuations, and teacher trainers had targets for 'science' PGCE entry, which meant that over a long period of time they preferentially recruited biologists, who were more abundant. A major step forward, therefore, was the Government setting independent targets for physics, chemistry and biology. The result of this simple move, together with some aggressive marketing from the (then) Training and Development Agency for Schools (TDA) and the IOP, meant that 2011 saw the highest number of PGCE entrants for physics and history.

The picture is even rosier for 2012. With the development of the new physics with mathematics PGCE – prompted by the IOP in partnership with the Institute of Mathematics and its Applications (IMA) and the Royal Academy of Engineering (RAEng) – and the introduction of the IOP Initial Teacher Training Scholarships, which give £20,000 scholarships to those selected, the figures for this year are even higher than the record-breaking numbers for 2011. And many of the extra applicants are career-changing engineers. It can only be good for both engineering, as well as physics, to have so many advocates for the subject in the classroom.

The IOP's work with schools demonstrates the importance of the teacher in subject choice and it is probably the case that, for physics, this is the major bottleneck. But there is still the issue of the other factors motivating subject choice, particularly for girls, where decades of dedicated outreach and interventions have, frankly, come to nothing. I see this as a controversial area where much has been done – more in hope than anything else – and with little evidence for the efficacy of the activities, whether they are based around careers advice, ambassadors, competitions or anything else. We are all guilty! Over the last few years, the Economic and Social Research Council (ESRC), in conjunction with the Gatsby Trust, the IOP and the Association for Science Education, has funded a suite of projects which go under the collective title of TISME. It is early days for this work, but I am optimistic that, by working with the social science experts, we in the learned societies and professional bodies can learn from the burgeoning evidence base and build our activities on robust and well-tested ideas.

In summary, while numbers in physics and engineering are still too low, there are good reasons to be optimistic. While the current pool of potential students is fully depleted, there is every reason to expect an influx over the next few years.

8.12 Scottish Highers and Advanced Highers

8.12.1 Scottish Highers

In Scotland, Highers are the equivalent qualifications to A levels. They are aimed particularly at students who have passed subjects at Standard Grade credit level, or who have successfully completed a course at Intermediate 2. Highers are set at Scottish Credit and Qualifications Framework (SCQF) level 6 and are roughly equivalent to NQF level 3.

In 2012, there were 181,568 entries for Scottish Highers – an increase of 1.5% on the previous year (Table 8.13). Overall, entries for STEM subjects decreased by 1.2%. Of the STEM subjects, only three had positive growth in 2012: chemistry grew by 0.7%, maths by 0.1%, and technology studies by 1.0%, although the latter declined by 18.6% over eight years.

Looking at the subjects that saw a decline in entries in 2012, biology fell by 2.2% and physics fell by 3.0%. However, both of these subjects have shown growth over eight years. Entries to both computing and information systems declined in 2012, by 2.4% and 14.1% respectively. Over eight years, entries to technology studies fell by 51.1%, while computing fell by 13.0%.

Looking at the Scottish Highers entry data by gender it can be seen that as well as having the largest fall in entries in 2012. It is also the most gender-biased STEM course, with 93.8% of all entrants being male. For both physics (71.1%) and computing (77.1%), approximately three quarters of all entrants were male. The only STEM subject which had a preponderance of female entrants was biology, where two thirds (64.0%) were female. Both chemistry (49.0%) and mathematics (47.9%) were close to gender parity.[459]

8.12.2 Advanced Highers

Advanced Highers are aimed at students who have passed Highers, and are usually taken in the sixth year of school or at college.

In 2012, the number of entrants for Advanced Highers increased by 0.8% compared with the previous year (Table 8.13). Four of the five STEM subjects had entries above this average, with physics growing by 9.1%, biology by 5.6%, maths by

458 http://www.stimulatingphysics.org/ **459** Close to gender parity is defined as no gender representing less than 40% of the number of entrants.

Table 8.13: Trends in entries for each STEM subject at Higher National and Advanced Higher (2005-2012) – Scotland

Course Subject	2005	2006	2007	2008	2009	2010	2011	2012	Change over one year	Change over eight years
					HIGHER					
Mathematics	19,181	18,623	18,792	19,636	19,638	20,657	20,550	20,564	0.1%	7.2%
Biology	8,943	9,044	9,169	9,132	9,107	9,308	9,767	9,548	-2.2%	6.8%
Chemistry	9,411	9,168	9,490	9,505	9,582	10,179	10,288	10,361	0.7%	10.1%
Physics	8,952	8,617	8,582	8,765	9,002	9,018	9,445	9,166	-3.0%	2.4%
Computing	4,628	4,356	4,180	4,256	4,307	4,356	4,124	4,025	-2.4%	-13.0%
Information systems	2,469	1,904	1,656	1,484	1,413	1,433	1,407	1,208	-14.1%	-51.1%
Technological studies	848	771	771	758	621	728	683	690	1.0%	-18.6%
Total STEM entries at Higher level	54,432	52,483	52,640	53,536	53,670	55,679	56,264	55,562	-1.2%	2.1%
Subtotal (all students at Higher)	164,142	159,140	161,081	162,576	167,792	175,614	178,838	181,568	1.5%	10.6%
					ADVANCED HIGHER					
Mathematics	2,318	2,598	2,484	2,752	3,027	2,936	3,098	3,239	4.6%	39.7%
Biology	1,693	1,886	1,929	1,955	2,095	2,177	2,288	2,417	5.6%	42.8%
Chemistry	1,792	2,016	2,039	2,143	2,183	2,226	2,472	2,496	1.0%	39.3%
Physics	1,426	1,437	1,380	1,403	1,550	1,736	1,757	1,917	9.1%	34.4%
Computing	499	450	349	366	411	414	461	460	-0.2%	-7.8%
Total STEM entries at Advanced Higher level	7,728	8,387	8,181	8,619	9,266	9,489	10,076	10,529	4.5%	36.2%
Subtotal advanced (all students)	17,140	18,264	17,831	18,854	19,648	20,585	21,414	21,587	0.8%	25.9%

Source: SQA

4.6% and chemistry by 1.0%. Entrants to the fifth STEM subject, computing, fell by 0.2%.

Looking at the trend over eight years, biology had the strongest growth (42.8%), followed by maths (39.7%), chemistry (39.3%) and physics (34.4%). For all four of these STEM subjects, the growth over eight years was higher than the average for all students (25.9%). Computing was the only STEM subject to show a decline over eight years, falling by 7.8% to just 460 students in 2012.

Looking at the gender split for National Higher entries (Table 8.14), we see that chemistry has an almost even gender split (49.0% female compared with 51.0% male). Maths also has a close to even gender split, with 47.9% female entrants. By comparison, only 6.2% of entrants to technology studies are female.

Table 8.15 shows the gender balance of STEM Advanced Higher courses. Chemistry has an almost equal split of female and male entrants (49.1% to 50.9%). However, entries to both physics and computing are skewed towards male students, with 79.3% of physics entrants and 85.9% computing entrants being male.

The only STEM subject to be skewed towards female entrants is biology, were nearly two thirds (65.2%) are female.

Table 8.14: Higher entries by gender (2012) – Scotland

Subject	Percentage female	Percentage male
Mathematics	47.9%	52.1%
Biology	64.0%	36.0%
Chemistry	49.0%	51.0%
Physics	28.9%	71.1%
Computing	22.9%	77.1%
Information systems	32.2%	67.8%
Technological studies	6.2%	93.8%
All entries	55.4%	44.6%

Source: SQA

Table 8.15: Advanced Higher entries by gender (2012) – Scotland

Subject	Percentage female	Percentage male
Mathematics	37.5%	62.5%
Biology	65.2%	34.8%
Chemistry	49.1%	50.9%
Physics	20.7%	79.3%
Computing	14.1%	85.9%
All entries	51.9%	48.1%

Source: SQA

Part 2 - Engineering in Education and Training
9.0 The Further Education sector

Table 9.0: Number of Colleges by college type and home nation (2012) – UK

Colleges in England	341
General Further Education Colleges	219
Sixth Form Colleges	94
Land-based Colleges	15
Art, Design and Performing Arts Colleges	3
Specialist Designated Colleges	10
Colleges in Scotland	41
Colleges in Wales	19
Colleges in Northern Ireland	6
Colleges in the UK	407

Source: Association of Colleges[465]

The Further Education (FE) sector is critical to meeting the education and skills needs of the UK. In 2010/11, the total number of learners participating in Government-funded FE (excluding schools) was 4.3 million,[460] a fall of 10.7% on the previous year.[461] The total number of learners achieving a Government-funded FE qualification was 3.1 million, down 8.5% on the previous year.

Table 9.0 shows that the 4.3 million learners were spread across 407 different institutions. Of these, 341 are in England, with General Further Education Colleges (219) and Sixth Form Colleges (94) predominating. Outside of England, the largest number of colleges was in Scotland (41) while Wales had 19 colleges and Northern Ireland had six.

In addition to FE Colleges offering FE courses, it should be noted that 38 Higher Education (HE) Institutions also offer FE courses.[462]

The FE sector is currently undergoing considerable change. As highlighted in section 11.0, two FE Colleges have been awarded foundation degree awarding powers. In August 2013, FE loans will be provided over-24-year-olds who are studying for a level 3 or level 4 FE course or apprenticeship.[463] The Government will, however, continue to grant fund courses for those under the age of 24 and those with skills needs below level 3.[464]

The Government estimates FE loans will cost £129 million for 2013/14, rising to £398 million for 2014/15. The FE loans will work in a similar way to loans in HE. Learners will be able to borrow up to £4,000, with repayments starting once earnings hit a threshold of £21,000 per annum.[466] Repayments will be nine per cent of earnings above the threshold, with a 30-year repayment period (the same as for HE loans).

In addition to these changes, FE will have to do more with less. Funding for FE will decrease over the next two years: in 2012/13, the investment in adult FE and skills will be £3.8 billion, dropping to £3.4 billion in 2013/14 and £3.3 billion in 2014/15.[467]

FE colleges will also have to deal with businesses as partners, because the Department for Education and the Department for Business, Innovation and Skills have introduced a jointly-funded programme to allow employers to take ownership of the skills and apprenticeship needs in their sector and/or supply chain.[468] Over a two-year period, £250 million is being

460 Quarterly Statistical First Release, The Data Service, 28 June 2012, p1 **461** The decline in the number of learners was driven by a 10.7% fall in the number of learners aged 19+. The number of learners under the age of 19 actually increased. **462** *New Freedoms New Focus FE Strategic Framework,* LSIS, 2011, p12 **463** *An Introduction to FE Loans for Colleges and Training Organisations, Skills Funding Agency,* 13 December 2011, p2 **464** *An Introduction to FE Loans for Colleges and Training Organisations, Skills Funding Agency,* 13 December 2011, p2 **465** Website accessed on the 7 August 2012 (http://www.aoc.co.uk/en/about_colleges/index.cfm) **466** *Apprenticeship policy,* House of Commons, 13 December 2011, p7 **467** *Skills investment statement 2011 – 2014: Investing in a world class skills system,* Department for Business, Innovations and Skills,1 December 2011, p1 **468** *Skills investment statement 2011 – 2014: Investing in a world class skills system,* Department for Business, Innovations and Skills, 1 December 2011, p5 invested in the programme. This scheme has already attracted 269 bids from employers through the first funding round.[469]

Alongside this investment, the intention is for individuals and employers to contribute a further £1 billion to FE[470] – around 20% of the combined total investment in FE. Based on historical data, however, the Department for Business, Innovation and Skills expects this target to missed by a "considerable margin". Nevertheless, businesses are willing to invest in skills training. The UK Commission for Employment and Skills (UKCES) estimates that employers spend around £49 billion on training.[471] UKCES also estimates that employers spend £2 billion on fees (to private training providers and FE Colleges) but only £75 million is spent on training in FE Colleges.[472] Also according to UKCES, three fifths of employers used private training providers in 2008/9, but just over a quarter used Colleges.[473]

If FE Colleges are to increase the level of funding they get from employers, then they will need to understand and address employer concerns. Research by the Confederation of British Industry (CBI)[474] has identified the key areas where employers feel action needs to be taken to strengthen workforce skills. Fifty-eight per cent of surveyed companies said action needed to be taken on the relevance of vocational qualifications, while 56% said the bureaucracy associated with Government funding and support needed to be addressed. It is also concerning that 42% of employers expressed concern over the quality of apprenticeships.

BIS identified that the Net Present Value[475] of FE qualifications started in 2008/09 for those aged 19+ would be £75 billion over the years in which the learners stay in the workforce (Table 9.1).[476] The average Net Present Value for a level 2 apprenticeship is £112,000 per achievement and for a level 3 apprenticeship it is £106,000.[477]

In the *Engineering UK report 2012* [478] we showed that the estimated wage returns for those completing vocational qualifications

Table 9.1: Net Present Value of the FE system for those aged 19+ (2008/09)

	Participation funding (£m)	Qualification aims (000s)		Average NPV per achievement (£000)	Total NPV (£bn)
		Starts	Achievements		
Apprenticeship L2	179	76	56	112	6
Work-based NVQ L2	771	587	429	59	25
Provider-based NVQ L2	353	113	81	31	3
Apprenticeship L3	298	94	67	106	7
Work-based NVQ L3	298	179	131	72	9
Provider-based NVQ L3	283	68	47	87	4
Basic skills	557	651	476	27	13
Developmental learning	273	400	300	25	8
Total	**3,012**	**2,169**	**1,586**	**47**	**75**

Source: BIS

varied considerably, with a level 3 ONC or OND qualification generating the highest return, at 25%. Level 3 Advanced Apprenticeships generated the second highest return, of more than 15%. Level 2 NVQ generated the lowest rate of wage return, below 5%.

As well as generating a direct financial return, FE also generates an employment boost.[479] However, there is considerable variation in the contribution made to this employment boost by courses at different levels and between different vocational qualifications.

Finally, it should be noted that colleges are significant economic assets for the UK, as well as improving the skills of the workforce. Indeed, as section 9.5 will show, many colleges are rising to the challenges they face and collectively see themselves as a catalyst for change. This is not surprising when you consider that, overall, colleges employ over a quarter of a million people (265,000), of whom 140,000 are teachers and lecturers.[480] The Department for Business, Innovation and Skills has also estimated that the value FE exports into technician and higher-level vocational skills is £1 billion a year.[481]

469 http://www.ukces.org.uk/employerownership/ **470** *Independent review of fees and co-funding in Further Education in England Co-investment in the skills of the future,* Department for Business, Innovation and Skills, July 2010, p5 **471** *Employer skills survey 2011:* UK Results, UKCES, May 2012, p19 **472** *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p15 **473** *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p15 **474** *Learning to grow: what employers need from education and skills Education and Skills survey 2012,* CBI, June 2012, p21 **475** The Net Present Value is defined as the present value of the benefits minus the present value of the costs associated with particular activity. **476** *Measuring the economic impact of Further Education,* Department for Business, Innovation and Skills, March 2011 **477** Level 3 apprenticeships receive 66% more funding in total than level 2 apprenticeships. **478** *Engineering UK Report 2012 – the state of engineering,* EngineeringUK, December 2012, p121 **479** *The Long Term Effect of Vocational Qualifications on Labour Market Outcomes,* Department for Business, Innovation and Skills, June 2011, p13 **480** *A dynamic nucleus,* Commission of Colleges in their Communities, July 2011, p11 **481** *New challenges, New chances Further Education skills system reform plan: building a world class skills system,* Department for Business, Innovation and Skills, December 2011, p30

9.1 Participation in FE

Figure 9.0 shows the overall participation level in engineering and manufacturing technologies. Although data in 2008/09 is not directly comparable with earlier years, it is still evident that the total number of adult (aged 19+) learners has been declining over the six-year period. In 2010/11 the total number of adult learners was 57,500, down from 145,310 in 2005/06. The number of adult learners has also fallen in each of the last two years.

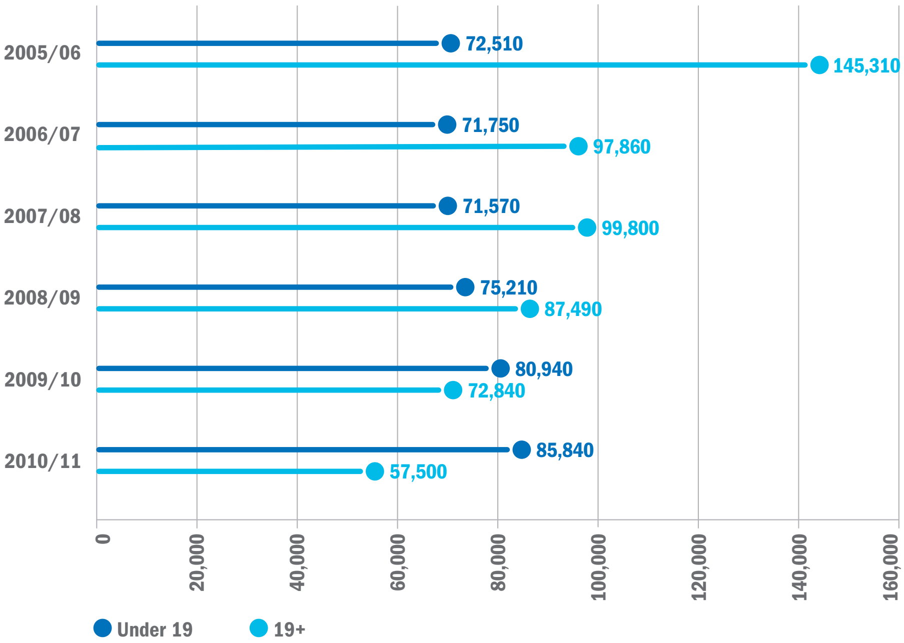
For under-19s, the number of learners has increased steadily for the last three years reaching 85,840 in 2010/11. This is likely to be a result of the extra funding and targeting of apprenticeships by the Government as part of its Plan for Growth strategy.

There was also been a steady rise in under-19 learners on the construction, planning and the built environment framework between 2005/06 and 2009/10 (Figure 9.1). However, 2010 saw a slight dip, to 67,710. In 2005/6, adult learners outnumbered under-19s by 98,430 to 49,620. But by 2010/11, under-19s were outnumbering adults by 67,710 to 66,580 – despite the slight dip in the number of under-19s.

A notably sharp decline in learner numbers is evident among adults taking information and communication technology: down from 885,760 in 2005/06 to 212,400 in 2010/11 (Figure 9.2). There has also been a decline in the number of under-19 learners for this subject, from 125,950 in 2005/06 to 87,620 in 2010/11. Information and communication technology was the only one of the three Sector Subject Areas to have a year-on-year decline in learner numbers for both under-19s and adults.

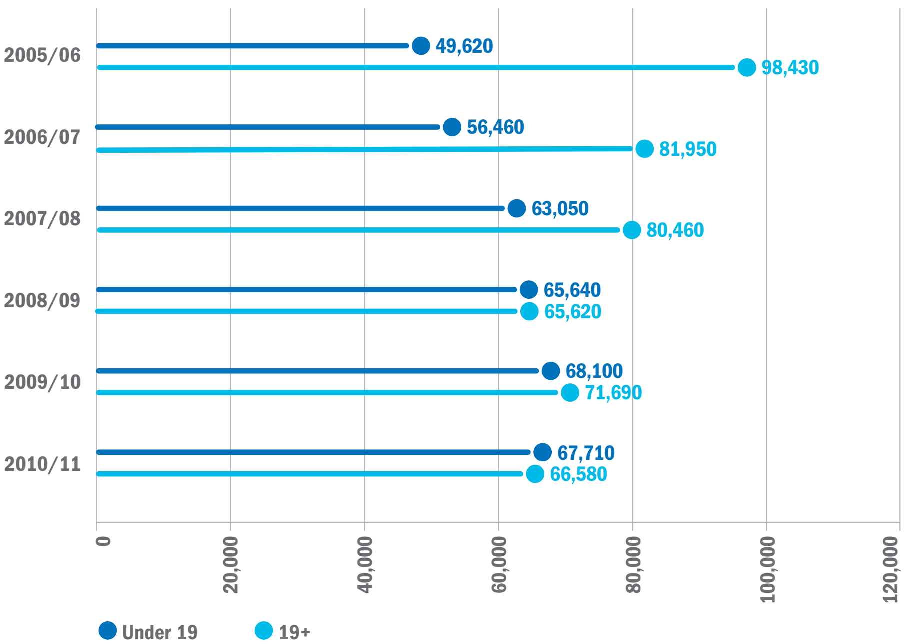
It should be noted that only a proportion of learners (those doing practitioner courses rather than how to use ICT courses) in the information and communication technology Sector Subject Area are considered to fall within the engineering footprint.

Fig. 9.0: Overall participation (aims) in FE, all levels, engineering and manufacturing technologies (2005/06-2010/11) – England



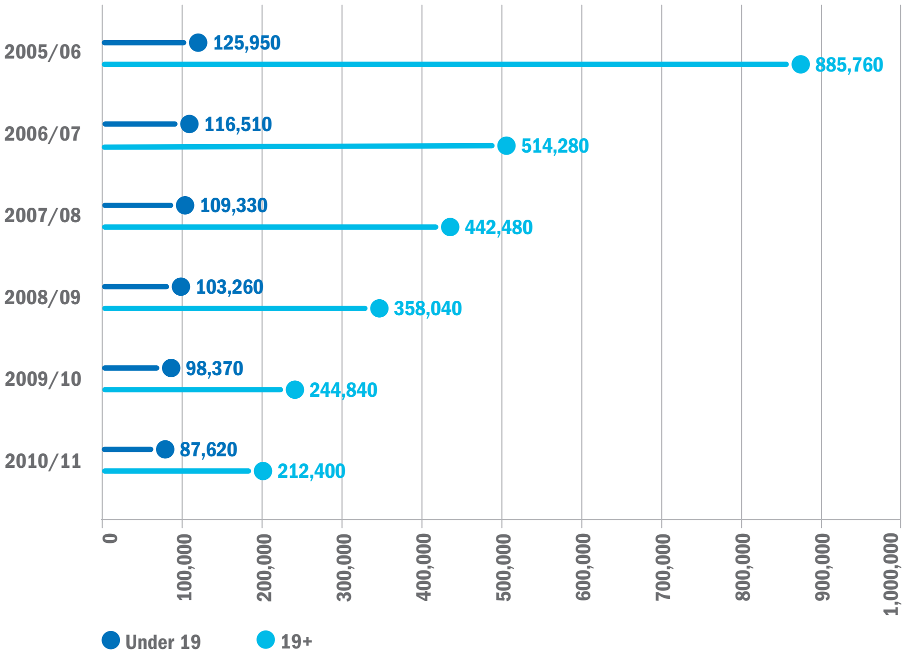
Source: The Data Service

Fig. 9.1: Overall participation (aims) in FE, all levels, for construction, planning and the built environment (2004/05-2009/10) – England



Source: The Data Service

Fig. 9.2: Overall participation (aims) in FE, all levels, information and communication technology (2005/06-2010/11) – England



Source: The Data Service

9.2 Other vocational qualifications

N/SVQ qualifications recognise the level of skill and knowledge needed to demonstrate competency in the area of work related to the subject studied. Candidates must pass a performance-based assessment, usually in a work environment. It should be noted, however, that N/SVQs are not related to a specific course of study. Since their introduction in 1987, 8.5 million N/SVQs have been awarded to successful candidates.[482] N/SVQ level 3 qualifications also form a substantial element of the Advanced/Modern Apprenticeship.

Table 9.2 shows the number of achievements in engineering NVQs for three engineering Sector Subject Areas, along with the number of achievements for all NVQs over a 10-year period. It shows that the overall number of achievements for all NVQs has risen by over half (55.2%) over the 10 years, but that in 2010/11, the latest year we have the data for, there was a 40.0% decrease to 587,000.

Of the three engineering Sector Subject Areas, only one – engineering and manufacturing technologies – has grown by more than the 10-year average for all N/SVQs, rising 73.8% to 115,400. Engineering and manufacturing technologies is also the only engineering Sector Subject Area to have declined by less than the overall average in 2010/11, down 20.0%. In 2010/11, engineering and manufacturing technologies was more than twice the size of the other two engineering Sector Subject Areas added together.

Construction, planning and the built environment is the second largest engineering Sector Subject Area, with 40,300 achievements in 2010/11, although this is down by over half (56.8%) on the previous year. Over the 10 years, its achievements have only risen by a quarter (26.7%), about half the rise for all NVQs, which grew by 55.2%.

Information and communication technology is the only engineering Sector Subject Area to have declined both over 10 years and in the last year. In 2010/11, the number of achievements fell by 70.3%, to just 10,500 which was also 5.4% lower than the 11,100 achievements in 2001/02.

Analysis by the Technician Council has identified the need for 450,000 higher skilled workers to go into science, engineering and technology jobs by 2020.[484] Level 3+ qualifications are generally regarded as the technician-level qualification. It is therefore concerning that the proportion of level 3+ achievements for all three engineering Sector Subject Areas is below the average for all N/SVQs, which is 35.0% (Table 9.3).

Of the three engineering Sector Subject Areas, construction, planning and the built environment has the highest percentage of level 3+ achievements, at 28.5%. It also has very few achievements at level 1, with just 200.

Table 9.2: Achievements of NVQs by Sector Subject Area (2001/02-2010/11) – UK[483]

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
Construction, planning and the built environment	31,800	27,700	48,500	52,800	55,400	74,000	99,100	116,500	93,300	40,300	-56.8%	26.7%
Engineering and manufacturing technologies	66,400	69,400	81,300	88,900	94,600	92,400	93,900	135,000	144,300	115,400	-20.0%	73.8%
Information and communication technology	11,100	10,200	9,200	8,500	12,600	16,600	27,200	35,300	35,400	10,500	-70.3%	-5.4%
Total	**378,500**	**401,800**	**470,100**	**538,500**	**598,600**	**630,400**	**727,900**	**922,900**	**979,000**	**587,300**	**-40.0%**	**55.2%**

Source: The Data Service

482 *Statistical First Release – Supplementary table on vocational qualifications*, The Data Service, June 2010 483 Numbers are rounded to nearest 100. 484 *Professional Technician the future delivering growth through skill creativity and innovation*, Technician Council, 2012, p2

Engineering and manufacturing technologies had the second highest proportion of level 3+ achievements, at just below a quarter (24.1%). This Sector Subject Area was also the largest of the three engineering Sector Subject Areas, with 122,500 achievements – although it is concerning that 7,000 of these achievements were at level 1.

Information and communication technology had the lowest proportion of level 3+ achievements, at just 18.5%. Only 100 achievements were at level 4 or 5 and 1,900 were at level 3, compared with 1,000 at level 1 and 7,900 at level 2.

With 49.4% of all achievements completed by females, there is almost gender parity for the number of achievements across all N/SVQs (Table 9.4). However, when you examine the three engineering Sector Subject Areas, there is a very different pattern.

More than half (50.9%) of achievements in information and communication technology went to women. By comparison, the figure for engineering and manufacturing technologies was 6.9%, and for construction, planning and the built environment it was even worse, at just 1.5%.

Table 9.3: N/SVQ achievements by Sector Subject Area and level of award (2010/11) – UK[485]

	Total achievements	Level 1	Level 2	Level 3	Levels 4 and 5	% achievements which are level 3+
Construction, planning and the built environment	45,600	200	32,500	11,700	1,300	28.5%
Engineering and manufacturing technologies	122,500	7,000	85,900	29,300	200	24.1%
Information and communication technology	10,800	1,000	7,900	1,900	100	18.5%
Total UK achievements	**628,400**	**17,100**	**391,500**	**192,500**	**27,300**	**35.0%**

Source: The Data Service

Table 9.4: N/SVQ achievements by Sector Subject Area and gender (2010/11) – UK

	Total achievements	Male	Female	Percentage female
Construction, planning and the built environment	45,600	44,900	700	1.5%
Engineering and manufacturing technologies	122,500	114,100	8,400	6.9%
Information and communication technology	10,800	5,300	5,500	50.9%
Total UK achievements	**628,400**	**317,900**	**310,500**	**49.4%**

Source: The Data Service

9.3 Vocationally Related Qualifications (VRQs)

VRQs, such as National Certificates and Diplomas, provide the knowledge and practical skills required for a job through a programme of structured learning. VRQs are usually assessed through assignments, projects and sometimes written tests. As well being a standalone qualification, VRQs are often, but not always, a component of apprenticeships.

Overall, a lower proportion of VRQs were at level 3 than N/SVQs in 2010/11 (Table 9.5). In total, 23.9% of VRQs were at level 3, compared with 35.0% of N/SVQs at level 3+. In engineering and manufacturing technologies, 74,400 achievements were at level 3: 55.1% of all achievements. Of the remaining achievements, most, 51,800 (37.8%) were at level 2.

Just under a third (31.2%) of achievements in construction, planning and the built environment were at level 3. Of the 59,300 achievements in 2010/11, most (44.7%) were at level 2.

Table 9.5: All VRQ achievements (as reported by participating awarding bodies) by Sector Subject Area and level (2010/11) – UK[486]

	Total achievements	Level 1	Level 2	Level 3	Percentage of VRQs level 3+
Construction, planning and the built environment	59,300	14,300	26,500	18,500	31.2%
Engineering and manufacturing technologies	135,000	8,800	51,800	74,400	55.1%
Information and communication technology	338,200	15,500	303,400	19,200	5.7%
Total achievements	**1,298,000**	**100,500**	**887,000**	**310,400**	**23.9%**

Source: The Data Service

Information and communication technology had the most achievements of all the engineering Sector Subject Areas, with 338,200 in 2010/11. However, almost all (303,400 or 89.7%) were at level 2. Only 19,200 were at level 3, representing just 5.7% of all achievements.

Across all VRQ achievements in 2010/11, nearly half (45.8%), were attributed to females (Table 9.6). Information and communication technology has a slightly higher proportion of females than the other frameworks, at 46.4%. By comparison, females were responsible for only 3.6% of achievements in engineering and manufacturing technologies, and 3.0% in construction, planning and the built environment.

485 Achievements between 1 October 2010 and 30 September 2011. 486 Numbers rounded to nearest 100

Table 9.6: All VRQ achievements (as reported by participating awarding bodies) by Sector Subject Area and gender (2010/11) – UK

	Total achievements	Male	Female	Percentage female
Construction, planning and the built environment	59,300	57,500	1,800	3.0%
Engineering and manufacturing technologies	135,000	130,100	4,900	3.6%
Information and communication technology	338,200	181,200	157,000	46.4%
Total UK achievements	**1,298,000**	**703,700**	**594,200**	**45.8%**

Source: The Data Service

9.4 Further Education teaching workforce

EngineeringUK believes that continuing professional development (CPD) and prior industry experience enable lecturers to build their lessons on real life experience, which enthuses and inspires students into working in STEM careers. Under the STEM framework, set out by the STEM High Level Strategy Group, the National Science Learning Centre has been given lead responsibility for improving the teaching and learning of science teachers through CPD. Furthermore, the raising of the participation age to 17 in 2013 and to 18 in 2015 will have consequences in the form of larger group sizes, and greater demands on staff.

9.4.1 Further Education staff

The Further Education Teachers' Qualifications, and the Further Education Teachers' Continuing Professional Development and Registration (England) Regulations, both came into force on 1 September 2007. They set requirements for teachers to:

- hold or acquire recognised qualifications within a specified period of time
- complete a period of professional formation leading to Qualified Teacher Learning and Skills (QTLS) status
- complete at least 30 hours of continuing professional development each year
- provide an annual record to the Institute for Learning (IfL)
- be registered with IfL and maintain that registration continuously

In November 2011, the Government recommended that the 2007 regulations be revoked and replaced with largely discretionary advice to employers on appropriate qualifications for staff and continuous professional development. This is in line with Government's policy of de-regulating and allowing colleges and providers greater freedom and flexibility.[487]

The 2010/11 data from the Learning and Skills Improvement Service (LSIS) estimated that the number of standard contracts of employment for Further Education staff had dropped by 12.5% from 2009/10 figures, to 216,962 (a drop of 12.5% from 2009-2010) (Table 9.7). However, it is estimated that approximately 10-15% of Further Education College staff hold multiple contracts, so the actual number of staff is approximately 85-90% of the total number of staff records.[488]

Table 9.7 Staff numbers by occupational group in Further Education Colleges in England, 2010/11

Occupational group	Number	Percentage
Senior managers	946	4%
Other managers	13,141	6%
Administrative and professional staff	15,183	7%
Technical staff	13,751	6%
Word processing, clerical and secretarial staff	22,560	10%
Service staff	34,877	16%
Assessors and verifiers	5,313	2%
Teaching staff (lecturers, tutors and trainers)	106,053	49%
Not known/ not provided	5,138	2%
Total	216,962	100%

Source: LSIS

Table 9.8 illustrates the gender of staff working in Further Education Colleges in England. It shows that full-time teaching staff still have an almost equal gender balance (51.4% male to 48.6% females). It also reveals that nearly two thirds (65.3%) of all part-time teaching staff are female, compared with a third (34.7%) male.

Table 9.8 Teaching staff and all Further Education staff by gender and by full-time or part-time (2010/11) – England

	Teaching staff		All staff	
	Male	Female	Male	Female
Full-time	51.4%	48.6%	47.1%	52.9%
Part-time	34.7%	65.3%	29.1%	70.9%

Source: LSIS

487 *Consultation on revocation of the Further Education workforce regulations,* Department for Business, Innovation and Skills, April 2012 **488** LSIS currently does not have any reliable methods of identifying the precise number of staff in Further Education Colleges and uses individual contracts as a proxy for individual members of staff. For ease of presentation and readability, each contract will be referred to as a member of staff.

9.4.2 Subject areas taught

Because FE staff teach across a range of subject areas, it can be difficult to identify the actual number of staff engaged in teaching engineering in the sector, a problem we highlighted in the *Engineering UK Report 2012.* For example, a member of staff teaching an automotive course may also teach elements of mathematics and science instead of a mathematics or science lecturer.

Table 9.9 shows the number of teaching staff in the three engineering Sector Subject Areas for the last five years. It shows that overall there has been a decline in the number of engineering FE teaching staff across all three subject areas, with information and communication technology showing a steady decline since 2008/09 and engineering, manufacturing and technology and construction showing a decline since 2009/10.

By 2010/11, the numbers of teaching staff had been falling for five years in all three engineering-related Sector Subject Areas: by 12.4% for engineering and manufacturing technology; 14.0% for construction; and 22.2% for information and communication technology (Table 9.9). In comparison, overall numbers of teaching staff across all Sector Subject Areas had increased by 19.0%.

It should, however, be noted that the 19.0% five year 2006/07 – 2010/11 increase for all Sector Subject Areas actually masks a 21.8% decline over the four most recent years, 2007/08 – 2010/11.

We can't currently identify the impact, if any; the decision to allow members of IfL with QTLS status to teach in schools will have on the number and profile FE teachers. But it will mean that nearly 7,000 teachers in the FE and skills sector will now be eligible to work in schools.[489]

Table 9.9 Sector Subject Areas taught by FE teaching staff (2006/07-2010/11) – England[490]

Subject taught	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over five years
Engineering, manufacturing and technology	6,555	7,079	7,574	6,776	5,935	-9.5%	-12.4%
Construction	5,549	6,710	6,903	6,444	5,542	-0.1%	-14.0%
Information and communication technology	6,628	7,417	7,229	6,427	5,003	-24.5%	-22.2%
Total	**18,732**	**21,206**	**21,706**	**19,647**	**16,480**	**-12.0%**	**-16.1%**
Engineering Sector Subject Areas as a percentage of all teaching staff	21.0	15.6	15.7	16.0	15.5	-0.5%	-5.5%
Total for all Sector Subject Areas	**89,152**	**135,606**	**138,222**	**122,578**	**106,053**	**-13.5%**	**19.0%**

Source: LSIS

489 Website accessed on 10 April 2012 (http://www.fenews.co.uk/fe-news/qtls-achievers-now-recognised-as-qualified-to-teach-in-schools) **490** In 2008/09 National Specialist Colleges were included for the first time.

9.4.3 Gender in engineering Sector Subject Areas

Figure 9.3 shows the gender breakdown of FE teachers in the three engineering subject areas over a five-year period. Over the five years, information and communication technology is the only subject area that has managed to attract similar number of males and females. In 2006/07 there were slightly more females (52.3%) than males, although this has since fallen back, dropping to 47.9% in 2010/11.

Construction, and engineering, manufacturing and technology have a strong bias towards male teachers, with over 90% being male in each of the five years.

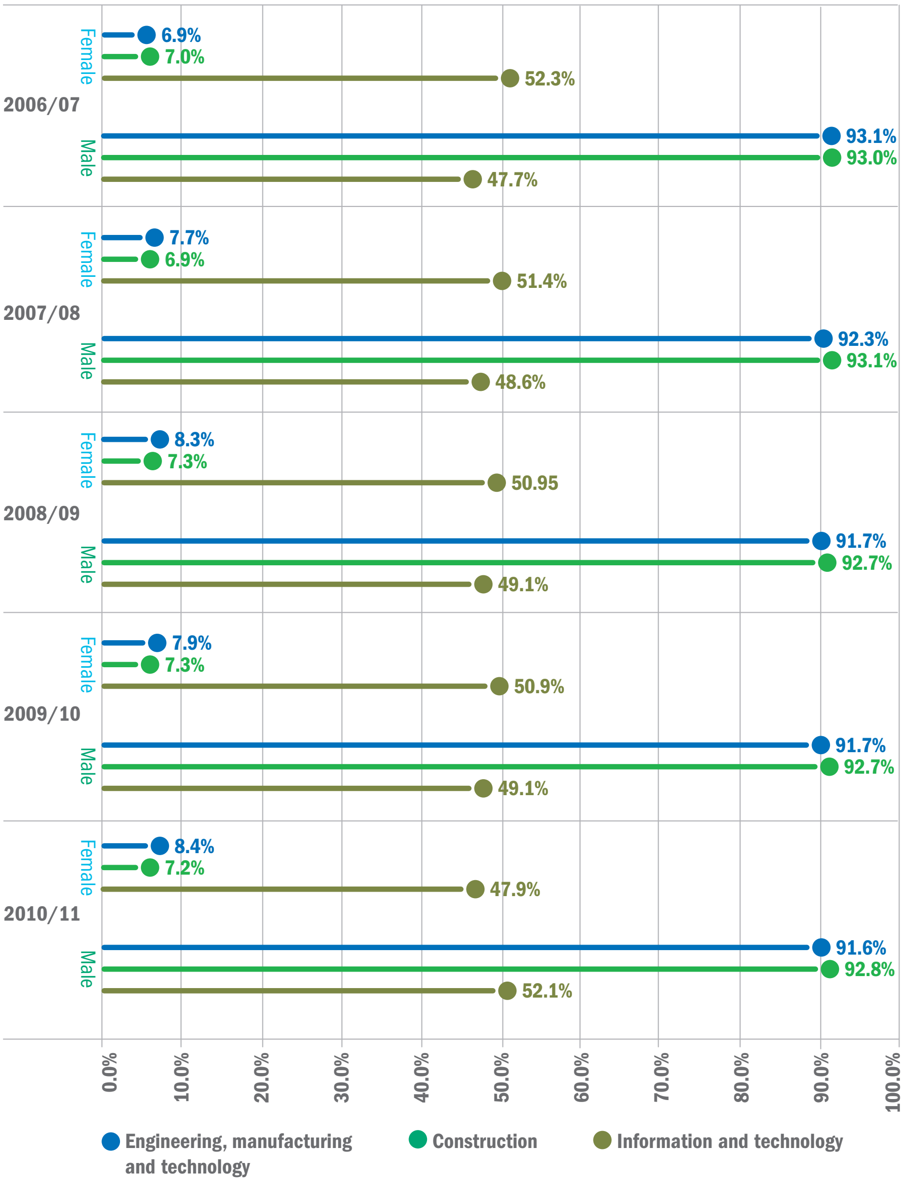
9.4.4 Salaries in engineering subject areas

LSIS has identified that salary levels are very important when recruiting staff in vocation-related teaching jobs.

Figure 9.4 looks at the salary levels for full-time staff in all Sector Subject Areas in 2010/11. Out of the three engineering-related subject areas, staff in information and communication technology earn £29,965 – slightly above the average salary for a teacher (£29,773). Teachers of engineering, manufacturing technology and construction earn slightly below the average for all teachers, with average salaries of £29,022 and £29,183 respectively. Although not an engineering subject area, it should be noted that those teaching science and mathematics have the second highest average salary at £32,246. With a difference of over £3,000, perhaps this is diverting potential engineering teachers away from teaching engineering.

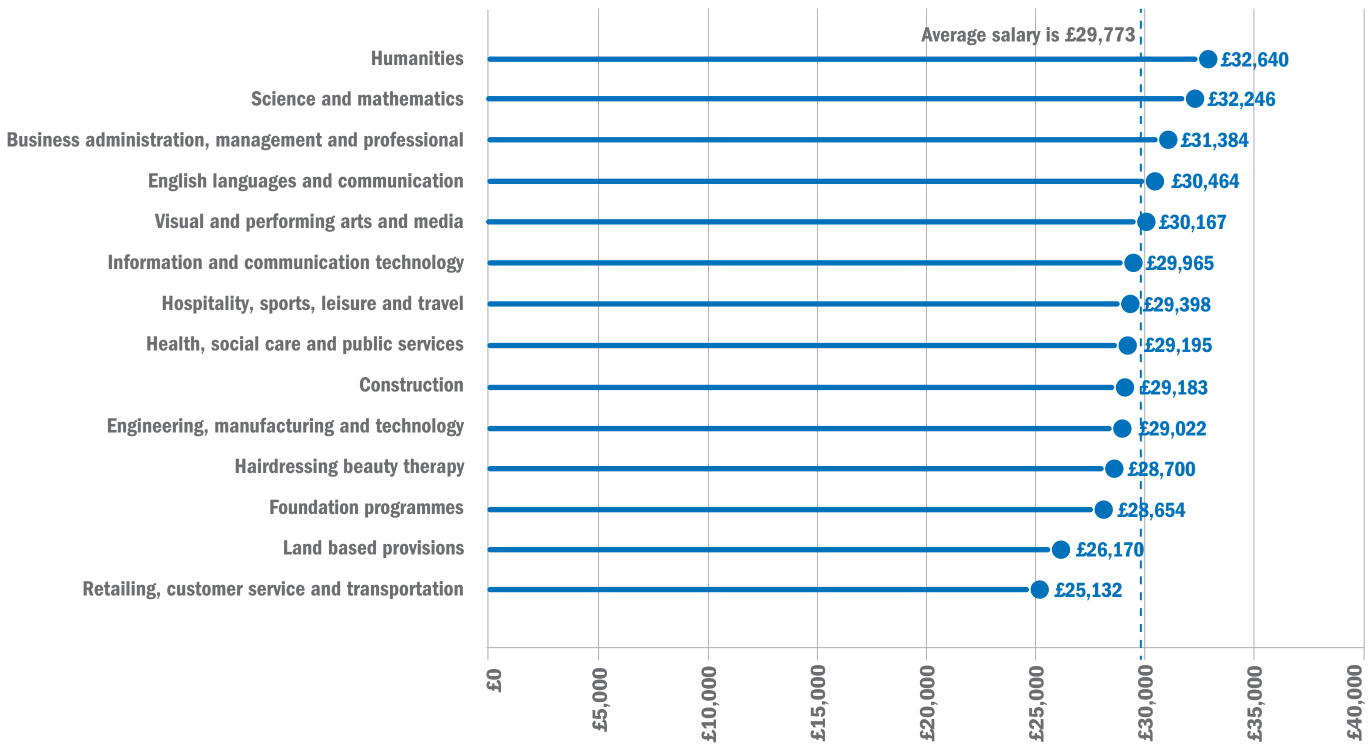
Male teaching staff earned a slightly higher average salary (£30,017) than women did (£29,355). In section 14, we identify that the average mean salary for someone in work is £26,871. Full-time male workers, on average, earn £36,511 compared with £27,006 for women in full-time employment. This means that both male and female teaching staff in FE earn less than the average salary for male and female full-time workers.

Fig. 9.3: Engineering subjects taught by FE teaching staff by gender (2006/07-2010/11) – England



Source: LSIS

Fig. 9.4: Average salaries for full-time FE teaching staff by subject area (2010/11) – England



Source: LSIS

9.5 Colleges as a catalyst for change

Authored by Debbie Ribchester, Senior Policy Manager 14-19 and Curriculum, Association of Colleges

There are 345 colleges in England, including 94 Sixth Form Colleges and 251 Further Education Colleges. In Scotland, there are a further 41 colleges, 19 in Wales and 6 in Northern Ireland. All of them offer a breadth of educational opportunities for adults and young people.

Colleges educate 853,000 young people aged 16 to 18, almost twice as many as schools.[491] This includes 185,000 A level students[492] and a quarter of all apprentices.[493] There are 58,000 14- to 15-year-olds taking college courses, 3,000 of them studying full-time.[494] Thirty-three colleges sponsor Academies. Colleges account for a third of all Higher Education entrants, with 266 offering undergraduate and postgraduate courses, including many foundation degrees.[495] Colleges also train and educate 2.2 million adults.

Colleges and STEM subjects

Colleges play a vital role in delivering STEM subjects, particularly engineering and manufacturing. In 2010/11, 177,000 people progressed through such STEM courses to university and work, with courses from entry to degree level.[496] Encouragingly, these numbers look set to increase, with most colleges predicting growing take-up for STEM courses, particularly among young people.

Colleges benefit from strong links with employers, often directly meeting the needs of the local engineering and manufacturing industry. Qualifications on offer range from A levels in electronics to vocational qualifications in motor vehicle maintenance. In 2010/11, there were also 49,000 new engineering and manufacturing technology apprenticeships on offer. Of the students taking these qualifications, 96,000 were aged nineteen or over, 74,000 were aged 16-18 and 7,000 were under 16. Colleges also delivered 335,000 science and mathematics qualifications and 247,000 information and communication technology qualifications, with many students progressing to further STEM courses.

Some interesting examples

The aeronautical engineering programme at Blackpool and The Fylde College is a good example of how college's can work well with local employers. At Blackpool, 26 students are learning to repair and maintain planes and to manufacture new aircraft and space vehicles through the college's level 3 extended diploma course. The course is developed closely with industry and offers local young people a route into jobs and apprenticeships in the North West's aerospace industries, as well as the Royal Navy and the RAF. The courses are provided by the college's Aviation Academy, and successful students gain jobs at Blackpool's growing international airport, as well as Manchester and Liverpool John Lennon airports. The academy has its own specialist training facilities with a working aircraft and a base at the local airport.

Another interesting example is the National Skills Academy for the Nuclear Industry at Bridgwater College in Somerset, where employees at the Hinkley Power Station can improve their skills. Qualifications, from a basic award in nuclear industry awareness to

491 AoC analysis of Individualised Learner Record, 2010/11 – learner responsive dataset 492 ibid 493 AoC analysis of Individualised Learner Record, 2010/11 – employer responsive dataset 494 AoC analysis of Individualised Learner Record, 2010/11 – learner responsive dataset 495 UCAS data on applications and acceptances for 2011 entry in England 496 AoC analysis of Individualised Learner Record, 2010/11 – learner responsive dataset

full foundation degrees, are run in partnership with the University of Central Lancashire. The specialist facilities enable students to learn about nuclear engineering, the construction of a nuclear facility and best practice in radiation safety and nuclear decommissioning.

The college is providing many of the skills needed as Hinkley B closes in 2016 and Hinkley C opens at an adjacent site. Twenty-seven students are currently enrolled on the 30-month foundation degree in nuclear engineering, which includes materials and manufacture, engineering and technology, instrumentation and control and safety management.

Challenges facing the sector

Colleges can be a catalyst for change as the economy recovers from the recession. Their direct links with industry and their practical courses, backed by high tech equipment, are an essential part of the UK's growth strategy. But it is important that Government policy helps colleges to meet those ambitions.

The Government has sent some mixed signals on technology and vocational education. A recent Association of Colleges (AoC) survey of its members showed that two-thirds of colleges believe that the report by Professor Alison Wolf on vocational education will have a positive impact on STEM provision. However, a significant minority – 39% – feared that changes to career guidance would see fewer students encouraged by their schools to apply for college-based STEM courses.

A particular concern of colleges is the impact of league table changes on technology and practical STEM courses. The new English Baccalaureate encourages schools to focus on languages and humanities in addition to English, maths and science. But it offers no credit for technology or engineering courses. At the same time, the Government has treated all vocational qualifications equally in a revised league table tariff: an engineering diploma, which is widely recognised as a strong qualification, is treated the same as other vocational qualifications which were over-valued in the past. There is no effort made to position stronger vocational qualifications more favourably, despite the effort required.

Colleges are actively working to develop new University Technical Colleges, aimed at 14- to 19-year-olds. The 32 UTCs now open or in development are also working closely with Higher Education and industry. A good example is the Bristol and South Gloucestershire UTC, led by City of Bristol College and the University of the West of England, with major employers including Rolls Royce and Airbus. Opening in September 2013, it will specialise in engineering and environmental technology.

While we welcome UTCs, their limited number means they are only part of the solution. All young people should have the chance from the age of 14 to do practical STEM courses, and we are working with the Department for Education to make a proposal by Professor Wolf that all young people should have the choice to study at college from 14 a reality.

Conclusion

Because they offer a wide range of courses in engineering and other STEM subjects, colleges can be a catalyst for economic change. But this is provided that all young people have the choice and the chance to take the courses that are right for them – and that are right for the economy. We also need more employers to work with us to design the right courses for skilling and up-skilling adults. It is vital that national education policy supports people's choices and ensures that all those who can benefit from STEM courses at our colleges have the opportunity to do so.

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Part 2 - Engineering in Education and Training
10.0 Apprentices

At current estimates, there are two million people employed as technicians and skilled operatives in the UK.[497] Apprenticeships are key to training the technicians of the future. There are currently three levels of apprenticeships available:[498]

1 – Intermediate level apprenticeships

- Apprentices work towards work-based learning qualifications such as an NVQ level 2, key skills and, in most cases, a relevant knowledge-based qualification such as a BTec. These provide the skills needed for their chosen career and allow entry to an Advanced Apprenticeship.

2 - Advanced level apprenticeships

- Advanced Apprentices work towards work-based learning qualifications such as an NVQ level 3, key skills and, in most cases, a relevant knowledge-based certificate such as a BTec. To start this programme, the applicant should ideally have five GCSEs (grade C or above) or have completed an apprenticeship.

3 – Higher Apprenticeships

- Higher Apprentices work towards work-based learning qualifications such as an NVQ level 4 and, in some cases, a knowledge-based qualification such as a foundation degree.

The National Apprenticeship Service[499] estimates that over 100,000 employers offer at least one type of apprenticeship.

Currently there are 13 higher level (greater than level 3) apprenticeship frameworks that employers can choose from (Table 10.0). Nine of the frameworks are available at level 4, three are available at level 5 and one (construction operations management) is available at both levels 4 and 5. The National Apprenticeship Service has just started a consultation on Higher Apprenticeships at levels 4, 5 and 6 to ensure they best meet the needs of individuals and employers and to support their continued development and expansion.[500]

To support the development of Higher Apprenticeships, the Prime Minister has launched the Higher Apprenticeship Fund.[501] Round two of this initiative is targeting a number of growth sectors identified by the Department for Business, Innovation and Skills (see box). Furthermore following the Holt Review the Government have announced specific support for small and medium enterprises (SME) to take on apprentices.[502]

Table 10.0: Higher Apprenticeships available – UK

Higher Apprenticeship	Level
Accounting	4
Business and administration	4
Contact centre operations	4
Engineering technology	4
Food and drink	4
IT, software, web and telecoms professionals	4
Providing financial advice	4
Life sciences	4
Project management	4
Construction operations management	4 and 5
Management	5
Human resource management	5
Express logistics	5

Source: National Apprenticeship Service

497 *Professional Technician the future delivering growth through skill creativity and innovation,* Technician Council, 2012, p2 **498** Website accessed on 10 August 2012 (http://www.apprenticeships.org.uk/Employers/The-Basics.aspx) **499** Website accessed on 10 August 2012 (http://www.apprenticeships.org.uk/Employers/The-Basics.aspx) **500** Website accessed on 13 September 2012 (http://www.apprenticeships.org.uk/partners/frameworks/SASE/HigherApprenticeshipsConsultation.aspx) **501** Website accessed on 10 August 2012 (http://www.apprenticeships.org.uk/Employers/The-Basics/Higher-Apprenticeships.aspx) **502** Website accessed on 11 October 2012 http://www.bis.gov.uk/news/topstories/2012/Aug/holt-review-new-measures-to-improve-apprenticeships-for-smes

All apprenticeships must include the following elements:

- A competencies qualification, which must be achieved by the apprentice to qualify for an apprenticeship certificate, and which is the qualification required to demonstrate competence in performing the skill, trade or occupation to which the framework relates.
- A technical knowledge qualification, which is the qualification required to demonstrate achievement of the technical skills, knowledge and understanding of theoretical concepts and knowledge and understanding of the industry and its market, relevant to the skill, trade or occupation to which the framework relates. Sometimes an apprenticeship framework may have an integrated qualification which combines competence and technical knowledge elements, in which each element is separately assessed.
- Either key skills (eg working in teams, problem solving, communication and using new technology) or functional skills (eg maths and English) qualifications, or a GCSE with enhanced content (eg maths and English).

Apprenticeship training is provided by around 900 providers, mainly a mixture of colleges and private training companies.[503] There has been concern raised about the duration of some apprenticeships. In 2010/11[504] 19% of apprenticeships lasted less than six months and 3% lasted less than three months: 87 providers of short duration apprenticeships are being investigated to see if they are complying with their contracts.[505]

The Government is keen to ensure that apprenticeships continue to be seen as a gold standard vocational qualification. To this end, the Government has announced a number of initiatives. From August 2012,[506] the minimum duration of an apprenticeship for those aged 16-18 will be 12 months. The National Apprenticeship Service is currently reviewing whether a minimum apprenticeship duration needs to be set for adult apprentices too.

There is also a new requirement that all apprenticeship providers must support training in English and maths up to A*-C grade GCSE level, where this has not previously been achieved.[507] The Government is also conducting an employer-led review into the quality and standards of apprenticeships, which is due to report in the autumn of 2012.[508]

Finally, it is worth noting that there is a separate minimum wage system for apprentices. From October 2012, the minimum apprenticeship wage for those under the age of 19 will be £2.65 per hour. This pay applies to time working and also time spent on training as part of their apprenticeship.[509] Apprentices over the age of 19 in the first 12 months of their apprenticeship are also eligible for the apprentice minimum wage. After this 12-month period, apprentices then become eligible for the national minimum wage of £6.19.[510 511] The median hourly rate for apprentices in the UK was £5.87.[512]

Table 10.1 shows that the top 10 apprenticeship frameworks in 2010/11 were responsible for nearly three quarters (71.6%) of all apprenticeship starts. The National Audit Office has also shown that 83% of all apprenticeships are concentrated in the top 15 apprenticeship frameworks, out of a total of 118 frameworks,[513] and that training providers concentrate on delivering just a small subset of frameworks which they then deliver in bulk. The National Audit Office[514] also identified that in 2009/10, 36% of frameworks were offered by five or fewer training providers.

Table 10.1: Top 10 Apprenticeship Programme Starts by Sector Framework Code (2010/11) – England[515]

				All apprenticeships				
	All level 2 apprenticeships	All level 3 apprenticeships	Male	Female	All	All apprenticeships (percentage female)	Percentage of all apprenticeships at level 3	Percentage of all apprenticeship starts
Customer service	42,150	11,820	20,590	33,380	53,970	61.8%	21.9%	11.8%
Health and social care	31,060	22,650	9,400	44,320	53,720	82.5%	42.2%	11.7%
Retail	37,930	3,470	13,370	28,030	41,410	67.7%	8.4%	9.1%
Business administration	24,820	14,080	9,190	29,710	38,900	76.4%	36.2%	8.5%
Hospitality and catering	24,280	5,530	14,510	15,300	29,810	51.3%	18.6%	6.5%
Management	15,430	14,350	12,040	17,740	29,790	59.6%	48.2%	6.5%
Children's care learning and development	10,990	16,420	1,680	25,730	27,410	93.9%	59.9%	6.0%
Engineering	9,680	8,650	17,400	940	18,330	5.1%	47.2%	4.0%
Active leisure and learning	13,630	4,020	13,040	4,610	17,650	26.1%	22.8%	3.9%
Hairdressing	11,610	4,840	1,420	15,030	16,450	91.4%	29.4%	3.6%
All apprenticeships	**301,100**	**156,100**	**211,200**	**246,000**	**457,200**	**53.8%**	**34.1%**	**71.6%**

Source: The Data Service

503 *Adult apprenticeships,* National Audit Office, February 2012, p7 504 *Adult Apprenticeships,* House of Commons Committee of Public Accounts, 23 April 2012, p8 505 *Adult apprenticeships,* National Audit Office, February 2012, p7 506 Website accessed on 10 August 2012 http://www.apprenticeships.org.uk 507 *Autumn statement,* HM Treasury, November 2011, p60 508 Website accessed on 10 August 2012 (http://www.bis.gov.uk/news/topstories/2012/Jun/richard-review-of-apprenticeships) 509 Website accessed on 10 August 2012 (http://www.apprenticeships.org.uk/Employers/The-Basics.aspx) 510 *Apprenticeships policy,* House of Commons, February 2012, p5 511 Website accessed on 30 August 2012 (http://www.direct.gov.uk/en/NI1/Newsroom/DG_201426) 512 *Apprenticeship pay survey 2011,* Department of Business, Innovation and Skills, February 2012, p14 513 *Adult apprenticeships,* National Audit Office, February 2012, p8 514 *Adult apprenticeships,* National Audit Office, February 2012, p30 515 Volumes are rounded to the nearest ten except for all apprenticeships which are rounded to the nearest hundred.

It is concerning that as there is such a high concentration of apprenticeships in a limited number of frameworks. In 2010/11, only one of the top 10 frameworks was engineering specific. This is a decrease on 2009/10, when two engineering frameworks (engineering and construction) made it into the top 10.[516]

As mentioned in section 9, level 3 vocational qualifications are essential for training the next generation of technicians. However, only one framework, children's care learning and development, has more than half (59.9%) of its apprentices studying at level 3 and just three other frameworks have at least 40% studying at level 3:

- management – 48.2%
- engineering – 47.2%
- health and social care – 42.2%

Overall, a third (34.1%) of apprenticeship starts were at level 3. This compares unfavourably with other countries such as France, where 60% of apprentices are level 3.[517] It should also be noted that the UK has a lower proportion of apprentices per 1,000 people than several of our main competitors:[518] 11 per 1,000, compared with 40 in Germany and 17 in France.

Research by the Department for Business, Innovation and Skills has shown that around three quarters of adult apprentices who enrolled on a level 2 apprenticeship already had prior attainment at level 2 or above, and around half of level three apprentices had previously studied at this level or above.[519] The research indicated that the contribution of adult apprenticeships towards up-skilling new learners to level 2 is limited.[520] To an extent, however, this is driven by some apprenticeships having particular standards for literacy and numeracy which can be met by prior attainment at GCSE level.[521] Encouragingly, it should be noted that apprentices who were surveyed said their apprenticeship had a strong positive impact on their skills and working life.[522]

10.1 Programme starts[523]

Over a nine-year period, Table 10.2 shows us that the number of apprenticeship programme starts in England has increased by 172.6%. Disappointingly only one engineering Sector Subject Area exceeded this overall average. Information and communication technology starts has grown by 305.0% in nine years, and also grew by 55.3% in 2010/11 to reach 19,520 starts. Despite this very rapid growth, however, information and communication technology is still the smallest of the three engineering Sector Subject Areas.

The largest engineering Sector Subject Area is engineering and manufacturing technologies, with 48,970 starts in 2010/11. It grew by 29.3% in 2010/11 and by 86.8% over the nine years. However, both of these numbers are below the average for all programme starts.

Construction, planning and the built environment has had the lowest growth of the engineering Sector Subject Areas, both in the last year and over nine years. In 2010/11 it grew 11.4% to reach 28,090 starts, which is a third (39.3%) higher than in 2002/03. Although growth for construction, planning and the built environment was only around a fifth of that for all programmes, it is pleasing to see growth, following the 13.7% decline in 2009/10.

Table 10.2: Apprenticeship Programme Starts by Sector Subject Area (2002/03-2010/11) – England[524]

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over nine years
Construction, planning and the built environment	20,160	26,680	25,450	21,670	27,520	27,830	29,220	25,210	28,090	11.4%	39.3%
Engineering and manufacturing technologies	26,220	33,060	33,730	30,870	34,660	43,100	36,990	37,860	48,970	29.3%	86.8%
Information and communication technology	4,820	5,750	5,940	7,500	6,430	8,010	8,820	12,570	19,520	55.3%	305.0%
All apprenticeships	**167,700**	**193,600**	**189,000**	**175,000**	**184,400**	**224,800**	**239,900**	**279,700**	**457,200**	**63.5%**	**172.6%**

Source: The Data Service

516 *Engineering UK Report – the state of engineering,* EngineeringUK, December 2011, p130 517 *Adult apprenticeships,* National Audit Office, February 2012, p6 518 *The State of Apprenticeship in 2010,* Apprenticeship Ambassador Network, August 2010, p2 519 *Prior qualifications of adult apprentices 2009-10,* Department for Business, Innovation and Skills, June 2011, p19 520 *Prior qualifications of adult apprentices 2009-10,* Department for Business, Innovation and Skills, June 2011, p21 521 *Prior qualifications of adult apprentices 2009-10,* Department for Business, Innovation and Skills, June 2011, p21 522 *Evaluation of apprenticeships: Learners,* Department for Business, Innovations and Skills, May 2012, p119 523 Unlike participation figures, figures for 2008/09 are comparable with earlier years as demand led funding rules are not applied to starts. 524 Volumes are rounded to the nearest ten except for all apprenticeships which is rounded to the nearest hundred.

10.2 Framework achievements[525]

Framework achievements have seen a remarkable growth over nine years, rising 372.4% overall (Table 10.3). The total framework achievements also rose by 16.8% in the last year, to break the 200,000 mark for the first time.

Of the three engineering Sector Subject Areas, two have grown faster than average over nine years. But only information and communication technology has grown faster than average over nine years and in the last year.

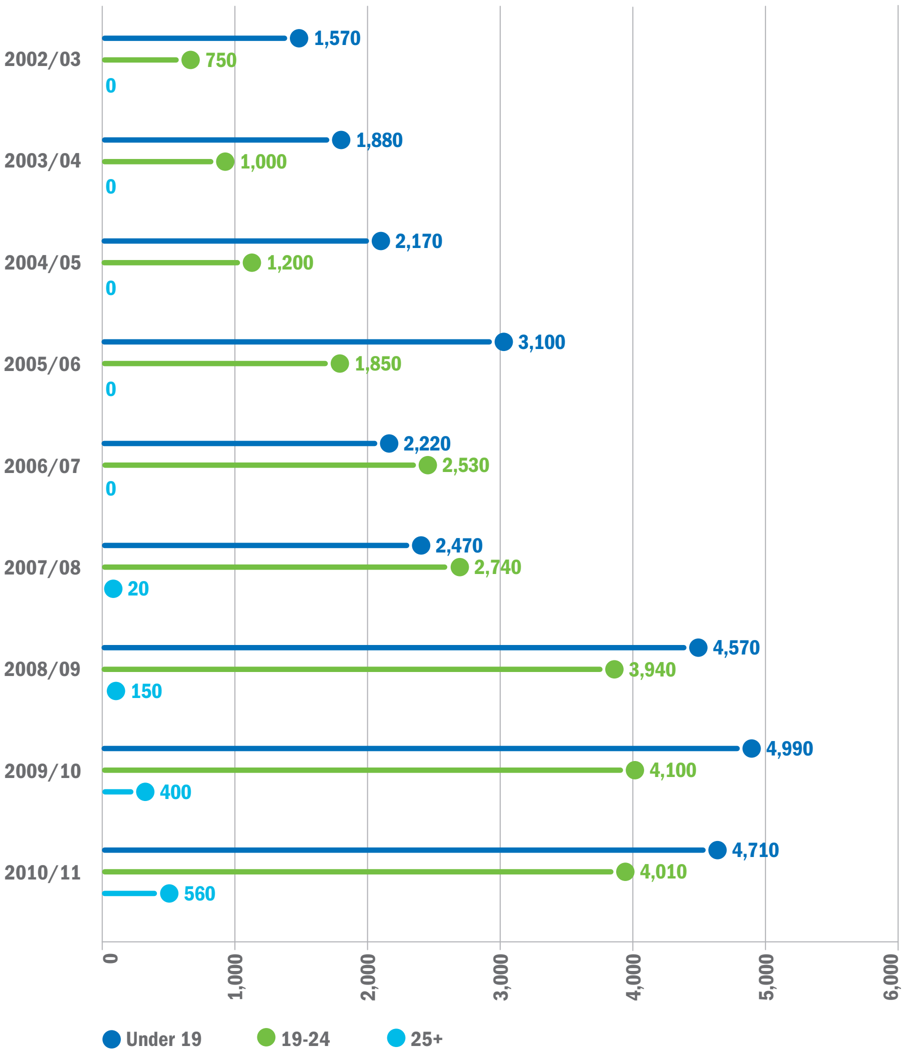
Information and communication technology is the smallest of the three engineering Sector Subject Areas, with just 10,510 framework achievements in 2010/11. Over nine years, the number of achievements has risen by a staggering 1,247.4%, albeit from a very low base of 780. Numbers also rose by over a third (35.3%) in the last year, more than double the average for all framework achievements.

Construction, planning and the built environment has also seen above average growth in framework achievements over nine years, rising 405.2%. However, the number of achievements has been falling for the last two years. In 2010/11 they fell 11.7% to 18,390.

Engineering and manufacturing technologies has had below average growth, both over nine years and in the last year. In 2010/11, the number of framework achievements rose by just 3.6% to 27,040. Although engineering and manufacturing technologies has had low growth over nine years, it is still the largest of the three engineering Sector Subject Areas.

Looking at framework achievements in level 3+ apprenticeships for construction, planning and the built environment, there was steady year-on-year growth for 19- to 24-year-olds through to 2009/10. But in the last year, numbers have fallen back slightly to 4,010 (Figure 10.0).

Fig. 10.0: Level 3+ apprenticeship framework achievements for construction, planning and the built environment by age (2002/03-2010/11) – England[526 527]



Source: The Data Service

Table 10.3: Apprenticeship framework achievements by Sector Subject Area (2002/03-2010/11)[528 529]

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over nine years
Construction, planning and the built environment	3,640	5,620	9,290	14,850	17,300	17,810	22,330	20,830	18,390	-11.7%	405.2%
Engineering and manufacturing technologies	8,280	8,340	12,010	18,210	21,470	20,770	22,890	26,090	27,040	3.6%	226.6%
Information and communication technology	780	2,470	2,920	4,270	4,880	5,550	5,670	7,770	10,510	35.3%	1,247.4%
All apprenticeships	**42,400**	**49,300**	**67,200**	**98,700**	**111,800**	**112,600**	**143,400**	**171,500**	**200,300**	**16.8%**	**372.4%**

Source: The Data Service

525 Unlike participation figures, figures for 2008/09 onwards are comparable with earlier years as demand led funding rules are not applied to achievements. 526 Age is calculated based on age at start of the programme rather than based on 31 August. 527 0 indicates a base value of less than five. 528 0 indicates a base value of less than five. 529 Volumes are rounded to the nearest ten except for all apprenticeships which is rounded to the nearest hundred.

The pattern for those under the age of 19 has been very mixed. There was growth until 2005/06, but a sharp decline in 2006/07. In 2008/09 there was a large increase in framework achievements, followed by more modest growth the following year. But in 2010/11 there was a decline again, to 4,710.

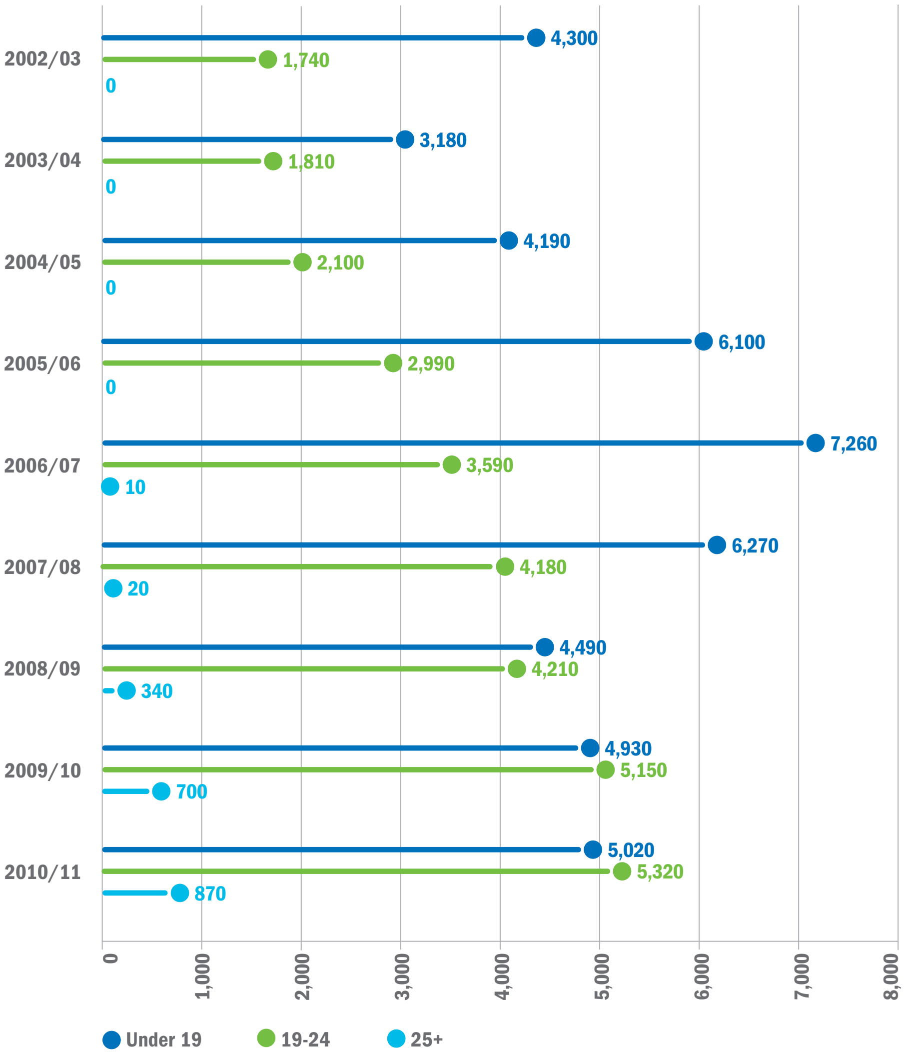
Since 2007/08, when the numbers were large enough to be released, there has been a steady increase in the number of achievements among the over-25s.

There has been steady year-on-year growth in the number of achievements for 19- to 24-year-old students of engineering and manufacturing technologies (Figure 10.1). From 1,740 in 2002/03, the number of achievement has more than tripled, to 5,320 in 2010/11.

For those aged under 19 the pattern is very mixed. The number of achievements has fluctuated quite widely from year to year. The highpoint was in 2006/07 when there were 7,260 achievements. The low point was in 2003/4, when there were 3,180. In 2009/10 and 2010/11, the 19-24 age group was larger than the under-19s in achievements.

From 2006/07 onwards, there has been a steady increase in the number of achievements from over 25s, reaching 870 in 2010/11.

Fig. 10.1: Level 3+ apprenticeship framework achievements for engineering and manufacturing technologies by age (2002/03-2010/11) – England



Source: The Data Service

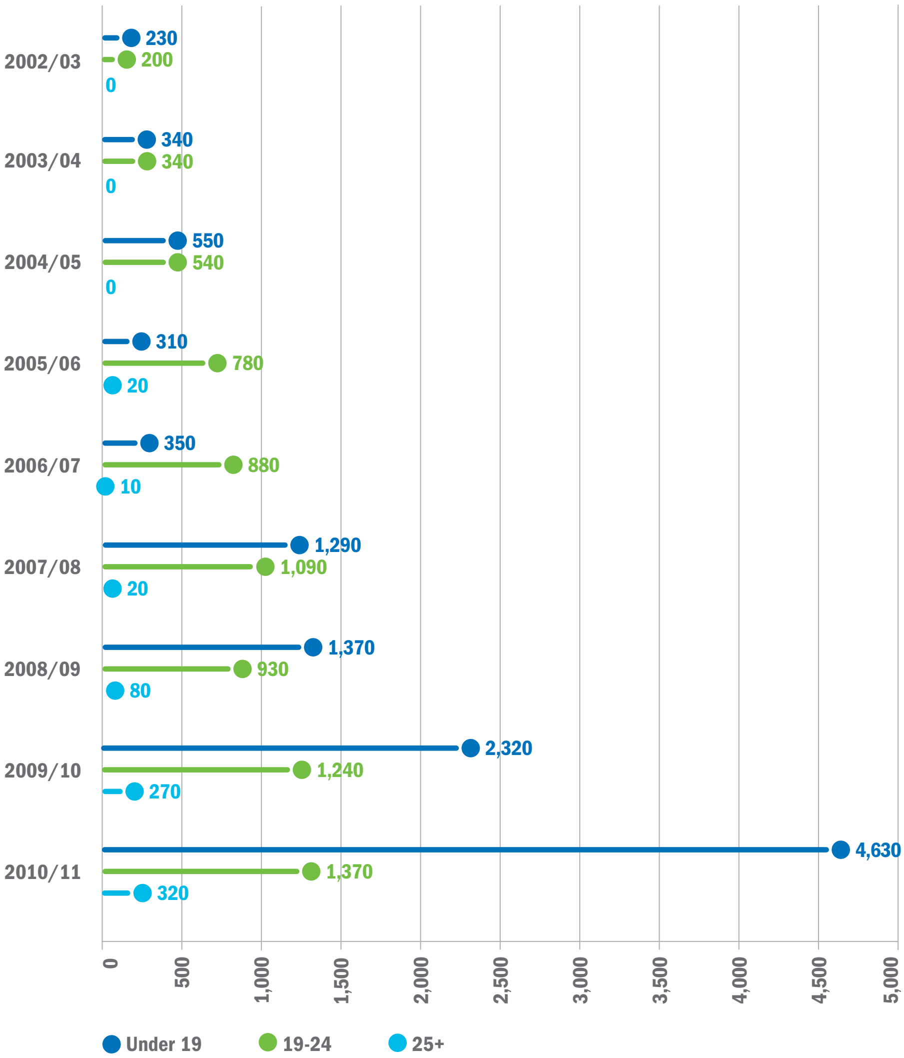
Over the period 2002/03 to 2010/11 there has been a dramatic increase in the number of achievements in information and communication technology from the under-19s (Figure 10.2). In 2002/03, under 19s registered 230 achievements. Although year-on-year growth hasn't been consistent, 2010/11 saw almost double (4,630) the achievements of the previous year.

There has been steady year on year growth for the 19-24 age group (with the exception of 2008/09), from 200 in 2002/03 to 1,370 in 2010/11. The over-25 group fared less well, with a high point of 320 achievements in 2010/11.

An evaluation of apprenticeships by the Department for Business, Innovation and Skills[530] has shown that employers in engineering and manufacturing technologies and construction, planning and the built environment were much more likely than average to provide apprenticeships to 16- to 19-year-olds (60% likely, compared with an average of 46%). They were also much more likely to only provide apprenticeships to 16- to 19-year-olds already in work (57% likely, compared with an average of 46%). Eighteen per cent of all employers are willing to offer apprenticeships to the over-25s, but only 7% of employers in engineering and manufacturing technologies and 8% of employers in construction, planning and the built environment.

In terms of progression, the movement from an apprenticeship to HE is very low. In 2005/06, only 5% of those completing an apprenticeship progressed directly into HE. This increased to 13% of the same cohort after another three years.

Fig. 10.2: Level 3+ apprenticeship framework achievements for information and communication technology by age (2002/03-2010/11) – England



Source: The Data Service

10.3 Success rates[531] [532]

Looking at the success rates for all frameworks and the three engineering Sector Subject Areas, there has been a significant increase in the percentage of successful apprenticeship completions (Figure 10.3). The success rates for all frameworks has increased from just over a third (36.7%) in 2004/05 to three quarters (76.4%) in 2010/11.

Success rates for construction, planning and the built environment have increased from 40.3% in 2004/05 to 72.2% in 2010/11, with improvements each year. Success in this Sector Subject Area was above the average for all frameworks in each year up to 2008/09. However, in the last three years it has fallen below the average for all frameworks. The gap worsened in 2009/10 and again in 2010/11.

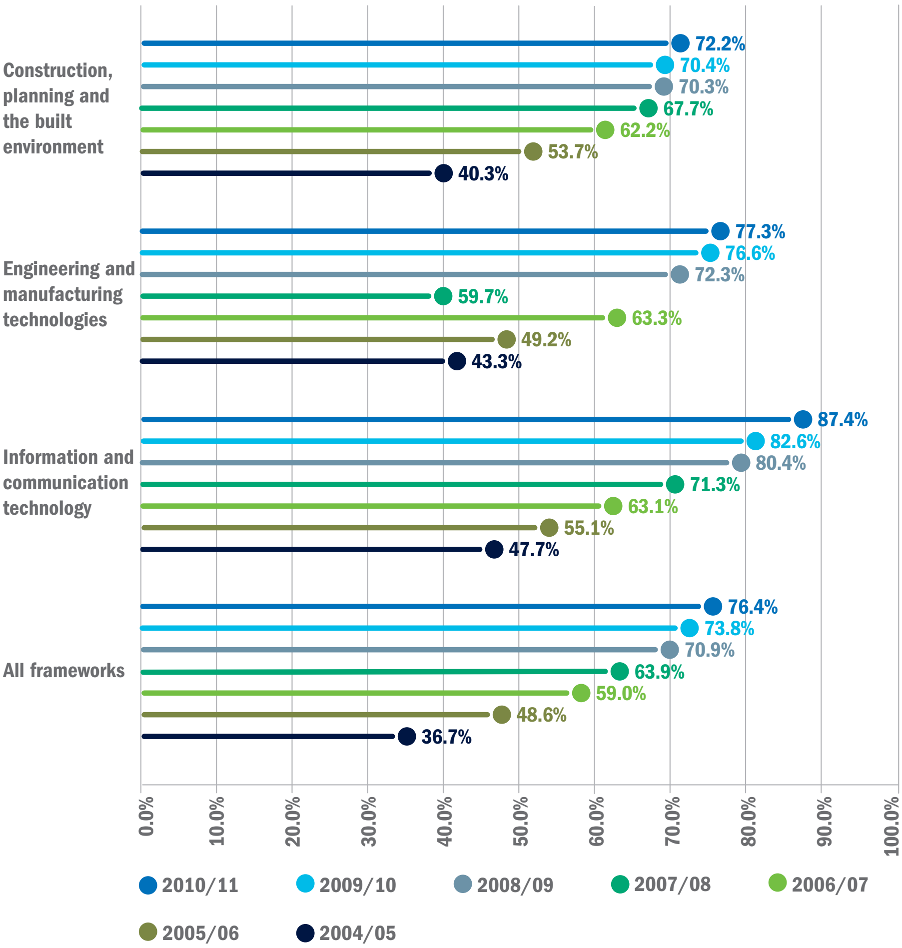
The engineering and manufacturing technologies Sector Subject Area has had above average success rates for each year except 2007/08. This was also the only year when percentage success rates declined.

However, the success rate did rebound strongly in 2008/09. Over the seven-year period, the success rate has increased from 43.3% to 77.3%.

Information and communication technology is the only one of the three engineering Sector Subject Areas to have achieved above average success rates each year. It also has the highest success rate for any of the three Sector Subject Areas in each of the seven years analysed. Overall, the success rate for information and communication technology has increased from 47.7% to 87.4%.

530 *Evaluation of apprenticeships Employers,* Department for Business, Innovations and Skills, May 2012, p24 **531** Apprenticeship success rates are based on the number of learners who meet all of the requirements of their apprenticeship framework, divided by the number of learners who have left training or successfully completed their training in the academic year. **532** Apprenticeship success rates are based on the number of learners who meet all of the requirements of their apprenticeship framework, divided by the number of learners who have left training or successfully completed their training in the academic year.

Fig. 10.3: Apprenticeship success rates by Sector Subject Area (2004/05-2010/11) – England



Source: The Data Service

10.4 Engineering apprenticeships in England

Authored by Mandy Crawford-Lee, Apprenticeship Development Manager, National Apprenticeship Service

Introduction

UK Government and business leaders consider a skilled workforce as a number one investment priority[533] and given that drive, more and more employers are looking for new ways of recruiting and developing the skills of their existing and future workforce.

In recent years there has been a renaissance in Apprenticeship training. In line with the desire to see growth in Apprenticeships over the period to 2014/15 we have seen an increase in the size of direct investment by the UK Government with investment in apprenticeships rising from £1.1 billion in 2009/10 to £1.4 billion in 2011/12.

Policy Developments

The National Apprenticeship Service (NAS) has end to end responsibility for the delivery of Apprenticeships in England. NAS is designed to drive the expansion of Apprenticeship opportunities and provide a dedicated, responsive service for both employers and learners. It works in partnership with employers, learning providers and other key stakeholders to focus on the delivery of an expanded, high quality Apprenticeship programme and recent key developments that impact on Apprenticeships in all Sector Subject Areas within the engineering footprint include:

Higher Apprenticeships[534] at Degree Levels

Higher Apprenticeships are being designed to support higher level skills development critical to the economy: they respond to employers' higher level skills needs, support business growth, meet individuals' career aspirations and enhance opportunities for social mobility. It is the vision of the National Apprenticeship Services for a new family of Apprenticeships spanning craft, technical and professional levels that open up work-based learning routes to the professions and senior job roles.

The renaissance in Apprenticeship training has until recently largely been confined to

533 15th Annual Global CEO Survey 2012, PWC 534 Higher Apprenticeships are being developed as higher education level learning programmes through which individuals develop the knowledge and competencies required to perform specific job roles.

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craft and technician level job roles. With the launch of the Higher Apprenticeship Fund[535] by the Prime Minister in the summer of 2011, this started to change as around 30 partnerships were awarded funding to develop and implement Higher Apprenticeships at levels 4 and 5 (Higher Education Certificate and Foundation Degree Levels). These partnerships are demonstrating that there is substantial employer demand across a wide range of industry sectors for Apprenticeships at levels 4 and 5 and for Apprenticeships in development at level 6 (Bachelor's degree levels) and level 7 (Master's degree level).

Higher Apprenticeships are putting employers in the driving seat and developing and delivering learning on the basis of business need. Employers, individual learners and Government want to see Apprenticeships at degree levels. For employers, Higher Apprenticeships are enabling them to develop their workforce to a higher level of skill. For individual learners, Higher Apprenticeships give unique access to employment combined with developing valuable higher level and professional skills, and opportunities for career progression. By including opportunities for professional accreditation and membership, Higher Apprenticeships present a significant new route for enhancing social mobility. To ensure the success of a Higher Apprenticeship culture, we need more employer-driven partnerships across all sectors and industries but particularly in the advanced engineering and manufacturing sector where there is a high demand for higher technical skills.

STEM apprenticeships

NAS is committed to meeting the required growth in uptake of STEM[536] related Apprenticeships by helping to stimulate employer and individual demand for Advanced and Higher Apprenticeships. However, starts in STEM related Apprenticeship frameworks[537] are not currently performing at a rate that satisfies current or future need.

It is estimated that at least 96,300 engineers, scientists and technologists will need to be recruited by 2016 and 1.5 million qualified in STEM subjects by 2020[538]. Only 11% of companies in the manufacturing and engineering sectors are currently employing apprentices and this is at a time when the number of new workplaces with apprentices has grown by 50,000 compared to the previous year. Indeed, although there has been a growth (57%) in STEM starts since 2006/07 this is below the average for all apprenticeships, which is 161%.

Growth in STEM Apprenticeships is largely concentrated in Advanced Apprenticeships and at level 4 and above although overall numbers at level 2 (Intermediate Apprenticeships) are still greater than level 3 and level 4 or higher, combined.

STEM Apprenticeships are still dominated by 16- to 18-year-old recruitment but at a decreasing rate. Encouragingly, 16-24 year old growth is concentrated at the higher levels. Growth of apprentices aged 25+ is significant but in contrast is concentrated at the Intermediate level (Level 2).

NAS is working with partners from Cogent, Gatsby Charitable Foundation, Semta, STEMNET, The Royal Academy of Engineering and the UK Commission for Employment and Skills (UKCES) to develop and deliver a STEM Strategy and action plan for initiating growth in Apprenticeships and to ensure that the learning provision can meet current and future need. By transforming the culture and practice of Apprenticeship delivery, NAS is providing a suitable platform for the promotion and take-up of vocational learning in STEM Apprenticeships at all levels through learner and employer engagement. More focus is needed on the mix and balance of provision which needs to be achieved in partnerships through the implementation of the STEM Strategy.

10.4.1 Regional analysis of apprenticeships in England[539]

The Engineering Council is responsible for setting the competencies required for registered engineers, which it sets out in UKSPEC.[540] According to UKSPEC Engineering Technicians are required to show evidence of competence, including academic knowledge at or above level 3.

Table 10.4 analyses, by English region; the percentage of apprentices who start a level 3+ qualification is 41.0%. Looking at construction, planning and the built environment it can be seen that the two English regions with the highest percentage of level 3+ apprentices are Yorkshire and the Humber and the South East, both with 46.4%. By comparison the region with the lowest percentage was the East Midlands with 37.1%.

For engineering and manufacturing technologies the region with the highest percentage of level 3+ apprentices was the South East (50.5%). This was nearly double the percentage of level 3+ apprentices in the South West (26.5%). Overall five of the nine English regions had less than a third of their apprenticeship starts at level 3:

- South west (26.5%)
- East Midlands (28.3%)
- North West (29.5%)
- North East (30.5%)
- West Midlands (31.6%)

Looking at information and communication technology it can be seen that the South West has the highest percentage of apprenticeship starts at level 3 or higher (69.1%). The English region with the lowest percentage was Yorkshire and the Humber where only a third (33.9%) of starts were at level 3+. This was the only English region where apprenticeship starts was below 50%.

Table 10.5 shows the percentage of apprenticeship starts, by ethnicity, in England. Construction, planning and the built environment is the Sector Subject Area that has the highest percentage of white apprentices (95.9%). London has the lowest percentage of while apprentices, 83.9%. For all the other English regions the percentage of white apprentice starts is above 90% with the north east having the highest percentage (98.8%).

Overall, the number of white apprenticeship starts in engineering and manufacturing technologies is 93.1%. For eight of the English regions more than 90% of their apprenticeship starts are white. The region

535 The Higher Apprenticeship Fund was launched by the Prime Minister in July 2011 to invest £25 million in the development of new Higher Apprenticeship Frameworks led by employers, in conjunction with other stakeholders, to the benefit of industry and SMEs. 536 STEM groups together the subjects of science and technology with engineering and mathematics. It takes place, in varying degrees, in all sectors of education and training and in varying concentrations in all sectors of the economy. 537 An apprenticeship framework is a document which covers all the statutory requirements for an apprenticeship in England and is used by colleges, employers and training organisations to make sure that all apprenticeships are delivered consistently and therefore to national standards, no matter where in England the apprenticeship takes place. See www.apprenticeships.org.uk/Partners/Frameworks.aspx 538 *Skills Assessment,* Semta, 2009 539 Section 11.5.4 provides regional analysis for the number of engineering graduates while section 15.2.1 shows the demand for engineers, in engineering enterprises, over 10 years by region. 540 The equivalent academic standards in the Scottish Credit and Curriculum Framework are 11, 9 and 6 respectively.

Table 10.4: Number of apprenticeship starts by level, region[541] and Sector Subject Area (2010/11) – England

	Construction, planning and the built environment	Engineering and manufacturing technologies	Information and communication technology	All engineering Sector Subject Areas
England	27,920	50,240	19,430	97,590
Level 2	16,110	33,670	8,620	58,420
Level 3	11,970	17,110	10,820	39,910
Level 4+	0	70	50	140
Percentage level 3+	42.9%	34.2%	55.9%	41.0%
North East	2,530	3,930	990	7,450
Level 2	1,550	2,730	410	4,690
Level 3	980	1,200	570	2,750
Level 4+	0	0	0	0
Percentage level 3+	38.7%	30.5%	57.6%	36.9%
North West	4,790	8,690	2,020	15,500
Level 2	2,720	6,130	880	9,740
Level 3	2,060	2,540	1,140	5,740
Level 4+	0	20	0	20
Percentage level 3+	43.0%	29.5%	56.4%	37.2%
Yorkshire and the Humber	3,450	7,350	2,830	13,630
Level 2	1,850	4,690	1,870	8,410
Level 3	1,600	2,630	950	5,180
Level 4+	0	30	10	40
Percentage level 3+	46.4%	36.2%	33.9%	38.3%
East Midlands	2,590	5,020	1,000	8,600
Level 2	1,630	3,600	410	5,640
Level 3	960	1,410	580	2,950
Level 4+	0	10	0	10
Percentage level 3+	37.1%	28.3%	58.0%	34.4%
West Midlands	2,680	5,910	2,350	10,940
Level 2	1,680	4,040	930	6,650
Level 3	1,000	1,870	1,410	4,280
Level 4+	0	0	10	10
Percentage level 3+	37.3%	31.6%	60.4%	39.2%
East of England	2,600	3,710	2,220	8,530
Level 2	1,410	2,450	1,030	4,890
Level 3	1,190	1,260	1,170	3,620
Level 4+	0	0	10	20
Percentage level 3+	45.8%	34.0%	53.2%	42.7%
London	1,920	2,360	2,550	6,830
Level 2	1,060	1,550	1,230	3,850
Level 3	860	800	1,300	2,970
Level 4+	0	0	10	10
Percentage level 3+	44.8%	33.9%	51.4%	43.6%
South East	3,880	6,830	2,380	13,090
Level 2	2,080	3,380	860	6,320
Level 3	1,800	3,450	1,510	6,750
Level 4+	0	0	10	10
Percentage level 3+	46.4%	50.5%	63.9%	51.6%
South West	3,480	6,460	3,110	13,040
Level 2	2,040	4,740	950	7,730
Level 3	1,440	1,700	2,150	5,300
Level 4+	0	10	0	20
Percentage level 3+	41.4%	26.5%	69.1%	40.8%
Other and unknown	170	610	100	880
Level 2	90	360	50	500
Level 3	80	250	40	370
Level 4+	0	0	0	0
Percentage level 3+	47.1%	41.0%	40.0%	42.0%

Source: The Data Service June 2012 Statistical First Release

541 Those apprentices whose government region is unknown have been excluded from this table

Table 10.5: Number of apprenticeship starts by ethnicity, Government region and Sector Subject Area (2010/11) – England

	Construction, planning and the built environment	Engineering and manufacturing technologies	Information and communication technology	All engineering Sector Subject Areas
North East	2,530	3,930	980	7,440
Asian/Asian British	*[542]	*	*	*
Black/African/Caribbean/Black British	*	*	*	*
Mixed/multiple ethnic group	*	*	*	*
Not known/Not provided	*	*	*	*
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	*
White	2,500	3,880	960	7,340
Percentage white	98.8%	98.7%	98.0%	98.7%
North West	4,780	8,690	2,020	15,500
Asian/Asian British	*	110	60	220
Black/African/Caribbean/Black British	*	50	*	80
Mixed/multiple ethnic group	50	90	*	160
Not known/Not provided	*	*	*	90
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	*
White	4,650	8,380	1,890	14,910
Percentage white	97.3%	96.4%	93.6%	96.2%
Yorkshire and the Humber	3,450	7,350	2,830	13,630
Asian/Asian British	*	250	130	400
Black/African/Caribbean/Black British	*	130	*	180
Mixed/multiple ethnic group	*	90	50	170
Not known/Not provided	*	*	*	60
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	50
White	3,370	6,810	2,580	12,760
Percentage white	97.7%	92.7%	91.2%	93.6%
East Midlands	2,590	5,020	990	8,600
Asian/Asian British	*	200	110	340
Black/African/Caribbean/Black British	*	50	*	90
Mixed/multiple ethnic group	*	70	*	130
Not known/Not provided	*	*	*	*
Other ethnic group (Incl. Chinese Pre 2011/12)	*	50	*	60
White	2,500	4,610	820	7,930
Percentage white	96.5%	91.8%	82.8%	92.2%
West Midlands	2,680	5,910	2,350	10,940
Asian/Asian British	60	230	340	630
Black/African/Caribbean/Black British	50	90	110	250
Mixed/multiple ethnic group	60	100	100	250
Not known/Not provided	*	*	*	80
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	50
White	2,470	5,440	1,760	9,670
Percentage white	92.2%	92.0%	74.9%	88.4%
East of England	2,600	3,710	2,210	8,530
Asian/Asian British	20	60	110	180
Black/African/Caribbean/Black British	*	*	70	120
Mixed/multiple ethnic group	*	50	60	140
Not known/Not provided	*	*	*	90
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	*
White	2,510	3,520	1,940	7,980
Percentage white	96.5%	94.9%	87.8%	93.6%
London	1,920	2,350	2,540	6,830
Asian/Asian British	70	330	530	930
Black/African/Caribbean/Black British	120	300	660	1,070
Mixed/multiple ethnic group	90	110	160	360
Not known/Not provided	*	50	60	130
Other ethnic group (Incl. Chinese Pre 2011/12)	*	80	110	210
White	1,610	1,480	1,030	4,120
Percentage white	83.9%	63.0%	40.6%	60.3%
South East	3,880	6,830	2,380	13,080
Asian/Asian British	*	90	230	330
Black/African/Caribbean/Black British	*	80	100	190
Mixed/multiple ethnic group	70	80	60	210
Not known/Not provided	*	*	*	80
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	60
White	3,750	6,520	1,940	12,220
Percentage white	96.6%	95.5%	81.5%	93.4%
South West	3,480	6,450	3,100	13,050
Asian/Asian British	*	*	110	150
Black/African/Caribbean/Black British	*	130	90	220
Mixed/multiple ethnic group	*	80	50	170
Not known/Not provided	*	*	*	60
Other ethnic group (Incl. Chinese Pre 2011/12)	*	*	*	80
White	3,410	6,150	2,790	12,370
Percentage white	98.0%	95.3%	90.0%	94.8%
England	27,910	50,240	19,400	97,600
Asian/Asian British	270	1,340	1,640	3,220
Black/African/Caribbean/Black British	270	860	1,100	2,220
Mixed/multiple ethnic group	420	680	520	1,610
Not known/Not provided	120	290	230	650
Other ethnic group (Incl. Chinese Pre 2011/12)	60	330	200	600
White	26,770	46,790	15,710	89,300
Percentage white	95.9%	93.1%	81.0%	91.5%

Source: The Data Service June 2012 Statistical First Release

542 The number has been removed from the table due to the low number of apprentices from this ethnic background

with the highest percentage of white apprenticeship starts is the North East, 98.7%. The most ethnically diverse English region was London, where just under two thirds (63.0%) of apprenticeship starts were white.

Of the three engineering Sector Subject Areas information and communication technology has the lowest percentage of apprenticeship starts that are white (81.0%). At least 90% of the apprenticeship starts, in four English regions were white. Once again the North East had the highest percentage of white apprenticeship starts (98.0%). However for London the comparable figure was only 40.6%.

Of the 55,434 framework achievements in engineering subjects, in 2010/11, 9,201 were in London 8,344 in the North West and 8,198 in Yorkshire and the Humber (Table 10.6). The region with the lowest number of engineering framework achievements was London, with 3,633.

Looking specifically at engineering and manufacturing technologies it can be seen that it represented nearly half of all the engineering framework achievements (26,724 out of 55,434). The region with the largest number of achievements was the South East (5,012) followed by Yorkshire and the Humber (4,164) and the North West (4,101). Two English regions had below 2,000 achievements they were London (1,061) and the North East (1,860).

For construction, planning and the built environment it can be seen that out of 18,261 framework achievements 3,320 were in the North West. However five regions had less than 2,000 achievements:

- London (1,260)
- North East (1,493)
- West Midlands (1,582)
- East Midlands (1,631)
- East of England (1,667)

Looking at information and communication technology it can be seen that the region with the largest number of framework achievements was the South East (1,806). However three regions had less than a thousand framework achievements:

- East Midlands (441)
- North East (532)
- North west (923)

Table 10.6: Number of framework achievements by Government region and Sector Subject Area (2010/11) – England

	Construction, planning and the built environment	Engineering and manufacturing technologies	Information and communication technology	All engineering Sector Subject Areas
North East	1,493	1,860	532	3,885
North West	3,320	4,101	923	8,344
Yorkshire and the Humber	2,379	4,164	1,655	8,198
East Midlands	1,631	2,074	441	4,146
West Midlands	1,582	2,352	1,305	5,239
East of England	1,667	2,122	1,134	4,923
London	1,260	1,061	1,312	3,633
South East	2,383	5,012	1,806	9,201
South West	2,546	3,978	1,341	7,865
England	18,261	26,724	10,449	55,434

Source: The Data Service June 2012 Statistical First Release

10.5 Employer investment in apprenticeships

The cost of running an apprenticeship for an employer is considerable. However, employers continue to invest in this form of vocational training for a number of reasons:[543]

- to maintain and improve their skills supply
- as a means of recruiting and retaining talent
- to motivate and reward staff
- because it is an industry norm to invest in apprenticeships (this is particularly true for engineering and manufacturing technologies and construction, planning and the built environment)
- as a form of corporate social responsibility

Table 10.7 shows the Net Training Costs for apprenticeships at level 2 and/or 3 for different sectors. It shows that in engineering the Net Cost for level 2 and 3 is £39,600, while for construction it is £26,000. This is much higher than the cost of apprenticeships in other sectors. Part of the reason why engineering and construction have much higher Net Training Costs is because the duration of the apprenticeship is typically three to four years, whereas other sectors such as retailing and hospitality tend to deliver all their training within one year.

Table 10.8 shows that three of the evaluated sectors have a very quick payback period on an apprenticeship. These are transport (six months), business administration (nine months) and hospitality (10 months). Engineering had the second longest payback period, at three years and seven months, while construction had a much shorter payback period of two years and three months.

Employers tend to recoup their investment in apprenticeships by paying the apprentice a wage that is less than their marginal productivity. (As productivity rises, as a result of training, so do wages – but at a lower rate).

As well as employers getting a return on their investment from apprenticeships, it should be noted that apprentices and the Government also get a return on

543 *Employer Investment in Apprenticeships and Workplace Learning: The Fifth Net Benefits of Training to Employers Study,* Department for Business, Innovations and Skills, May 2012, p17-18

apprenticeship training. The Department for Business, Innovation and Skills estimates the return on investment for apprenticeships is around £24-35 per pound of funding, which is similar to other vocational qualifications.[544] However the National Audit Office, in its analysis, estimated the returns as slightly less: £21 per pound for advanced apprenticeships and £16 per pound for intermediate apprenticeships.[545]

Another way of looking at the Government return on investment in apprenticeships is to look at the Net Present Value (NPV).[546] The Government gets particularly high returns for level 3 qualifications. A level 3 NVQ typically has a return of £21,000 to £36,000 but, for an advanced apprenticeship, the return is £56,000 to £81,000.

Employees also get a wage return from completing an apprenticeship. The lifetime benefits of getting an apprenticeship are between £48,000 and £74,000 for a foundation apprenticeship and between £77,000 and £117,000 for an advanced apprenticeship.[547] The Department for Business, Innovations and Skills[548] has also identified that earnings increased 24.1% in the first year after completing a foundation apprenticeship, when compared to those who didn't complete the course. For an advanced apprenticeship, the earnings boost is slightly higher at 25.3%, with men getting a premium of 31.9% and women getting a premium of just 14.3%. The earnings premium for apprenticeship completers does deteriorate over time, but is still significant seven years after completion.[549]

As well as leading to higher average salaries for those in work, the acquisition of an apprenticeship led to an increase in employment and a reduction in the number of days a worker was on Job Seekers Allowance and/or Incapacity Benefit per year.[550] Both of these impacts were still in effect seven years after the completion of the apprenticeship.

Table 10.7: Summary of employers Net Training Costs[551]

	Apprenticeships		
	Level 2	**Level 3**	**Level 2 and 3 combined**
Engineering	-	-	£39,600
Construction	-	-	£26,000
Retailing	£3,000	-	-
Hospitality	£5,050	-	-
Transport and logistics	£4,550	-	-
Financial services	£7,250	£11,400	-
Business administration	£4,550	-	-
Social care	£3,800	-	-

Source: Department for Business, Innovation and Skills

Table 10.8: Payback period by sector[552]

	Apprenticeship level	Payback period
Engineering	Level 3	3 years and 7 months
Construction	Level 2 and 3	2 years and 3 months
Retailing	Level 2	2 years and 3 months
Hospitality	Level 2	10 months
Transport and logistics	Level 2	6 months
Financial services	Level 3	2 years and 6 months
	Level 2	3 years and 8 months
Business administration	Level 2	9 months
Social care	Level 2	3 years and 3 months

Source: Department for Business, Innovation and Skills

544 *Measuring the economic impact of FE,* Department of Business, Innovation and Skills, March 2011, p5 **545** *Adult apprenticeships,* National Audit Office, February 2012, p7 **546** The Net Present Value is defined as the present value of the benefits minus the present value of the costs associated with particular activity. **547** *Returns to intermediate and low level vocational qualifications,* Department for Business, Innovation and Skills, September 2011, p13 **548** *The Long Term Effect of Vocational Qualifications on Labour Market Outcomes,* Department for Business, Innovation and Skills, June 2011, p15 **549** *The Long Term Effect of Vocational Qualifications on Labour Market Outcomes,* Department for Business, Innovation and Skills, June 2011, p15-16 **550** *The Long Term Effect of Vocational Qualifications on Labour Market Outcomes,* Department for Business, Innovation and Skills, June 2011, p15-16 **551** Data has been rounded to the nearest £50. **552** This analysis was only done where an apprenticeship was offered to a new employee, existing employees were excluded.

Part 2 – Engineering in Education and Training
11.0 Higher Education

The Higher Education sector in England is going through a period of considerable change. The 2012/13 academic year is the first to operate under the new funding arrangements,[553] which allow universities to charge up to £9,000 per year in fees, subject to approval by the Office of Fair Access.

In addition, the reforms will allow unrestrained recruitment of high-achieving students (there are around 65,000 who achieve AAB or above at A level), making those places contestable between institutions.[554] The Government has also created a flexible margin of 20,000 places to reward universities and colleges who combine good quality with value for money, and whose average charge (including waivers) is at or below £7,500.[555] [556] The introduction of 'margin' places has resulted in 9,643 places being distributed to 35 Higher Education Institutions (HEIs). A further 10,354 places were awarded to 155 Further Education Colleges, 65 of which received no HEFCE funding in 2011/12.[557]

There will be further liberalisation in 2013/14, with the threshold for contestable places being reduced to ABB+. This is estimated to target around 120,000 students or approximately 1/3 of student places. In addition, the 20,000 margin places awarded in 2012/13 will be carried forward and an extra 5,000 made available.[558]

The Government and the Higher Education Funding Council for England (HEFCE) have both recognised the potential impact of the new fee arrangements on strategically important and vulnerable subjects (SIVS) courses, of which engineering is one. HEFCE has therefore excluded numbers associated with SIVS from its calculation to create 'margin' places, on condition that the institutions at least maintain their entrant levels to SIVS courses.[559] This is critical for the engineering sector. As the House of Lords Select Committee on Science and Technology[560] stated: *"It appears that the SIVS policy has been, at least partly, responsible for raising the numbers studying SIVS."*

To pay the increased tuition fees, students will be able to take out up-front loans. In 2012/13, loans will be available to part-time students for the first time, so long as they are studying for at least 25% of an academic year. Loans will be repayable at the rate of 9% of earnings over £21,000.[561] Full-time students start repaying their loans after graduation. Part-time students, however, will start repaying their loans while still studying if they earn over £21,000.[562]

EngineeringUK has previously shown that students tend to underestimate the level of financial support they are eligible for and to date have made key decisions on very limited data.[563] The Government have recognised this issue and accordingly have re-launched their Unistats website.[564] We have also shown that the average undergraduate premium (taking into account the costs associated with a degree) is approximately £108,121, for someone with two A levels. However, for engineering it is around 33% more, at approximately £143,959.[565] Further research by OpinionPanel Research has shown that there is a lack of understanding of the financial implications – and in particular the repayment method for student loans – for a sizeable minority of students who have decided to apply to university.[566]

553 *Government response to Students at the heart of the system and A new regulatory framework for the HE sector,* Department of Business, Innovation and Skills, June 2012, p3 **554** Contestable and margin places allow universities to recruit above their contracted headcount for UK full-time undergraduate students. **555** Website accessed on 4 July 2012 http://www.hefce.ac.uk **556** Website accessed on 4 July 2012 (http://www.hefce.ac.uk/news/newsarchive/2012/name,69551,en.html) **557** Website accessed on 4 July 2012 (http://www.hefce.ac.uk/news/newsarchive/2012/name,69551,en.html) **558** Website accessed on 4 July 2012 http://www.hefce.ac.uk **559** *Student numbers for 2012-13,* HEFCE, October 2011, p2 **560** *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects, House Of Lords Select Committee on Science and Technology,* July 2012, p37 **561** *Engineering UK Report 2012 – the state of engineering in the UK,* EngineeringUK, December 2011, p148 **562** *Impact of Higher Education for PT students,* UKCES, September 2010, p28 **563** *Engineering UK Report 2012 – the state of engineering in the UK,* EngineeringUK, December 2011, p149 **564** http://unistats.direct.gov.uk/ **565** *Engineering UK Report 2012 – the state of engineering in the UK,* EngineeringUK, December 2011, p149 **566** *2012 Applicants survey,* OpinionPanel, February 2012, p4

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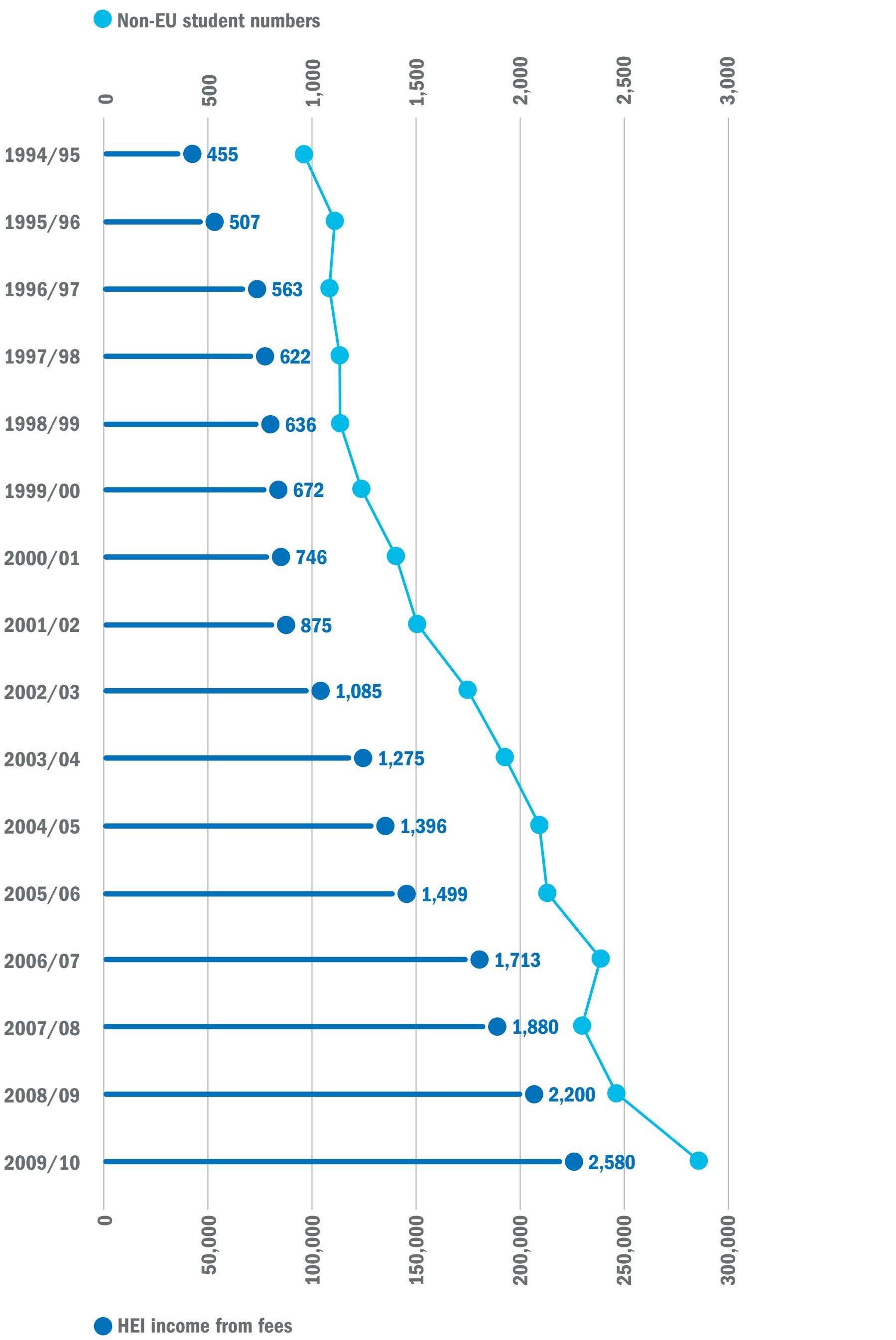
To facilitate better informed choices and competition, the Government has also introduced Key Information Sets,[567] which will give information on different courses and institutions to students. The Government is also keen to stimulate competition by encouraging new universities. The criterion for a university title has been reduced from 4,000 students to 1,000,[568] of whom 750 must be studying for a degree.[569] The Government is also keen to encourage new universities to open in England by removing barriers.[570] Two Further Education Colleges have already been awarded the power to award foundation degrees.[571]

With all these changes in the HE sector in England, it is important to consider what the impact has been on applications. At the time of going to press, UCAS was reporting that the total number of applicants for 2012/13 was down 7.6%.[572] (Pleasingly, applications to engineering fell by only 2.6%.)[573] However, it should be noted that not all applicants to university get a place. So while the total number of applicants may have fallen by 7.6%, it is possible that all university places will be successfully filled.

In 2012/13, the Higher Education sector will receive total Government funding of £9.46 billion, of which £3.6 billion will come from student loans.[574] However, in these uncertain financial times, many institutions are looking to postgraduate and non-EU student recruitment to provide additional sources of revenue. Figure 11.0 shows that income from non-EU students has increased more than fivefold since 1994/5, from £455m to £2.6 billion. While according to the Department of Business, Innovation and Skills (BIS), tuition fee income from EU students was £292.6 million.[575] Universities UK has calculated the total value of UK HE exports at £5.3 billion.[576] While BIS calculated that in 2008/09, the total value of UK education exports was £14.1 billion, with over half – £7.9 billion – coming from HE.[577]

Fig. 11.0: HE income and student numbers (1994/95-2009/10) – all non-EU domiciled[578]



Source: Universities UK

567 *Government response to Students at the heart of the system and A new regulatory framework for the HE sector,* Department of Business, Innovation and Skills, June 2012, p3 **568** *Government response to Students at the heart of the system and A new regulatory framework for the HE sector,* Department of Business, Innovation and Skills, June 2012, p3 **569** *Reforms to the Higher Education sector announced today,* Department for Business, Innovation and Skills, 11 June 2012, p1 **570** *Engineering UK Report 2012 – the state of engineering in the UK,* EngineeringUK, December 2011, p148 **571** *Policy update 30th July – 30th August 2011,* Learning and Skills Improvement Service, 2011, p18 **572** Website accessed on 23 August 2012 (http://www.ucas.ac.uk/about_us/media_enquiries/media_releases/2012/app_stats12/22august2012) **573** Website accessed on 23 August 2012 (http://www.ucas.ac.uk/about_us/media_enquiries/media_releases/2012/20120709) **574** Website accessed on 4 July 2012 (http://www.bis.gov.uk/assets/biscore/higher-education/docs/L/letter-he-funding-25-jan-2012) **575** *Estimating the value of UK education exports,* Department for Business, Innovation and Skills, June 2011, p23 **576** *Efficiency and effectiveness in Higher Education,* UniversitiesUK, September 2011, p14 **577** *Estimating the value of UK education exports,* Department for Business, Innovation and Skills, June 2011, p9 **578** From 2007/08 writing up and sabbatical students are no longer included in standard counts of students.

However, changes to the visa system for students (for instance, requiring all education providers wanting to recruit international students to have Highly Trusted Sponsor status)[579] does raise concerns for the continued success of UK HE institutions in attracting international students. Research by the British Council has shown that tightening visa restrictions in Australia cost the country A$428 million in 2010 alone.[580] The Government is aware of the risk to the UK HE sector of tighter visa controls and is trying to address this via promoting transnational education[581] through its HE Global website.[582]

In 2010/11, the total number of postgraduate students in the UK was 182,605.[583] Postgraduate numbers are not capped by the Government. Nor does the Government regulate the tuition fees universities can charge. So, while it is not possible to provide a profile of tuition fee income from UK and international students, it should be noted that it is an important source of income for universities, and one where they have the potential to expand further.

Finally, analysis by HEFCE[584] shows that the value of services to business (including commercialisation of new knowledge and delivery of professional training, consultancy and services) to the UK economy was £3.3 billion in 2010/11. Once more, this emphasises the importance of HE to the UK's economic development.

11.1 The UK Higher Education sector

Table 11.0 gives an overview of the distribution of universities and HE institutions in the UK. As of August 2011, there were 115 universities and 165 HE institutions. Of these, 89 universities and 131 HE institutions are located in England. Scotland has the second largest number of institutions: 14 and 19 respectively. While Northern Ireland has the smallest number of institutions: two universities and four HE institutions. As already mentioned in this section, two Further Education Colleges have recently been granted the power to award foundation degrees, as have two private colleges.[589]

Table 11.0: Overview of the HE sector (August 2011) – UK[585] [586]

	Universities[587]	Higher Education Institutions[588]
England	89	131
Scotland	14	19
Wales	10	11
Northern Ireland	2	4
UK	115	165

Source: Universities UK

The importance of FE to the HE sector is highlighted by research conducted by the Commission of Colleges in their Communities[590] which showed that colleges provide 38% of HE entrants. UniversitiesUK[591] has also shown that two thirds (64.6%) of HE students studying in an FE college are studying part-time. Research by the Department for Business, Innovation and skills[592] has shown that students in colleges are more likely to be older than students in HEIs, and that their undergraduate students are more likely to come from areas where participation in HE is low. However, HE in FE is very unevenly distributed across the circa 300 or so FE colleges, with approximately 50-60 colleges accounting for half of the FE students taking Higher Education courses.[593] HE in FE is vitally important to the engineering sector, since 14,320 HE students in England were studying engineering in an FE college in 2009/10.[594] This is in addition to the 9,280 level 3+ apprenticeship achievements in the three engineering frameworks.[595]

Table 11.1 provides a breakdown of income and expenditure for the publicly-funded HE sector in 2009/10 and 2010/11. Compared with the previous year, total income increased by 2.8% to £27.6 billion. The largest source of income was tuition fees and education contracts, generating £9.0 billion – 8.3% up on the previous year. Funding body grants worth £8.9 billion were the second largest source of income. However, this was down 1.8% on the previous year. In 2009/10, funding body grants were the largest source of income, representing 33.7% of all income. But in 2010/11, they had slipped to second place, representing a smaller share of total income at 32.2%. The largest source of growth was endowment and investment income, which increased 11.9% in one year to £240.6 million. However, this was still only 0.9% of total income in 2010/11. Both research grants and contracts and other income showed a slight increase on the previous year, at 2.0% and 2.6% respectively.

The largest area of expenditure was once again staff costs. In 2010/11, staff costs were £14.7 billion, or 56.2% of all costs. However, staff costs rose by less than the average for all costs, at just 0.7% over the year. The largest percentage increase in costs was for depreciation, which rose 5.9%. However, depreciation only represents 5.6% of all costs. Other operating expenses also showed an above-average increase, rising 3.1% to £9.7 billion. Interest and other finance costs was the only area to show a one-year decline in costs, falling 17.8% to £372.8 million.

Research by Universities UK has shown that the UK HE sector contributes £59 billion to the UK economy.[596] When compared with the total HE expenditure of £26.2 billion, the UK HE sector represents a very good return on investment.

The National Audit Office, in its report *Regulating the financial sustainability in HE,*[597] found that the largest institution has an annual income in excess of £1 billion, while around a quarter of institutions have an income below £50 million.

579 Website accessed on 4 July 2012 (http://www.bis.gov.uk/assets/biscore/further-education-skills/docs/g/11-860-Government-review-of-tier-4-student-visa) **580** Website accessed on the 4 July 2012 (http://www.timeshighereducation.co.uk/story.asp?storycode=418963) **581** Transnational education is where some or all of the course is delivered outside of the country of the university awarding the degree. **582** http://heglobal.international.ac.uk/ **583** HESA student record – qualifications obtained **584** Website accessed on 30 July 2012 http://www.hefce.ac.uk/news/newsarchive/2012/name,73740,en.html **585** This list excludes foreign HE institutions operating in the UK. **586** There are also a significant number of Further Education Colleges at which HE students study. **587** Institutions with 'university' title. Federal institutions such as the University of Wales and the University of London are counted as one University. **588** The term Higher Education Institutions includes universities, university colleges, specialist Higher Education institutions and other Higher Education colleges. **589** Website accessed on 27 July 2012 http://www.bbc.co.uk/news/education-18996223 **590** *A dynamic nucleus,* Commission of Colleges in their Communities, July 2011, p10 **591** *Patterns and trends in UK Higher Education,* UniversitiesUK, October 2011, p8 **592** *Understanding Higher Education in Further Education Colleges,* Department for Business, Innovation and Skills, June 2012, p12 **593** *Understanding Higher Education in Further Education Colleges,* Department for Business, Innovation and Skills, June 2012, p41 **594** *Understanding Higher Education in Further Education Colleges,* Department for Business, Innovation and Skills, June 2012, p69 **595** See section 10.0 for further details. **596** *Adapting business models in a changing environment,* UniversitiesUK, 9 July 2010, p4 **597** *Regulating the financial sustainability in HE,* National Audit Office, 4 March 2011, p9

Table 11.1: Total income and expenditure by source of income and category of expenditure (2009/10-2010/11) – UK

	Total in thousand £ 2009/10	Percentage of 2009/10 total	Total in thousand £ 2010/11	Percentage of 2010/11 total	One year change in thousand £	One year percentage change
Income						
Funding body grants	9,043,793	33.7%	8,877,801	32.2%	-165,992	-1.8%
Tuition fees and education contracts	8,287,779	30.9%	8,975,819	32.6%	688,040	8.3%
Research grants and contracts	4,346,357	16.2%	4,432,394	16.1%	86,037	2.0%
Other income	4,905,878	18.3%	5,034,898	18.3%	129,020	2.6%
Endowment and investment income	215,087	0.8%	240,627	0.9%	25,540	11.9%
Total income	**26,798,894**		**27,561,539**		**762,645**	**2.8%**
Expenditure						
Staff costs	14,633,889	56.6%	14,730,242	56.2%	96,353	0.7%
Other operating expenses	9,362,419	36.2%	9,651,373	36.8%	288,954	3.1%
Depreciation	1,396,363	5.4%	1,478,453	5.6%	82,090	5.9%
Interest and other finance costs	453,249	1.8%	372,791	1.4%	-80,458	-17.8%
Total expenditure	**25,845,920**		**26,232,859**		**386,939**	**1.5%**

Source: HESA finance table

11.2 Participation rates

In 2010/11, the provisional Higher Education Initial Participation Rate (HEIPR) for English-domiciled first-time students was 46.5% (Table 11.2). The overall HEIPR increased year-on-year from 2007/08 to 2009/10. However, in 2010/11 it stayed level with the previous year's figures. Participation rates for male students increased in each year, including 2010/11. However, there was a decline in female participation in 2010/11, from 52.2% to 51.7%. Despite this decline, the female HEIPR has been at least 10 percentage points higher than the equivalent participation rate for males in each year since 2006/07.

Full-time HEIPRs have increased steadily each year from 2007/08 onwards, although the increase in 2010/11 was marginal. In the *EngineeringUK Report 2011*[598] we showed that 55% of 16- to 17-year-olds in England believed they were likely to go to university. A participation rate of only 46.5% means that nearly one in ten of those who believe they will go to university will be frustrated.

Although there has been some fluctuation in participation rates for part-time students, over time they have fallen, from 6.8% in 2006/07 to 6.1% in 2010/11. Analysis by the UK Commission for Education and Skills (UKCES)[599] has shown that the part-time HE population is very polarised, with a high proportion already holding a degree. These students are re-skilling and often have financial support from their employer. However, there is a substantial minority with no or low-level entry qualifications. These students are up-skilling and frequently have to pay for their degree themselves.

Table 11.2: Participation rates for 17- to 30-year-old students at UK Higher Education Institutions (2006/07-2010/11) – English domiciled

	2006/07	2007/08	2008/09	2009/10	2010/11 (provisional)[600]
HEIPR (male and female) %	42.0	43.4	45.6	46.5	46.5
Initial entrants (thousands)	285	296	313	323	323
HEIPR (male) %	36.5	37.9	40.1	41.1	41.6
Initial entrants (thousands)	127	133	141	147	148
HEIPR (female) %	47.8	49.1	51.2	52.2	51.7
Initial entrants (thousands)	158	163	172	177	174
HEIPR (full-time) %	35.3	36.9	39.0	40.3	40.4
Initial entrants (thousands)	240	252	268	279	279
HEIPR (part-time) %	6.8	6.4	6.5	6.2	6.1
Initial entrants (thousands)	45	44	45	44	44

Source: Department for Business, Innovation and Skills

598 *Engineering UK Report 2011 – the state of engineering,* EngineeringUK, December 2010 **599** *Impact of Higher Education for PT students,* UKCES, September 2010, p2 **600** Provisional figures for England in 2010/11 excludes students studying at Welsh Further Education Colleges

The Scottish Funding Council now publishes HEIPR statistics which match those of England (Table 11.3). While the highpoint for HEIPR in England is 46.5%, the highpoint in Scotland is 55.6%, 9.1 percentage points higher. The Scottish data shows a slight dip in 2007/08, when HEIPR fell from 53.2% to 52.0%. But, as in England, the HEIPR for 2010/11 remained unchanged from 2009/10.

Again, as in England, the Scottish figures show a much higher participation rate for females: 61.7% in 2010/11, compared with 49.8% for males. Figure 11.1 shows the participation rates for males and females in England and Scotland for 2006/07 to 2009/10. The figure shows that the participation rate amongst males in Scotland is consistently above English males and just below the participation rate for females. The participation rate for Scottish females was consistently higher than for all other groups.

Wales and Northern Ireland do not produce participation statistics in the same way as England and Scotland. It is therefore not possible to compare participation rates between these countries. The national participation rate for Welsh-domiciled students in 2006/07 was 3.7.[602 603] The figure was higher for females, at 4.3, than it was for males, at 3.1. These figures have remained unchanged since 2004/05. The provisional 2009/10 Higher Education age participation index for Northern Ireland was 50.7%.[604] This was a sizeable increase from 48.2% the previous year and more than double the 24.6% achieved in 1989/90.

Table 11.4 shows the postgraduate participation rate for English domiciled 17- to 30-year-old students at UK HE institutions. In 2008/09 and 2009/10 there was growth in the postgraduate participation rate, however in 2010/11 the percentage of postgraduates declined slightly. As with the HEIPR data for English-domiciled students, female participation is higher than male participation.

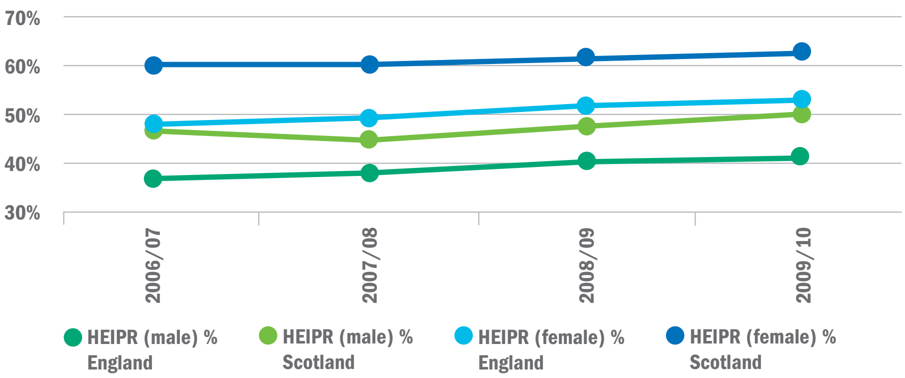
Longer term, there is a concern about the impact of the increase in tuition fees on postgraduate participation rates. HEIs may seek to increase postgraduate numbers to cover the cost of the reduced HEFCE teaching grant. But this will be at a time when students will have higher levels of debt on completing their undergraduate degrees (due to the maximum limit being raised to £9,000 per year). This situation may be exacerbated by the fact that there are no student loans for postgraduate study, institutions can set their own tuition fees, and those fees have to be paid in advance.

Table 11.3: Participation rates for 17- to 30-year-old students at UK Higher Education Institutions (2006/07-2010/11) – Scottish domiciled

	2006/07	2007/08	2008/09	2009/10	2010/11 (provisional)[601]
HEIPR (male and female) %	53.2	52.0	54.2	55.6	55.6
Initial entrants (thousands)	35	34	36	37	37
HEIPR (male) %	46.9	44.7	47.6	49.3	49.8
Initial entrants (thousands)	16	15	16	17	17
HEIPR (female) %	59.8	59.7	61.2	62.2	61.7
Initial entrants (thousands)	19	19	20	20	20
HEIPR (full-time) %	44.2	43.5	44.8	46.7	47.0
Initial entrants (thousands)	29	29	30	31	31
HEIPR (part-time) %	9.0	8.6	9.5	9.0	8.7
Initial entrants (thousands)	6	6	6	6	6

Source: Scottish Funding Council

Fig. 11.1: Participation rates for 17- to 30-year-old students at UK Higher Education Institutions (2006/07-2009/10) – English and Scottish domiciled



Source: Scottish Funding Council

601 Provisional figures for Scotland in 2010/11 excludes students studying at English, Welsh and Northern Irish Further Education Colleges. 602 Participation rates for Welsh students in Higher Education within the UK during 2006/07, HEFCW, June 2009 603 The Welsh participation data is based on a percentage of the whole population rather than a percentage of an age cohort. 604 Higher Education age participation index for Northern Ireland – 1989/90 to 2009/10, Department for Employment and Learning, June 2011

Table 11.4: Postgraduate participation rates for 17- to 30-year-old students at UK Higher Education Institutions (2006/07-2010/11) – English domiciled

	2006/07	2007/08	2008/09	2009/10	2010/11 (provisional)[605]
HEIPR (male and female) %	8.8	8.3	8.8	9.6	9.3
Initial entrants (thousands)	59	58	62	69	67
HEIPR (male) %	6.8	6.5	6.8	7.6	7.2
Initial entrants (thousands)	23	23	24	28	26
HEIPR (female) %	10.8	10.3	11.0	11.7	11.5
Initial entrants (thousands)	36	35	38	41	40
HEIPR (full-time) %	5.9	5.5	5.7	6.5	6.3
Initial entrants (thousands)	40	38	40	47	45
HEIPR (part-time) %	2.9	2.8	3.1	3.1	3.0
Initial entrants (thousands)	19	19	22	22	22

Source: Department for Business, Innovation and Skills

11.3 Student and graduate numbers

11.3.1 Applicants to undergraduate STEM HE courses[606]

Over a 10-year period from 2001/02 to 2010/11, applicants to all subject areas increased by 51.8% (Table 11.5). It is worth noting that growth for all the STEM subjects over 10 years was lower than the average for all subjects, which was 51.8%. The best performing STEM subject was physical sciences, which grew by 51.6% over the period, although it is still the smallest of the four STEM subject areas. The main source of this growth was EU applicants, who increased in number by 255.5% over 10 years and by 11.3% in the last year. Growth for non-EU applicants was lower, at 127.6% over 10 years and 2.9% in the last year. By comparison, growth for UK-domiciled applicants was only 43.3% over 10 years, although it did grow by 6.7% in 2010/11.

Research by the Institute of Physics[607] has shown that the number of full-time students starting an enhanced first degree course (leading to an MPhys/MSci qualification) increased by 51% between 2004/05 and 2009/10, while the number starting a bachelor degree course increased by 5%.

The STEM subject area with the second-best growth over 10 years was biological sciences, up 51.1% overall and 3.6% in the last year. As with physical sciences, growth for biological sciences has been fuelled by EU applicants (up 190.7%) and non-EU applicants (up 105.6%). By comparison, applicants from the UK were up 44.4% over 10 years and 2.7% in the last year.

Engineering and technology has had lower growth than both physical and biological sciences, up 47.9% over 10 years. However, growth has been more even between the different domiciles. EU applicant numbers increased by 103.3% between 2001/02 and 2010/11, non-EU applicants had the second-highest growth at 49.2%, closely followed by UK-domiciled applicants at 42.1%. In 2010/11, non-EU applicant numbers declined by 3.4%, while UK numbers increased by 3.2%.

Mathematical and computer sciences was the only STEM subject area to show a decline in applicant numbers over 10 years (down 2.1%), although it did grow by 3.6% in 2010/11. The number of EU applicants increased by 215.5% over 10 years and by 23.5% in 2010/11 alone. However, there was a decline in the number of applicants from outside the EU (down 27.1% over the period) and from the UK (down 4.6% over 10 years).

605 Provisional figures for England in 2010/11 excludes students studying at Welsh Further Education Colleges. **606** UCAS applicants are those who apply to full-time, undergraduate Higher Education courses (first degrees, HNC/HNDs etc) offered by universities or colleges who are members of the UCAS scheme. Some international applicants apply directly without going through UCAS. **607** *Physics Students in UK Higher Education Institutions,* Institute of Physics, March 2012, p2

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Table 11.5: Applicants to STEM HE courses by domicile (2001/02-2010/11)

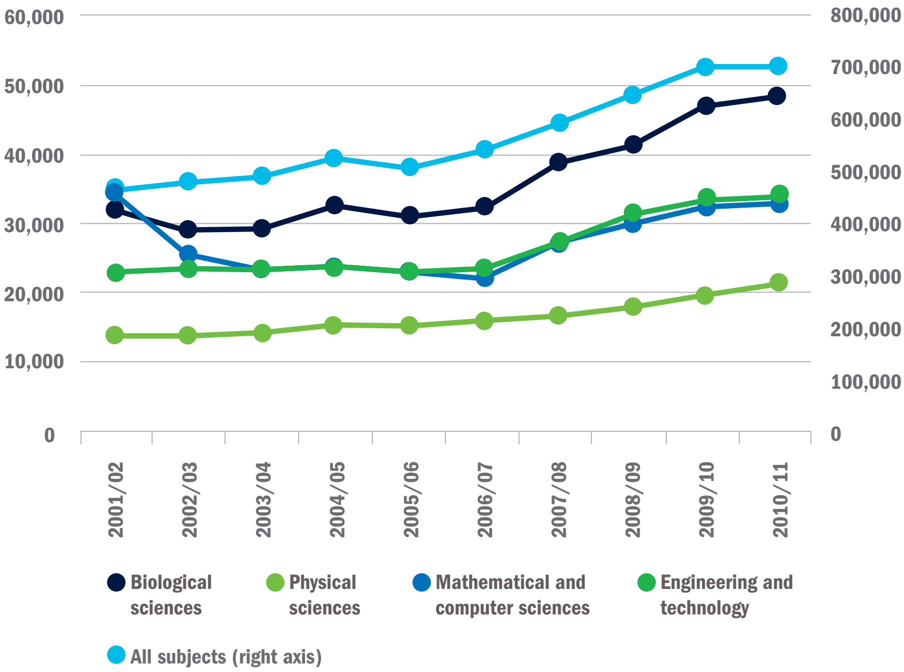
		2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
Biological sciences	UK	29,788	31,734	30,654	32,537	31,172	32,923	34,903	37,037	41,895	43,016	2.7%	44.4%
	EU	1,011	1,046	1,355	1,510	1,727	1,784	1,752	2,086	2,658	2,939	10.6%	190.7%
	Non-EU	1,075	1,362	1,492	1,567	1,383	1,421	1,454	1,682	1,920	2,210	15.1%	105.6%
	Total	**31,874**	**28,982**	**29,262**	**32,446**	**30,916**	**31,769**	**38,109**	**40,805**	**46,473**	**48,165**	**3.6%**	**51.1%**
	% non-UK	6.5%	8.3%	9.7%	9.5%	10.1%	10.1%	8.4%	9.2%	9.9%	10.7%	8.1%	64.6%
	% non-EU	3.4%	4.7%	5.1%	4.8%	4.5%	4.5%	3.8%	4.1%	4.1%	4.6%	12.2%	35.3%
Physical sciences	UK	12,797	12,642	12,200	13,159	13,246	14,168	14,826	15,637	17,178	18,336	6.7%	43.3%
	EU	335	416	432	479	561	692	708	860	1,070	1,191	11.3%	255.5%
	Non-EU	503	608	649	746	692	707	880	961	1,113	1,145	2.9%	127.6%
	Total	**13,635**	**13,666**	**13,878**	**14,980**	**14,927**	**15,572**	**16,414**	**17,458**	**19,361**	**20,672**	**6.8%**	**51.6%**
	% non-UK	6.1%	7.5%	7.8%	8.2%	8.4%	9.0%	9.7%	10.4%	11.3%	11.3%	0.0%	85.2%
	% non-EU	3.7%	4.4%	4.7%	5.0%	4.6%	4.5%	5.4%	5.5%	5.7%	5.5%	-3.5%	48.6%
Mathematical and computer sciences	UK	29,511	26,473	22,107	21,929	21,086	20,967	22,373	24,988	27,274	28,152	3.2%	-4.6%
	EU	776	752	996	1,093	1,143	1,441	1,444	1,674	1,982	2,448	23.5%	215.5%
	Non-EU	3,849	3,307	3,152	3,228	2,493	2,694	2,683	2,700	2,978	2,807	-5.7%	-27.1%
	Total	**34,136**	**25,597**	**23,273**	**23,886**	**23,031**	**22,033**	**26,500**	**29,362**	**32,234**	**33,407**	**3.6%**	**-2.1%**
	% non-UK	13.5%	15.9%	17.8%	18.1%	15.8%	18.8%	15.6%	14.9%	15.4%	15.7%	1.9%	16.3%
	% non-EU	11.3%	12.9%	13.5%	13.5%	10.8%	12.2%	10.1%	9.2%	9.2%	8.4%	-8.7%	-25.7%
Engineering and technology	UK	16,372	15,851	15,812	16,132	15,218	16,250	18,044	20,916	22,556	23,268	3.2%	42.1%
	EU	1,598	1,552	1,946	2,001	2,180	2,514	2,434	2,889	3,140	3,248	3.4%	103.3%
	Non-EU	4,764	5,414	6,016	6,237	5,370	5,672	6,332	6,837	7,360	7,108	-3.4%	49.2%
	Total	**22,734**	**23,616**	**23,380**	**23,653**	**22,852**	**23,141**	**26,810**	**30,642**	**33,056**	**33,624**	**1.7%**	**47.9%**
	% non-UK	28.0%	29.5%	34.1%	34.8%	33.0%	35.4%	32.7%	31.7%	31.8%	30.8%	-3.1%	10.0%
	% non-EU	21.0%	22.9%	25.7%	26.4%	23.5%	24.5%	23.6%	22.3%	22.3%	21.1%	-5.4%	0.5%
All subject areas	UK	401,854	409,968	413,334	444,630	432,196	454,148	502,461	544,285	586,821	589,350	0.4%	46.7%
	EU	19,313	20,428	25,217	28,708	29,932	33,621	34,530	39,504	47,318	49,275	4.1%	155.1%
	Non-EU	40,198	46,071	47,477	48,817	44,176	46,726	51,698	56,071	63,212	61,536	-2.7%	53.1%
	Total	**461,365**	**476,467**	**486,028**	**522,155**	**506,304**	**534,495**	**588,689**	**639,860**	**697,351**	**700,161**	**0.4%**	**51.8%**
	% non-UK	12.9%	14.0%	15.0%	14.8%	14.6%	15.0%	14.6%	14.9%	15.8%	15.8%	0.0%	22.5%
	% non-EU	8.7%	9.7%	9.8%	9.3%	8.7%	8.7%	8.8%	8.8%	9.1%	8.8%	-3.3%	1.1%

Source: UCAS

Figure 11.2 shows the trends in applicant numbers over the 10-year period for the four STEM subject areas and all subjects. It shows that the big decline in applicant numbers for mathematical and computer science came in 2002/03 and 2003/04. It then fluctuated for a few years before rising steadily since 2007/08.

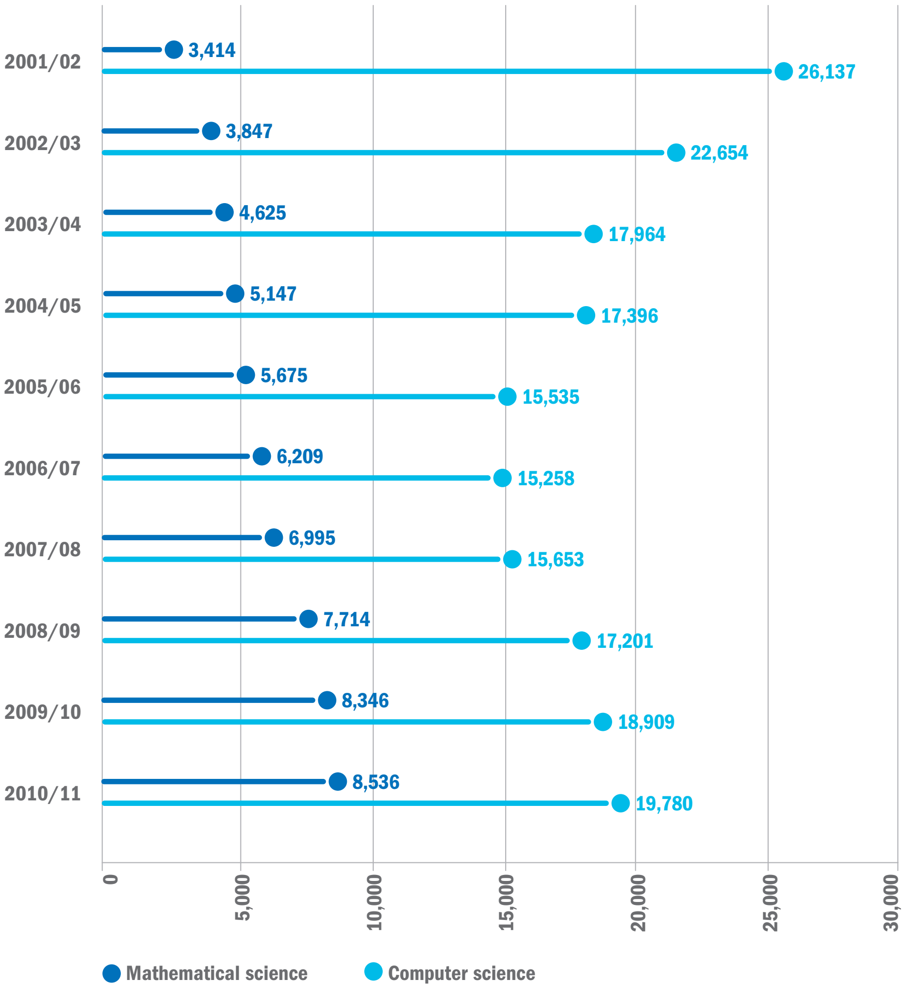
Mathematical and computer science is the only STEM subject area to have shown a decline in applicant numbers over 10 years. Figure 11.3 shows that this was due to a severe decline in applicant numbers to computer science between 2001/02 and 2006/07, falling from 26,137 in 2001/02 to 15,258 in 2006/07. Since then, however, applicant numbers to computer science have risen steadily, to 17,780 in 2010/11. By comparison, there has been steady year-on-year growth for applicants to mathematical science, rising from 3,414 in 2001/02 to 8,536 in 2010/11.

Fig. 11.2: Trends in applicants to STEM HE courses (2001/02-2009/10) – all domiciles



Source: UCAS

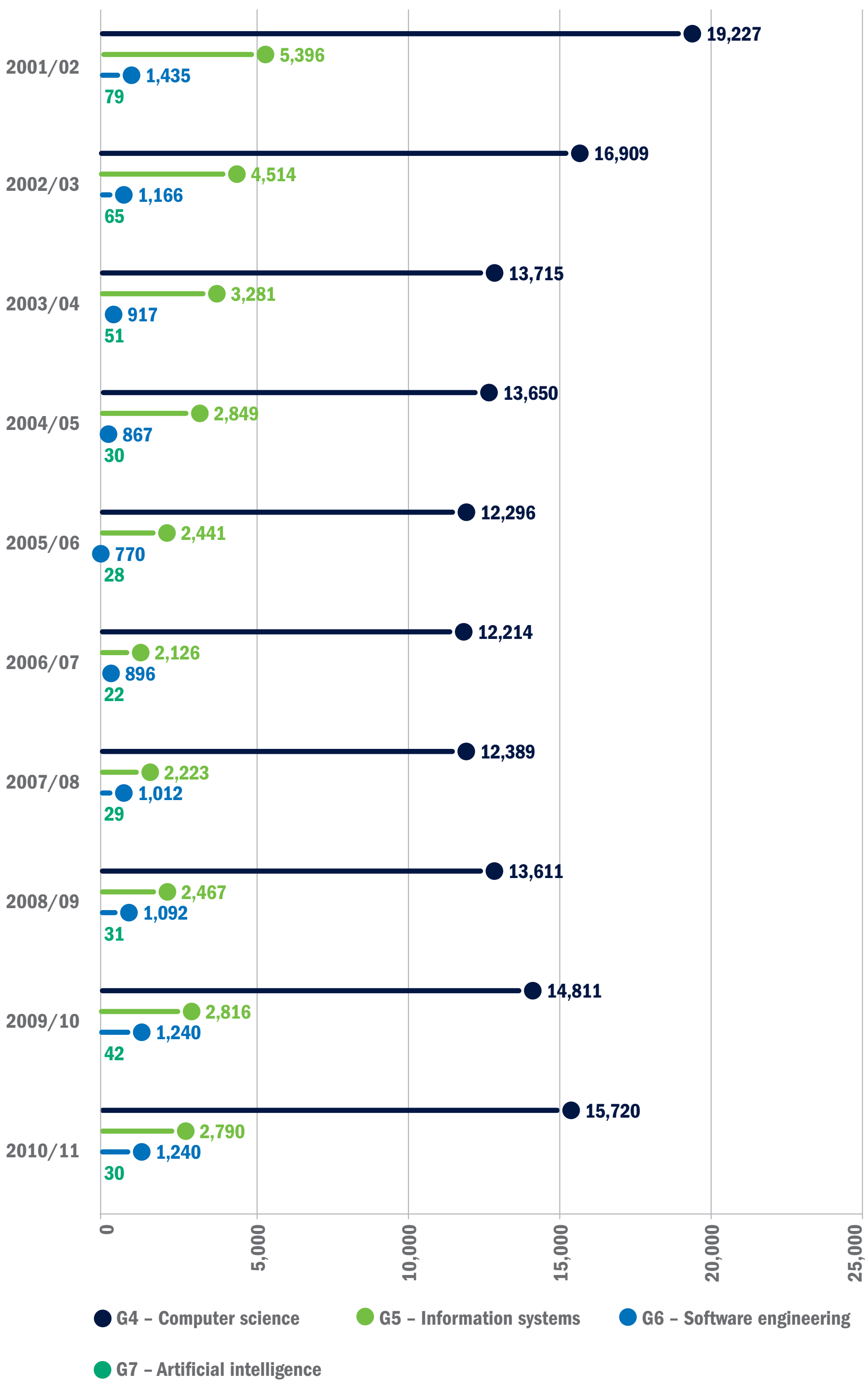
Fig. 11.3: Mathematical and computer sciences (2001/02-2009/10) – all domiciles



Source: UCAS

Figure 11.4 examines the computer science subject area in more detail. It shows that the fall in applicants was driven by a decline in computer science (course G4). In 2010/11, out of 19,780 applicants to computer science, 15,720 were from computer science (course G4). Applicants to computer science (course G4), information systems and software engineering all follow the general pattern shown by the computer science subject area. Applicant numbers declined until 2006/07 and have risen each year since then. Applicant numbers to artificial intelligence are very low, but this subject has fluctuated in its number of applicants over the 10 years.

Fig. 11.4: Computer sciences (2001/02-2009/10) – all domiciles



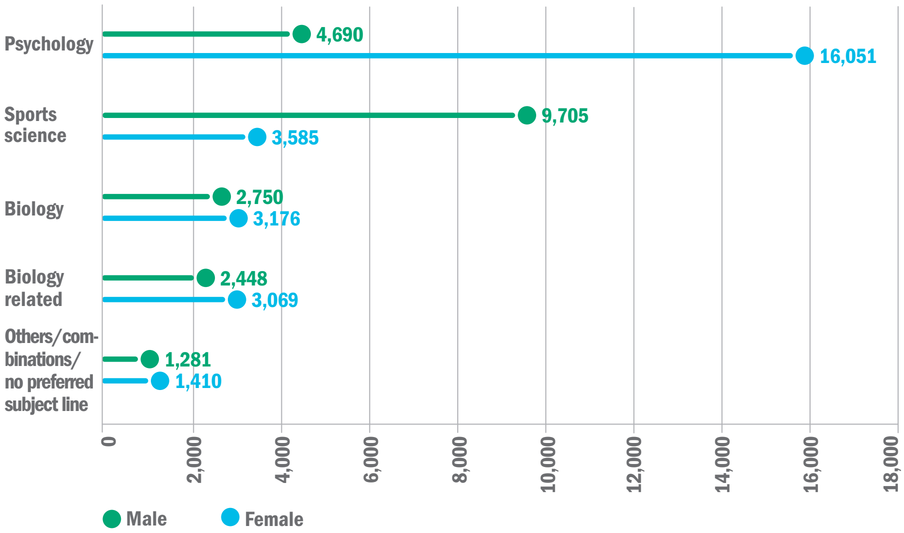
Source: UCAS

11.3.2 Applicants to STEM by gender

Figure 11.5 shows the gender breakdown of those wanting to study different subjects within biological sciences. A very clear gender divide is evident, with 16,051 females wanting to study psychology, compared with only 4,690 males. Conversely, men are much more likely to want to study sports science, with 9,705 applicants compared with just 3,585 females. The gender breakdown for biology, biology-related subjects and other subjects is more even.

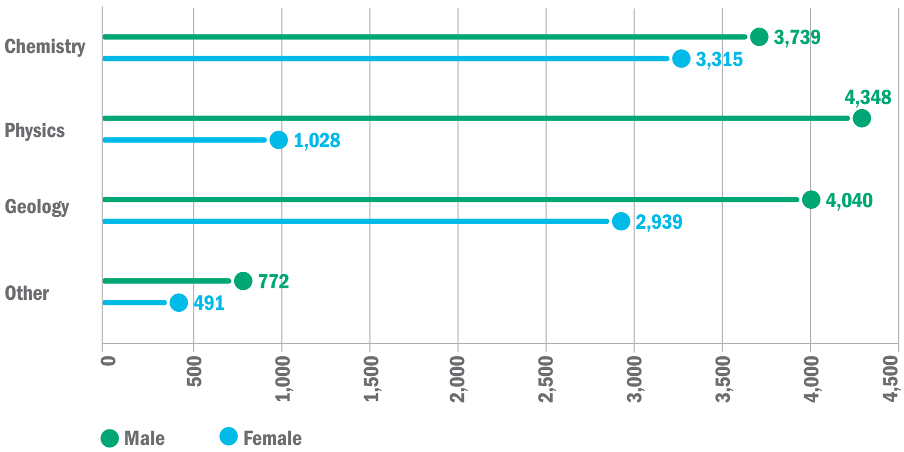
Applicants to physical sciences also demonstrate some interesting patterns by gender (Figure 11.6). Out of 5,376 applicants to physics, only 1,028 were female and 4,348 were male. By comparison, chemistry and geology had a more similar number of male and female applicants, although in each case male applicants did outnumber female applicants.

Fig. 11.5: Applicant numbers in biological sciences by subject and gender (2010/11) - all domiciles



Source: UCAS

Fig. 11.6: Applicant numbers in physical sciences by gender and subject type (2010/11) – all domiciles

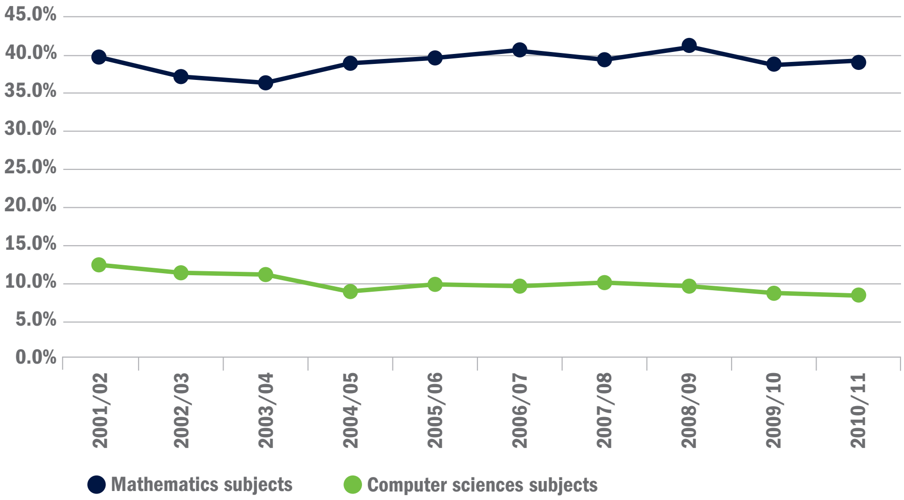


Source: UCAS

The proportion of female applicants for mathematics subjects fluctuated around the 40% mark between 2001/02 and 2010/11 (Figure 11.7). However, the proportion of female applicants to computer sciences has been slowly declining, from a highpoint of 17.7% in 2001/02 to a low point of 13.3% in 2010/11.

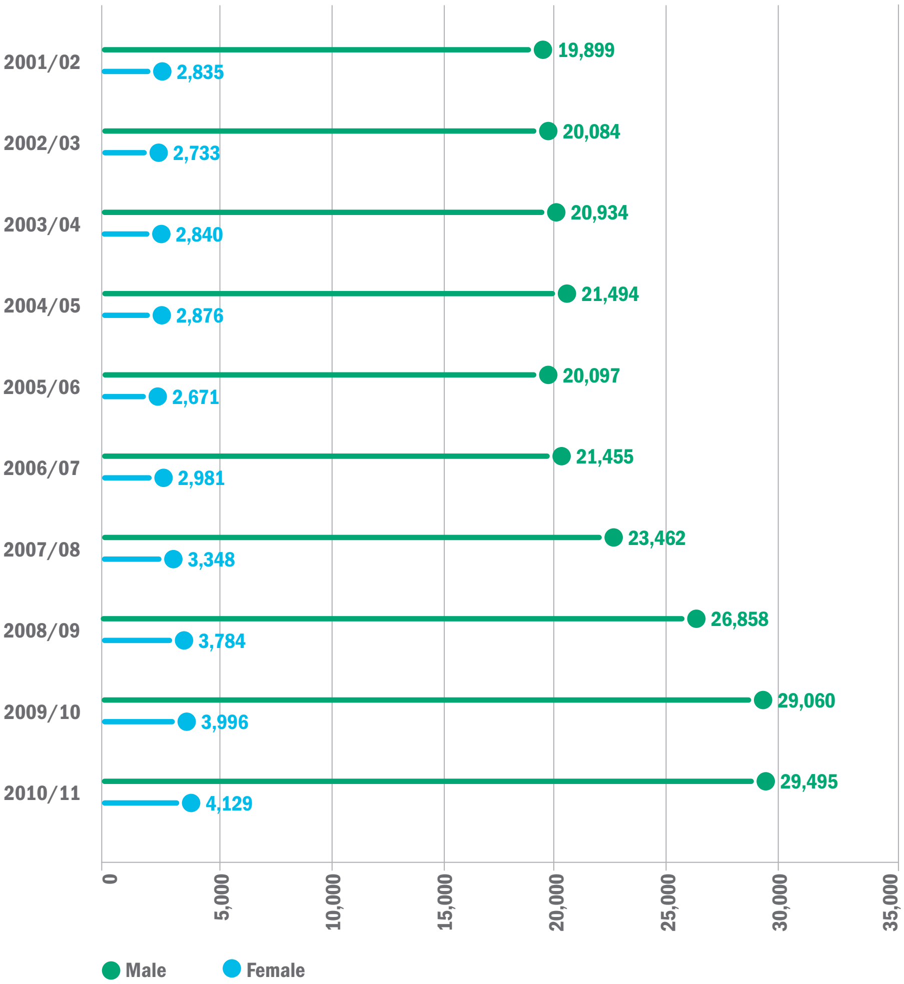
Figure 11.8 shows the number of male and female applicants to engineering and technology over a 10-year period (2001/02-2010/11). It shows that the number of male applicants has grown from 19,899 in 2001/02 to 29,495 in 2010/11 and that since 2005/06 there has been steady year-on-year growth. By comparison, the number of female applicants to engineering stayed consistent, at just under 3,000 for six years (2001/02-2006/07). However, since 2006/07 there has been consistent growth with the number of females rising to 4,129 in 2010/11.

Fig. 11.7: Proportion of female applicants in mathematical and computer sciences subjects (2001/02-2010/11) – all domiciles



Source: UCAS

Fig. 11.8: Applicant numbers in engineering and technology by gender (2001/02-2010/11) – all domiciles



Source: UCAS

11.3.3 Applicants to engineering by sub-discipline

Tables 11.6-11.12 detail the trends, over 10 years, in the number of applicants to the selected engineering sub-disciplines (general engineering, civil engineering, mechanical engineering, aerospace engineering, electronic and electrical engineering, production and manufacturing engineering and chemical, process and energy engineering).

Of all the selected engineering sub-disciplines, production and manufacturing engineering had the largest one-year decrease in the number of applicants, down 9.0% (Table 11.11). This was driven by a fall of 11.5% in UK applicants and 10.0% in EU applicants. However, non-EU applicants actually rose 20.0% in 2010/11 to 42. In total, there were 415 applicants to production and manufacturing engineering in 2010/11, down from 1,138 in 2001/02, a fall of 63.5%.

The engineering sub-discipline with the second-largest decline in total applicant numbers in 2010/11 was general engineering, down 8.8% (Table 11.6). There was a decline in applicants for this sub-discipline in 2010/11 across all domicile regions, with non-EU down 22.0%, UK down 6.1% and EU down 5.7%. However, these falls are very much against the longer term trend: 2010/11 applicant numbers are still above 2008/09 figures, and numbers rose by 83.7% between 2001/02-2010/11.

Table 11.7 shows that there was a slight (0.8%) decline in applicant numbers to civil engineering in 2010/11, driven by a 6.3% fall in applicants from the EU. However, this one-year fall is very much against the long term trend. Over 10 years, applicant numbers have increased by 119.9%. Over the 10-year period, there has been growth of over 100% for all three domiciles, with EU applications rising by 135.3%, UK applications up 118.1%, and non-EU applications increasing by 115.1%.

The engineering sub-discipline with the highest number of applicants was mechanical engineering. With 8,514 applicants in 2010/11, it increased by 8.3% on the previous year (Table 11.8). There was growth in applicant numbers across all three domiciles, with EU applicants rising by 17.2%, UK applicants increasing by 8.4% and non-EU applicants up 4.4%. There has also been a large increase in the number of female applicants, which increased by 21.3% in 2010/11, although the total percentage of female applicants was only 7.2%.

The fourth subject area to show a decline in applicant numbers in 2010/11 was aerospace engineering, which fell by 0.6% (Table 11.9). This was caused by a 13.8% decline in applicants from outside the EU. However, EU applications rose by 9.1% and UK applications rose by 2.3%. The table shows that aerospace engineering is becoming more gender diverse, with the number of females rising by 8.2% in 2010/11. Over the 10-year period, the number of female applicants rose by 89.1%, compared with an overall increase of 77.0%.

Chemical, process and energy engineering (Table 11.12) had the largest percentage one-year increase in applicant numbers in 2010/11, rising by 11.6%. It also had the largest increase in applicant numbers over 10 years, up by 187.4%. This subject area showed strong growth across all three domiciles, with EU applicant numbers rising by an impressive 377.4%, non-EU applicants up 181.9% and UK applicants increasing by 179.7%. Although the number of female applicants is up 151.1% over 10 years, this is below the overall growth rate.

Table 11.10 shows that applicants to electronic and electrical engineering increased by 2.3% in 2010/11 – the fifth consecutive year of growth. However, over the 10-year period, applicants are down 21.1%. Applications from the EU are up 16.8% over the ten years, but applicants from outside the EU and UK fell by 24.8% and 23.1% respectively.

Table 11.6: Applicants to general engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	783	755	754	853	855	824	1,070	1,299	1,470	1,381	-6.1%	76.4%
EU (excluding UK)	92	103	84	118	183	176	151	200	192	181	-5.7%	96.7%
Non-EU	126	146	147	185	229	215	246	283	355	277	-22.0%	119.8%
Total non-UK	218	249	231	303	412	391	397	483	547	458	-16.3%	110.1%
Female	131	141	141	164	172	168	208	273	276	278	0.7%	112.2%
Total	1,001	1,004	985	1,156	1,267	1,215	1,467	1,782	2,017	1,839	-8.8%	83.7%
Percentage of non-EU	12.6%	14.5%	14.9%	16.0%	18.1%	17.7%	16.8%	15.9%	17.6%	15.1%	-14.2%	19.8%
Percentage of female applicants	13.1%	14.0%	14.3%	14.2%	13.6%	13.8%	14.2%	15.3%	13.7%	15.1%	10.2%	15.3%

Source: UCAS

Table 11.7: Applicants to civil engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,744	1,894	2,205	2,557	2,453	2,924	3,479	3,868	3,810	3,803	-0.2%	118.1%
EU (excluding UK)	374	378	607	626	698	831	879	960	939	880	-6.3%	135.3%
Non-EU	549	619	739	714	616	760	863	970	1,160	1,181	1.8%	115.1%
Total non-UK	923	997	1,346	1,340	1,314	1,591	1,742	1,930	2,099	2,061	-1.8%	123.3%
Female	363	416	488	561	514	627	838	865	923	907	-1.7%	149.9%
Total	2,667	2,891	3,551	3,897	3,767	4,515	5,221	5,798	5,909	5,864	-0.8%	119.9%
Percentage of non-EU	20.6%	21.4%	20.8%	18.3%	16.4%	16.8%	16.5%	16.7%	19.6%	20.1%	2.6%	-2.4%
Percentage of female applicants	13.6%	14.4%	13.7%	14.4%	13.6%	13.9%	16.1%	14.9%	15.6%	15.5%	-0.6%	14.0%

Source: UCAS

Table 11.8: Applicants to mechanical engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	3,670	3,700	3,797	3,839	3,560	3,888	4,515	5,417	6,090	6,604	8.4%	79.9%
EU (excluding UK)	276	283	386	449	412	483	447	588	667	782	17.2%	183.3%
Non-EU	762	939	1,174	1,265	1,149	1,307	1,460	1,619	1,757	1,834	4.4%	140.7%
Total non-UK	1,038	1,222	1,560	1,714	1,561	1,790	1,907	2,207	2,424	2,616	7.9%	152.0%
Female	308	338	386	378	339	427	450	554	545	661	21.3%	114.6%
Total	4,708	4,922	5,357	5,553	5,121	5,678	6,422	7,624	8,514	9,220	8.3%	95.8%
Percentage of non-EU	16.2%	19.1%	21.9%	22.8%	22.4%	23.0%	22.7%	21.2%	20.6%	19.9%	-3.4%	22.9%
Percentage of female applicants	6.5%	6.9%	7.2%	6.8%	6.6%	7.5%	7.0%	7.3%	6.4%	7.2%	12.5%	10.7%

Source: UCAS

Table 11.9: Applicants to aerospace engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,523	1,459	1,628	1,673	1,647	1,714	1,760	2,101	2,399	2,454	2.3%	61.1%
EU (excluding UK)	102	102	112	113	151	146	145	201	254	277	9.1%	171.6%
Non-EU	264	306	379	472	447	465	493	609	710	612	-13.8%	131.8%
Total non-UK	366	408	491	585	598	611	638	810	964	889	-7.8%	142.9%
Female	202	162	204	205	170	236	252	270	353	382	8.2%	89.1%
Total	1,889	1,867	2,119	2,258	2,245	2,325	2,398	2,911	3,363	3,343	-0.6%	77.0%
Percentage of non-EU	14.0%	16.4%	17.9%	20.9%	19.9%	20.0%	20.6%	20.9%	21.1%	18.3%	-13.3%	30.7%
Percentage of female applicants	10.7%	8.7%	9.6%	9.1%	7.6%	10.2%	10.5%	9.3%	10.5%	11.4%	8.6%	6.5%

Source: UCAS

Table 11.10: Applicants to electronic and electrical engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	4,117	3,729	3,146	2,934	2,462	2,381	2,504	2,766	2,937	3,164	7.7%	-23.1%
EU (excluding UK)	423	367	376	335	336	397	339	399	442	494	11.8%	16.8%
Non-EU	2,052	2,280	2,330	2,190	1,696	1,621	1,773	1,729	1,705	1,543	-9.5%	-24.8%
Total non-UK	2,475	2,647	2,706	2,525	2,032	2,018	2,112	2,128	2,147	2,037	-5.1%	-17.7%
Female	639	670	630	527	424	425	422	498	491	484	-1.4%	-24.3%
Total	6,592	6,376	5,852	5,459	4,494	4,399	4,616	4,894	5,084	5,201	2.3%	-21.1%
Percentage of non-EU	31.1%	35.8%	39.8%	40.1%	37.7%	36.8%	38.4%	35.3%	33.4%	29.7%	-11.1%	-4.5%
Percentage of female applicants	9.7%	10.5%	10.8%	9.7%	9.4%	9.7%	9.1%	10.2%	9.7%	9.3%	-4.1%	-4.1%

Source: UCAS

Table 11.11: Applicants to production and manufacturing engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,018	904	801	721	467	424	376	369	401	355	-11.5%	-65.1%
EU (excluding UK)	29	29	31	29	13	31	12	26	20	18	-10.0%	-37.9%
Non-EU	91	102	91	96	68	65	44	69	35	42	20.0%	-53.8%
Total non-UK	120	131	122	125	81	96	56	95	55	60	9.1%	-50.0%
Female	169	162	125	138	103	121	98	102	95	82	-13.7%	-51.5%
Total	1,138	1,035	923	846	548	520	432	464	456	415	-9.0%	-63.5%
Percentage of non-EU	8.0%	9.9%	9.9%	11.3%	12.4%	12.5%	10.2%	14.9%	7.7%	10.1%	13.1%	26.3%
Percentage of female applicants	14.9%	15.7%	13.5%	16.3%	18.8%	23.3%	22.7%	22.0%	20.8%	19.8%	-4.8%	32.9%

Source: UCAS

Table 11.12: Applicants to chemical, process and energy engineering (2001/02-2010/11) – all domiciles

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	536	559	561	683	713	877	1,042	1,240	1,302	1,499	15.1%	179.7%
EU (excluding UK)	31	31	48	51	62	84	91	105	128	148	15.6%	377.4%
Non-EU	320	338	420	494	493	553	681	786	855	902	5.5%	181.9%
Total non-UK	351	369	468	545	555	637	772	891	983	1,050	6.8%	199.1%
Female	268	263	267	323	335	388	475	569	618	673	8.9%	151.1%
Total	887	928	1,029	1,228	1,268	1,514	1,814	2,131	2,285	2,549	11.6%	187.4%
Percentage of non-EU	36.1%	36.4%	40.8%	40.2%	38.9%	36.5%	37.5%	36.9%	37.4%	35.4%	-5.3%	-1.9%
Percentage of female applicants	30.2%	28.3%	25.9%	26.3%	26.4%	25.6%	26.2%	26.7%	27.0%	26.4%	-2.2%	-12.6%

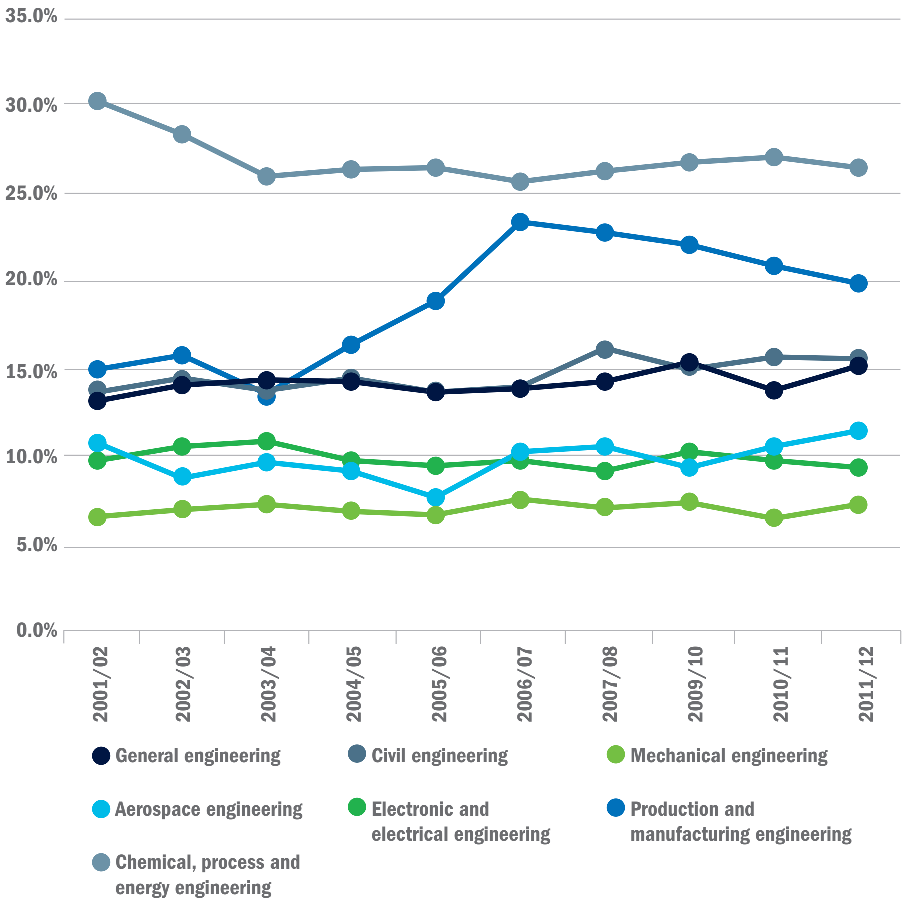
Source: UCAS

11.3.4 Female applicants to engineering sub-disciplines

Figure 11.9 shows the proportion of female applicants to selected engineering sub-disciplines over a 10-year period. Chemical, process and energy engineering has consistently had the largest proportion of female applicants, but numbers have fallen from 30.2% in 2001/02 to 26.4% in 2010/11. The proportion of female applicants to production and manufacturing engineering has increased from 14.9% in 2001/02 to 19.8% in 2010/11, despite overall applicant numbers falling by nearly two thirds (63.5%). The proportion of female applicants to mechanical engineering has never reached 10% over the 10-year period, while the other sub-disciplines have oscillated between a low point of 7.6% and a high point of 15.1%.

The poor performance of the engineering sector in recruiting female applicants is emphasised when you consider that there were 1.41 million women in Further and Higher Education in 2009, compared with 1.06 million men.[608]

Fig. 11.9: Proportion of female applicants by sub-discipline (2001/02-2010/11) – all domiciles



Source: UCAS

608 *Gender and skills in changing economy*, UKCES, September 2011, pvi

11.3.5 Educational backgrounds of applicants to HE engineering undergraduate full-time courses

Analysing the educational backgrounds of selected engineering sub-disciplines highlights some interesting patterns (Figure 11.10).

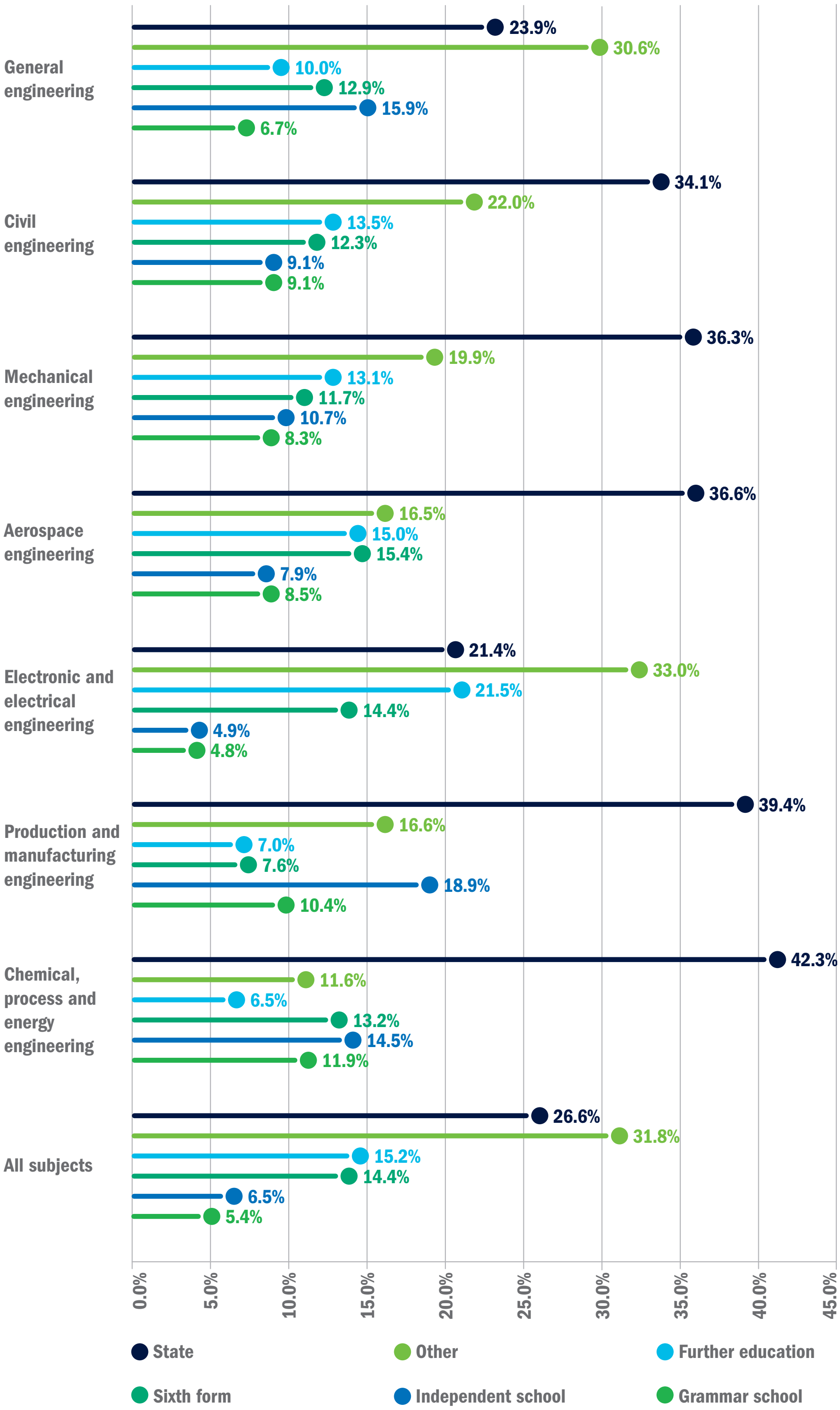
For all applicants, the proportion with a state school educational background was 26.6%. However, when you look at chemical, process and energy engineering, 42.3% were from a state school. State schools also provided more than a third of applicants to production and manufacturing engineering (39.4%), aerospace engineering (36.6%), mechanical engineering (36.3%) and civil engineering (34.1%). However, there was a below-average number of applicants to general engineering (23.9%) and electronic and electrical engineering (21.4%).

Amongst all applicants, 15.2% were from FE. Electronic and electrical engineering was the only engineering sub discipline to have above average numbers of FE applicants, at 21.5%. Production and manufacturing engineering (7.0%) and chemical, process and energy engineering (6.5%) both had fewer than one in ten applicants from the FE sector. The low number of applicants from FE is disappointing when one considers the importance of HE in FE[609] and the number of level 3+ engineering apprentices.[610]

Independent Schools are a very important source of applicants to engineering courses. Overall, 6.5% of applicants came from independent Schools, while for six of the seven selected engineering sub-disciplines, this figure was more than 6.5%. In particular, production and manufacturing engineering (18.9%), general engineering (15.9%), chemical, process and energy engineering (14.5%) and mechanical engineering (10.7%) all had more than one in ten applicants coming from an independent school. The only sub-discipline to have a below-average number of engineering applicants from independent schools was electronic and electrical engineering, at 4.9%.

Although independent schools are a very important source of applicants to engineering, research by the Independent Schools Council (ISC) has shown that 91% of post-18 schools leavers already go from ISC schools to HE.[611] This indicates that there is limited scope for encouraging more students

Fig. 11.10: Educational background of applicants to engineering undergraduate level full-time HE courses by sub-discipline (2010/11) – UK domiciled



Source: UCAS

609 See section 11.1 for further details **610** See section 10 for more details **611** *ISC Census 2012, Independent Schools Council*, 2012, p19 from independent schools to enter HE, but there is potentially an opportunity to persuade more to choose engineering degree courses over other degrees.

Overall, approximately one in 20 applicants (5.4%) came from a grammar school. All of the selected engineering sub-disciplines, except electronic and electrical engineering, had an above-average number of grammar school applicants. Chemical, process and energy engineering (11.9%) and production and manufacturing engineering (10.4%) both had at least one in ten applicants from a grammar school.

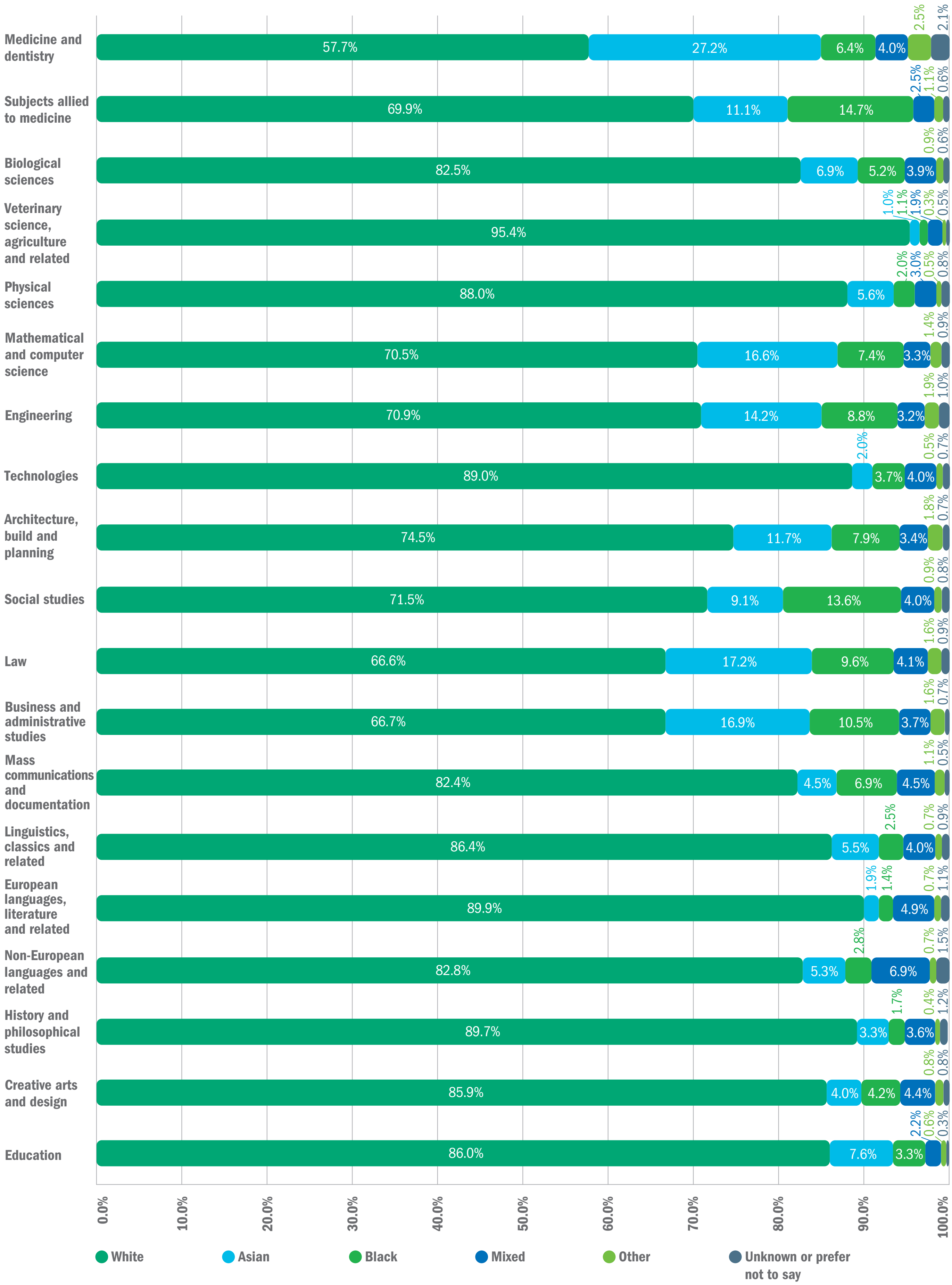
School sixth forms accounted for 14.4% of applicants: most selected engineering sub-disciplines were close to this average. The one exception was production and manufacturing engineering, where only 7.6% of applicants came from a sixth form.

11.3.6 Ethnicity of applicants

Figure 11.11 shows the very varied ethnic makeup of different subject areas. Veterinary science, agriculture and related had the highest proportion of white applicants (95.4%), with mixed-race applicants being the next highest, at 1.9%. No other subject areas had at least 90% of their applicants with a white ethnic background.

Medicine and dentistry had the highest proportion of applicants who had a non-white ethnic background (42.3%). For medicine and dentistry, the second largest ethnic group was Asian (27.2%). Other subject areas to have a large percentage of applicants from an ethnic minority background were law (33.4%), business and administrative studies (33.3%) and subjects allied to medicine (30.1%).

Fig. 11.11: Breakdown by ethnicity of applicants across HE subject areas (2010/11) – UK domiciled



Source: UCAS

Ethnicity of applicants to engineering

The proportion of white applicants has fallen over the 10-year period, from 78.0% in 2001/02 to 70.9% in 2010/11 (Table 11.13).

Table 11.13: Percentage split of engineering applicants by ethnic group (2001/02-2010/11) – UK domiciled

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Asian	10.2%	10.3%	11.2%	10.7%	11.7%	12.0%	12.7%	12.9%	13.4%	14.2%
Black	4.4%	4.9%	5.6%	6.4%	7.1%	7.8%	7.8%	8.2%	8.3%	8.8%
Mixed	1.9%	2.0%	1.7%	2.5%	2.3%	2.8%	2.7%	3.0%	3.1%	3.2%
Other	0.6%	0.8%	1.1%	1.3%	1.5%	1.5%	1.3%	1.5%	1.5%	1.9%
Unknown or prefer not to say	5.0%	5.1%	4.9%	3.9%	1.6%	1.8%	1.7%	0.9%	1.1%	1.0%
White	78.0%	76.9%	75.6%	75.2%	75.8%	74.1%	73.8%	73.5%	72.6%	70.9%

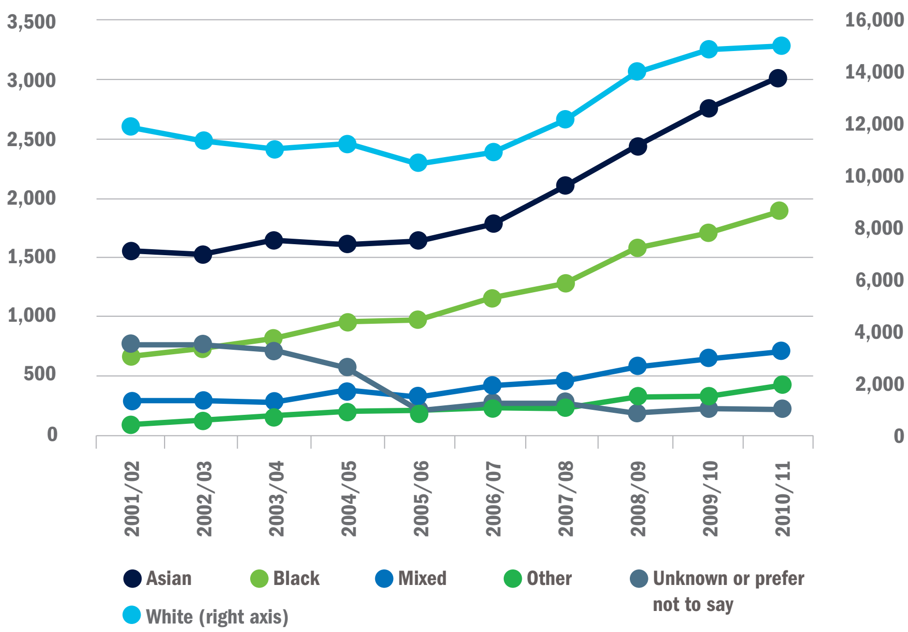
Source: UCAS

Conversely, the proportion of Asian, black, or applicants of mixed or other ethnicity has steadily risen over the 10-year period. The most significant rise has been in black applicants, number of which have risen from 4.4% in 2001/02 to 8.8% in 2010/11. After white applicants, however, the largest ethnic minority group is Asian, which in 2010/11 accounted for 14.2% of applications.

Figures 11.12 to 11.14 show the number of UK engineering applicants by ethnic group. The figures show that, overall, the number of white applicants to engineering has been rising steadily since the low point of 2005/06. As mentioned earlier, however, the overall proportion of white applicants has decreased. The number of Asian applicants has shown strong growth, and is the second largest ethnic group, with around 3,000 applicants in 2010/11. The only group to show a decline in numbers over 10 years is the unknown ethnicity category.

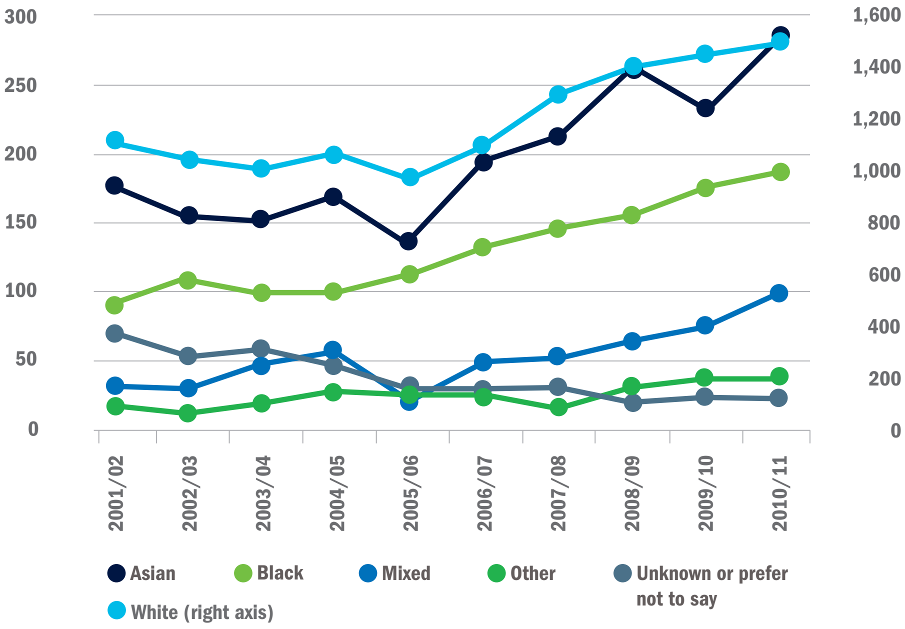
Looking specifically at female applicants, the tables show that numbers have been rising for all ethnic groups, except the unknown category, over 10 years. However, the increase has been unstable for most ethnic groups, with periods of growth and decline. There has been strong growth for male, Asian and black applicants since 2005/06.

Fig. 11.12: Applicants to engineering by ethnic group (2001/02-2010/11) – UK domiciled



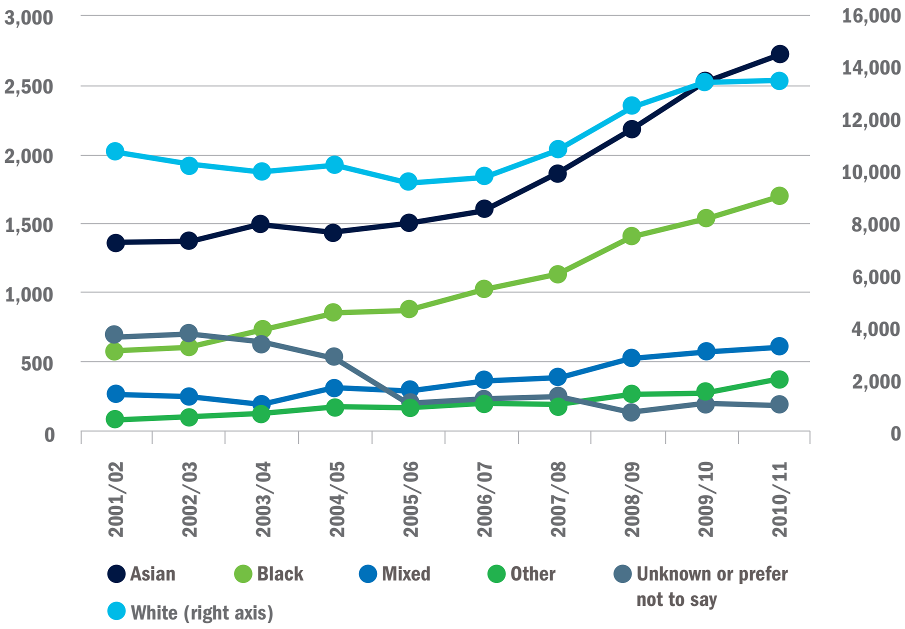
Source: UCAS

Fig. 11.13: Female applicants to engineering by ethnic group (2001/02-2010/11) – UK domiciled



Source: UCAS

Fig. 11.14: Male applicants to engineering by ethnic group (2001/02-2010/11) – UK domiciled



Source: UCAS

11.3.7 POLAR2 groupings of applicants to engineering

POLAR2 is based on HE participation rates of people who were aged 18 between 2000 and 2004 and started an HE course in a UK HE Institution or Great Britain FE College. The POLAR2 classification is formed by ranking all 2001 Census Area Statistics Wards[612] by their young participation rates for the combined 2000 to 2004 cohorts. This gives five quintile groups of areas from 1 (those wards with the lowest participation) to 5 (those wards with the highest participation). Each quintile represents 20% of the UK young cohort.

Figure 11.15 shows the proportion of applicants to different subject areas by their POLAR2 rating. The Figure shows that education has the lowest proportion of applicants with a POLAR2 rating of 5, at 22.2%. Conversely, nearly double the number of applicants to medicine and dentistry (43.7%) had a POLAR2 rating of 5, along with 41.8% of applicants to European languages, literature and related subjects.

As well as having the lowest proportion of applicants with a POLAR2 rating of 5, education also had the highest number of applicants with a rating of 1, at 14.3%. Subjects allied to medicine were just behind, with 13.5% of applicants having a POLAR2 rating of 1.

Looking specifically at engineering shows that just over a third (37.8%) of applicants have a POLAR2 rating of 5, while nearly a quarter (23.8%) have a rating of 4. Only 8.0% of applicants come from those neighbourhoods which are least likely to go into HE (POLAR2 rating of 1).

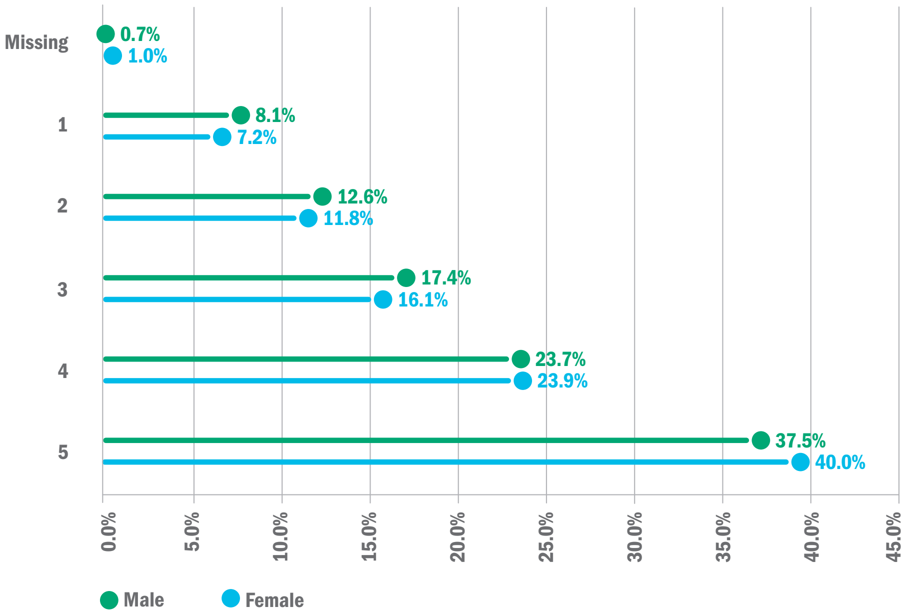
Looking at applications to engineering by POLAR2 and gender (Figure 11.16) shows that there are slightly fewer female than male applicants in three of the POLAR2 ratings: POLAR2 ratings 1-3. For POLAR2 rating 4, there are fractionally more female applicants than male applicants. However, the biggest gender gap is in those neighbourhoods most likely to go to HE (POLAR2 rating of 5): 40.0% of female applicants had a POLAR2 rating of 5 against 37.5% male.

612 A ward is an administrative division of a city or borough that typically elects and is represented by a councillor or councillors.

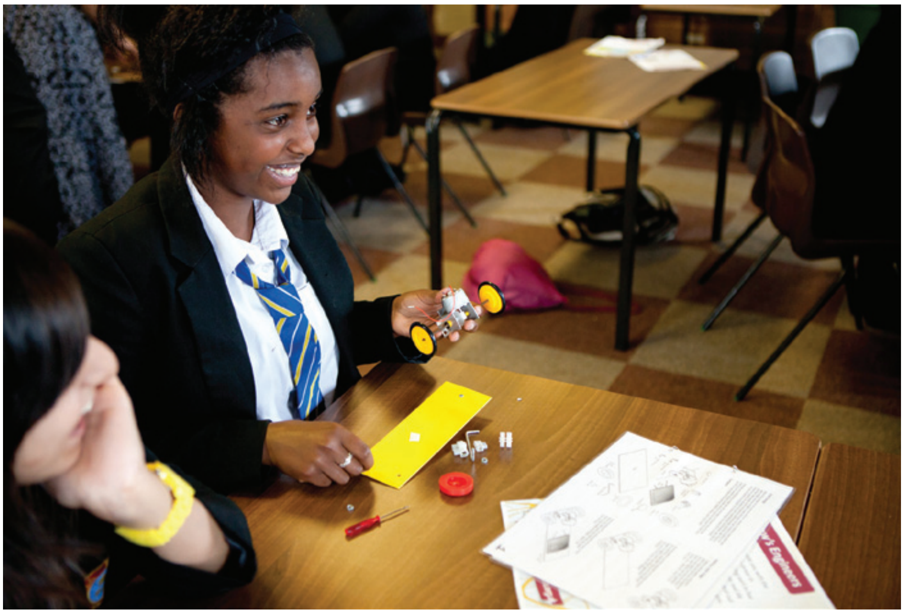
Fig 11.15: POLAR2 grouping of applicants, aged 17-19, by subject area (2010/11) – UK domiciled

Source: UCAS

Fig. 11.16: Proportion of applicants, aged 17-19, to engineering by POLAR2 and gender (2010/11) – UK domiciled



Source: UCAS



11.3.8 Importance of maths and physics A level for prospective HE engineering students[613]

Table 11.14 uses a bespoke dataset to show the number of applicants to engineering with at least 180 UCAS points and an A level/Scottish Higher in both maths and physics, broken down by UK regions. The table shows that the total number of applicants and the proportion of applicants who apply to engineering varies by region. Scotland produced the highest number of applicants with the requisite qualifications (7,959). But the percentage who then applied to study engineering at university was the lowest of all the regions, at 24.5%.

Overall, nearly a third (30.6%) of applicants with at least 180 UCAS points and an A level/Scottish Higher in maths and physics applied for engineering. But this rose to 35.6% in Greater London and was also well above average in Wales (34.5%). The North East, which is seen as a traditional manufacturing area, had the lowest number of applicants, with just 791 having at least 180 UCAS points and A levels/Scottish Highers in maths and physics.

Table 11.15 shows several interesting patterns. Firstly, there were 60,037 applicants who had an A level/Scottish Higher in maths but not physics. This is nearly double the number of applicants who had an A level/Scottish Higher in both maths and physics. However, amongst applicants who had an A level/Scottish Higher in maths only, 2.9% applied for an engineering degree. This compares with 30.6% of those with an A level/Scottish Higher in maths and physics applying to engineering.

This shows that to significantly grow the pool of applicants to engineering, we need to encourage students studying A level/Scottish Higher in maths to also study physics and hence grow the pool of students who have the two key level 2 subjects.

Table 11.14: Analysis of the number of applicants to engineering with A level/Scottish Higher in maths and physics and at least 180 UCAS points (2010/11) – UK regions[614]

UK region	Preferred subject line is engineering[615]	Preferred subject line is not engineering	All applicants	Percentage of all applicants who applied to engineering
East Midlands	549	1,192	1,741	31.5%
Eastern	759	1,706	2,465	30.8%
Greater London	1,435	2,596	4,031	35.6%
North East	257	534	791	32.5%
North West	872	1,820	2,692	32.4%
Northern Ireland	401	758	1,159	34.6%
Scotland	1,947	6,012	7,959	24.5%
South East	1,433	3,019	4,452	32.2%
South West	722	1,625	2,347	30.8%
Wales	357	678	1,035	34.5%
West Midlands	603	1,373	1,976	30.5%
Yorkshire and The Humber	560	1,170	1,730	32.4%
Total	**9,895**	**22,483**	**32,378**	**30.6%**

Source: UCAS

Table 11.15: Applicants to engineering with at least 180 UCAS points by whether they have A level/Scottish Higher in maths, physics or maths and physics, by preferred subject line (2010/11) – UK[616]

	Didn't apply to engineering	Applied to engineering	Total number of applicants	Percentage applying to engineering
Maths but not physics	58,270.0	1,767.0	60,037.0	2.9%
Physics but not maths	6,018.5	422.5	6,441.0	6.6%
Maths and physics[617]	22,512.0	9,927.5	32,439.5	30.6%

Source: UCAS

613 In this section where a field had 1 or 2 applicants it was rounded to 1.5. 614 Due to data restrictions, the number of accepted applicants is based on those with three A levels or Scottish Highers only. Therefore those with two A levels or at least four A levels are excluded from the table. 615 Preferred subject line is based on the subject area they apply to most frequently. Applicants can apply to subjects in multiple subject lines but only one is ever the preferred subject line. 616 Due to data restrictions, the number of accepted applicants is based on those with three A levels or Scottish Highers only. Therefore those with two A levels or at least four A levels are excluded from the table. 617 Total does not match table 11.14 total due to rounding error.

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11.3.9 Accepted applicants to STEM degrees

Data on accepted applicants is the closest indication we have on actual starts in STEM degrees. Table 11.16 shows the number of accepted applicants to different STEM degree subject areas over a 10-year period. Engineering and technology was the only STEM degree subject area to show a one-year decline in the number of accepted applicants in 2010/11, down 0.9%. This was driven by a 16.0% fall in non-EU accepted applicants and a 2.5% fall in EU accepted applicants. However, accepted applicants from the UK rose by 3.3%, meaning the percentage of accepted applicants from outside the UK fell to just below a quarter (24.3%). Over the 10-year period, accepted applicants to engineering and technology rose across all domicile groups and increased overall by 22.4%. Further analysis shows that in 2010/11 only 10.8% of UK domiciles accepted applicants were female.

The biggest increase in the number of accepted applicants, both in the last year and over 10 years, was for biological sciences, rising by 3.5% and 44.2% respectively. Looking at growth over 10 years, the number of EU accepted applicants has risen by 150.1%, while non-EU applicants were up 70.6%. By comparison, accepted applicants from the UK only rose by 40.3%. However, despite the rapid increase in non-UK accepted applicants, they still only represented 8.1% of all accepted applicants in 2010/11.

Physical sciences had the lowest number of accepted applicants in 2010/11, with 18,391. Growth in accepted applicants was very strong from outside the UK, with EU accepted applicants rising by 157.8% and non-EU applicants increasing by 95.8%, compared with an increase from the UK of 25.0%. In 2010/11, the strongest growth in the number of accepted applicants was 3.4% from the UK, compared with growth of 1.3% from the EU and a fall of 6.8% from outside the EU.

Over the 10-year period, mathematical and computer sciences had the lowest percentage increase in accepted applicants, at 5.1%. Looking at the data by domicile shows that, although EU accepted applicants rose by 162.5% over ten years, this was from a very low base of 642 in 2001/02. The number of

Table 11.16: Number of accepted applicants to STEM degrees by subject area and domicile (2001/02-2010/11)

		2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
Biological sciences	UK	26,112	27,179	27,133	30,155	28,654	29,451	32,726	33,862	35,410	36,633	3.5%	40.3%
	EU	759	822	1,089	1,178	1,292	1,354	1,370	1,586	1,734	1,898	9.5%	150.1%
	Non-EU	786	981	1,040	1,113	970	964	1,031	1,133	1,366	1,341	-1.8%	70.6%
	Total	**27,657**	**28,982**	**29,262**	**32,446**	**30,916**	**31,769**	**35,127**	**36,581**	**38,510**	**39,872**	**3.5%**	**44.2%**
	% non-UK	5.6%	6.2%	7.3%	7.1%	7.3%	7.3%	6.8%	7.4%	8.8%	8.1%	-8.0%	44.6%
	% non-EU	2.8%	3.4%	3.6%	3.4%	3.1%	3.0%	2.9%	3.1%	3.9%	3.4%	-12.8%	21.4%
Physical sciences	UK	13,414	13,336	12,933	13,973	13,849	14,356	15,075	15,692	16,226	16,772	3.4%	25.0%
	EU	303	381	376	405	461	608	601	719	771	781	1.3%	157.8%
	Non-EU	428	588	569	602	617	608	736	804	899	838	-6.8%	95.8%
	Total	**14,145**	**14,305**	**13,878**	**14,980**	**14,927**	**15,572**	**16,412**	**17,215**	**17,896**	**18,391**	**2.8%**	**30.0%**
	% non-UK	5.2%	6.8%	6.8%	6.7%	7.2%	7.8%	8.1%	8.8%	9.3%	8.8%	-5.4%	69.2%
	% non-EU	3.0%	4.1%	4.1%	4.0%	4.1%	3.9%	4.5%	4.7%	5.0%	4.6%	-8.0%	53.3%
Mathematical and computer sciences	UK	23,709	22,167	19,984	20,542	19,963	18,786	22,042	23,940	24,085	24,720	2.6%	4.3%
	EU	642	674	848	913	990	1,106	1,185	1,370	1,516	1,685	11.1%	162.5%
	Non-EU	2,627	2,756	2,441	2,431	2,078	2,141	2,193	2,214	2,420	1,959	-19.0%	-25.4%
	Total	**26,978**	**25,597**	**23,273**	**23,886**	**23,031**	**22,033**	**25,420**	**27,524**	**28,021**	**28,364**	**1.2%**	**5.1%**
	% non-UK	12.1%	13.4%	14.1%	14.0%	13.3%	14.7%	13.3%	13.0%	14.0%	12.8%	-8.6%	5.8%
	% non-EU	9.7%	10.8%	10.5%	10.2%	9.0%	9.7%	8.6%	8.0%	8.6%	6.9%	-19.8%	-28.9%
Engineering and technology	UK	17,566	16,995	16,622	17,240	16,387	16,156	18,648	20,302	20,666	21,344	3.3%	21.5%
	EU	1,451	1,423	1,713	1,698	1,959	2,159	2,034	2,229	2,269	2,213	-2.5%	52.5%
	Non-EU	4,013	4,431	5,045	4,715	4,506	4,826	5,017	5,265	5,500	4,622	-16.0%	15.2%
	Total	**23,030**	**22,849**	**23,380**	**23,653**	**22,852**	**23,141**	**25,699**	**27,796**	**28,435**	**28,179**	**-0.9%**	**22.4%**
	% non-UK	23.7%	25.6%	28.9%	27.1%	28.3%	30.2%	27.4%	27.0%	27.3%	24.3%	-11.0%	2.5%
	% non-EU	17.4%	19.4%	21.6%	19.9%	19.7%	20.9%	19.5%	18.9%	19.3%	16.4%	-15.0%	-5.7%

Source: UCAS

UK accepted applicants increased only slightly over 10 years, rising 4.3%, while non-EU accepted applicant numbers fell by 25.4%, driven by a fall of 19.0% in 2010/11. In 2010/11, accepted applicants rose by 1.2%.

11.3.10 Accepted applicants by selected engineering sub-disciplines

Tables 11.17 to 11.23 show the number of accepted applicants for selected engineering sub-disciples by domicile status and the number of female accepted applicants. Overall, four out of the seven selected engineering sub-disciplines saw a fall in accepted applicant numbers in 2010/11 from the previous year. The largest fall was for general engineering, which was also the only sub-discipline to have a fall in accepted applicants in 2009/10. In 2010/11, there was a one-year decline of 11.5% in applicant numbers. Looking at the sub-discipline by domicile status shows that UK accepted applicants fell by 13.7%, compared with a fall of 9.2% for EU accepted applicants. Conversely, non-EU accepted applicants actually rose by 3.5%.

Of the selected engineering sub-disciplines, production and manufacturing engineering had the lowest number of accepted applicants in 2010/11, at just 707. It also had the second-largest one-year decline in accepted applicants, falling by 2.5%. Over the 10-year period, accepted applicant numbers have fallen by 53.5%. In 2010/11, accepted applicants from the EU rose by 123.1%, while accepted applicants from outside the EU and from the UK fell 16.7% and 6.5% respectively.

Over the 10-year period, accepted applicants to civil engineering have almost doubled, up by 92.5%. However, in 2010/11 the number of accepted applicants actually fell by 1.6%, with EU accepted applicants falling by 18.1% and non-EU accepted applicants falling by 12.6%. By comparison, UK accepted applicant numbers rose by 4.5%. Over the 10-year period, there has been growth for all three domicile regions, with the UK growing by 103.4%, compared with 72.1% for those outside the EU and 62.7% for those living in the EU.

The fourth of the selected engineering sub-disciplines to show a fall in accepted applicant numbers in 2010/11 was electronic and electrical engineering, although the decline was only marginal (0.8%). This decline was driven by a 26.7% fall in accepted applicants from outside the EU. However, accepted applicants from the UK rose by 11.5% and from the EU by 5.1%. The 10-year trend shows that overall accepted applicant numbers have fallen by nearly a third (32.1%). There has been a decline across all domicile groups, more markedly in the UK (34.9%) and outside the EU (30.9%) than in the EU (2.0%).

Chemical, process and energy engineering showed the largest percentage growth in the number of accepted applicants, growing by 16.3% in 2010/11. Chemical, process and energy engineering has also shown the strongest 10-year growth, rising by 116.2% and growing across all the domicile regions. Ten-year growth was strongest among those from the EU (up 219.4%), while the number of accepted applicants from the UK rose by 115.4% and from outside the EU by 104.2%.

Overall, mechanical engineering saw growth in accepted applicants of 2.6% in 2010/11, with the UK growing 7.4% and the EU up 1.6%, although accepted applicants from outside the EU fell by 16.2%. Over the 10-year period, the number of accepted applicants has risen in all domicile regions, with the increase greater than for any other selected engineering sub-discipline. EU applicants increased by 88.0%, while accepted applicants from the UK rose by 71.2% and from outside the EU by 64.6%.

Aerospace engineering is the third of the selected engineering sub-disciplines to have grown in 2010/11, rising by 5.4%. The percentage growth in the number of accepted applicants was almost identical for the UK (7.6%) and the EU (7.5%). By comparison, accepted applicants from outside the EU fell by 4.9%. Across the 10-year period, growth in accepted applicants has been strongest amongst those from the EU (188.7%) and outside the EU (118.4%). UK growth in accepted applicant numbers rose by 43.4% over the same 10-year period.

Table 11.17: Accepted applicants onto first degrees in general engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,996	2,056	2,016	2,245	2,176	2,269	2,553	2,682	2,601	2,245	-13.7%	12.5%
EU (excluding UK)	139	130	169	186	249	272	211	232	218	198	-9.2%	42.4%
Non-EU	279	375	432	456	438	438	440	379	342	354	3.5%	26.9%
Total non-UK	418	505	601	642	687	710	651	611	560	552	-1.4%	32.1%
Female	330	356	395	397	363	389	437	425	449	423	-5.8%	28.2%
Total	2,414	2,561	2,617	2,887	2,863	2,979	3,204	3,293	3,161	2,797	-11.5%	15.9%
Percentage of non-EU	11.6%	14.6%	16.5%	15.8%	15.3%	14.7%	13.7%	11.5%	10.8%	12.7%	17.6%	9.5%
Proportion of female students	13.7%	13.9%	15.1%	13.8%	12.7%	13.1%	13.6%	12.9%	14.2%	15.1%	6.3%	10.2%

Source: UCAS

Table 11.18: Accepted applicants onto first degrees in civil engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,690	1,871	2,267	2,469	2,458	2,607	3,151	3,281	3,290	3,437	4.5%	103.4%
EU (excluding UK)	311	294	426	423	494	583	685	681	618	506	-18.1%	62.7%
Non-EU	451	507	619	563	502	564	601	633	888	776	-12.6%	72.1%
Total non-UK	762	801	1,045	986	996	1,147	1,286	1,314	1,506	1,282	-14.9%	68.2%
Female students	343	382	447	518	500	563	707	704	776	711	-8.4%	107.3%
Total	2,452	2,672	3,312	3,455	3,454	3,754	4,437	4,595	4,796	4,719	-1.6%	92.5%
Percentage of non-EU	18.4%	19.0%	18.7%	16.3%	14.5%	15.0%	13.5%	13.8%	18.5%	16.4%	-11.4%	-10.9%
Proportion of female students	14.0%	14.3%	13.5%	15.0%	14.5%	15.0%	15.9%	15.3%	16.2%	15.1%	-6.8%	7.9%

Source: UCAS

Table 11.19: Accepted applicants onto first degrees in mechanical engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	3,028	3,157	3,387	3,515	3,311	3,193	4,032	4,553	4,829	5,185	7.4%	71.2%
EU (excluding UK)	241	283	314	334	365	383	360	440	446	453	1.6%	88.0%
Non-EU	611	716	846	885	874	1,016	1,020	1,151	1,201	1,006	-16.2%	64.6%
Total non-UK	852	999	1,160	1,219	1,239	1,399	1,380	1,591	1,647	1,459	-11.4%	71.2%
Female students	290	297	326	318	292	359	377	458	459	497	8.3%	71.4%
Total	3,880	4,156	4,547	4,734	4,550	4,592	5,412	6,144	6,476	6,644	2.6%	71.2%
Percentage of non-EU	15.7%	17.2%	18.6%	18.7%	19.2%	22.1%	18.8%	18.7%	18.5%	15.1%	-18.4%	-3.8%
Proportion of female students	7.5%	7.1%	7.2%	6.7%	6.4%	7.8%	7.0%	7.5%	7.1%	7.5%	5.6%	0.0%

Source: UCAS

Table 11.20: Accepted applicants onto first degrees in aerospace engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,326	1,397	1,412	1,522	1,483	1,289	1,489	1,346	1,766	1,901	7.6%	43.4%
EU (excluding UK)	60	71	87	80	120	99	95	138	160	172	7.5%	186.7%
Non-EU	185	232	256	300	302	273	325	402	425	404	-4.9%	118.4%
Total non-UK	245	303	343	380	422	372	420	540	585	576	-1.5%	135.1%
Female students	165	146	166	176	162	193	202	217	244	278	13.9%	68.5%
Total	1,571	1,700	1,755	1,902	1,905	1,661	1,909	1,886	2,351	2,477	5.4%	57.7%
Percentage of non-EU	11.8%	13.6%	14.6%	15.8%	15.9%	16.4%	17.0%	21.3%	18.1%	16.3%	-9.9%	38.1%
Proportion of female students	10.5%	8.6%	9.5%	9.3%	8.5%	11.6%	10.6%	11.5%	10.4%	11.2%	7.7%	6.7%

Source: UCAS

Table 11.21: Accepted applicants onto first degrees in electronic and electrical engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	5,110	4,272	3,469	3,336	2,824	2,699	2,689	2,990	2,986	3,329	11.5%	-34.9%
EU (excluding UK)	403	333	329	325	311	389	304	348	376	395	5.1%	-2.0%
Non-EU	1,587	1,770	1,969	1,620	1,495	1,549	1,538	1,457	1,496	1,097	-26.7%	-30.9%
Total non-UK	1,990	2,103	2,298	1,945	1,806	1,938	1,842	1,805	1,872	1,492	-20.3%	-25.0%
Female students	807	760	742	588	521	532	498	553	537	488	-9.1%	-39.5%
Total	7,100	6,375	5,767	5,281	4,630	4,637	4,531	4,795	4,858	4,821	-0.8%	-32.1%
Percentage of non-EU	22.4%	27.8%	34.1%	30.7%	32.3%	33.4%	33.9%	30.4%	30.8%	22.8%	-26.0%	1.8%
Proportion of female students	11.4%	11.9%	12.9%	11.1%	11.3%	11.5%	11.0%	11.5%	11.1%	10.1%	-9.0%	-11.4%

Source: UCAS

Table 11.22: Accepted applicants onto first degrees in production and manufacturing engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	1,355	1,177	980	899	677	618	603	553	651	609	-6.5%	-55.1%
EU (excluding UK)	46	48	44	37	36	49	44	41	26	58	123.1%	26.1%
Non-EU	120	122	114	106	109	103	101	93	48	40	-16.7%	-66.7%
Total non-UK	166	170	158	143	145	152	145	134	74	98	32.4%	-41.0%
Female students	268	246	204	201	165	189	175	143	155	153	-1.3%	-42.9%
Total	1,521	1,347	1,138	1,042	822	770	748	687	725	707	-2.5%	-53.5%
Percentage of non-EU	7.9%	9.1%	10.0%	10.2%	13.3%	13.4%	13.5%	13.5%	6.6%	5.7%	-13.6%	-27.8%
Proportion of female students	17.6%	18.3%	17.9%	19.3%	20.1%	24.5%	23.4%	20.8%	21.4%	21.6%	0.9%	22.7%

Source: UCAS

Table 11.23: Accepted applicants onto first degrees in chemical, process and energy engineering (2001/02-2010/11)

	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over 10 years
UK	681	676	689	768	855	953	1,084	1,192	1,182	1,467	24.1%	115.4%
EU (excluding UK)	36	42	47	46	58	80	62	75	86	115	33.7%	219.4%
Non-EU	262	282	362	389	393	422	494	549	552	535	-3.1%	104.2%
Total non-UK	298	324	409	435	451	502	556	624	638	650	1.9%	118.1%
Female students	272	272	275	311	356	368	428	489	496	548	10.5%	101.5%
Total	979	1,000	1,098	1,203	1,306	1,455	1,640	1,816	1,820	2,117	16.3%	116.2%
Percentage of non-EU	26.8%	28.2%	33.0%	32.3%	30.1%	29.0%	30.1%	30.2%	30.3%	25.3%	-16.5%	-5.6%
Proportion of female students	27.8%	27.2%	25.0%	25.9%	27.3%	25.3%	26.1%	26.9%	27.3%	25.9%	-5.1%	-6.8%

Source: UCAS

11.3.11 Gender of accepted applicants to selected engineering sub-disciplines

Figure 11.17 shows the proportion of female accepted applicants for selected engineering sub-disciplines. Chemical, process and energy engineering has had the highest proportion of female accepted applicants in every year of the 10-year period, although production and manufacturing engineering came close in 2006/07. For each of the 10 years, at least a quarter of all accepted applicants to chemical, process and energy engineering have been female. The only other selected engineering sub-discipline to have at least 20% female accepted applicants in 2010/11 was production and manufacturing engineering. This subject also showed the largest increase in the proportion of female accepted applicants over the 10 years.

Mechanical engineering has not reached 8% female accepted applicants in any of the 10 years investigated. Its high point was just 7.8% in 2006/7.

11.3.12 Destination of those with an A level/Scottish Higher in maths and physics whose preferred subject group was not engineering

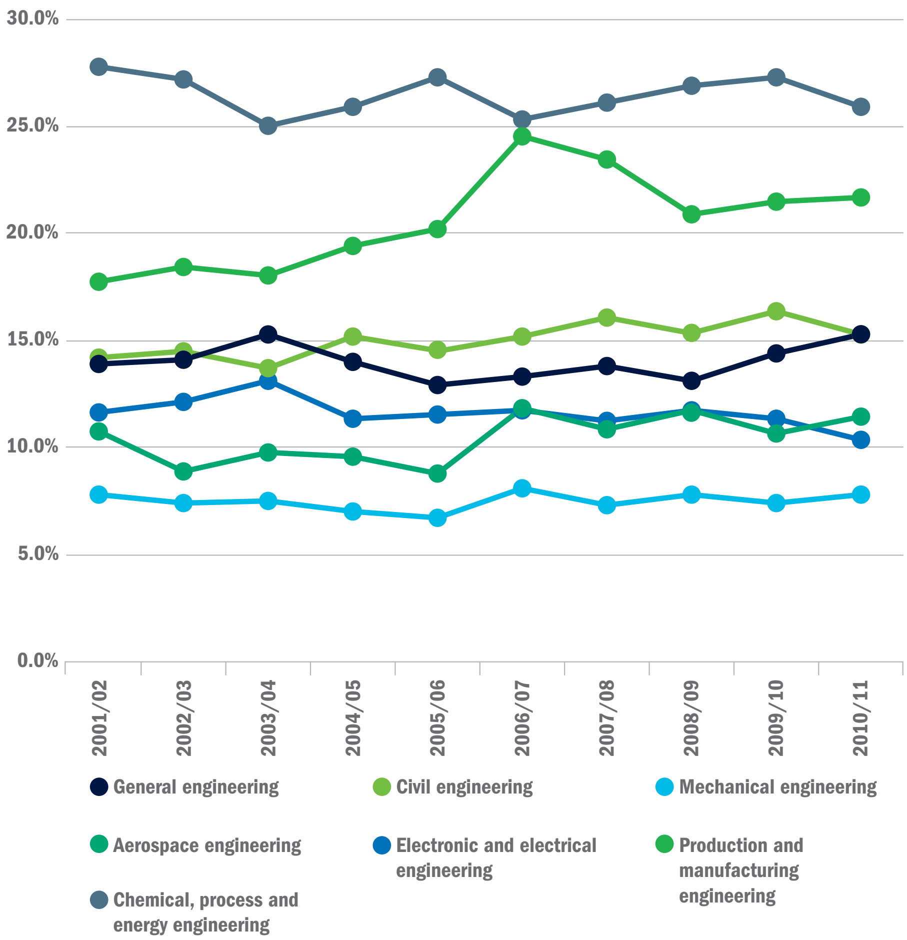
In section 11.3.8, we showed that 30.6% of applicants who had an A level/Scottish Higher in maths or physics and at least 180 UCAS points, applied to engineering, based on their preferred subject line. Table 11.24 shows the subjects applicants were accepted on, where they had an A level/Scottish Higher in maths or physics and at least 180 UCAS points, but where their preferred subject area was not engineering.

It shows that the two subject areas which had the largest number of accepted applicants were physical sciences (5,047) and mathematical and computer science (4,280). In 2010/11, the number of accepted applicants to physical sciences grew by 30.4% and the number to mathematical and computer science grew by 33.0%.

Only three other subject areas had more than a thousand accepted applicants. These were medicine and dentistry (1,156), subjects allied to medicine (1,161) and business and administrative studies (1,006). It should also be noted that 634 accepted applicants whose preferred subject area was not engineering were accepted on an engineering course, and 177 were accepted on a technologies course.

This shows that although around two thirds (69.4%) of applicants with an A level/Scottish Higher in maths or physics and at least 180 UCAS points didn't apply to engineering, they did go into STEM disciplines.

Fig. 11.17: Proportion of female accepted applicants to degree courses by engineering discipline (2001/02-2010/11) – all domiciles



Source: UCAS

Table 11.24: Accepted applicants with an A level/Scottish Higher in mathematics and physics and at least 180 UCAS points, whose preferred subject group was not engineering, by which subject group they were accepted onto (2006/07-2010/11) – UK[618]

Accepted subject group	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over five years
Medicine and dentistry	1,195	1,137	1,170	1,198	1,156	-3.5%	-3.3%
Subjects allied to medicine	771	753	867	1,029	1,161	12.8%	50.6%
Biological sciences	652	601	714	822	838	1.9%	28.5%
Vet sci, ag and related	167	172	166	133	209	57.1%	25.1%
Physical sciences	3,870	3,912	4,204	4,543	5,047	11.1%	30.4%
Mathematical and computer science	3,218	3,285	3,555	3,827	4,280	11.8%	33.0%
Engineering	571	500	535	506	634	25.3%	11.0%
Technologies	101	126	147	168	177	5.4%	75.2%
Architecture, build and plan	686	701	699	684	705	3.1%	2.8%
Social studies	541	676	713	801	895	11.7%	65.4%
Law	355	272	295	320	371	15.9%	4.5%
Business and admin studies	868	845	791	902	1,006	11.5%	15.9%
Mass comms and documentation	36	27	40	35	56	60.0%	55.6%
Linguistics, classics and related	99	96	98	109	83	-23.9%	-16.2%
European langs, lit and related	39	50	57	60	58	-3.3%	48.7%
Non-European langs and related	18	20	24	14	15	7.1%	-16.7%
Hist and philosophical studies	154	182	167	211	234	10.9%	51.9%
Creative arts and design	319	317	400	378	446	18.0%	39.8%
Education	79	85	82	95	95	0.0%	20.3%
Combined arts	83	77	83	97	94	-3.1%	13.3%
Combined sciences	607	636	698	722	688	-4.7%	13.3%
Combined social sciences	130	148	138	162	157	-3.1%	20.8%
Sciences combined with social sciences or arts	571	547	591	561	570	1.6%	-0.2%
Social sciences combined with arts	113	118	137	125	137	9.6%	21.2%
General, other combined and unknown	605	548	588	592	626	5.7%	3.5%
All accepted applicants	15,848	15,831	16,959	18,094	19,738	9.1%	24.5%
Engineering as a percentage of all accepted applicants	3.6%	3.2%	3.2%	2.8%	3.2%	14.3%	11.1%

Source: UCAS

11.4 Engineering students

11.4.1 Qualification of engineering students

The Higher Education Statistics Agency (HESA) provides data on the highest qualification status of first year full-time undergraduates (Table 11.25).[619] This shows that 87.4% of students studying engineering entered with a level 3 qualification. The next highest category was other undergraduate qualifications on 8.3%.

618 Due to data restrictions, the number of accepted applicants is based on those with three A levels or Scottish Highers only. Therefore those with two A levels or at least four A levels are excluded from the table.
619 HESA cannot accept responsibility for any inferences or conclusions derived from the data by third parties.

Table 11.25: First year undergraduate full-time first degree students by highest qualification on entry (2010/11) – UK domiciled[620]

	Postgraduate (excluding PGCE)	PGCE	First degree	Other undergraduate qualification	Other qualification	Level 3 qualification (including A levels and Highers)	Qualifications at level 2 and below	No formal qualification	Not known	Total
Engineering and technology total	20	5	195	1,735	330	18,295	160	115	85	20,940
Percentage	0.1%	0.0%	0.9%	8.3%	1.6%	87.4%	0.8%	0.5%	0.4%	100.0%

Source: HESA student record 2010/11

11.4.2 Number of engineering students

Table 11.26 shows that there were 2,501,290 students overall in 2010/11 and, of these, 23.4% were studying a STEM course. Male students were more likely to be studying a STEM course than female students, at 33.8% compared with 15.3%.

Looking specifically at engineering and technology shows that the total number of undergraduate students studying engineering was 98,215, with the vast majority (85,635) studying full-time. There were also 44,950 postgraduate students, of whom 31,700 were studying full-time.

The number of students studying a STEM sandwich degree varies quite significantly (Table 11.27). Overall, 24.0% of students studying computer science are on a STEM sandwich degree with more male students (24.3%) than female students (22.3%). Engineering and technology also has a high percentage of students studying a sandwich degree (16.7%). Interestingly, women (17.5%) are more likely to be on a sandwich course than men (16.6%). By comparison, only 5.7% of students studying biological sciences and 6.8% of those studying physical sciences are on a sandwich course.

Table 11.26: Number of STEM students by study level, mode and proportion of all students (2010/11) – all domiciles

	All HE students			Postgraduate						Undergraduate first degree					
				Full-time			Part-time			Full-time			Part-time		
	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
Biological sciences	118,150	71,885	190,035	13,455	7,400	20,855	7,790	3,585	11,375	74,320	49,130	123,445	15,620	6,390	22,010
Physical sciences	37,925	55,655	93,580	6,280	9,845	16,125	1,680	2,130	3,810	23,590	34,750	58,340	3,515	5,050	8,565
Mathematical sciences	16,115	24,995	41,110	1,520	2,870	4,390	535	935	1,470	11,130	16,250	27,380	1,820	3,315	5,135
Computer science	17,850	81,170	99,020	3,375	12,960	16,335	1,260	4,885	6,145	8,985	46,990	55,975	1,690	7,855	9,545
Engineering and technology	26,005	134,880	160,885	6,635	25,065	31,700	2,765	10,485	13,250	13,770	71,865	85,635	1,155	11,425	12,580
Total STEM	216,045	368,585	584,630	31,265	58,140	89,405	14,030	22,020	36,050	131,795	218,985	350,780	23,800	34,035	57,835
All subject areas	1,411,090	1,090,200	2,501,290	154,750	155,260	310,010	164,025	114,675	278,700	679,090	571,165	1,250,255	124,910	88,915	213,825
Proportion STEM	15.3%	33.8%	23.4%	20.2%	37.4%	28.8%	8.6%	19.2%	12.9%	19.4%	38.3%	28.1%	19.1%	38.3%	27.0%

Source: HESA student record 2010/11

620 Due to HESA rounding policy, which rounds to the nearest 5, there may be slight errors in the percentages which have been calculated.

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Table 11.27: Proportion of undergraduate first degree students who are on a sandwich course, by gender (2010/11) – all domiciles

	All students			Sandwich students			Percentage sandwich students		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Biological sciences	89,940	55,520	145,460	4,880	3,340	8,220	5.4%	6.0%	5.7%
Physical sciences	27,105	39,800	66,905	2,150	2,410	4,555	7.9%	6.1%	6.8%
Mathematical sciences	12,950	19,565	32,515	995	1,395	2,390	7.7%	7.1%	7.4%
Computer science	10,675	54,845	65,520	2,380	13,330	15,710	22.3%	24.3%	24.0%
Engineering and technology	14,925	83,290	98,215	2,615	13,820	16,435	17.5%	16.6%	16.7%
Total STEM	155,595	253,020	408,615	13,020	34,295	47,310	8.4%	13.6%	11.6%
All subject areas	804,000	660,080	1,464,080	49,240	67,545	116,785	6.1%	10.2%	8.0%

Source: HESA student record 2010/11

In 1994/95, 33% of engineering and technology students were studying a sandwich degree,[621] therefore the proportion of engineering and technology students on a sandwich degree has halved over the time period. The Wilson Review[622] highlighted the fact that provision of sandwich degrees was patchy. At some universities, the majority of undergraduate students study a sandwich placement year, so the decline in provision of sandwich courses has not been uniform. This implies that sustaining sandwich courses is a consequence of individual universities' culture, strategy and course portfolio. However, the Confederation of British Industry (CBI), in its report *Future Fit,*[623] identified that employers want graduates to have work experience, meaning the decline in sandwich course provision could affect students' job prospects. The importance of sandwich degrees is also reinforced by statistics produced by BIS, which show that 74.6% of engineering graduates who did a sandwich placement were in employment six months after graduation, compared with 67.8% of engineering graduates who didn't do a sandwich placement.[624]

Table 11.28 shows that there were over half a million (503,795) students studying for a UK HE qualification wholly overseas. Of these, 355,410 were studying for a first degree outside of the EU.

Finally, when it comes to reporting on the output of UK graduates and engineering graduates in particular, we cannot ignore the on-going coverage of the high numbers of engineering graduates coming out of China and India. This has been a cause for concern for some in western countries who fear that they are losing their technological edge due to the millions of globally-competitive Chinese and Indian engineering graduates qualifying each year.

EngineeringUK[626] has investigated this issue and found that:

- 76,400 Chinese and 124,400 Indian engineering graduates are globally employable, compared with 8,600 UK graduates.
- Comparing the number of globally-employable engineering graduates per 100,000 of population reveals that the UK produces 2.5 times more globally-employable engineers than China and 1.5 times as many as India.

11.5 Qualification obtained

Applications and acceptances data has a time lag attached to it, since it may well be five or six years before an applicant becomes a graduate who is able to enter the jobs market. So in this section, we look at the number of students qualifying in different STEM degrees.

HESA collects data from all publically-funded universities on their HE students. Table 11.29 shows trends in the number of first degree qualifiers[627] for different STEM subjects over a nine-year period. Throughout the period, STEM degree qualifiers have accounted for at least a quarter of all qualifiers, although this percentage has been declining steadily from 27.9% in 2002/03 to 25.2% in 2010/11.

Over the nine-year period, biological sciences was the STEM subject with the largest increase in the number of first degree qualifiers, rising by 42.5%. Its growth in 2010/11 was also

Table 11.28: Number of students studying wholly overseas for a UK qualification, by region and study level (2010/11)[625]

	Within the European Union				Outside the European Union				
	Total postgraduate	Total first degree	Further education	All students	Total postgraduate	Total first degree	Further education	All students	Total for EU and outside EU
Number of students	22,670	46,590	0	72,025	66,130	355,410	200	431,765	503,795

Source: HESA student record 2010/11

621 *Engineering UK Report 2011,* EngineeringUK, December 2010, p160 **622** *Following Up the Wilson Review of Business-University Collaboration,* Department for Business, Innovation and Skills, June 2012 **623** http://www.cbi.org.uk **624** *Following Up the Wilson Review of Business-University Collaboration,* Department for Business, Innovation and Skills, June 2012, p14 **625** HESA doesn't break down courses studied wholly overseas by subject area. **626** *The skills 'threat' from China and India – Fact or fiction,* EngineeringUK, March 2012, p1 **627** First degree qualifiers includes first degrees (including eligibility to register to practise with a health or social care or veterinary statutory regulatory body), first degrees with Qualified Teacher Status (QTS)/registration with a General Teaching Council (GTC), enhanced first degrees, first degrees obtained concurrently with a diploma and intercalated first degrees.

Table 11.29: Number of first degrees achieved in STEM (2002/03-2010/11) – all domiciles

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over nine years
Biological sciences	23,725	25,955	27,200	27,840	29,095	31,185	30,720	32,185	33,800	5.0%	42.5%
Physical sciences	12,480	11,995	12,530	12,900	12,480	13,015	13,510	13,795	14,745	6.9%	18.1%
Mathematical sciences	5,100	5,395	5,270	5,500	5,645	5,815	5,980	6,470	6,965	7.7%	36.6%
Computer science	18,240	20,205	20,095	18,840	16,445	14,915	14,035	14,255	14,505	1.8%	-20.5%
Engineering and technology	19,455	19,780	19,575	19,765	19,900	20,420	20,805	21,955	22,905	4.3%	17.7%
Total STEM	79,000	83,330	84,670	84,845	83,565	85,350	85,050	88,660	92,920	4.8%	17.6%
All subjects	283,280	292,090	306,365	315,985	319,260	334,890	333,720	350,860	369,010	5.2%	30.3%
STEM proportion of all degrees	27.9%	28.5%	27.6%	26.9%	26.2%	25.5%	25.5%	25.3%	25.2%	-0.4%	-9.7%

Source: HESA qualifications table

above average for all STEM subjects, at 5.0% against 4.8%. Biological sciences was also the largest STEM subject in terms of the number of first degree qualifiers in each of the nine years covered.

Engineering and technology was the second-largest STEM subject area for first degree qualifiers in each of the nine years, reaching 22,905 in 2010/11. However, its growth in the number of qualifiers was below the average for all STEM subjects in 2010/11, at 4.3% against 4.8%. In 2010/11, 6.2% of all first degree qualifiers were in engineering and technology – 22,905 qualifiers out of a total of 369,010.

Of all the STEM subjects, mathematical sciences had the highest percentage growth in 2010/11, up 7.7% to 6,965. Over nine years, mathematical sciences has grown by 36.6%, which is higher than the average for all STEM subjects (17.6%) and also above the average for all subjects (30.3%).

Physical sciences had above average growth of 6.9%, when compared with all subjects (5.2%) in 2010/11. Over the nine-year period, its growth has been above average for all subjects (18.1% compared with 30.3%). In 2010/11, there were 14,745 first degree qualifiers, making it larger than computer science for the first time.

Over the nine-year period, computer science is the only STEM subject to have shown a declining number of qualifiers, falling by 20.5% to 14.505. However, computer science did enjoy its second successive year of growth in 2010/11, rising by 1.8%.

A proportion of first degree graduates in physical sciences, mathematical sciences and computer sciences do progress into engineering and technology occupations on graduating (section 12.7). Overall, 51.5% of computer science graduates, 11.0% of physical sciences graduates and 10.0% of mathematical sciences graduates who go into employment go into an engineering and technology occupation, with IT service delivery occupations and engineering professionals being the two main occupations.

Research by UKCES[628] has shown that there were over 2.4 million people with a STEM degree in employment in the UK in 2008/10. This is an increase of 42% on 2002/04.

Figure 11.18 shows the compound growth over nine years across all subjects, all STEM subjects and engineering and technology. All subjects have grown much faster than all STEM subjects and engineering and technology, reaching 30.3% in 2010/11. Growth in engineering and technology lagged behind all STEM subjects until 2008/09. But since then, the compound growth for both has been comparable.

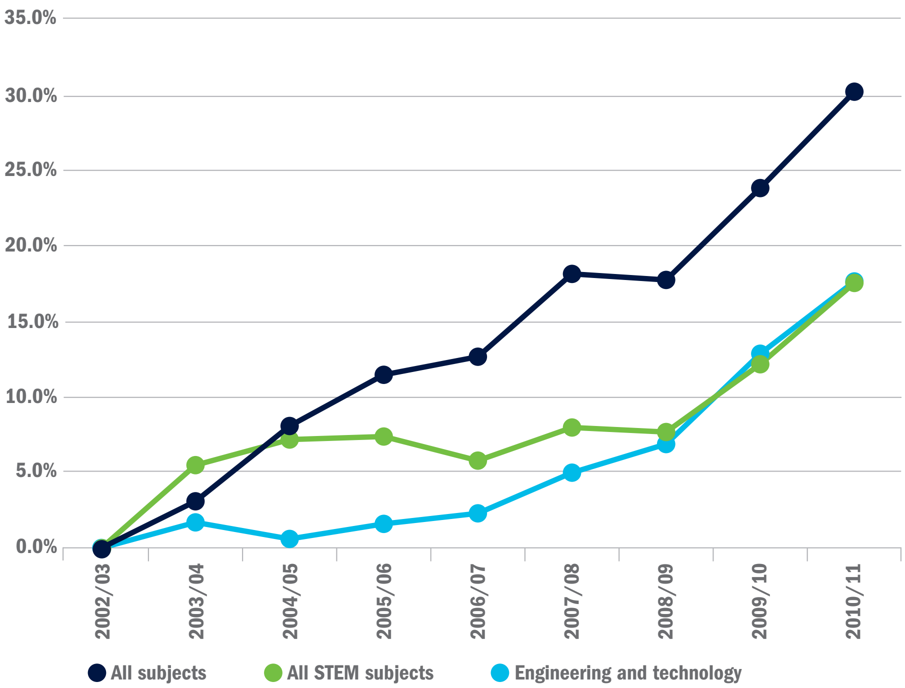
Looking at the classification of degree achieved shows that overall, 59.4% of qualifiers achieve a first or upper second class degree (Table 11.30). The average for STEM subjects is slightly above this at 61.2%. Engineering and technology has an above-average number of qualifiers achieving a first or upper second class degree (60.9%), but it is slightly behind the average for all courses.

However, engineering and technology has 1,510 qualifiers who achieved an unclassified degree. When unclassified degrees are excluded from the calculation, it can be seen that 65.2% of engineering and technology qualifiers achieve an first class or upper second class degree, compared with an average of 63.6% for all STEM subjects. Further research is required to explore why so many engineering and technology qualifiers have an unclassified degree.

Of all the STEM subjects, the only one to have a below-average percentage of first class and upper second class degrees is computer science (52.5%). This subject area also has a large number of unclassified degrees when compared with the total number of qualifiers (795 unclassified degrees out of 14,505 qualifiers).

628 *The supply of and demand for high level STEM skills,* UKCES, December 2011, p13

Fig. 11.18: Percentage growth in first degrees achieved (2002/09-2010/11) – all domiciles



Source: HESA qualifications table

Table 11.30: Classification of undergraduate first degrees by subject area (2010/11) – all domiciles

	First	Upper second	Lower second	Third/pass	Unclassified	Total number of students	Percentage of first or upper-second class degrees	Percentage of first or upper-second class degrees (when unclassified is excluded)
Biological sciences	4,675	16,580	9,705	2,065	775	33,800	62.9%	64.4%
Physical sciences	3,145	6,420	3,860	1,005	315	14,745	64.9%	66.3%
Mathematical sciences	2,030	2,455	1,645	640	195	6,965	64.4%	66.2%
Computer science	2,685	4,930	4,295	1,805	795	14,505	52.5%	55.5%
Engineering and technology	5,105	8,835	5,665	1,790	1,510	22,905	60.9%	65.2%
Total STEM	17,640	39,220	25,170	7,305	3,590	92,920	61.2%	63.6%
All subject areas	53,215	166,100	99,210	24,825	25,540	369,010	59.4%	63.9%

Source: HESA qualifications table

11.5.1 Domicile status and gender of engineering qualifiers

Table 11.31 shows the domicile[629] and gender for first degree qualifiers in engineering over an eight-year period. Over the period, the number of first degree qualifiers has increased by 12.5%, with a 4.4% rise in the last year. Looking specifically at 2010/11 shows that the number of UK-domiciled qualifiers rose by 4.6%. By comparison, the number of non-EU qualifiers rose by 7.0%, while there was a decline of 4.2% from those in the EU.

Table 11.32 shows that overall there was a 23.2% growth in postgraduate qualifiers in engineering in 2010/11. Unsurprisingly, this high level of growth can be accounted for by growth across all seven selected engineering sub-disciplines in this academic year (Table 11.35).

The proportion of female qualifiers has barely changed over eight years, reaching a high of 13.9% in 2009/10 and a low of 13.0% in 2004/05.

In 2010/11, there was 23.2% growth in the number of qualifiers with a postgraduate qualification. There was strong growth from all domicile groups, with the UK rising 27.1%, the EU up 26.0% and qualifiers from outside the EU 21.0% higher (Table 11.32).

As with first degree qualifiers, postgraduate engineering qualifiers are more likely than average to be non-EU domiciled (59.8% to 39.2%). Indeed, in its recent SIVS report, HEFCE[630] highlighted the importance of international postgraduate taught and postgraduate research students to the future viability of engineering courses, and also highlighted the risk to the UK's future workforce of international students staying in the UK to work.

Table 11.31: Number of first degrees achieved in engineering (2003/04-2010/11) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
UK	12,915	12,435	11,900	11,990	11,955	12,085	12,295	12,865	4.6%	-0.4%
EU	1,655	1,575	1,625	1,690	1,745	1,715	1,860	1,780	-4.2%	7.7%
Non-EU	3,185	3,380	3,940	3,740	4,085	4,350	4,970	5,320	7.0%	67.0%
Total non-UK	4,840	4,960	5,565	5,430	5,830	6,065	6,835	7,105	4.0%	46.7%
All female students	2,435	2,260	2,430	2,280	2,372	2,405	2,650	2,710	2.1%	11.3%
Total	**17,755**	**17,395**	**17,465**	**17,420**	**17,785**	**18,155**	**19,125**	**19,970**	**4.4%**	**12.5%**
Percentage of non-EU	18.0%	19.4%	22.6%	21.5%	23.0%	24.0%	26.0%	26.6%	2.3%	47.8%
Proportion of female students	13.7%	13.0%	13.9%	13.1%	13.3%	13.2%	13.9%	13.6%	-2.2%	-0.7%
Percentage of non-EU (for all courses)	6.9%	7.3%	8.0%	8.2%	8.0%	8.5%	9.2%	10.2%	10.9%	47.8%

Source: HESA bespoke data request

Table 11.32: Number of postgraduate degrees (excluding doctorates and PGCE) achieved in engineering (2003/04-2010/11) - all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
UK	2,665	2,960	2,860	2,760	2,815	2,925	3,170	4,030	27.1%	51.4%
EU	1,700	1,735	1,665	1,755	1,550	1,420	1,670	2,105	26.0%	23.8%
Non-EU	3,460	4,565	5,175	5,025	5,640	5,690	7,560	9,145	21.0%	164.3%
Total non-UK	5,160	6,300	6,840	6,780	7,190	7,110	9,230	11,250	21.9%	118.0%
All female students	1,415	1,780	1,865	1,735	1,880	1,790	2,140	2,775	29.5%	96.3%
Total	**7,825**	**9,260**	**9,700**	**9,540**	**10,005**	**10,035**	**12,400**	**15,285**	**23.2%**	**95.3%**
Percentage of non-EU	44.2%	49.3%	53.4%	52.7%	56.4%	56.7%	60.9%	59.8%	-2.0%	35.3%
Proportion of female students	18.1%	19.2%	19.2%	18.2%	18.8%	17.8%	17.3%	18.1%	4.6%	0.0%
Percentage of non-EU (for all courses)	28.8%	30.8%	31.8%	32.2%	34.7%	35.6%	38.1%	39.2%	2.9%	36.1%

Source: HESA bespoke data request

629 Domicile status does not denote nationality. Some international students will be UK domiciled and some UK national students may be non-UK domiciled. 630 *Strategically important and vulnerable subjects*, HEFCE, 2011, p4

The proportion of female postgraduate qualifiers has never reached one in five. In 2010/11, it was 18.2%, up on the previous year but below the 19.2% achieved in 2004/05 and 2005/06.

Compared with postgraduate qualifiers, growth in doctorates for 2010/11 was modest, at just 3.1%. In 2010/11, the number of qualifiers from the EU fell by 1.1%, and from the UK they fell by 0.4%, but from outside the EU they actually rose by 7.1%. As with first degree and postgraduate students, engineering is more dependent than average on non-EU students, who account for 49.6% compared with an average of 30.7% (Table 11.33).

Over the eight-year period, growth in doctorates was 27.1%, with all domicile areas showing growth. The strongest growth was from outside the UK, with non-EU doctorates up 45.8% and EU doctorates rising by 41.7%, compared with 3.9% for the UK.

In 2010/11, the proportion of women doctoral qualifiers reached an eight-year high of 465, which was 20.2% of all qualifiers.

Around a quarter of all PhD students are funded by the Research Councils.[631] In 2008/09, funding was provided for 19,202 doctoral students at a cost of £375.9 million. In addition to this, HEFCE provided £200 million through its quality-related funding stream.

Table 11.33: Number of doctorates achieved in engineering (2003/04-2010/11) – all domiciles

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
UK	780	750	760	850	690	780	810	810	-0.4%	3.9%
EU	245	265	300	285	295	320	350	345	-1.1%	41.7%
Non-EU	780	790	910	1,010	915	1,000	1,060	1,135	7.1%	45.8%
Total non-UK	1,025	1,060	1,210	1,295	1,210	1,320	1,410	1,485	5.1%	44.8%
All female students	350	320	385	425	350	430	430	465	7.7%	33.4%
Total	**1,805**	**1,810**	**1,965**	**2,145**	**1,900**	**2,100**	**2,225**	**2,290**	**3.1%**	**27.1%**
Percentage of non-EU	43.2%	43.8%	46.2%	47.2%	48.2%	47.6%	47.7%	49.6%	4.2%	14.8%
Proportion of female students	19.3%	17.8%	19.6%	19.8%	18.5%	20.4%	19.4%	20.2%	4.7%	4.1%
Percentage of non-EU (for all courses)	24.9%	25.8%	27.7%	28.0%	28.7%	29.5%	29.3%	30.7%	4.8%	23.3%

Source: HESA bespoke data request

631 *Strategically important and vulnerable subjects*, HEFCE, 2011, p15

11.5.2 Degrees achieved in selected engineering sub-disciplines

Table 11.31 showed that the number of first degree qualifiers in engineering increased by 4.4% in 2010/11. It is therefore not surprising that looking at selected engineering sub-disciplines (Table 11.34) shows growth in the number of qualifiers in six out of the seven sub-disciplines.

The largest one-year percentage increase in the number of qualifiers was for chemical, process and energy engineering, which grew by 17.2% in 2010/11. However, the numbers qualifying are still small, at just 810. Over the course of eight years, the sub-discipline has grown by half (50.2%). Looking at growth by gender shows that in both 2010/11 and over eight years there has been a higher percentage growth amongst female qualifiers than amongst male qualifiers.

Mechanical engineering was the sub-discipline with the largest number of first degree qualifiers of the selected sub-disciplines, with 3,155. In 2010/11, the sub-discipline grew by 5.9%, and by 19.7% over eight years.

Civil engineering had the biggest growth in the number of first degree qualifiers over eight years, rising by 82.8%. It also increased by 7.4% to 2,835 in 2010/11, making it the second-largest sub-discipline for the first time.

Overall, general engineering grew by 8.9% in 2010/11. However, examining this by gender shows some stark differences. Male qualifiers rose by 11.0% while female qualifiers actually fell by 3.6%. Over the eight-year term, there has been a 14.1% decline in first degree qualifiers, with females falling by 32.6% and males by 10.4%.

Electronic and electrical engineering saw slight growth in the number of first degree qualifiers in 2010/11, rising by 0.4%. However, over eight years, electronic and electrical engineering first degree qualifiers have fallen by 29.6%. In 2003/04, this sub-discipline was the largest of the seven, with 3,940 qualifiers. In 2010/11, it was the third largest with 2,775.

Aerospace engineering also had marginal growth in 2010/11, rising by just 0.2%. Within this, female first degree qualifiers rose by 4.3%, while male first degree qualifiers fell by 0.3%. Over the eight-year period, first degree qualifiers have actually fallen by 1.2%.

Production and manufacturing engineering was the only selected engineering sub-

Table 11.34: Number of first degrees achieved in engineering subjects (2003/04-2010/11) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
General engineering	Female	285	225	260	245	230	205	200	190	-3.6%	-32.6%
	Male	1,430	1,455	1,420	1,500	1,235	1,220	1,155	1,280	11.0%	-10.4%
	Male and female	**1,715**	**1,680**	**1,680**	**1,745**	**1,470**	**1,422**	**1,350**	**1,475**	**8.9%**	**-14.1%**
Civil engineering	Female	240	235	220	275	310	355	385	405	4.7%	67.8%
	Male	1,310	1,500	1,380	1,620	1,920	2,160	2,255	2,430	7.9%	85.5%
	Male and female	**1,550**	**1,735**	**1,605**	**1,900**	**2,230**	**2,515**	**2,640**	**2,835**	**7.4%**	**82.8%**
Mechanical engineering	Female	235	205	205	211	225	215	230	270	18.5%	14.9%
	Male	2,400	2,430	2,445	2,555	2,570	2,680	2,755	2,885	4.8%	20.2%
	Male and female	**2,640**	**2,635**	**2,650**	**2,765**	**2,800**	**2,895**	**2,980**	**3,155**	**5.9%**	**19.7%**
Aerospace engineering	Female	109	93	105	105	90	105	100	105	4.3%	-3.7%
	Male	905	945	925	895	875	940	900	895	-0.3%	-0.9%
	Male and female	**1,010**	**1,035**	**1,030**	**1,000**	**965**	**1,050**	**1,000**	**1,000**	**0.2%**	**-1.2%**
Electronic and electrical engineering	Female	431	360	310	282	315	255	275	290	5.2%	-32.8%
	Male	3,510	3,210	2,915	2,775	2,655	2515	2,490	2,485	-0.2%	-29.2%
	Male and female	**3,940**	**3,565**	**3,222**	**3,060**	**2,980**	**2,770**	**2,765**	**2,775**	**0.4%**	**-29.6%**
Production and manufacturing engineering	Female	160	155	139	145	115	130	135	95	-28.0%	-40.4%
	Male	1,090	955	870	730	690	620	600	570	-5.5%	-47.8%
	Male and female	**1,250**	**1,105**	**1,010**	**875**	**805**	**755**	**735**	**665**	**-9.6%**	**-46.8%**
Chemical, process and energy engineering	Female	128	125	140	120	140	130	155	195	24.4%	52.1%
	Male	411	405	385	380	430	450	535	615	15.1%	49.5%
	Male and female	**539**	**535**	**522**	**500**	**570**	**580**	**690**	**810**	**17.2%**	**50.2%**
Total of selected sub-disciplines		**12,645**	**12,295**	**11,720**	**11,485**	**11,815**	**11,985**	**12,165**	**12,715**	**4.5%**	**0.5%**

Source: HESA bespoke data request

discipline which showed a fall in the number of first degree qualifiers in 2010/11, down 9.6% to 665. In 2010/11, there was a particularly sharp decline in female first degree qualifiers: they fell by 28.0%, while male qualifiers fell by 5.5%. It also had the largest percentage decline over eight years, falling by 46.8%.

Table 11.32 shows that overall there was a 23.2% growth in postgraduate qualifiers in engineering in 2010/11. Given this high level of growth, it is not surprising that all seven selected engineering sub-disciplines grew in this academic year (Table 11.35).

Production and manufacturing engineering had the strongest growth in 2010/11, up 46.4%. However, over eight years, the number of postgraduate qualifiers is actually down by 12.3%: in 2010/11 there were 305 qualifiers compared with 350 in 2003/04.

The largest sub-discipline for the number of postgraduate qualifiers was civil engineering, with 1,375 in 2010/11 – a rise of 37.4% on the previous year. Over the eight-year period, the number of qualifiers has risen by 150.8%, with male qualifiers up 159.1% and female qualifiers up 130.7%.

Mechanical engineering also grew over the last eight years – up 59.3%. However, much of this growth occurred in 2010/11, when it rose by 43.6% to 470 postgraduate qualifiers.

From a very small base of just 105 postgraduate qualifiers in 2003/04, aerospace engineering has grown by 82.1% in eight years to reach 190 in 2010/11. There was particularly strong growth in 2010/11, when the number of qualifiers increased by 38.7%.

Chemical, process and energy engineering has grown by over three quarters (75.3%) over eight years. Looking at the eight-year growth by gender shows very strong growth in male qualifiers (up 109.7%) but marginal growth in female qualifiers (up 7.8%). Chemical, process and energy engineering grew by 22.9% in 2010/11, reaching a total of 300 postgraduate qualifiers.

Table 11.35: Number of postgraduate degrees (excluding doctorates and PGCE) achieved in engineering sub-disciplines (2003/04-2010/11) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
General engineering	Female	60	110	110	85	80	85	100	110	9.0%	82.7%
	Male	360	625	610	535	500	465	490	515	4.5%	42.4%
	Male and female[632]	**420**	**735**	**720**	**620**	**575**	**550**	**595**	**625**	**5.3%**	**48.2%**
Civil engineering	Female	160	160	140	195	205	230	260	370	42.7%	130.7%
	Male	390	390	412	470	545	665	740	1,005	35.5%	159.1%
	Male and female	**550**	**550**	**555**	**670**	**750**	**895**	**1,000**	**1,375**	**37.4%**	**150.8%**
Mechanical engineering	Female	35	35	25	20	70	35	35	45	*[633]	*
	Male	260	265	225	235	310	275	295	425	44.9%	61.7%
	Male and female	**295**	**300**	**250**	**255**	**380**	**310**	**330**	**470**	**43.6%**	**59.3%**
Aerospace engineering	Female	20	20	20	20	10	15	20	25	*	*
	Male	80	105	115	90	115	130	120	165	37.4%	98.2%
	Male and female	**105**	**125**	**135**	**110**	**125**	**140**	**135**	**190**	**38.7%**	**82.1%**
Electronic and electrical engineering	Female	130	150	105	100	80	75	50	65	31.5%	-50.0%
	Male	590	555	525	505	445	475	495	530	6.7%	-10.5%
	Male and female	**720**	**700**	**635**	**605**	**525**	**550**	**545**	**595**	**8.9%**	**-17.7%**
Production and manufacturing engineering	Female	45	50	50	30	45	30	35	55	*	*
	Male	305	250	230	220	185	175	175	250	43.4%	-18.2%
	Male and female	**350**	**300**	**280**	**250**	**230**	**210**	**210**	**305**	**46.4%**	**-12.3%**
Chemical, process and energy engineering	Female	60	60	60	40	30	50	50	60	*	7.8%
	Male	115	130	125	125	110	135	195	240	21.4%	109.7%
	Male and female	**170**	**190**	**185**	**160**	**140**	**185**	**245**	**300**	**22.9%**	**75.3%**
Total of selected sub-disciplines		**2,615**	**2,900**	**2,765**	**2,680**	**2,730**	**2,840**	**3,060**	**3,865**	**26.3%**	**47.8%**

Source: HESA bespoke data request

632 Some students were of indeterminate gender. Therefore the male and female total will not always match the total number of qualifiers. 633 * means percentage has been removed due to small base size.

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Unlike some of the other selected sub-disciplines, general engineering saw more modest growth in the number of postgraduate qualifiers in 2010/11, rising by 5.3%. Over eight years, numbers of civil engineering postgraduate qualifiers grew by 48.2%, reaching 625 in 2010/11. Over eight years, numbers of female qualifiers have grown by 82.7%, compared with 42.4% for male qualifiers.

Over eight years, there has been a decline of 17.7% in the number of postgraduate qualifiers in electrical and electronic engineering. The decline has been sharpest amongst female postgraduates, who have halved in number to just 65. The decline in male postgraduate qualifiers has been less pronounced, falling by 10.5%. Positively, there was overall growth of 8.9% in 2010/11, with female qualifiers rising by 31.5% and male qualifiers by 6.7%.

Table 11.36 shows the number of students qualifying with a doctorate in the selected engineering sub-disciplines. Overall, the number of qualifiers in 2010/11 for all the selected sub-disciplines fell by 0.3%, but over eight years it actually rose by 5.5%.

Due to the small number of qualifiers each year in the selected sub-disciplines, there is a lot of fluctuation in the percentages. However, it is positive to note that only one sub-discipline – chemical, process and energy engineering – has shown a decline over eight years, falling by 2.2%.

Table 11.36: Number of doctorates achieved in engineering sub-disciplines (2003/04-2010/11) – UK domiciled

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
General engineering	Female	35	25	40	25	20	30	35	40	*	*
	Male	155	140	135	150	125	135	160	150	-4.7%	-3.5%
	Male and female	**190**	**170**	**175**	**175**	**145**	**165**	**190**	**190**	**-1.0%**	**0.3%**
Civil engineering	Female	20	25	25	30	30	30	25	30	*	*
	Male	75	70	75	70	65	50	60	65	10.4%	-11.6%
	Male and female	**95**	**95**	**105**	**105**	**90**	**80**	**85**	**95**	**13.2%**	**1.6%**
Mechanical engineering	Female	25	15	20	25	15	20	25	20	*	*
	Male	115	110	115	150	90	105	115	125	7.4%	9.4%
	Male and female	**140**	**125**	**135**	**180**	**105**	**125**	**140**	**145**	**3.1%**	**4.8%**
Aerospace engineering	Female	0	5	0	10	5	10	5	5	*	*
	Male	20	20	25	40	20	40	35	35	*	*
	Male and female	**20**	**25**	**25**	**50**	**30**	**45**	**40**	**40**	*	*
Electronic and electrical engineering	Female	25	25	30	30	25	40	25	30	*	*
	Male	160	175	145	205	165	185	210	180	-12.8%	13.0%
	Male and female	**190**	**200**	**175**	**235**	**190**	**230**	**235**	**210**	**-9.7%**	**12.5%**
Production and manufacturing engineering	Female	10	15	15	5	10	10	10	15	*	*
	Male	35	25	30	20	35	30	20	25	*	*
	Male and female	**45**	**35**	**45**	**30**	**45**	**40**	**30**	**40**	*	*
Chemical, process and energy engineering	Female	30	20	25	20	30	20	25	30	*	*
	Male	60	60	65	55	60	75	60	55	-0.9%	-4.2%
	Male and female	**90**	**80**	**90**	**75**	**85**	**90**	**85**	**85**	**4.2%**	**-2.2%**
Total of selected sub-disciplines		**765**	**730**	**745**	**845**	**690**	**780**	**810**	**805**	**-0.3%**	**5.5%**

Source: HESA bespoke data request

11.5.3 Ethnicity of engineering graduates

Tables 11.37 – 11.40 shows the break down of degrees by ethnicity. The ethnicity of first degree qualifiers in engineering over an eight-year period is shown in Table 11.37. White qualifiers rose by 4.1% in 2010/11 to 9,725, which was three quarters (75.6%) of all qualifiers. However, despite the increasing number of white qualifiers their proportion of all qualifiers fell from 76.0% in 2009/10 to 75.6% in 2010/11. Over the course of eight years, the proportion of white qualifiers has fallen from a high point in 2004/05 of 79.1%.

The largest percentage increase over eight years was for black or black British – African, where the number of qualifiers has more than doubled (up 119.4%). In 2010/11, the number of qualifiers from a black or black British – African background was 20.4%, reaching a total of 640. Since 2007/08, black or black British – African qualifiers have formed the largest ethnic minority group in engineering.

In 2003/04, Asian or Asian British – Indian students were the largest ethnic minority. However, the number of qualifiers has declined by 4.0% over eight years to 545 in 2010/11.

The number of Chinese qualifiers has declined by 19.0% over eight years. But positively, their numbers did rise by 2.3% in 2010/11. The largest percentage decline in an ethnic group was for unclassified, which fell by 34.7% over eight years and by 4.3% in 2010/11.

The proportion of first degree qualifiers from different ethnic groups does vary by selected engineering sub-discipline (Table 11.38). For two of the engineering sub-disciplines, over 80% of the first degree qualifiers are white. These are production and manufacturing engineering (85.5%) and general engineering (82.3%). By comparison, two sub-disciplines have less than 70% of their qualifiers from a white ethnic background. These are chemical, process and energy engineering (61.4%) and aerospace engineering (67.1%).

Within chemical, process and energy engineering, 11.5% of first degree qualifiers are from a black or black British – African ethnic background, and 6.2% are from an Asian or Asian British – Indian ethnic background. Asian or Asian British – Indian qualifiers also represented 8.8% of those qualifying in aerospace engineering.

Looking at all of engineering shows that only 0.3% of qualifiers came from an other black background, while 0.8% of qualifiers came from a black or black British – Caribbean or Asian, or Asian British – Bangladeshi background.

Table 11.39 shows the proportion of first degree qualifiers by gender and ethnicity for selected engineering sub-disciplines. It shows only one sub-discipline where the proportion of white female qualifiers is larger than the proportion of white male qualifiers. This is aerospace engineering, where 70.1% of female qualifiers are female and 66.8% are male.

Conversely, there are two sub-disciplines where the proportion of male qualifiers is at least 10 percentage points higher than the proportion of female qualifiers. These are mechanical engineering (80.6% and 65.8%) and production and manufacturing engineering (87.1% and 75.9%). These facts show that male qualifiers are more likely than average to be white and female qualifiers are more likely than average to be from an ethnic minority background.

As was identified in Table 11.38, chemical, process and energy engineering has the lowest proportion of qualifiers who are from a white ethnic background. Only 53.9% of female qualifiers were white, while 63.7% of male qualifiers were also white. Chemical, process and energy engineering was particularly successful in attracting black or black British – African female qualifiers (19.5%), Asian or Asian British – Indian (5.7%) and Asian or Asian British – Pakistani (5.1%) qualifiers.

Table 11.37: First degrees achieved in engineering by ethnic origin (2003/04-2010/11) – UK domiciled

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	Change over one year	Change over eight years
White	10,195	9,835	9,240	9,420	9,270	9,235	9,345	9,725	4.1%	-4.6%
Black or black British – Caribbean	85	75	85	85	75	75	110	100	-8.7%	20.9%
Black or black British – African	290	305	375	360	485	515	530	640	20.4%	119.4%
Other black background	50	25	40	35	25	20	45	35	*	*
Asian or Asian British – Indian	565	485	510	450	515	460	525	545	3.9%	-4.0%
Asian or Asian British – Pakistani	265	265	270	240	265	300	290	310	8.1%	17.5%
Asian or Asian British – Bangladeshi	100	90	75	70	90	90	95	105	10.4%	6.6%
Chinese	275	240	215	250	230	260	220	225	2.3%	-19.0%
Other Asian background	190	190	230	215	235	285	285	315	9.1%	65.2%
Other (including mixed) ethnicity	285	280	295	360	365	450	440	475	8.1%	65.5%
Unknown	610	650	565	505	400	400	415	400	-4.3%	-34.7%
Percentage white	78.9%	79.1%	77.6%	78.6%	77.5%	76.4%	76.0%	75.6%	-0.5%	-4.2%
Total	**12,915**	**12,435**	**11,900**	**11,990**	**11,955**	**12,085**	**12,295**	**12,865**	**4.6%**	**-0.4%**

Source: HESA bespoke data request

Table 11.38: Percentage breakdown of first degrees achieved by ethnic origin in engineering subjects (2010/11) – UK domiciled

	White	Black or black British – Caribbean	Black or black British – African	Other black background	Asian or Asian British – Indian	Asian or Asian British – Pakistani	Asian or Asian British – Bangladeshi	Chinese	Other Asian background	Other (including mixed) ethnicity	Unknown
General engineering	82.3%	0.8%	3.0%	0.1%	2.0%	1.1%	0.2%	1.2%	2.2%	2.4%	4.6%
Civil engineering	76.9%	0.6%	4.2%	0.4%	3.4%	2.3%	0.7%	1.7%	2.9%	3.5%	3.5%
Mechanical engineering	79.3%	0.6%	3.4%	0.2%	4.5%	2.2%	0.7%	1.4%	1.7%	3.8%	2.3%
Aerospace engineering	67.1%	1.0%	4.9%	0.6%	8.8%	3.4%	1.3%	1.7%	4.0%	5.6%	1.6%
Electronic and electrical engineering	70.7%	1.2%	7.5%	0.2%	3.9%	3.0%	1.3%	2.1%	2.4%	3.9%	3.7%
Production and manufacturing engineering	85.5%	0.9%	2.3%	0.4%	3.5%	0.7%	0.6%	1.8%	1.1%	2.0%	1.4%
Chemical, process and energy engineering	61.4%	0.4%	11.5%	0.2%	6.2%	4.7%	0.8%	3.0%	3.5%	4.6%	3.8%
Total engineering	75.6%	0.8%	5.0%	0.3%	4.2%	2.4%	0.8%	1.7%	2.4%	3.7%	3.1%

Source: HESA bespoke data request

Table 11.39: Percentage breakdown by gender of first degrees achieved by ethnic origin in engineering subjects (2010/11) – UK domiciled[634]

		White	Black or black British – Caribbean	Black or black British – African	Other black background	Asian or Asian British – Indian	Asian or Asian British – Pakistani	Asian or Asian British – Bangladeshi	Chinese	Other Asian background	Other (including mixed)	Unknown
General engineering	Female	79.3%	0.0%	3.2%	0.3%	3.2%	0.0%	0.0%	2.6%	2.6%	3.4%	5.4%
	Male	82.7%	1.0%	2.9%	0.1%	1.9%	1.3%	0.2%	1.0%	2.1%	2.3%	4.5%
Civil engineering	Female	74.6%	2.0%	3.6%	0.0%	3.4%	0.7%	0.8%	2.9%	3.7%	3.8%	4.5%
	Male	77.2%	0.3%	4.3%	0.4%	3.4%	2.6%	0.7%	1.5%	2.8%	3.5%	3.3%
Mechanical engineering	Female	65.8%	1.5%	6.6%	0.0%	7.1%	3.2%	0.7%	3.2%	4.1%	5.0%	2.8%
	Male	80.6%	0.5%	3.1%	0.2%	4.2%	2.1%	0.7%	1.2%	1.5%	3.7%	2.2%
Aerospace engineering	Female	70.1%	1.0%	3.8%	1.9%	9.4%	2.9%	0.0%	2.4%	2.4%	5.3%	1.0%
	Male	66.8%	1.0%	5.0%	0.4%	8.7%	3.5%	1.5%	1.6%	4.2%	5.6%	1.6%
Electronic and electrical engineering	Female	66.8%	1.4%	6.0%	0.5%	3.4%	5.3%	4.1%	2.1%	2.2%	5.2%	2.9%
	Male	71.1%	1.2%	7.7%	0.2%	4.0%	2.7%	1.0%	2.1%	2.4%	3.7%	3.8%
Production and manufacturing engineering	Female	75.9%	0.0%	1.6%	0.0%	6.9%	0.0%	1.7%	4.1%	3.6%	3.1%	3.1%
	Male	87.1%	1.0%	2.5%	0.4%	2.9%	0.8%	0.4%	1.4%	0.7%	1.8%	1.1%
Chemical, process and energy engineering	Female	53.9%	0.5%	19.5%	0.0%	5.7%	5.1%	1.1%	3.6%	3.6%	1.9%	5.1%
	Male	63.7%	0.3%	9.0%	0.3%	6.4%	4.6%	0.7%	2.8%	3.4%	5.5%	3.4%

Source: HESA bespoke data request

634 Qualifiers of indeterminate gender are not included in this table

Mechanical engineering has double the proportion of black or black British – African female qualifiers (6.6%) to male qualifiers (3.1%).

In general, a lower proportion of qualifiers come from a white ethnic background for higher engineering degrees than for engineering first degrees (Table 11.40). The engineering sub-discipline with the highest proportion of white qualifiers is general engineering (74.3%). By comparison, two sub-disciplines have close to just half their students coming from a white ethnic background. These are electronic and electrical engineering (50.9%) and chemical, process and energy engineering (53.5%).

At a higher engineering degree level, a large proportion of qualifiers come from black or black British – African ethnic backgrounds. They make up 14.0% of qualifiers in chemical, process and energy engineering, 9.6% of qualifiers in electronic and electrical engineering and 9.5% of qualifiers in production and manufacturing engineering.

11.5.4 Geographical location of qualifiers[635]

Table 11.41 shows the English region and home nation location of graduates in Engineering. Looking at graduates who qualify in civil engineering shows that out of 5,200 graduates, 1,025 came from London universities. The next most important English region was the North West, with 495 qualifiers. In the other home nations, 690 civil engineers graduated in Scotland, compared with 355 in Wales and 180 in Northern Ireland.

Electronic and electrical engineering had the second largest number of graduates, at 4,870. Of these, 830 graduated from London universities and 630 came from universities in the North West. Scotland was responsible for 490 graduates, while 290 graduated in Wales and 45 in Northern Ireland.

Six hundred and twenty-five mechanical engineering graduates came from London universities and 510 came from institutions in the South East. However, Scotland was only just behind London with 620 graduates, while there was 355 from Wales and 105 from Northern Ireland.

Looking at general engineering graduates shows that 475 came from the east of England, which is a large proportion of the 2,515 who graduated in England. Four hundred and fifty-five graduates graduated from institutions in the South East. Scotland was also an important source of graduates, with 380, compared with 150 for Wales and 75 from Northern Ireland.

Aerospace engineering is the only sub-discipline with no graduates from any institutions in a particular English region: in this case, the North East. Most of the 1,780 aerospace graduates were from London universities (650). Looking at the other home nations shows that Wales produced more aerospace graduates than Scotland (125 to 115), while 25 students graduated in Northern Ireland.

Out of 1,235 production and manufacturing engineering graduates, 1,015 came from English institutions. Only 150 students graduated in Scotland, 55 in Wales and 10 in Northern Ireland. Looking specifically at the English regions reveals that 210 students graduated from institutions in the East Midlands and 195 came from institutions in the West Midlands.

Table 11.40: Percentage breakdown by ethnic origin of higher degrees achieved in engineering subjects (2010/11) – UK domiciled

	White	Black or black British – Caribbean	Black or black British – African	Other black background	Asian or Asian British – Indian	Asian or Asian British – Pakistani	Asian or Asian British – Bangladeshi	Chinese	Other Asian background	Other (including mixed)	Unknown
General engineering	74.3%	0.3%	5.2%	0.0%	3.5%	1.6%	0.5%	2.0%	2.7%	3.1%	6.9%
Civil engineering	69.8%	0.6%	5.0%	0.1%	2.9%	2.1%	0.3%	1.8%	3.7%	5.0%	8.6%
Mechanical engineering	63.2%	1.0%	5.6%	0.2%	5.0%	2.2%	0.0%	1.5%	3.1%	5.2%	13.1%
Aerospace engineering	68.7%	0.4%	3.5%	0.4%	5.2%	4.6%	0.4%	3.2%	4.8%	3.1%	5.7%
Electronic and electrical engineering	50.9%	0.7%	9.6%	0.2%	4.0%	4.4%	1.4%	5.8%	4.6%	6.1%	12.3%
Production and manufacturing engineering	62.9%	0.3%	9.5%	0.9%	4.2%	2.2%	1.0%	4.4%	2.2%	7.8%	4.8%
Chemical, process and energy engineering	53.5%	0.5%	14.0%	0.3%	5.0%	3.7%	0.3%	5.0%	4.1%	4.6%	9.0%

Source: HESA bespoke data request

635 Section 10.4.1 has an analysis of apprenticeships by region, while section 15.2.1 shows demand for engineers in engineering enterprises, by region.

Table 11.41: Location of institution, for selected engineering graduates (2010/11) – UK domiciled[636]

	North East	North West	Yorkshire and The Humber	East Midlands	West Midlands	East of England	London	South East	South West	England	Wales	Scotland	Northern Ireland	Total
General engineering	100	235	210	130	355	475	355	455	200	2,515	150	380	75	3,120
Civil engineering	275	495	400	405	455	120	1,025	405	415	3,995	355	690	180	5,220
Mechanical engineering	250	370	380	460	490	200	625	510	385	3,675	355	620	105	4,755
Aerospace engineering	0	170	90	150	60	150	650	105	130	1,510	125	115	25	1,780
Electronic and electrical engineering	525	630	300	400	480	120	830	480	270	4,045	290	490	45	4,870
Production and manufacturing engineering	120	75	85	210	195	105	75	90	60	1,015	55	150	10	1,235
Chemical, process and energy engineering	95	160	95	85	150	50	255	35	60	985	20	260	20	1,290
All engineering sub-disciplines	1,370	2,150	1,580	1,870	2,205	1,245	3,880	2,300	1,535	18,140	1,370	2,785	465	22,760

Source: HESA bespoke data request

Chemical, process and energy engineering is the only engineering sub-discipline where an English region is not the largest source of graduates. Of 1,290 graduates, 260 came from Scottish universities, while 255 came from London. The North West was also an important source of graduates, with 160. Wales and Northern Ireland both produced 20 graduates each.

In total, out of 22,760 graduates, 3,880 came from London-based institutions, 2,300 from the South East, 2,205 from the West Midlands and 2,150 from the North West. Of the other home nations, Scotland produced the most graduates, at 2,785, followed by Wales with 1,370 and then Northern Ireland with 465. Northern Ireland was the only home nation or English region to have fewer than 1,000 engineering graduates. The next lowest was the East of England with 1,245.

Table 11.42 shows the number of STEM degree holders in employment for 2008-10 by English region and home nation. It shows that nearly half a million (414,563) STEM graduates are working in London: this is 17.1% of all STEM graduates in employment. The next most important region for employing STEM graduates is the South East, with 398,901 in employment. Of the English regions, the North East has the lowest number of STEM graduates in employment, at 78,301. This is just 3.2% of all STEM graduates in employment.

Of the other home nations, Scotland has nearly a quarter of a million (217,635) STEM graduates in employment. This is more than double the number in Wales (104,675) and nearly four times the number in Northern Ireland.

Table 11.42: STEM degree holders in employment in 2008-10

	Number	Percentage of STEM degree holders in employment
North East	78,301	3.2%
North West	249,697	10.3%
Yorkshire and the Humber	178,182	7.3%
East Midlands	139,651	5.8%
West Midlands	167,921	6.9%
East of England	212,201	8.7%
London	414,563	17.1%
South East	398,901	16.4%
South West	207,185	8.5%
England	2,046,601	84.4%
Scotland	217,635	9.0%
Wales	104,675	4.3%
Northern Ireland	56,459	2.3%
UK total	**2,425,370**	

Source: Adapted from UKCES[637]

636 This table includes first degree, other undergraduate, postgraduate and doctorate qualifiers. 637 *The supply of and demand for high level STEM skills,* UKCES, December 2011, p14

11.6 BTec Higher National Certificate (HNC) and Higher National Diploma (HND)

HNCs[638] and HNDs[639] 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; HNC/D holders may move on to the second or third year of a related degree course.

Changes to national qualifications frameworks (NQF) mean that HNC and HND qualifications are now at different levels within the NQF. An HNC is now a level 4 qualification and, as a result, HNCs started on or after 1 September 2010 are no longer exemplifying qualifications for Incorporated Engineer (IEng) registration. An HND qualification, however, is still a level 5 qualification and is still an exemplifying qualifications for IEng registration.

Table 11.43 shows the number of completions for engineering BTec Higher by domicile status. It shows that overall, completions were 28.0% higher in 2011/12 than in 2006/07, at 5,436. However, growth has not been even across the different domicile groups. There has been strong growth in the number of international completions, which have risen by 120.3%. By comparison, the overall growth from UK-domiciled students was just 0.8%. Within UK-domiciled students there was growth over six years of 3.1% for completions on HNC courses, but a decline of 4.1% on students completing a HND.

Table 11.44 breaks the number of completions in engineering down by selected sub-disciplines for UK-domiciled students. It shows that in 2011/12 there was an overall

Table 11.43: Completions for engineering BTec Highers (2006/07-2011/12) – all domiciles

	QCF size	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
International	HNC	11	16	26	28	9	19	111.1%	72.7%
	HND	955	1,118	809	1,286	1,517	2,109	39.0%	120.8%
International total		**966**	**1,134**	**835**	**1,314**	**1,526**	**2,128**	**39.4%**	**120.3%**
UK	HNC	2,245	2,233	2,241	2,515	2,863	2,314	-19.2%	3.1%
	HND	1,037	1,084	1,058	954	1,244	994	-20.1%	-4.1%
UK total		**3,282**	**3,317**	**3,299**	**3,469**	**4,107**	**3,308**	**-19.5%**	**0.8%**
Grand total		**4,248**	**4,451**	**4,134**	**4,783**	**5,633**	**5,436**	**-3.5%**	**28.0%**

Source: Edexcel

Table 11.44: Completions for engineering BTec Highers, by selected sub-discipline (2006/07-2011/12) – UK domiciled[640]

QCF size	Name	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	Change over one year	Change over six years
HNC	Electrical/electronic engineering (NQF)	533	593	563	667	727	323	-55.6%	-39.4%
HNC	Mechanical engineering (NQF)	356	373	418	488	502	280	-44.2%	-21.3%
HND	Electrical/electronic engineering (NQF)	124	198	221	250	291	139	-52.2%	12.1%
HNC	Electrical and electronic engineering (QCF)	-	-	-	-	20	531	2555.0%	
HNC	Manufacturing engineering (QCF)	-	-	-	-	3	212	6966.7%	
HNC	Mechanical engineering (QCF)	-	-	-	-	39	336	761.5%	
HND	Electrical and electronic engineering (QCF)	-	-	-	-	5	164	3180.0%	
HND	Mechanical engineering (QCF)	-	-	-	-	12	105	775.0%	
Total for all HNC/HND engineering courses		**3,282**	**3,317**	**3,299**	**3,469**	**4,107**	**3,308**	**-19.5%**	**0.8%**

Source: Edexcel

638 If studied full-time, an HNC takes one year to complete. 639 If studied full-time, an HND takes two years to complete. 640 Only those subjects with at least 100 completions in 2011/12 were selected.

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19.5% decline in the number of engineering completions. Looking at the selected sub-disciplines shows that 531 completions were in electrical and electronic engineering (QCF). The subject that showed the largest percentage decline in the number of completions in 2011/12, was electrical/electronic engineering (NQF), which declined by 55.6%.

11.7 Foundation degrees

The *Key Statistics report on Foundation Degrees,* produced by HEFCE, was last updated for the 2009/10 academic year. This section therefore provides a summary of the information which was included in the Engineering UK Report 2012.

Table 11.45 shows that in 2009/10 there were 3,595 new entrants to foundation degrees in engineering and technology. Of these, nearly two thirds (66.1%) were studying full-time, with the rest studying part-time. The number of new entrants on full-time courses increased by 22.1% in 2009/10, while new entrants to part-time courses fell by 10.9%.

Just under 11% of new entrants to engineering and technology foundation degrees in 2009/10 were female (Table 11.46). Looking specifically at new male entrants shows that nearly half (45%) are aged 20-24. Only one in five (19%) of new entrants are aged 16-19.

Table 11.45: New entrants to engineering and technology foundation degrees (2006/07-2009/10)

Academic year	Entrants to full-time programmes	Entrants to part-time programmes	Total entrants
2006/07	1,170	1,035	2,205
2007/08	1,455	1,110	2,565
2008/09	1,945	1,370	3,315
2009/10	2,375	1,220	3,595

Source: Higher Education Funding Council for England
Note: Data rounded to the nearest five

Table 11.46: Full-time and part-time entrants to engineering and technology foundation degrees by age and sex (2009/10)

Sex	Age on entry	Full-time		Part-time	
		Number	Proportion	Number	Proportion
Female	16 to 19	100	4%	20	2%
	20 to 29	120	5%	55	4%
	30 to 39	35	2%	20	2%
	40 to 49	20	1%	15	1%
	50 to 59	0	0%	10	1%
	60 plus	0	0%	0	0%
	Subtotal: female	275	12%	115	10%
Male	16 to 19	850	36%	240	19%
	20 to 29	925	39%	555	45%
	30 to 39	240	10%	175	14%
	40 to 49	80	3%	110	9%
	50 to 59	10	0%	25	2%
	60 plus	0	0%	0	0%
	Subtotal: male	2,100	88%	1,105	90%
	Total	**2,375**	**100%**	**1,220**	**100%**

Source: Higher Education Funding Council for England
Note: Data rounded to the nearest five

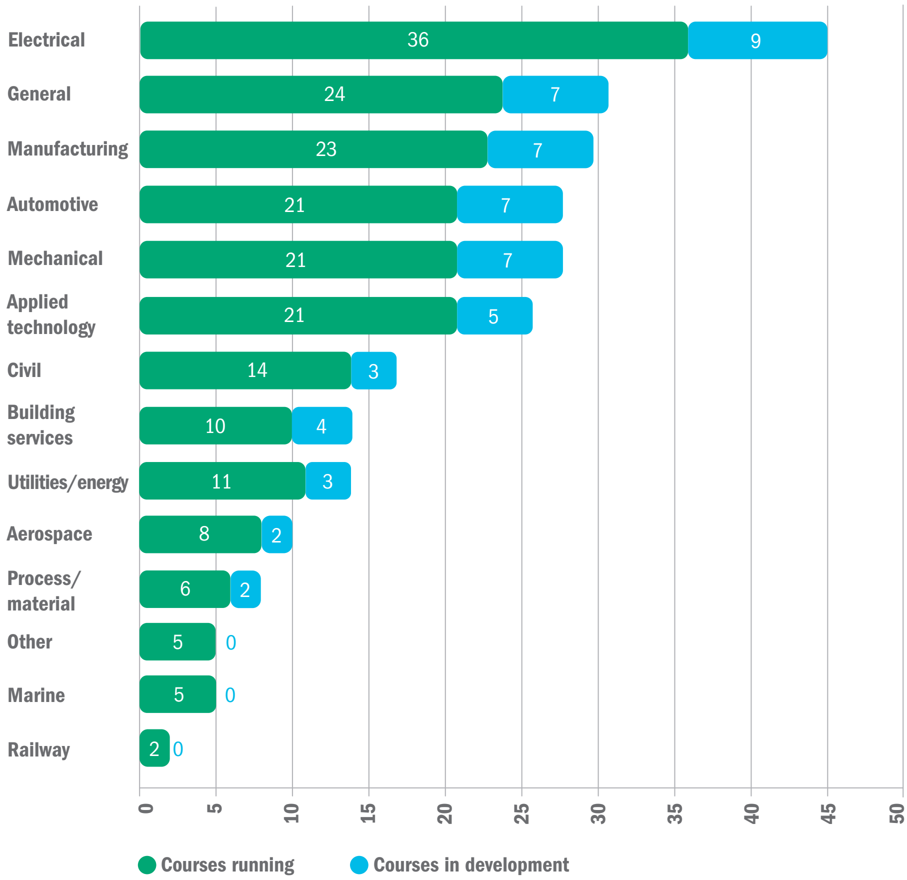
11.7.1 Course profile

Foundation degrees can be either general programmes covering a broad subject base or very specific programmes developed to suit the needs of a particular industry or company. General programmes are likely to offer a route into initial employment within the sector, whereas specific programmes are more likely to be aimed at up-skilling the existing workforce. Figure 11.19 shows a subject profile for the engineering and technology foundation degrees that were available in 2009/10. Courses in electrical, manufacturing and automotive engineering, as well as general programmes, dominate the profile and account for just under 40% of provision. Specialist programmes in aerospace, process, marine and railway engineering account for just 8% of provision.

The majority of engineering and technology Foundation degrees are delivered by Further Education Colleges (72%), 23% of courses are delivered by universities and 5% are delivered by other organisations such as private training providers or employers.

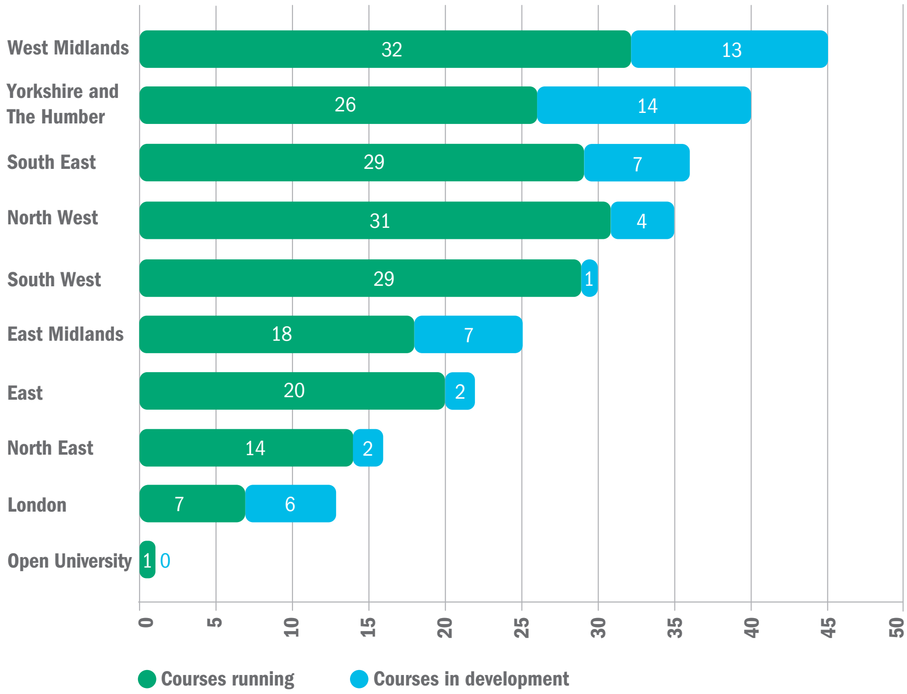
The distribution of programmes is uneven in terms of the number of courses offered within each of the English regions (Figure 11.20). More courses are located in the West Midlands than any other region. In contrast to the large number of programmes available in the West Midlands and Yorkshire and Humberside, only 5% of provision is in London.

Fig. 11.19: Subject focus of foundation degrees in engineering and technology (2009/10)



Source: fdf course database

Fig. 11.20: Location of engineering and technology foundation degrees (2009/10)



Source: fdf course database

Part 3 - Engineering in Employment
12.0 Graduate destinations

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One of the objectives of EngineeringUK is to improve the supply of engineers. Engineering graduate employment rates (and the destination of those employed graduates) is therefore a key issue for us. Research by the Confederation of British Industry (CBI)[641] has shown that employers want graduates to have previous work experience.

This is becoming a key selection criteria for graduate recruiters, who increasingly look for demonstrable competencies and employability skills. The Edge Foundation,[642] however, has identified that academics can be sceptical of including employability skills in their course content: their perception is that it could lead to a reduction of academic standards and that it is an attack on their academic freedoms.

In its review of HE STEM subjects,[643] the House of Lords Select Committee on Science and Technology identified work experience during study as a key element in developing employability skills. However, in section 5.0 of this report,[644] we showed that there are significant barriers to students being offered work experience at school, while in section 11.4.2,[645] we identified that the provision of sandwich courses for engineering students had declined from 33% in 1994/95 to just 16.7% in 2010/11. The Wilson Review highlighted the patchy provision of sandwich degrees, with some universities having a majority of their undergraduate students studying a sandwich placement year. It also points out that the decline in provision of sandwich courses has not been uniform, implying that sustaining sandwich courses is a consequence of individual universities' culture, strategy and course portfolio.

The Graduate Talent Pool (GTP) website was launched in July 2009 and helps businesses, particularly small and medium-sized businesses, to recruit graduate interns. Government funding for the GTP website has been extended for a further three years.[646]

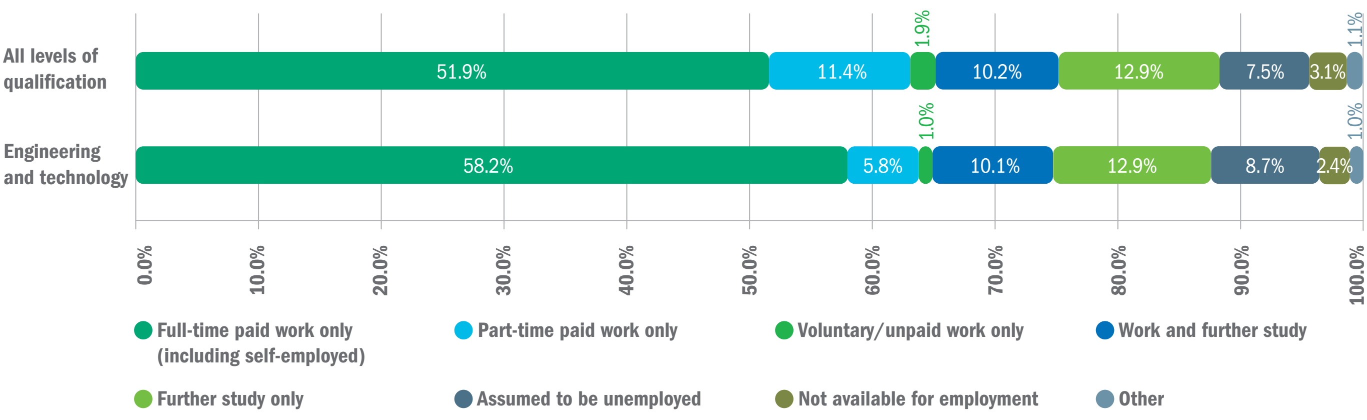
12.1 Destination of students

The Higher Education Statistics Agency (HESA) Destination of Leavers from Higher Education survey (DLHE)[647 648] is administered[649] about six months after graduation. In 2010/11, 396,650[650] qualifiers provided information about their destinations from a possible 526,225 within the eligible DLHE population. This gave an overall credible response rate of 75.4%.

Overall in 2010/11, 51.9%[651] of graduates went into full-time paid employment. By comparison, 58.2% of engineering and technology graduates went into full-time employment (Figure 12.0), highlighting the enhanced employability of an engineering and technology degree. The proportion of engineering and technology graduates going into just part-time work (5.8%), was about half of that of all graduates (11.4%). The proportion of engineering and technology graduates who were unemployed was fractionally higher (8.7%) than it was for all students (7.5%). After graduating, 12.9% of all graduates and of engineering and technology graduates went on to doing just further study. Overall, 86.9% of engineering graduates went into either paid work or were undertaking further study within six months of graduating, compared with 86.4% of all graduates.

Engineering and technology also gives long term employability prospects. Our own analysis of the HESA Longitudinal Destination of Leavers from Higher Education Institutions shows that of those who graduated in

Fig. 12.0: Destinations of leavers of HE (all qualifications) in all subjects and engineering and technology (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

641 http://www.cbi.org.uk **642** *Employers perceptions of the employability skills of new graduates,* Edge Foundation, 2011, p8 **643** *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects,* House Of Lords Select Committee on Science and Technology, July 2012, p58 **644** Understanding and influencing target audiences **645** Number of engineering students **646** *Following Up the Wilson Review of Business-University Collaboration,* Department for Business, Innovation and Skills, June 2012, p16 **647** Post-doctoral and non-EU domiciled students are excluded from the DLHE. **648** London Metropolitan University, Liverpool Hope University and University College Birmingham are generally excluded from HESA statistics. The University of Buckingham, a private University was included. **649** Data collection is undertaken by individual HEIs using a questionnaire and procedure set by HESA, with the data collected returned to HESA for analysis. Returned DLHE data is linked to earlier student returns submitted by HEIs. **650** All whole numbers used in this section have had HESA data rounding policy applied. http://www.hesa.ac.uk/index.php/content/view/146/178/ **651** Due to HESA rounding policy there may be slight errors in the percentages which have been calculated.

2006/07, 83.3% were in full-time employment in 2010, compared with an average for all subjects of 72.3%.[652]

In 2010/11, 90.5% of medicine and dentistry full-time first degree graduates went into full-time paid employment, while the comparable figure for veterinary science was 85.9% and for subjects allied to medicine it was 75.1% (Figure 12.4). These three subject areas always have very high full-time paid graduate employment rates, which distorts the average for all subjects upwards. This re-emphasises the success of engineering and technology in achieving an above-average graduate employment rate.

Analysis by the Office of National Statistics[653] has shown that graduates typically have a higher employment rates than non-graduates. In Q4 of 2011, 86.0% of all graduates were in employment, compared with under three quarters (72.3%) of non-graduates.

Figure 12.1 shows the destination of all graduates and engineering and technology graduates, broken down by gender. It shows that the percentage of all graduates going into full-time paid employment was similar for males and females (52.0% compared with 51.8%). However, when you look at engineering and technology there is a sharp distinction, with 58.6% of male graduates going into full-time employment compared with 55.8% of female graduates.

Overall, 87.0% of male engineering and technology graduates went into some form of paid work or further study. The comparable figure for women was slightly lower, at 86.6%.

Female engineering and technology graduates were also less likely than their male counterparts to go onto further study (11.8% compared with 13.0%). But female graduates were more likely to go into part-time paid employment (9.2% of females compared with 5.2% of males). This is perhaps not surprising when one considers that part-time employment is particularly pronounced for women,[654] with 5.2 million women employed part-time compared with 1.5 million men.

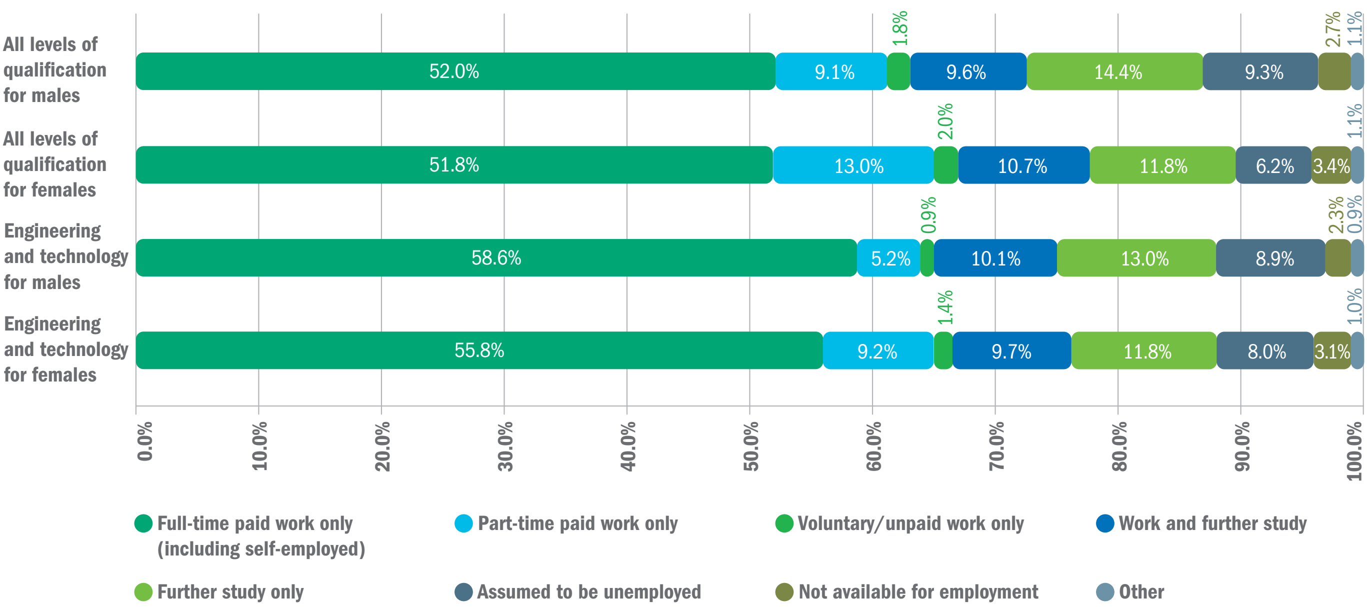
Examining the destination of engineering and technology graduates by level of study (Figure 12.2) shows a wide variation. Over two thirds (68.8%) of postgraduates went into full-time paid employment. The comparable figure for first degree engineering and technology graduates[655] was 58.9%. However, among other undergraduates[656] it was below half, at 45.5%.

Perhaps unsurprisingly, postgraduates were the least likely to progress into further study, with 7.1% working and studying and 7.6% just studying.

When we examine destinations by study level and gender, the proportion of male engineering and technology graduates going into full-time paid employment exceeded the proportion of females at each level (Figure 12.3). However, the size of the gap between males and females is not consistent across the three study levels. Looking at first degrees, 59.9% of male graduates and 59.3% of female graduates went into full-time paid employment. At postgraduate level, the gap was much wider: 71.1% of males compared with 59.9% of females. Similarly, the gap among other undergraduates was wide, with 46.2% of males going into a full-time paid job, compared with just over a third (37.3%) of females.

It is also noticeable that 33.9% of female other undergraduates went into work and further study, which is far higher that the equivalent figure for males (23.9%).

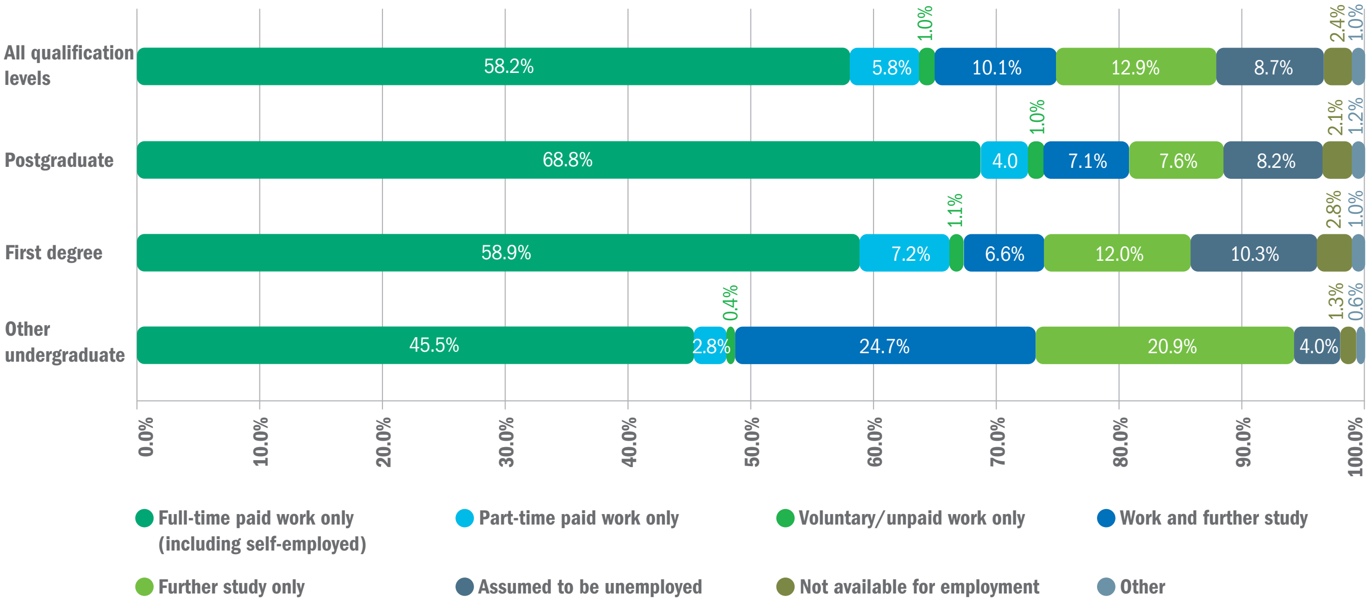
Fig. 12.1: Destinations of leavers of HE (all qualifications) in all subjects and engineering and technology, by gender (2010/11) - UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

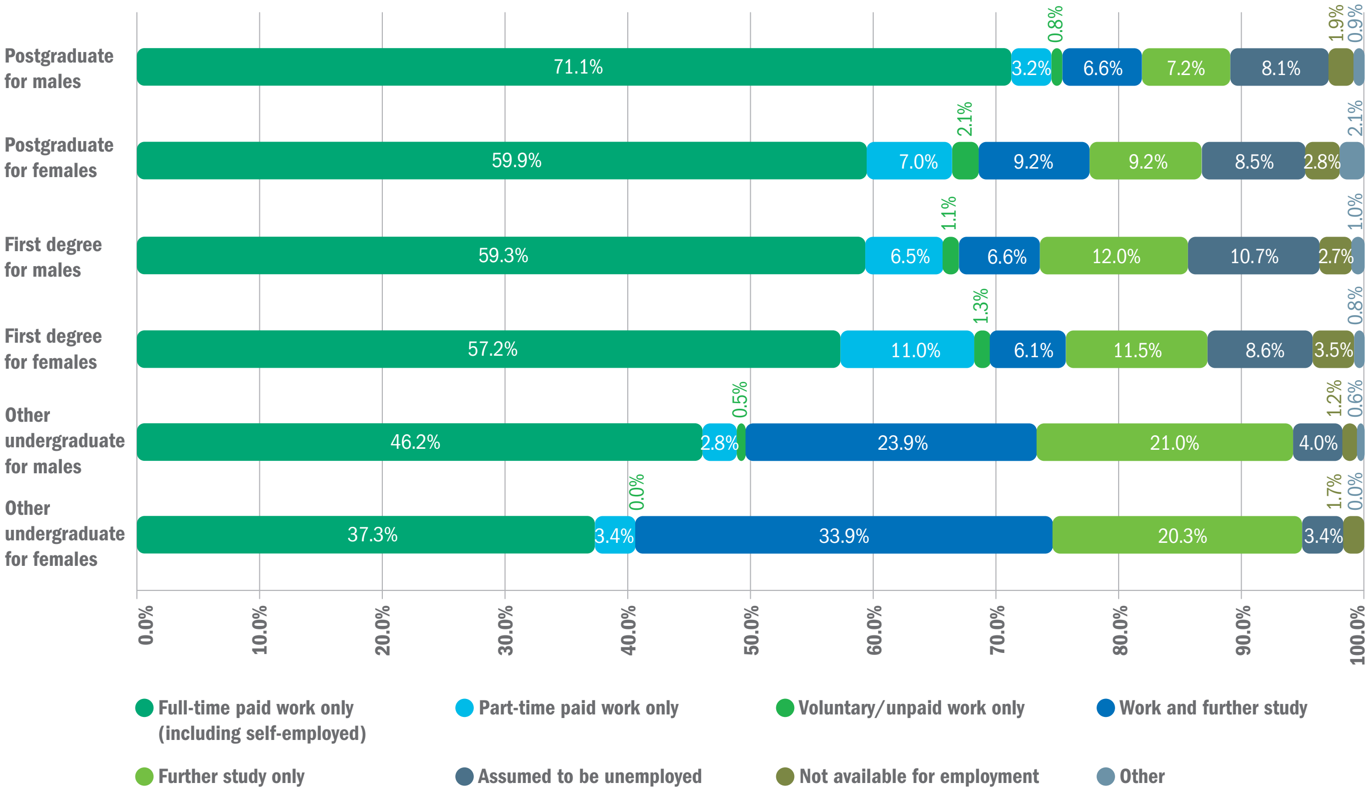
652 *Analysis of HESA Longitudinal Destination of Leavers from Higher Education data, 2010, EngineeringUK,* September 2012 **653** *Graduates in the labour market 2012,* Office for National Statistics, 6 March 2012, p3 **654** *Gender and skills in changing economy,* UKCES, September 2011, pv **655** First degree qualifications obtained includes integrated undergraduate/postgraduate taught master's degrees on the enhanced/extended pattern, including those leading towards obtaining eligibility to register to practise with a health or social care or veterinary statutory regulatory body, and first degrees with honours on the enhanced/extended pattern at level H; first degrees with honours/ordinary first degrees [including those leading to qualified teacher status (QTS)/registration with a General Teaching Council (GTC), but excluding those from the intercalated pattern]; first degrees with honours leading towards registration with the Architects' Registration Board (Part 1 qualification); pre-registration first degrees with honours/ordinary first degrees leading towards obtaining eligibility to register to practise with a health or social care or veterinary statutory regulatory body; first degrees with honours and diploma; postgraduate bachelors degrees at level H.

Fig. 12.2: Destinations of engineering and technology graduates (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

Fig. 12.3: Destinations of engineering and technology graduates, by gender (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

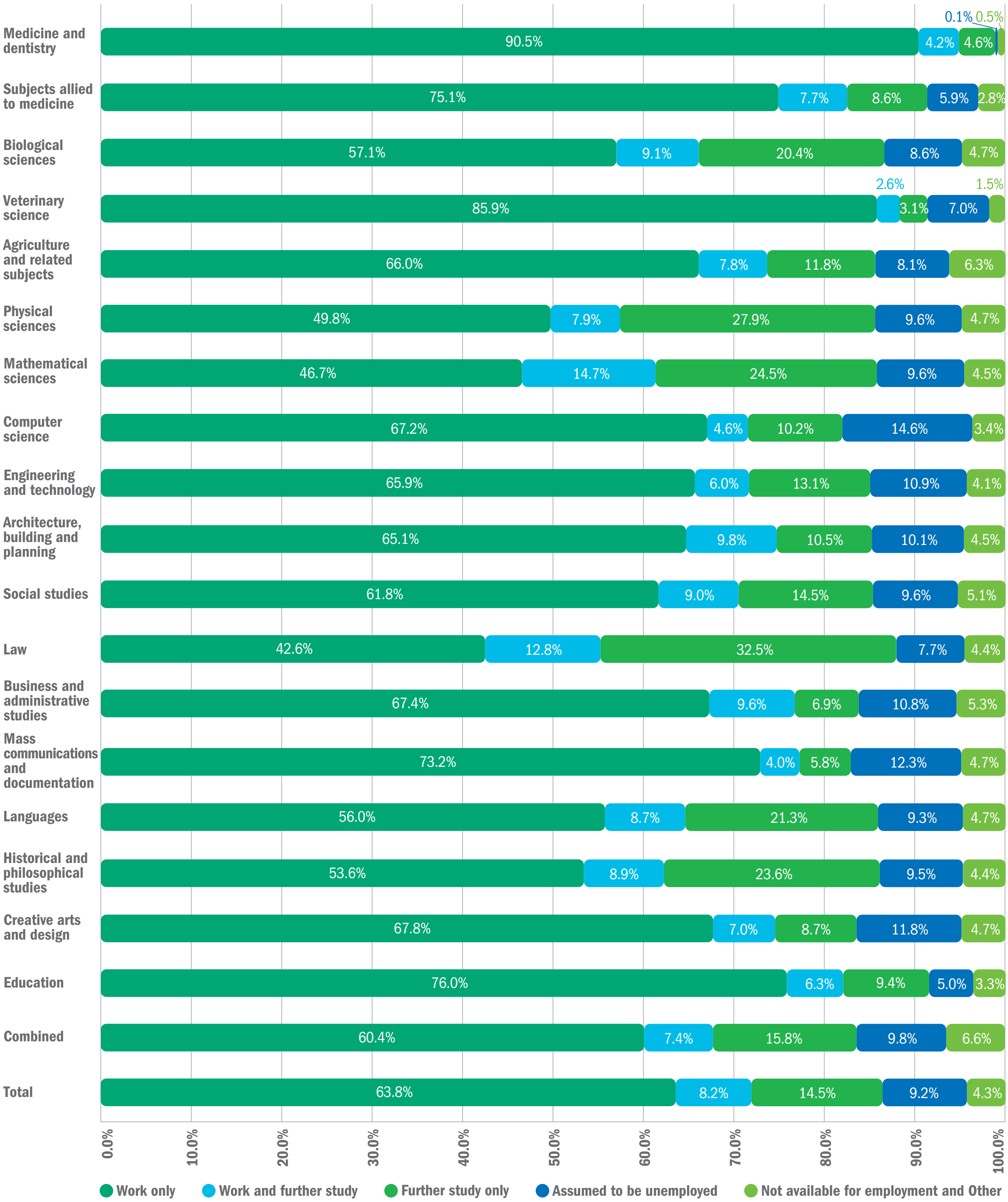
656 Other undergraduate qualifications obtained includes graduate diplomas/ certificates at level H; Professional Graduate Certificates in Education (unless shown separately); other qualifications at level H including those leading towards registration with the Architects' Registration Board (Part 2 qualification); Certificates at level H, graduate diplomas/certificates at level 1; foundation degrees (including those which on completion meet the entry requirement for pre-registration health or social care qualification); Diplomas of Higher Education (DipHE) (including those leading towards obtaining eligibility to register to practise with a health or social care or veterinary statutory regulatory body); Higher National Diplomas (HND); Certificates of Higher Education (CertHE); Higher National Certificates (HNC); Diplomas at level H (but excluding those specifically for Teaching in the Lifelong Learning Sector).

12.2 Destination of full-time first degree qualifiers

Figure 12.4 shows the destination of full-time first degree graduates by subject area for 2010/11. It shows that certain subjects areas, in particular the medically-based subjects, have a particularly high proportion of graduates going into employment. For medicine and dentistry the employment rate is 90.5%, for veterinary science it is 85.9% and for subjects allied to medicine it is 75.1%.

Conversely, three subject areas had fewer than half their full-time first degree graduates go into employment. These were law (42.6%), mathematical sciences (46.7%) and physical sciences (49.8%). However, a large percentage of graduates in all these

Fig. 12.4: Destinations of all full-time first degree graduates (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

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study areas went onto further study only (law 32.5%, mathematical sciences 24.5% and physical sciences 27.9%).

Nearly two thirds (65.9%) of full-time first degree graduates in engineering went into employment: above the average for all subjects of 63.8%. However, the percentage of engineering and technology graduates who were unemployed was also higher than average, at 10.9% against 9.2%.

12.3 Occupation of engineering and technology graduates

The DLHE data provided by HESA also provides a breakdown of type of occupation[657] for qualifiers six months after graduation. Figure 12.5 shows the trend for entering engineering and technology occupations, science and maths occupations, and non-STEM occupations over a seven-year period for those with a first degree in engineering and technology.

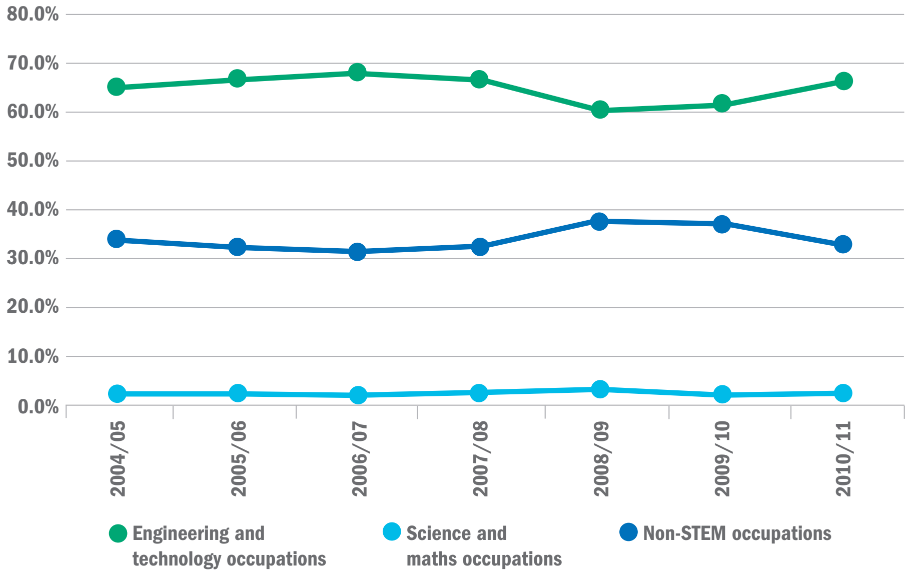
In 2010/11, the percentage of first degree engineering and technology graduates going into an engineering and technology occupation was 65.6%. The percentage of graduates going into an engineering and technology occupation rose steadily until 2006/07. Then, as the recession hit, the percentage fell back to a low point of 60.0% in 2008/09 before starting to rise again.

It is noticeable that the proportion of graduates going into a science and maths occupation has barely fluctuated over the seven years, hovering around 2.0%. Instead, when there was a fall in graduates going into engineering and technology occupations, there was a rise in those going into non-STEM occupations and vice versa.

It is worth mentioning that in its analysis of STEM subjects, the House of Lords Select Committee on Science and Technology[658] said that only 2% of engineering graduates went to work in the financial sector, compared with 4% of physical sciences graduates and 20% of mathematical sciences graduates.

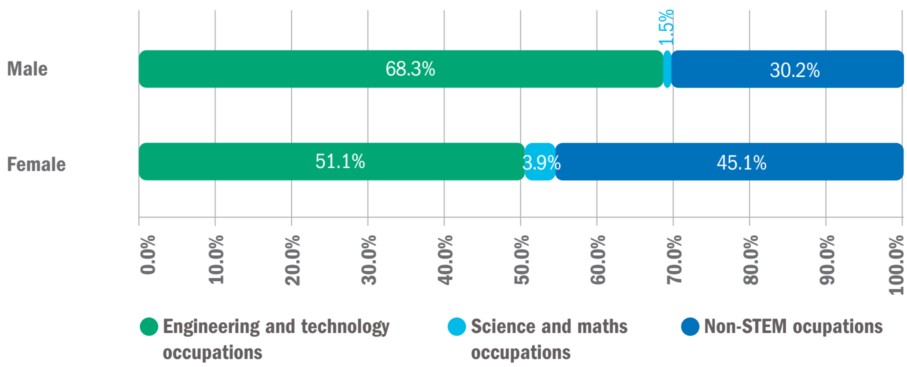
Looking at the destination of first degree graduates by gender shows a very stark gender divide (Figure 12.6). Over two thirds (68.3%) of male first degree graduates went

Fig. 12.5: Occupation of engineering and technology graduates who obtained first degrees (2004/05-2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

Fig. 12.6: Occupation of engineering and technology graduates who obtained first degrees, by gender (2009/10) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

into an engineering and technology occupation. The comparable figure for women was 51.1%. Conversely, just under a third (30.2%) of males went into a non-STEM career, compared with 45.1% of women.

Figure 12.7 shows the proportion of engineering and technology postgraduates going into different occupations within six months of graduating. From 2006/07, when it was 62.5%, there was a steady decline in the proportion of postgraduates going into an engineering and technology occupation until 2009/10. However, there was a sharp rebound in 2010/11 when it rose from 56.0% in 2009/10 to 62.3%.

Conversely, as the percentage of those going into engineering and technology occupations declined, the proportion going into non-STEM qualification rose. But this fell back sharply in 2010/11.

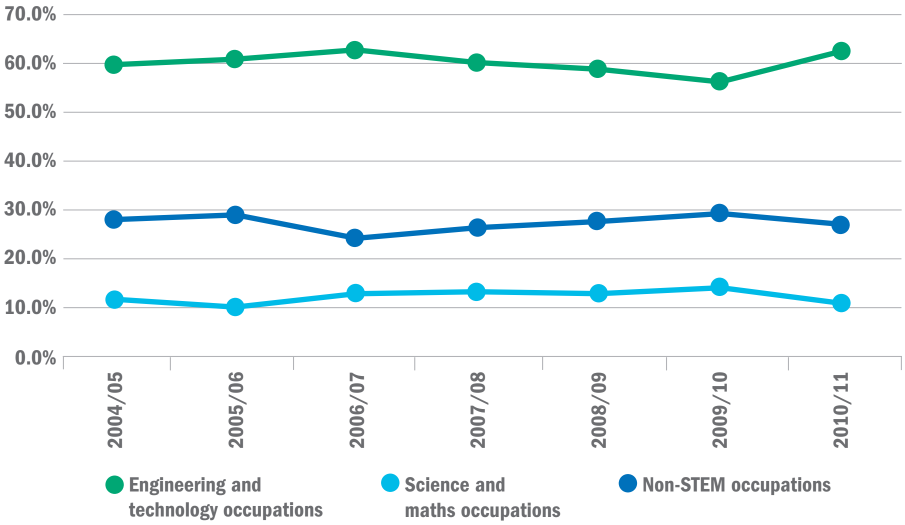
The proportion of postgraduates going into science and maths occupations has fluctuated over the seven years and these fluctuations have broadly been in line with the changes in the proportion going into

657 By Standard Occupational Classification (SOC) code. For further details see Table 17.4 in the Annex (http://www.engineeringuk.com/what_we_do/education_&_skills/engineering_uk_13.cfm).
658 *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects,* House Of Lords Select Committee on Science and Technology, July 2012, p34

engineering and technology occupations. When the proportion going into engineering and technology rises, the proportion going into science and maths falls, and vice versa.

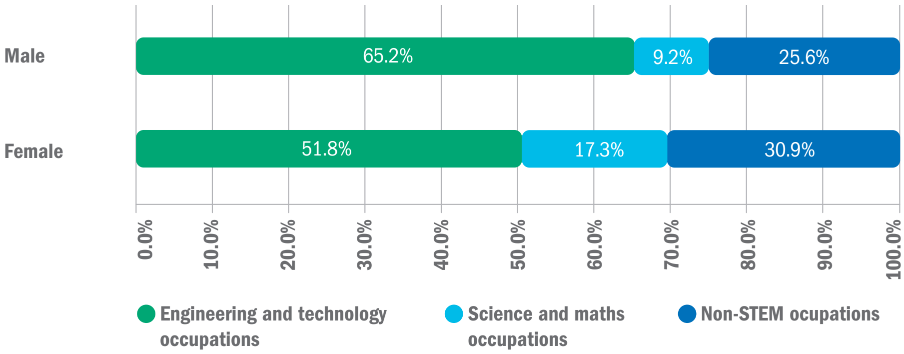
Looking at the occupation of engineering and technology postgraduates highlights the fact that around two thirds (65.2%) of male postgraduates go into an engineering and technology occupation, compared with just over half (51.8%) of females(Figure 12.8). Female postgraduates are almost twice as likely as male postgraduates to go into a science and maths occupation (17.3% compared with 9.2%).

Fig. 12.7: Occupation of engineering and technology graduates who obtained a postgraduate qualification (2004/05-2010/11) – UK domiciled

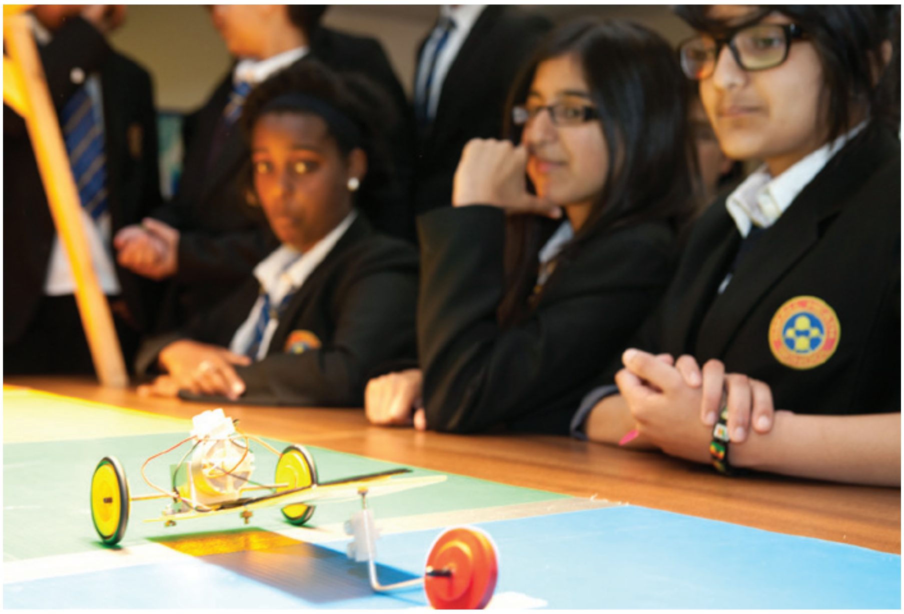


Source: HESA/Destinations of Leavers from Higher Education Institutions

Fig. 12.8: Occupation of engineering and technology graduates who obtained a postgraduate qualification, by gender (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

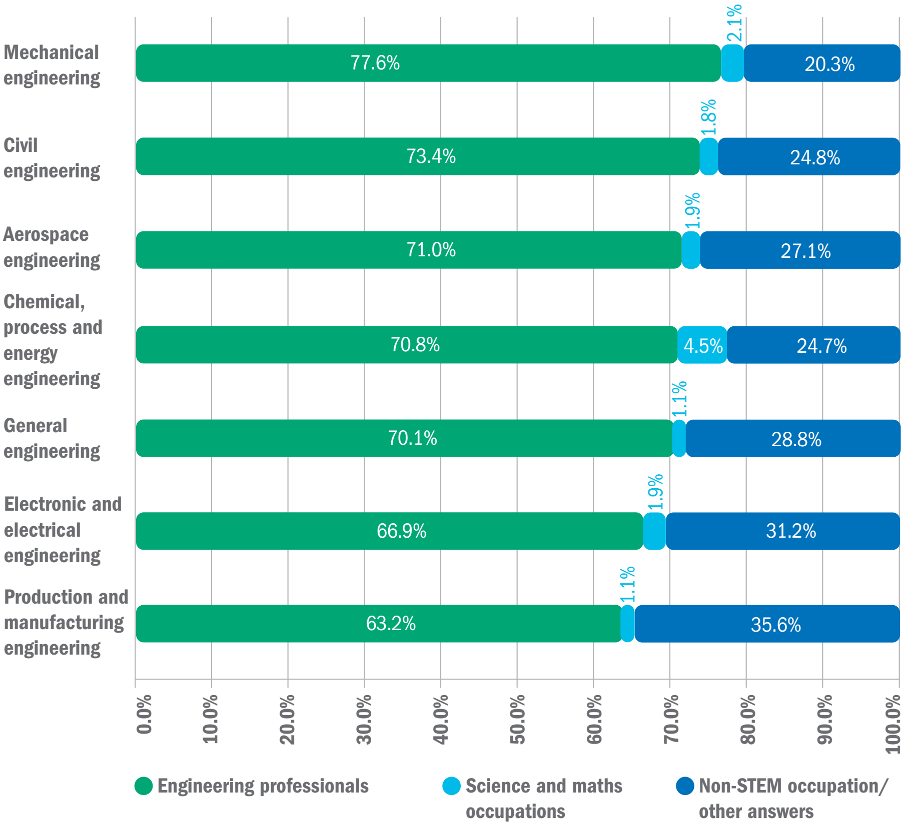


12.4 Occupations by selected engineering and technology sub-disciplines

The percentage of first degree engineering and technology graduates who enter an engineering and technology occupation does vary by selected engineering sub-disciplines (Figure 12.9). Just over three quarters (77.6%) of graduates from mechanical engineering went into an engineering and technology career. Civil engineering, aerospace engineering, chemical process and energy engineering and general engineering all had more than 70% of their graduates go into an engineering and technology occupation. By comparison, less than two thirds (63.2%) of production and manufacturing engineering graduates went into an engineering and technology occupation and over a third (35.6%) went into a non-STEM occupation.

Most of the selected engineering sub-disciplines had around 1-2% of their graduates go into a science and maths occupation. The exception was chemical, process and energy engineering, where 4.5% went into a science and maths occupation.

Fig. 12.9: Occupation type of qualifiers who obtained first degrees in engineering by sub-discipline (2010/11) – UK domiciled



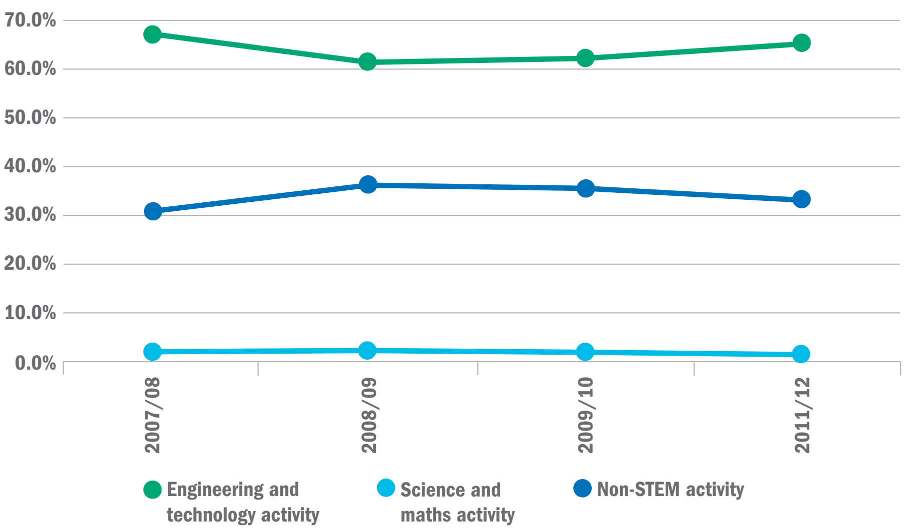
Source: HESA/Destinations of Leavers from Higher Education Institutions

12.5 Types of industry

It is also possible to examine the destination of qualifiers by Standard Industrial Classification (SIC) codes.[659] The SIC code denotes the primary occupation of the employer. However, it should be noted that the actual role of individuals within a company can be very different to the primary activity of the employer.

In 2007/08, two thirds (67.0%) of those graduating with a first degree in engineering and technology went to work for an employer whose primary activity was engineering and technology (Figure 12.10). This fell back to 61.4% in 2008/09, as the recession started. However, although levels are still below those of 2007/8, there has been steady growth in the last two years, with the proportion reaching 65.4% in 2010/11. As the proportion of graduates going to work in engineering- and technology-related companies fell, the proportion going to work for non-STEM-related companies increased. The proportion of engineering and technology graduates going into science and maths careers has barely moved over the four years.

Fig. 12.10: Employer destinations for engineering and technology subject area leavers who obtained first degree and entered employment by primary activity of employer (2007/08-2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

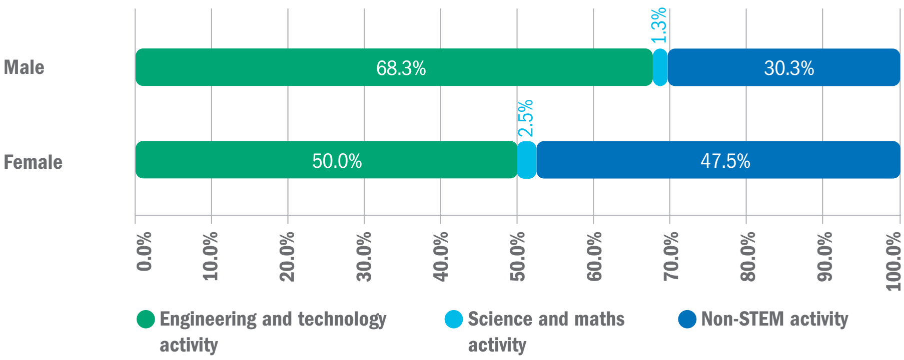
659 Standard Industrial Classification (SIC) codes. For further details see Table 17.8 in the Annex (http://www.engineeringuk.com/what_we_do/education_&_skills/engineering_uk_13.cfm)

Figure 12.11 shows the employer destinations for first degree engineering and technology graduates by employer type and gender. It shows that over two thirds (68.3%) of male graduates went to work for an employer whose primary activity was engineering and technology, but for females it was only half (50.0%). Nearly half (47.5%) of females went to work for an employer whose primary activity was not STEM, compared with almost a third (30.3%) of male graduates.

In 2007/08, over two thirds (69.3%) of engineering and technology postgraduates went to work for an employer whose primary activity was engineering- and technology-related (Figure 12.12). The impact of the recession led to a two-year decline in the proportion going to work for engineering and technology employers, reaching a low point of 62.5% in 2009/10. But the proportion rebounded to 68.0% in 2010/11. As the proportion going to work for engineering and technology employers increased, the proportion going to work for non-STEM employers increased.

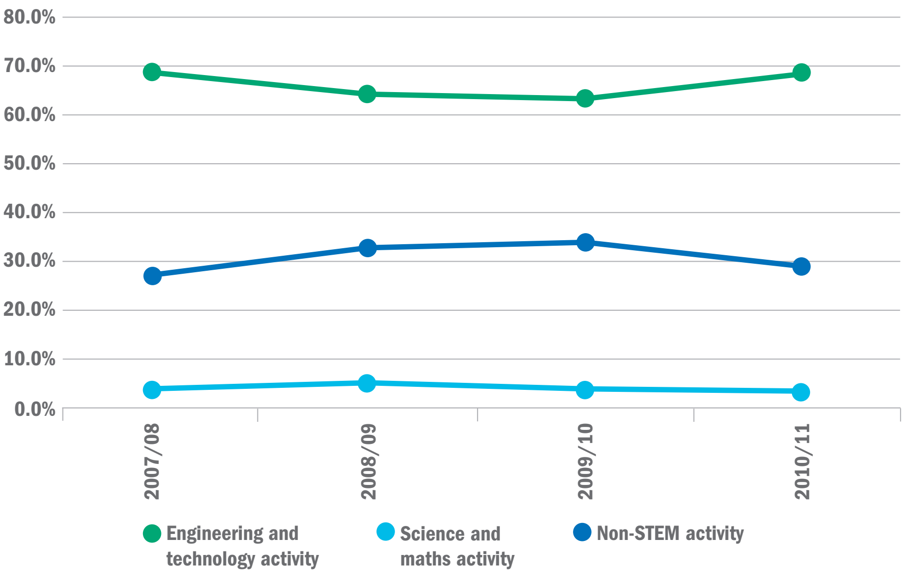
Nearly three quarters (70.5%) of male engineering and technology postgraduates go to work for an employer whose primary activity is engineering and technology (Figure 12.13). However, for women it is less than two thirds (57.3%). Female postgraduates are twice as likely as male postgraduates to go a work for an employer whose primary activity is science and maths (5.5% compared with 2.5%).

Fig. 12.11: Employer destinations for engineering and technology subject area leavers who obtained first degree and entered employment by primary activity of employer and by gender (2010/11) – UK domiciled



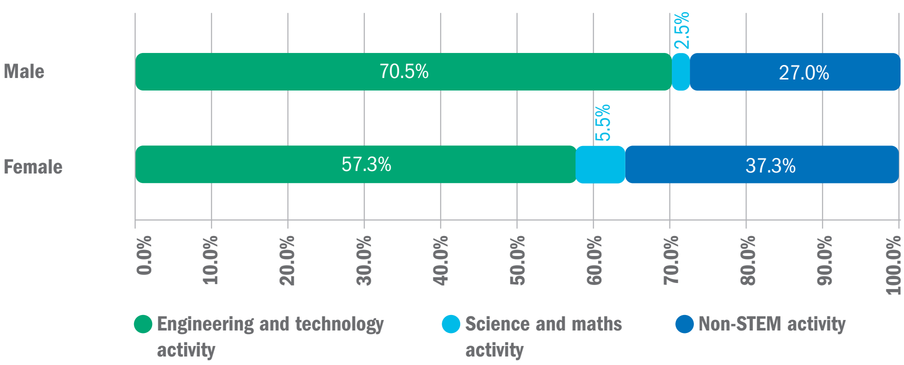
Source: HESA/Destinations of Leavers from Higher Education Institutions

Fig. 12.12: Employer destinations for engineering and technology subject area leavers who obtained postgraduate degree and entered employment by primary activity of employer (2007/08-2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

Fig. 12.13: Employer destinations for engineering and technology subject area leavers who obtained postgraduate degree and entered employment by primary activity of employer and by gender (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

12.6 Industry type by selected engineering sub-disciplines

Figure 12.14 looks at employer destinations for engineering and technology first degree graduates by selected sub-disciplines, and shows considerable variations.

For mechanical engineering, 760 graduates went to work for a manufacturer, while 340 went to a company doing professional, scientific and technical activities.

Two employer types took the majority of civil engineering graduates. These were construction (480 graduates) and professional, scientific and technical activities (470 graduates).

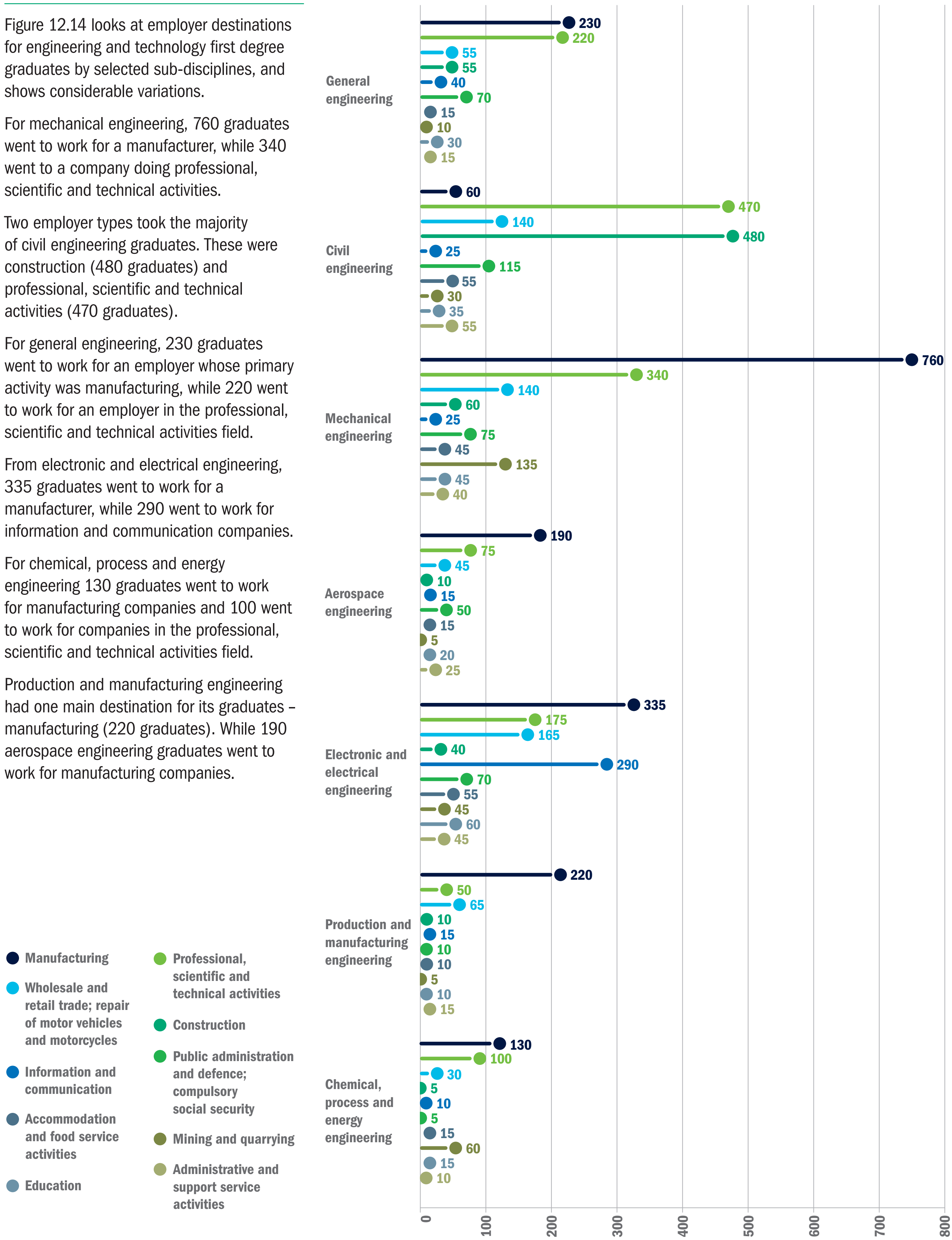
For general engineering, 230 graduates went to work for an employer whose primary activity was manufacturing, while 220 went to work for an employer in the professional, scientific and technical activities field.

From electronic and electrical engineering, 335 graduates went to work for a manufacturer, while 290 went to work for information and communication companies.

For chemical, process and energy engineering 130 graduates went to work for manufacturing companies and 100 went to work for companies in the professional, scientific and technical activities field.

Production and manufacturing engineering had one main destination for its graduates – manufacturing (220 graduates). While 190 aerospace engineering graduates went to work for manufacturing companies.

Fig. 12.14: Employer destinations for engineering and technology graduates who obtained first degree qualifications, by SIC (2010/11) – UK domiciled



Source: HESA/Destinations of Leavers from Higher Education Institutions

12.7 Number of non-engineering and technology graduates going to work in engineering and technology

As well as using the HESA data to look at the destination of first degree engineering and technology graduates, it is also possible to explore the percentage of non-engineering and technology graduates who have gone into employment and are working in an engineering and technology occupation (Table 12.0).[660] Three non-engineering and technology subject areas have been examined in detail: computer science, physical sciences and mathematical sciences. They show that just over half (51.5%) of computer science graduates go into an engineering and technology occupation. One in nine (11.0%) of physical science graduates and one in ten (10.0%) of mathematical sciences graduates also went into an engineering and technology occupation.

Table 12.1 shows the occupation of non-engineering and technology graduates who go into an engineering and technology career. It shows that out of the 1,355 non-engineering and technology graduates who went into an engineering and technology occupation, 555 went into IT service delivery, 345 became engineering professionals and 150 went into elementary trades, plant and storage-related occupations.

Table 12.0: Number of non-engineering and technology first degree graduates going into an engineering and technology occupation (2010/11) – UK domiciled[661]

	First degree	Percentage entering an engineering and technology occupation
Computer science	6,175	51.5%
Physical sciences	6,400	11.0%
Mathematical sciences	2,845	10.0%

Source: HESA/Destinations of Leavers from Higher Education Institutions

Table 12.1: Main occupation destinations for first degree non-engineering and technology graduates going into an engineering and technology occupation (2010/11) – UK domiciled

	Actual number of graduates
IT service delivery occupations	555
Engineering professionals	345
Elementary trades, plant and storage-related occupations	150
Production managers	85
Skilled metal and electrical trades	75
Architects, town planners, surveyors	55
Process, plant and machine operatives	50
Draughtspersons and building inspectors	20
Skilled construction and building trades	20
Total	1,355

Source: HESA/Destinations of Leavers from Higher Education Institutions

660 Standard Occupational Classification 2000 code. For further details see Table 17.6 in the Annex (http://www.engineeringuk.com/what_we_do/education_&_skills/engineering_uk_13.cfm) 661 Only those non-engineering and technology graduates who go into employment have been included in this analysis.

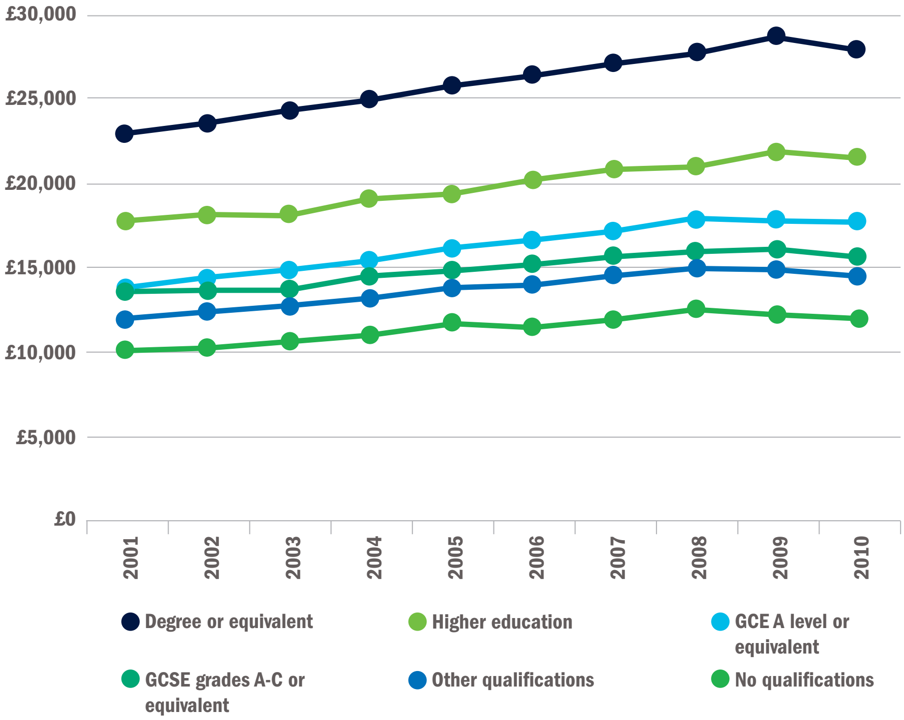
Part 3 – Engineering in Employment
13.0 Graduate recruitment and salaries

In this section we explore the recruitment and salaries of recent graduates. Before that, however, it is worth noting the premium that is paid to all graduates.

13.1 The graduate premium in the labour market

Analysis by the Office of National Statistics shows the average annual earnings by qualification level over a 10-year period (Figure 13.0). It shows that there is a substantial wage premium for those with a degree. In 2010, graduates earned on average £28,065.35, which was more than twice the earnings of those with no qualifications (£12,003.46). The figure also shows that generally speaking there were steady increases in the salaries being paid until the recession started to take effect. Annual salaries for those with other qualifications or no qualifications started to decline in 2009. However, for all other qualification groups the decline in salary took affect one year later in 2010.

Fig. 13.0: Average annual earnings by qualification level (2001-2010) – UK



Source: Office for National Statistics

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The Office of National Statistics[662] also published statistics on the median hourly wage for graduates aged 21-64 by their degree subject area (Figure 13.1). It shows that the highest paid graduates are those who studied medicine and dentistry (£21.29 per hour). Mathematical sciences, engineering, technology and architecture all came joint second, with a median salary of £18.92 per hour (24.6% more than the median for all graduates, which is £15.18). This was then followed by physical or environmental sciences on £17.74 (16.9% more). The median hourly wage for non-graduates was £8.92. This is supported by our own analysis of the longitudinal Destinations of Leavers from Higher Education Institutions (DLHE) data provided by the Higher Education Statistics Agency (HESA). This shows that among those who graduated in 2006/07, graduating engineers had the joint third highest median salary in 2010 (£28,000), behind medicine and dentistry (£40,000) and veterinary science (£30,000).[663]

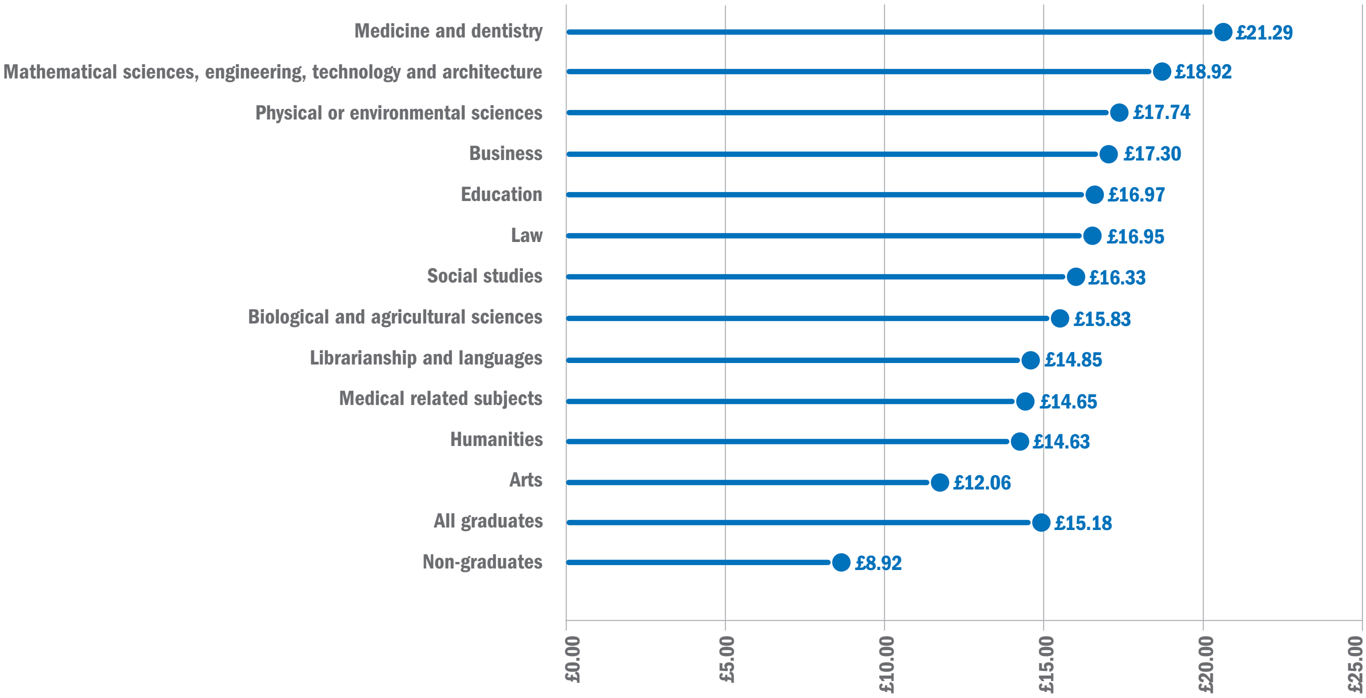
This graduate premium is supported by findings in the *Engineering UK Report 2012*[664] that the average undergraduate premium (taking into account the costs associated with a degree) is approximately £108,121, compared with someone with two A levels. For engineering, however, it was substantially higher, at around 33% or approximately £143,959.

In addition, research undertaken by the UK Commission for Employment and Skills (UKCES)[665] on HE graduates who studied part time but who are in full-time employment three and a half years after graduating, shows that they earn more than similar students who studied full-time. The research also notes that the contribution of these graduates to economic prosperity exceeds that of graduates from full-time study three and a half years after graduation.[666]

Finally, research by the Department for Business, Innovation and Skills has shown that the average salary of graduates six months after graduation is 8% higher for those who did a sandwich placement than for those who didn't do a sandwich placement.[667]

According to the CBI,[668] one in five jobs now requires degree-level skills and this is predicted to rise in the future. In addition, about a fifth of graduate-level jobs need the applicant to have studied a specific discipline at university.

Fig. 13.1: Median hourly wage for all graduates (4 quarter average) by degree subject studied for those aged 21-64 (2001-2011) – UK



Source: Office for National Statistics

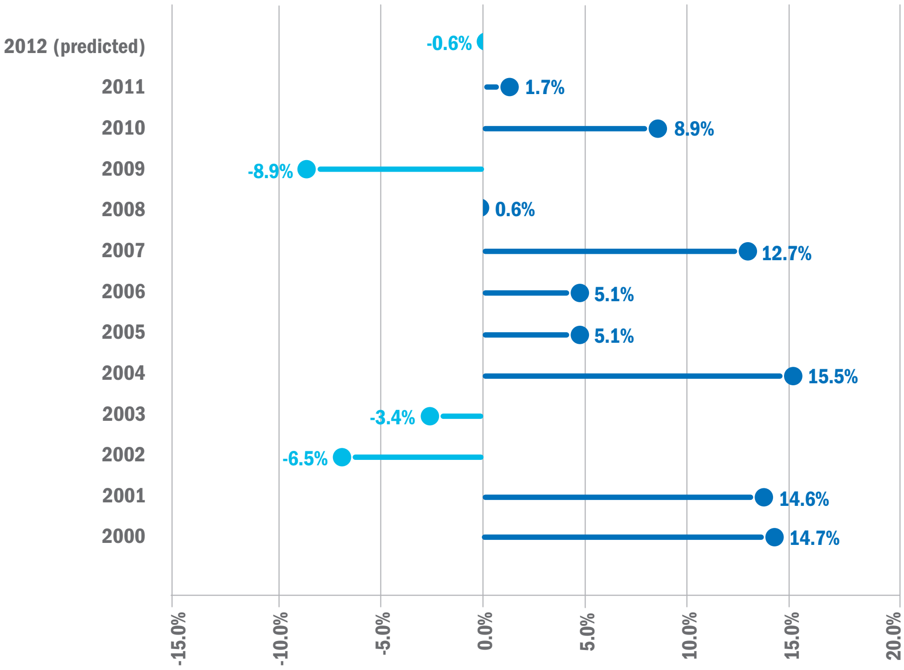
662 *Graduates in the labour market 2012,* Office for National Statistics, 6th March 2012, p4 **663** *Analysis of HESA Longitudinal Destination of Leavers from Higher Education data, 2010,* EngineeringUK, September 2012 **664** *Engineering UK Report 2012 – the state of engineering,* EngineeringUK, December 2011, p223 **665** *Impact of Higher Education for PT students,* UKCES, September 2010, p4 **666** *Impact of Higher Education for PT students,* UKCES, September 2010, p3 **667** *Following Up the Wilson Review of Business-University Collaboration,* Department for Business, Innovation and Skills, June 2012, p14 **668** *Learning to grow: what employers need from education and skills Education and Skills survey 2012, CBI,* June 2012, p7

13.2 Graduate vacancies

The Association of Graduate Recruiters (AGR) conducts two annual surveys looking at recruitment trends in some of the UK's largest graduate recruiters. In the most recent of these two surveys, the summer review, the AGR interviewed 215 AGR employers and estimated that they would offer a total of 21,194 graduate vacancies.[669]

Figure 13.2 shows the percentage change in the number of graduate vacancies offered over a 13-year period, with the predicted change for 2012. It shows that AGR members expect the number of vacancies to decline slightly by 0.6% in 2012. This follows two years of expansion, with vacancy numbers growing 8.9% in 2010 and 1.7% in 2011. In 2011/12, it is worth noting that the percentage change in the number of vacancies on the previous year is not equal across all industry sectors (Table 13.0). Demand for graduates in energy, water or utility companies has risen by 147.6%, making it the highest riser. In addition, IT/telecommunications showed predicted growth of 72.5% and engineering and industrial companies expected demand for graduates to rise by 60.2%. Conversely, demand for graduates in construction or consultancy dropped by 56.6%. This was the second largest fall, behind investment bank or fund manager (down 66.6%).

Fig. 13.2: Graduate vacancy changes at AGR employers (2000-2012)



Source: Association of Graduate Recruiters Summer Survey 2012

Table 13.0: Expected percentage changes in number of vacancies by sector (2010/11-2011/12)

Energy, water or utility company	147.6%
IT/telecommunications company	72.5%
Engineering or industrial company	60.2%
Public sector	47.3%
Transport or logistics company	7.5%
Accountancy or professional services firm	1.5%
Consulting or business services firm	-5.2%
Law firm	-16.5%
FMCG company	-18.8%
Retail	-19.7%
Banking or financial services	-23.6%
Insurance company	-26.5%
Construction company or consultancy	-56.6%
Investment bank or fund managers	-66.6%

Source: Association of Graduate Recruiters Summer Survey 2012

669 *The AGR Graduate Recruitment Survey 2012 Summer Review*, The Association of Graduate Recruiters, 2012, p8

The number of applications per vacancy also varied by sector (Figure 13.3). On average, AGR employers received 73.2 applications per place. Energy, water or utility company vacancies were well above this average, receiving 94.8 applications per place, while IT/telecommunications vacancies were just above the average, with 76.3 applicants per place. However, several sectors which employ large numbers of engineers also had below-average numbers of applications per place. This included engineering and industrial companies (50.8) and construction companies or consultancy (50.3).

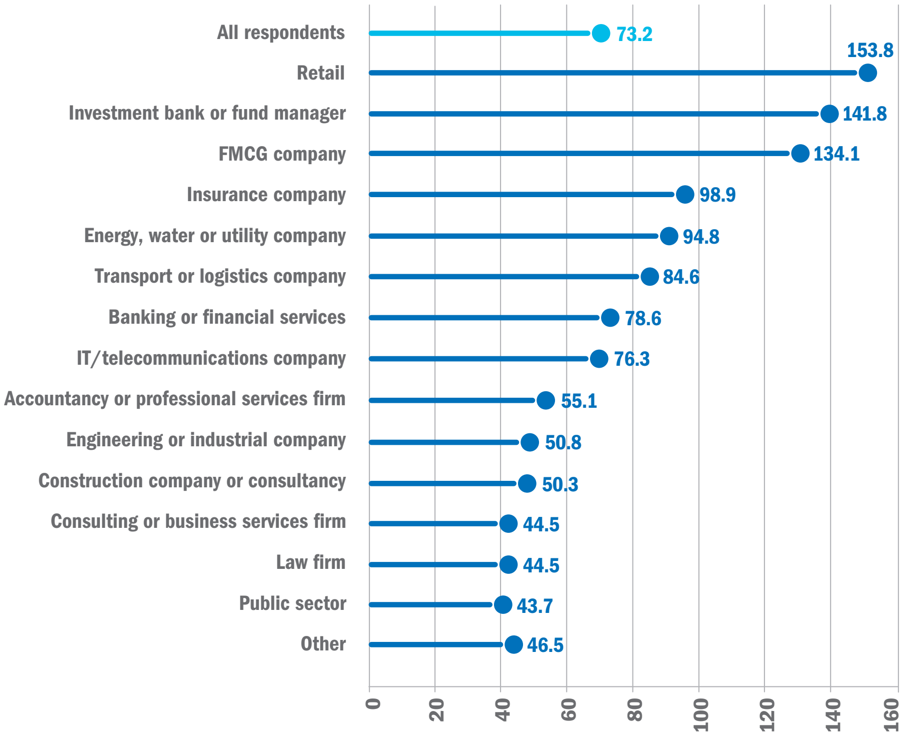
Retail had the largest number of applicants per place, at 153.8, with investment bank or fund managers second at 141.8. The high number of applicants per place investment bank or fund manager positions could be caused by the two thirds (66.6%) decline in the number of graduate vacancies on offer. The public sector had the lowest number of applicants per place, at just 43.7. This could be a result of the austerity measures and graduates thinking there are not many vacancies available in the public sector.

13.3 Graduate starting salaries

The AGR has measured the predicted change in graduate median starting salaries over a 13-year period (Figure 13.4). This shows that following three years of no predicted growth in salaries, growth is expected to be 4.0% in 2012. However, a note of caution needs to exercised, in that AGR employers predicted 2.0% growth in median starting salaries in 2011, which in reality became zero per cent growth.

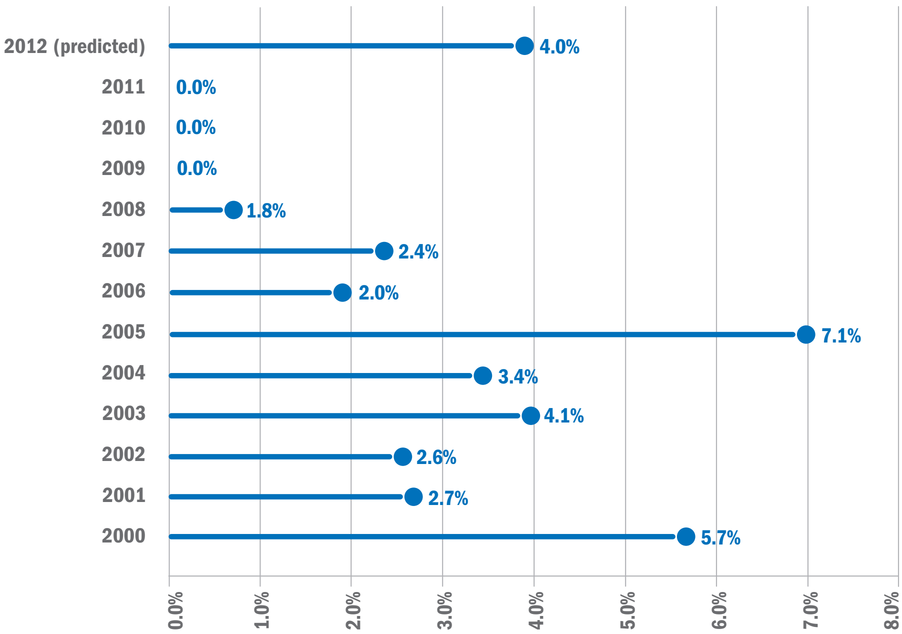
Although overall median graduate starting salaries are predicted to rise by 4.0%, growth is not even across all sectors (Table 13.1). Investment banking or fund managers (£38,250) and law firm (£37,000) are the two highest-paid sectors. However, starting salaries are not predicted to rise in 2011/12 in either of these sectors. The two lowest paid sectors are public sector and consulting or business services firms, both of which have a median starting salary of £23,000. Although salaries are predicted to growth in both of these sectors in 2011/12, growth is predicted at 10.9% for consulting or business services firms, the highest of all the sectors.

Fig. 13.3: Number of applications per vacancy received by AGR employers by sector (2011/12)



Source: Association of Graduate Recruiters Summer Survey 2012

Fig. 13.4: Changes in median graduate starting salaries at AGR employers (2000-2012)



Source: Association of Graduate Recruiters Summer Survey 2012

Table 13.1: Median predicted graduate starting salary by sector and percentage change from previous year (2010/11-2011/12)

	2010/11 salary	Expected percentage change in 2011/12
Investment bank or fund managers	£38,250	0.0%
Law firm	£37,000	0.0%
Banking or financial services	£28,000	1.8%
Insurance company	£26,000	0.0%
IT/telecommunications company	£26,000	1.0%
FMCG company	£25,750	6.8%
Energy, water or utility company	£25,000	2.0%
Accountancy or professional services firm	£24,750	8.1%
Transport or logistics company	£24,500	0.0%
Engineering or industrial company	£24,000	4.2%
Retail	£24,000	0.0%
Construction company or consultancy	£23,250	3.2%
Consulting or business services firm	£23,000	10.9%
Public sector	£23,000	3.3%

Source: Association of Graduate Recruiters Winter Survey 2012 and Summer Survey 2012

IT/telecommunications is the fourth highest paid sector, with starting salaries of £26,000 in 2010/11. These are projected to rise by one per cent in 2011/12. Energy, water or utility companies have a median graduate starting salary of £25,000 and a projected pay rise of 2.0%. Construction companies or consultancy have the third lowest median starting salary, at £23,250, but growth of 3.2% is projected for 2011/12. Finally, engineering or industrial companies have a median starting salary of £24,000, with pay expected to grow by 4.2% in 2011/12, making it has the third highest projected pay rise.

Looking at the median predicted graduate starting salary by career area (Table 13.2) shows that investment banking has the highest starting salary (£38,250), followed by legal work (£36,000). Median graduate starting salaries for different engineering careers were much lower, with electrical/ electronic engineering being the highest paid (£25,500). Mechanical engineering had a starting salary of £25,000, while civil engineering had the second lowest starting salary at £24,500, just above retail management on £24,000.

Our own research through the *Engineers and Engineering Brand Monitor*[670] has shown that the most important factor in choosing a career for 12- to 16-year-olds and 17- to 19-year-olds is finding something they are interested in. This reinforces the point that perceived interest and enjoyment are critical for improving the appeal of engineering to young people. Perceptions of pay are the second most important factor for young people when choosing a career.

Table 13.2: Median predicted graduate starting salary by career area (2011/12)

Investment banking	£38,250
Legal work	£36,000
Actuarial work	£28,000
Consulting	£27,750
Manufacturing engineers	£26,750
IT	£26,500
Sales	£26,500
Financial management	£26,250
Logistics	£26,250
Research and development	£26,250
Science	£25,500
Electrical/electronic engineering	£25,500
Purchasing	£25,500
Human resources	£25,500
Accountancy	£25,000
General management	£25,000
Mechanical engineering	£25,000
Marketing	£25,000
Civil engineering	£24,500
Retail management	£24,000

Source: Association of Graduate Recruiters Summer Survey 2012

670 *Engineers and Engineering Brand Monitor,* FreshMinds Research, August 2012

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In its DHLE survey,[671] HESA asks those graduates who are in employment what their salary is. Using this data, it is possible to calculate a mean average starting salary[672 673] for graduates from different subject areas (Figure 13.5). The highest graduate starting salary is for those who graduated in medicine and dentistry (£32,546). The second highest graduate starting salary is for graduates of engineering and technology: at £25,762, it is 15.7% more than the mean for all graduates. At the other end of the scale, the lowest graduate starting salary was for students of creative arts and design, whose mean starting salary was £15,884.

The mean starting salary for all graduates was £22,274.[674] Two STEM subjects had a below-average starting salary: physical sciences (£21,547) and biological sciences (£18,807). Two other STEM subject areas came in just above the mean starting salary: mathematics at £23,142 and computer science at £22,562.

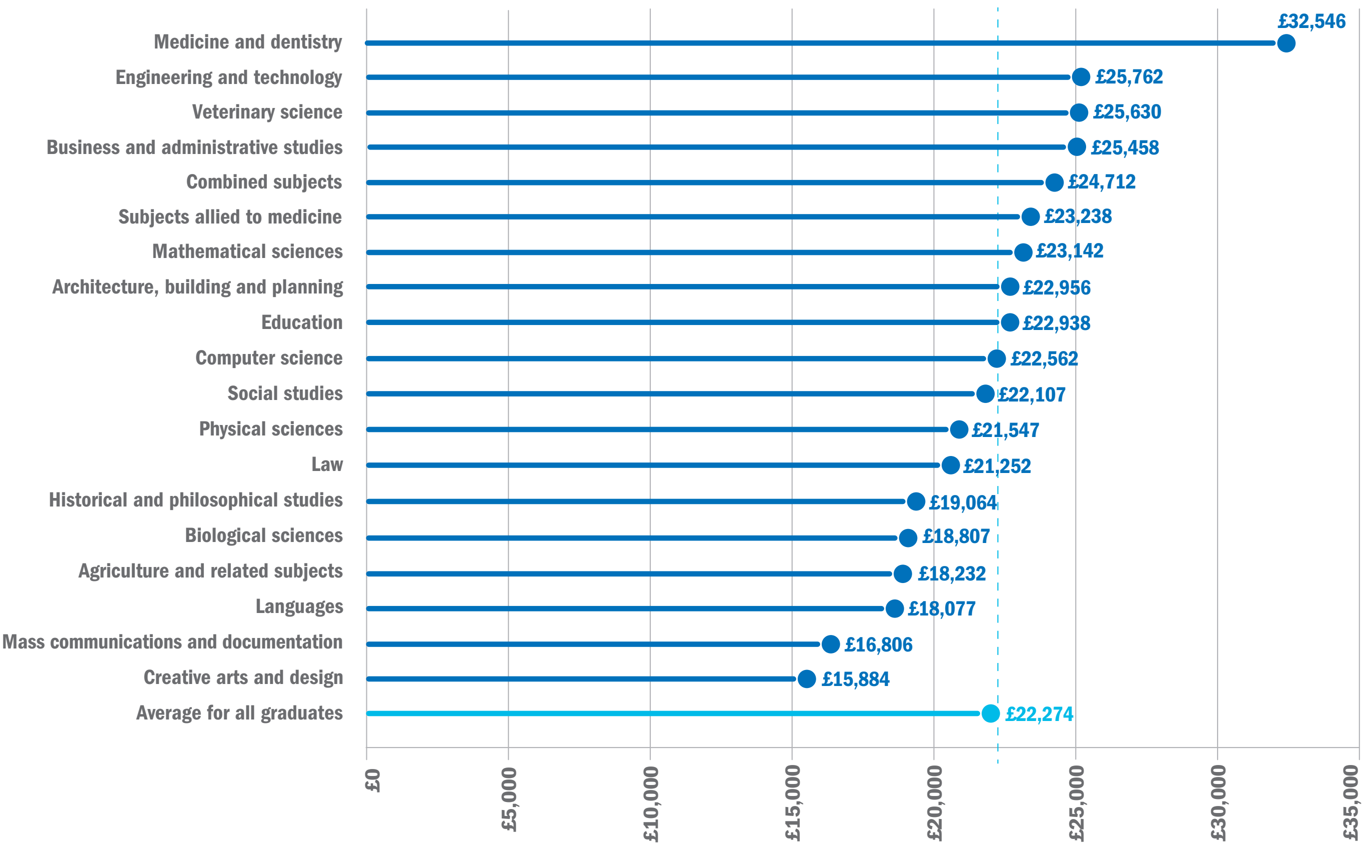
The mean average salary for all engineering graduates in 2010/11, whether they go into an engineering career or not, was £25,762 (Table 13.3).[678] However, on average women only earned 87.9% of the salary of men, at £23,074. The average salary for men was £26,250.

Looking at the different selected sub-disciplines shows that women, on average, earn less than men in all the engineering sub-disciplines. Only civil engineering is close to parity, with women earning 99.3% of the salary of men. Two other sub-disciplines also had women earning at least 90% of the average salary of men – these were chemical, process and energy engineering (97.1%) and mechanical engineering (92.2%). By comparison, the average salary for women doing a production and manufacturing engineering degree was only 79.4% of their male equivalents.

The only sub-discipline where women on average earned more than the average for all engineering students was chemical, process and energy engineering. Here, women earned £27,418 compared with an average of all engineering graduates of £25,762.

The engineering sub-disciplines with the highest mean average pay were general engineering (£29,673) and chemical, process and energy engineering (£28,029). The engineering sub-discipline with the worst mean average salary was civil engineering, on £23,921. Two other sub-disciplines had below average mean salaries: these were electronic and electrical engineering (£24,571) and mechanical engineering (£25,704).

Fig. 13.5: Mean average starting salary for graduates by subject area (2010/11) – UK domiciled[675 676 677]



Source: HESA/Destination of Leavers from Higher Education Institutions (bespoke request)

671 London Metropolitan University, Liverpool Hope University and University College Birmingham are generally excluded from HESA statistics. 672 The salary is their actual salary six months after graduating which, for most, will be their starting salary. But it is acknowledged that some graduates will have received a pay rise during this six month period. 673 Mean starting salary is not as accurate as median starting salary as the mean can be distorted by a few particularly high or low salary figures. Caution should therefore be exercised when looking at this data. 674 Excluding medicine and dentistry from the average salary for all graduates has only a marginal effect on the mean average salary for all graduates as only 5,338 medicine and dentistry graduates answered the salary question. 675 HESA DLHE data is provided in salary brackets: £0-£5, 000 then rising by £1,000 increments until £70,000 and then all salaries over £70,000. In order to calculate the mean average salary, the midpoint was used in each salary bracket. For salaries over £70,000 the salary midpoint used was £85,000. 676 The mean salary can be distorted by a few large salaries. 677 Not all graduates who completed the DLHE survey for 2010/11 provided salary information. 678 9,053 engineering graduates answered the salary question.

Table 13.3: Mean average starting salary for graduates in engineering and technology, by selected sub-discipline and gender (2010/11) – UK domiciled

	All engineering students	Male engineering students	Female engineering students	Female salary as a percentage of male salary
General engineering	£29,673	£30,158	£26,144	86.7%
Civil engineering	£23,921	£23,949	£23,773	99.3%
Mechanical engineering	£25,704	£25,867	£23,845	92.2%
Aerospace engineering	£25,961	£26,318	£23,090	87.7%
Electronic and electrical engineering	£24,571	£24,926	£20,525	82.3%
Production and manufacturing engineering	£26,026	£26,772	£21,258	79.4%
Chemical, process and energy engineering	£28,029	£28,238	£27,418	97.1%
Average for all engineering and technology graduates	£25,762	£26,250	£23,074	87.9%

Source: HESA/Destination of Leavers from Higher Education Institutions (bespoke request)

13.3.1 Graduate starting salaries by gender and type of employer

The HESA DLHE dataset allows us to examine graduate starting salaries by SIC codes.[679] The SIC code reflects the primary occupation of the employer. However, it should be noted that an individual's role can be quite different to the activity of the employer.

Table 13.4 shows the different mean starting salary for engineering and technology graduates, broken down by gender and whether they went to work for an engineering or non-engineering company. The table shows that the average mean salary for all engineering and technology graduates going to work for an engineering employer was £27,415. This was a fifth (22.1%) higher than the mean salary for those graduates who went to work for non-engineering companies (£22,446).

Male graduates who went to work for engineering companies had a mean salary of £27,667, which is 8.1% higher than the mean salary for women (£25,601). Men also earned more than women if they went to work for a non-engineering company, earning on average £23,062, compared with £20,256 for women.

It is therefore apparent that women are doubly disadvantaged when it comes to graduate salaries. As was shown in section 12, female graduates are more likely than male graduates to work for non-engineering companies (where the average graduate starting salaries is lower than for engineering companies). However, regardless of whether women work for an engineering or a non-engineering company, their mean salary is below the mean salary for men.

This is backed up by a finding from the *Engineering UK report 2012,*[680] which showed that for men, the return on an undergraduate engineering degree is around £157,000, while for women, it is just below £100,000.

Table 13.4: Mean starting salary for engineering and technology graduates, by primary activity of employer (2010/11) – UK domiciled

	All engineering and technology graduates	Male engineering and technology graduates	Female engineering and technology graduates
Engineering is the employer's primary activity	£27,415	£27,667	£25,601
Engineering is not the employer's primary activity	£22,446	£23,062	£20,256

Source: HESA/Destination of Leavers from Higher Education Institutions (bespoke request)

679 Standard Industrial Classification 2007 code. For further details see Table 17.10 in the Annex (http://www.engineeringuk.com/what_we_do/education_&_skills/engineering_uk_13.cfm) **680** *Engineering UK Report 2012 – the state of engineering,* EngineeringUK, December 2011, p224

Part 3 – Engineering in Employment
14.0 Earnings in STEM careers[681]

The annual survey of hours and earnings (ASHE) provides information about the level, distribution and make-up of earnings paid to employees within industries, occupations and regions.

This section presents mean[682] UK salary figures for selected STEM professional careers and also selected STEM technician/craft careers, broken down by gender, full-time and part-time.

14.1 Annual mean gross pay for selected STEM professions

Amongst STEM professionals, medical practitioners had the highest annual mean gross salary, which in 2011 was £74,721 (Figure 14.0). These were followed by managers in mining and energy, who earned £68,680. Researchers and development managers had the third highest salary, at £55,240, although this was substantially less than the two highest annual mean salaries.

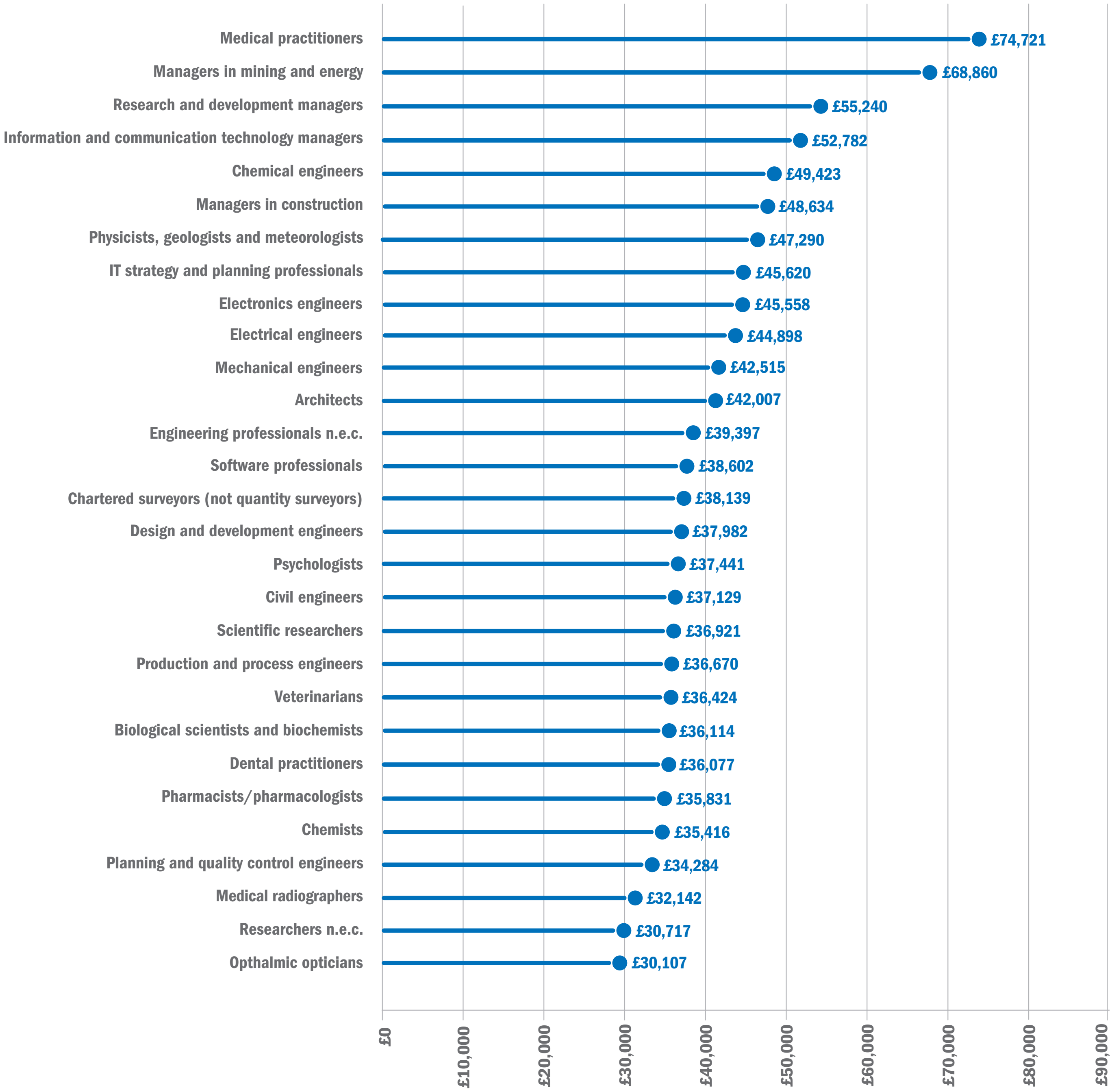
Looking specifically at the salaries for engineering careers shows that chemical engineers earned the most (£49,423). They also had the fifth highest salary of all STEM careers. Electronics engineers earned on average £45,558, electrical engineers earned £44,898 and mechanical engineers were on a slightly lower salary of £42,515.

Among those working in IT, the highest annual mean gross salary was for information and communication technology managers, who earned £52,782, while IT strategy and planning professionals had a salary of £45,620.

Overall, the lowest paid STEM professionals were ophthalmic opticians, who earned a salary of £30,107. This was just ahead of researchers n.e.c.[683] who earned £30,717. The lowest salary for an engineering career was for those working as planning and quality control engineers, who earned on average £34,284.

681 ASHE was developed to replace the New Earnings Survey (NES) in 2004. **682** The mean salary can be distorted by a few very large or small salaries in each career. **683** n.e.c. stands for not elsewhere classified.

Fig. 14.0: Annual mean gross pay for selected STEM professions (2011) – UK



Source: ONS/ASHE 2011

14.1.1 Annual mean gross pay for selected full-time STEM professions by gender

Table 14.0 examines the annual mean salary of full-time STEM professions by gender. It shows that there is only one STEM profession where full-time women in work earn more than full-time men: managers in mining and energy. Here, women earn 101.4% of the salary of men. There are six other occupations where women, on average, earn at least 90% of the salary of men. These are:

- ophthalmic opticians – 98.3%
- scientific researchers – 97.5%
- pharmacists/pharmacologists – 97.2%
- managers in construction – 94.3%
- IT strategy and planning professionals – 91.7%
- medical radiographers – 90.7%

Female planning and quality-control engineers on average earn 85.3% of the salary of men. This is the engineering occupation with the highest female salary as a proportion of the male salary.

Overall, the STEM occupation which had the worst female/male salary ratio was electrical engineers. At 72.8% of men's salaries, this is below the average for all women in full-time employment (74.0%). The only other STEM occupation to have a salary ratio for women which is worse than the average for all women in full-time employment was medical practitioners, at 73.7%.

Table 14.0: Annual mean gross pay for selected full-time STEM professions by gender (2011) – UK[684]

	All full-time workers	Male full-time workers	Female full-time workers	Female salary as a percentage of male salary
Managers in mining and energy	£66,432	£66,324	£67,267	101.4%
Ophthalmic opticians	£38,982	£39,395	£38,717	98.3%
Scientific researchers	£38,531	£38,946	£37,987	97.5%
Pharmacists/pharmacologists	£39,731	£40,411	£39,286	97.2%
Managers in construction	£50,789	£50,919	£48,041	94.3%
IT strategy and planning professionals	£47,875	£48,420	£44,415	91.7%
Medical radiographers	£37,521	£40,126	£36,386	90.7%
Researchers n.e.c.	£32,253	£33,727	£30,000	88.9%
Software professionals	£39,539	£40,235	£35,474	88.2%
Biological scientists and biochemists	£38,922	£41,439	£36,112	87.1%
Planning and quality control engineers	£35,237	£36,194	£30,861	85.3%
Information and communication technology managers	£54,052	£55,412	£47,017	84.8%
Civil engineers	£37,666	£37,973	£32,055	84.4%
Chemists	£36,217	£37,827	£31,835	84.2%
Physicists, geologists and meteorologists	£48,063	£49,567	£41,187	83.1%
Design and development engineers	£38,574	£39,135	£32,001	81.8%
Engineering professionals n.e.c.	£40,071	£40,823	£32,825	80.4%
Chartered surveyors (not quantity surveyors)	£39,237	£39,954	£31,645	79.2%
Psychologists	£41,945	£49,724	£38,852	78.1%
Mechanical engineers	£43,829	£44,573	£34,634	77.7%
Research and development managers	£57,488	£60,473	£46,928	77.6%
Medical practitioners	£85,176	£93,967	£69,258	73.7%
Electrical engineers	£45,870	£46,557	£33,871	72.8%
All employees	**£32,837**	**£36,511**	**£27,006**	**74.0%**

Source: ONS/ASHE 2011

684 It was not possible to break all the STEM professions data down by gender. Where it was not possible to break the data down by gender, this data has been excluded from the table.

14.1.2 Annual mean gross pay for selected part-time STEM professions by gender

Table 14.1 breaks down the mean average salary for men and women working as part-time professionals. For many occupations, it is not possible to break the data down by gender, as the Office for National Statistics doesn't publish this information. Of the five selected STEM professions where it is possible to break the data down by gender, women working as IT strategy and planning professionals earn an average salary 151.9 % greater than their male counterparts. For all other STEM professions, women earn less than men on average. The worse affected are medical practitioners, where women earn two-thirds (65.6%) of the salary of men. Over all occupations, the data shows that women working part time earn on average 82.1% of the salary of men.

14.2 Annual mean gross pay for selected STEM technician and craft careers

Figure 14.1 shows the annual mean gross salary for selected STEM technician and craft careers. It shows the highest paid career is engineering technician, with an average salary of £34,018. This was followed by line repairers and cable joiners on £33,893 and medical radiographers on £32,142. For comparison, the national mean average salary is £26,871, with a man in full-time work earning, on average, £ 36,511 compared with £27,006 for a woman.

The lowest-paid STEM technician and craft career was assembler (electrical products), with an annual mean salary of £17,997. Two other careers had salaries below £19,000: food, drink and tobacco process operatives (£18,061) and assemblers and routine operatives n.e.c. (£18,271).

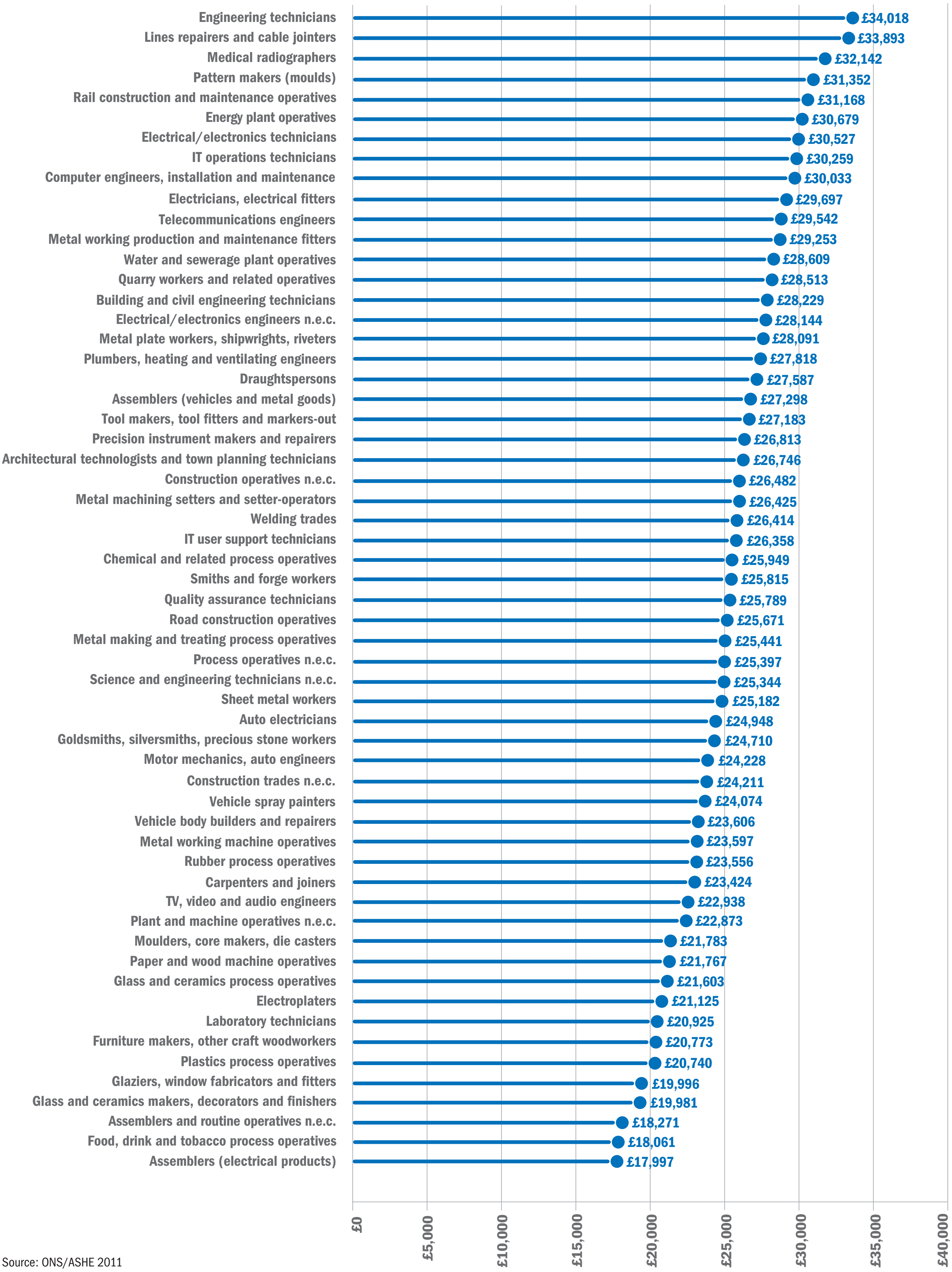
Table 14.1: Annual mean gross pay for selected part-time STEM professions by gender (2011) – UK[685]

	All full-time workers	Male full-time workers[686]	Female full-time workers	Female salary as a percentage of male salary
IT strategy and planning professionals	£26,466	£23,769	£36,106	151.9%
Software professionals	£21,716	£23,074	£20,120	87.2%
Pharmacists/pharmacologists	£23,088	£30,872	£21,609	70.0%
Information and communication technology managers	£28,932	£34,157	£22,937	67.2%
Medical practitioners	£40,570	£50,681	£33,261	65.6%
All employees	**£11,240**	**£13,056**	**£10,715**	**82.1%**

Source: ONS/ASHE 2011

685 It was not possible to break all the STEM professions data down by gender. Where it was not possible to break the data down by gender, this data has been excluded from the table. 686 Full-time employment is at least 30 hours per week.

Fig. 14.1: Annual mean gross pay for selected STEM technician and craft careers (2011) – UK



Source: ONS/ASHE 2011

14.2.1 Annual mean gross pay for selected full-time STEM technician and craft careers by gender

Looking at annual mean gross pay for those working full-time in selected STEM technician and craft careers shows that women earn more on average than men only two occupations (Table 14.2). Female plumbers, and heating and ventilating engineers, earn an average salary 118.6% of their male counterparts. Female precision instrument makers and repairers earn marginally more than men (100.1%). For seven of the STEM technician and craft careers, women earn on average at least 90% of the salary of men. These are:

- water and sewerage plant operatives –98.1%
- architectural technologists and town planning technicians – 96.8%
- electrical/electronic engineers n.e.c. – 94.3%
- construction trades n.e.c. – 92.8%
- motor mechanics, auto engineers – 92.7%
- medical radiographers – 90.7%
- telecommunications engineers – 90.4%

Female metal making and treating process operatives earn on average less than half (49.5%) of the salary of their male equivalents, while women working as metal machining setters and setter-operators earn just over half (55.3%) of the salary of their male counterparts.

The engineering occupation with the biggest gap between male and female salaries is building and civil engineering technician. Women in this role earn 70.6% of the salary of their male counterparts.

Table 14.2: Annual mean gross pay for selected full-time STEM technician and craft careers by gender (2011) – UK[687]

	All full-time workers	Male full-time workers[688]	Female full-time workers	Female salary as a percentage of male salary
Plumbers, heating and ventilating engineers	£28,440	£28,399	£33,672	118.6%
Precision instrument makers and repairers	£26,999	£26,998	£27,016	100.1%
Water and sewerage plant operatives	£28,713	£28,744	£28,200	98.1%
Architectural technologists and town planning technicians	£27,675	£27,903	£27,021	96.8%
Electrical/electronics engineers n.e.c.	£28,673	£28,730	£27,084	94.3%
Construction trades n.e.c.	£25,230	£25,309	£23,492	92.8%
Motor mechanics, auto engineers	£24,914	£24,941	£23,130	92.7%
Medical radiographers	£37,521	£40,126	£36,386	90.7%
Telecommunications engineers	£30,020	£30,170	£27,266	90.4%
Quality assurance technicians	£26,786	£27,914	£25,069	89.8%
IT operations technicians	£31,641	£32,547	£29,054	89.3%
IT user support technicians	£27,949	£29,033	£24,977	86.0%
Computer engineers, installation and maintenance	£30,343	£30,773	£26,388	85.8%
Assemblers (electrical products)	£18,797	£19,800	£16,970	85.7%
Science and engineering technicians n.e.c.	£26,390	£26,907	£23,035	85.6%
Glass and ceramics makers, decorators and finishers	£20,738	£21,517	£18,312	85.1%
Paper and wood machine operatives	£22,046	£22,234	£18,796	84.5%
Plastics process operatives	£21,156	£21,507	£18,139	84.3%
Metal working production and maintenance fitters	£29,411	£29,498	£24,625	83.5%
Assemblers and routine operatives n.e.c.	£19,119	£20,076	£16,634	82.9%
Draughtspersons	£28,468	£29,040	£23,520	81.0%
Quarry workers and related operatives	£28,565	£28,957	£23,318	80.5%
Food, drink and tobacco process operatives	£19,171	£20,316	£16,075	79.1%
Welding trades	£26,827	£26,902	£21,050	78.2%
Engineering technicians	£34,347	£34,791	£27,168	78.1%
Construction operatives n.e.c.	£27,834	£28,030	£21,631	77.2%
Laboratory technicians	£23,981	£27,104	£20,101	74.2%
Chemical and related process operatives	£26,278	£27,167	£19,526	71.9%
Plant and machine operatives n.e.c.	£24,257	£24,948	£17,722	71.0%
Building and civil engineering technicians	£29,400	£30,114	£21,267	70.6%
Assemblers (vehicles and metal goods)	£27,191	£27,987	£19,764	70.6%
Process operatives n.e.c.	£26,002	£26,479	£17,616	66.5%
Carpenters and joiners	£23,814	£23,863	£15,647	65.6%
Metal working machine operatives	£23,987	£24,780	£16,103	65.0%
Tool makers, tool fitters and markers-out	£27,698	£28,245	£17,483	61.9%
Energy plant operatives	£31,703	£33,107	£20,108	60.7%
Metal machining setters and setter-operators	£26,689	£26,940	£14,908	55.3%
Metal making and treating process operatives	£26,096	£26,886	£13,299	49.5%
All employees	£32,837	£36,511	£27,006	74.0%

Source: ONS/ASHE 2011

687 It was not possible to break all the STEM professions data down by gender. Where it was not possible to break the data down by gender, this data has been excluded from the table. **688** Full-time employment is at least 30 hours per week.

14.2.2 Annual mean gross pay for selected part-time STEM technician and craft careers by gender

Table 14.3 shows the mean average salary by gender for part-time workers in STEM technician and craft occupations. Women in two occupations earn more than men on average. These are IT operations technicians (127.3%) and science and engineering technicians n.e.c (105.0%). However, at the other end of the scale, women working as assemblers (vehicles and metal goods) earn on average less than a third (30.2%) of the salary of men, while female metal working machine operatives earn just over half (52.2%) of the salary of their male colleagues.

Through combining[689] and analysing the most relevant technician occupational groups from the ASHE data (that is, associate professional and technical occupations, skilled trades occupations, and process, plant and machine operatives), it has been possible to calculate an approximate mean salary for engineering technicians and craftsmen of £26,980. This is slightly above the mean salary for all non-engineering occupations, which was found to be £25,974.

Having analysed the ASHE data, the final part of this section looks at the state of the engineering recruitment market over the past year.

Table 14.3: Annual mean gross pay for selected part-time STEM technician and craft careers by gender (2011) – UK[690]

	All part-time workers	Male part-time workers	Female part-time workers	Female salary as a percentage of male salary
IT operations technicians	£14,769	£12,474	£15,877	127.3%
Science and engineering technicians n.e.c.	£13,055	£12,693	£13,328	105.0%
Laboratory technicians	£10,664	£11,668	£10,434	89.4%
Construction operatives n.e.c.	£13,586	£14,047	£12,089	86.1%
Food, drink and tobacco process operatives	£11,178	£13,598	£9,552	70.2%
Assemblers (electrical products)	£11,485	£16,795	£10,425	62.1%
Metal working machine operatives	£17,274	£20,164	£10,520	52.2%
Assemblers (vehicles and metal goods)	£28,500	£34,403	£10,382	30.2%
All employees	**£11,240**	**£13,056**	**£10,715**	**82.1%**

Source: ONS/ASHE 2011

689 In the ASHE dataset, figures for the number of jobs are indicative and are not an accurate estimate of employee job counts. Where it was not possible to break the data down by gender, this data has been excluded from the table.

690 It was not possible to break all the STEM professions data down by gender.

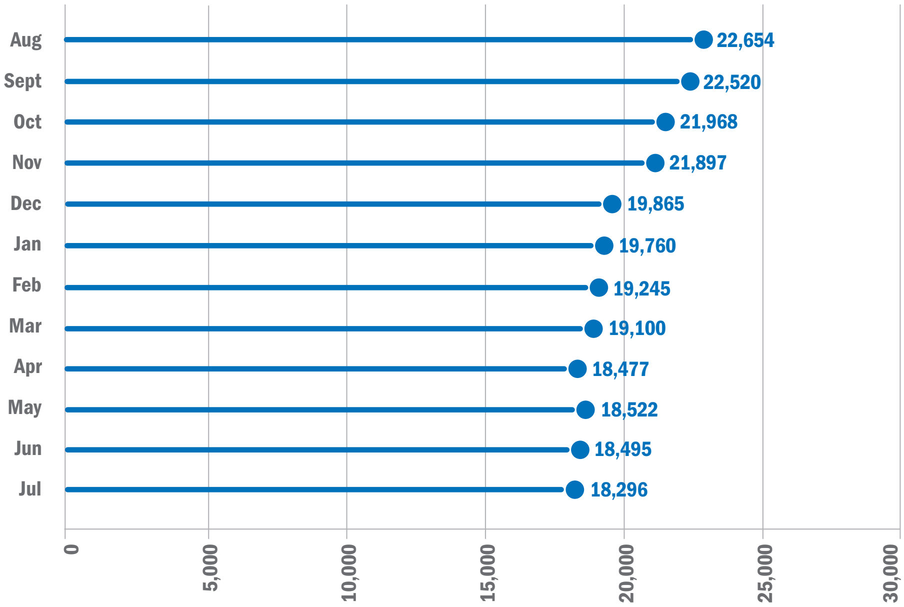
14.3 Engineering vacancy and salary trends 2011/2012

Authored by Mark Tully, Managing Director, Roevin

The UK jobs market over the past 12 months has been challenging for candidates. The aftermath of the 2008/2009 recession, the double dip and the Eurozone crisis have all taken their toll on the number of vacancies available, with hiring managers seemingly reluctant to hire in this time of uncertainty. A number of engineering projects have been taken offline and lost funding to make way for cost-cutting initiatives. Across the market, there has been a significant decrease in the number of engineering vacancies, as can be seen in Figures 14.2 and 14.3. However, it is not all bad news, with some engineering sectors – such as oil and gas, utilities, automotive and aerospace – all seeing a rise in vacancy numbers.

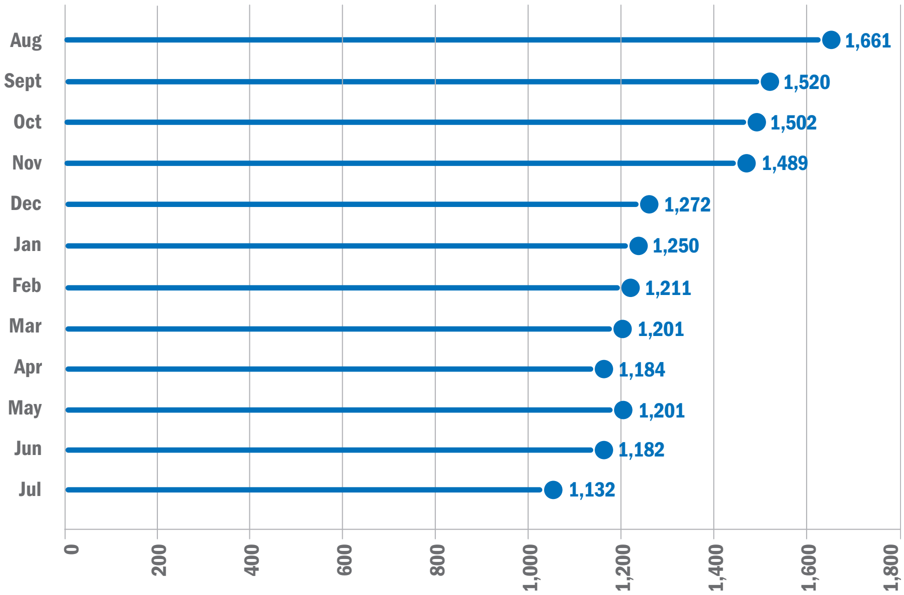
Compared with the previous 12 months, there has been a major drop in the number of both permanent and contractor vacancies. The largest decreases took place in August and November. Both months show a fall in the number of vacancies ranging from 8% to 15%. Whilst we would normally expect recruitment activity to reduce during the summer and festive periods, the similarly-anticipated rise in September and January simply did not materialise. This can probably be attributed to Greece's debt issues coming to light in August, causing companies to become more risk averse in the face of increased economic volatility.

Fig. 14.2: Vacancies for permanent roles (rolling 12 months)



Source: www.mysalarychecker.com

Fig. 14.3: Vacancies for contract roles (rolling 12 months)



Source: www.mysalarychecker.com

Salary review

Over the last year there have been minimal changes in salaries in the engineering and construction sector (Table 14.4). Salaries have all shown slight growth in 2011-2012. The largest increase in salary is for CAD technicians, who now earn 8.56% more than last year on average.

Popular engineering vacancies

Across the engineering sector, we continue to see high demand for senior engineers and design engineers. We have seen increased global demand for UK-trained senior and design engineers to work abroad. This is typical, as the UK is renowned worldwide for the quality of the education delivered to engineers (Table 14.5).

Engineering opportunities

As the UK continues to unlock emerging markets with renewable energy, life sciences, aerospace, automotive and oil and gas projects, there are significant global opportunities for engineers. Due to the continuously evolving nature of engineering, the demand for engineers is growing. Most (93%) hiring managers[691] expect their company to have a higher demand for engineers in the next five years than in previous years. This will have a major impact on the workforce.

Table 14.5: Jobs in demand (2011 – 2012)

Perm	Contract/temp
Senior engineer	Senior engineer
Design engineer	Design engineer
Technician	Project engineer
Production	Project manager
Sales	Designer
Service engineer	Technician
Project engineer	Mechanical engineer
Project manager	Process engineer
Maintenance engineer	Electrical engineer
Mechanical engineer	Mechanical design
Process engineer	

Source: Roevin

Table 14.4: Engineering pay (2011–2012)

	Average permanent salary			Average contractor pay (per hour)		
Job Title	**Aug 2011**	**July 2012**	**Change over one year**	**Aug 2011**	**July 2012**	**Change over one year**
Aerospace engineer	£35,946	£37,391	4.02%	£25	£25	-
Architect	£51,210	£52,713	2.93%	-	-	-
Automotive engineer	£32,669	£34,366	5.19%	£21	£20	-4.76%
Chemical engineer	£32,422	£34,328	5.88%	£25	£26	4.00%
Civil engineer	£44,168	£46,537	5.36%	£32	£32	-
Electrical engineer	£32,228	£33,210	3.05%	£23	£24	4.35%
Mechanical engineer	£35,258	£36,748	4.23%	£25	£26	4.00%
CAD technician	£24,081	£26,687	10.82%	£16	£16	-
Structural engineer	£42,349	£43,600	2.95%	£35	£33	-5.71%
Quantity surveyor	£42,124	£44,234	5.01%	£24	£23	-4.17%
Facilities manager	£38,393	£40,283	4.92%	£20	£19	-5.00%
Building surveyor	£36,788	£39,209	6.58%	£20	£20	-
Town/retail planner	£36,511	£38,516	5.49%	£15	£15	-
Asset manager	£41,895	£43,534	3.91%	-	-	-

Source: Roevin

691 Roevin's survey of 380 stakeholders across the UK in April 2012 to determine what the engineering workforce landscape will look like globally beyond 2012.

Part 3 – Engineering in Employment
15.0 Skills Shortage Vacancies and employment projections

Workforce skills are of critical importance to the success of the UK economy in the long term. In fact over the last 25 years, around a fifth of UK economic growth can be attributed to increased workforce skills.[692] The UK Commission on Employment and Skills (UKCES) has also identified that the productivity of the trained worker is, on average, nearly a quarter (23%) higher than that of an untrained worker.[693] It has also been found that firms that train their staff are two and a half times more likely to survive than companies that don't train their staff.[694]

The importance of investing in the workforce is recognised, and it is estimated that the UK's overall investment in training is £49 billion.[695] But UK productivity still lags behind that of other developed nations, at 10% below the average for the G7.[696] Put another way, a 1% increase in productivity or employment would generate an additional £10 billion of GDP per year.[697]

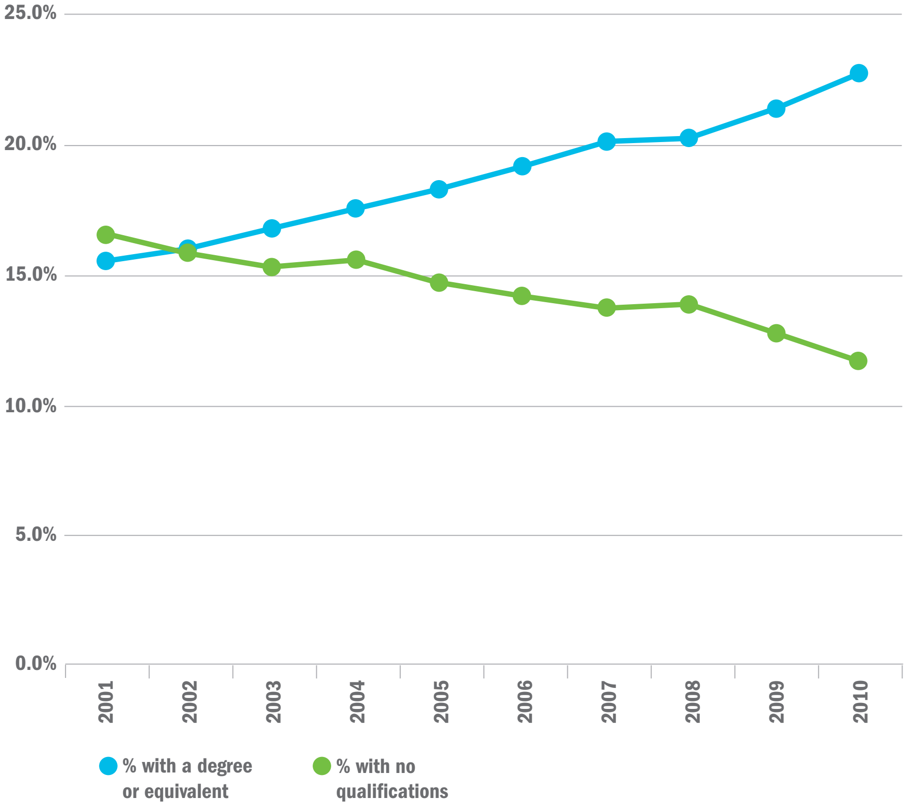
Despite the large investment in workforce skills, it should be noted that in 2012 only a fifth (19%) of adults were engaged in learning, with around 40% saying they had done some learning in the last three years. Just over a third (36%) of adults in the same survey had not participated in any learning since leaving full-time education,[698] while 12 million adults say they don't actively learn.[699] It has also been estimated that UK educational underachievement costs the UK around £22 billion per generation.[700]

It should also be noted that around a quarter (24%) of adults in the UK lack functional numeracy skills and 15% lack functional literacy skills.[701] Research by the Joseph Rowntree Foundation has shown that there is a strong relationship between unemployment and educational attainment, with unemployment rates for those without qualifications being four times higher than for those with a degree.[702]

The Office for National Statistics has shown a distinct trend in UK workforce qualifications: the percentage of the UK workforce without qualifications having declined over 10 years, while the corresponding percentage with a degree has increased (Figure 15.0).

692 *Employer ownership of skills Securing a sustainable partnership for the long term, UKCES,* December 2011, p12 **693** *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p12 **694** *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p12 **695** *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p13 **696** *Employer ownership of skills Securing a sustainable partnership for the long term,* UKCES, December 2011, p13 **697** *Big challenges bring big rewards The big picture narrative,* UKCES, March 2012, p7 **698** *Adult participation in learning: Headline findings,* NIACE, 2012, p1 **699** *Big challenges bring big rewards The big picture narrative,* UKCES, March 2012, p4 **700** *The cost of Exclusion Counting the cost of youth disadvantage in the UK,* Prince's Trust, 2010, p9 **701** *New challenges, New chances Further Education skills system reform plan: building a world class skills system,* BIS, December 2011, p10-11 **702** *Can improving UK skills levels reduce poverty and income inequality by 2020?,* Joseph Rowntree Foundation, June 2012, p11

Fig. 15.0: Highest and lowest qualification over time



Source: Labour Force Survey – Office for National Statistics

15.1 Skills shortages

A key issue for EngineeringUK is whether there are skills shortages in the science, technology, engineering and maths (STEM) sector. In *the Engineering UK Report 2011,*[703] we showed that, compared with all establishments, there was a disproportionately large percentage of vacancies within engineering establishments for professional and skilled tradespeople. In each case, the proportion of vacancies was double the average for all establishments.

We also showed that skilled trades people came from the ranks of level 3 and level 4 science, engineering and technology (SET) technicians but that at least 10% of level 3 and level 4 SET technicians held a qualification level below level 2. In short, they do not hold the appropriate qualification for their roles.[704]

Research by the Department for Business, Innovation and Skills[705] has shown that employers face specific recruitment issues in certain STEM sectors, including engineering and IT, and that, in part, these difficulties relate to a shortage of applicants with appropriate STEM knowledge and qualifications. However, there is also a broader issue which relates to a shortage of candidates with a range of skills including:

- technical skills
- practical work experience
- broader competencies eg mathematical skills

In its 2012 education and skills survey,[706] the Confederation of British Industry (CBI) identified that STEM qualifications are not sufficient on their own. Employers want candidates to have workplace experience and employability skills. Forty-two per cent of firms looking to recruit workers with STEM skills are currently experiencing difficulties. It is possible that shortages of workers with STEM skills could get worse. In the *Skills for a green economy report,*[707] the Government identified that demand for STEM skills will

703 *Engineering UK Report 2011 – the state of engineering, EngineeringUK,* December 2010, p190 **704** *Engineering UK Report 2011 – the state of engineering, EngineeringUK,* December 2010, p190 **705** *The demand for science, technology, engineering and mathematics (STEM) skills, Department for Innovation, Universities and Skills,* January 2009, p4 **706** *Learning to grow: what employers need from education and skills Education and Skills survey 2012,* CBI, June 2012, p7 **707** *Skills for a green economy,* HM Government, 2011, p15 increase significantly over the next 10 years, as the low carbon and environmental sectors expand and start to compete for workers with these skills. It also identified that shortages in STEM skills could act as a barrier to green growth.[708]

Skills shortages vary geographically and can be regional, local or even within a community. Analysis by the Learning and Skills Improvement Service (LSIS)[709] has shown, for example, that 11.4% of working-age adults in Leeds had no qualifications in 2009. But the comparable figure for neighbouring Bradford was 16.4%.

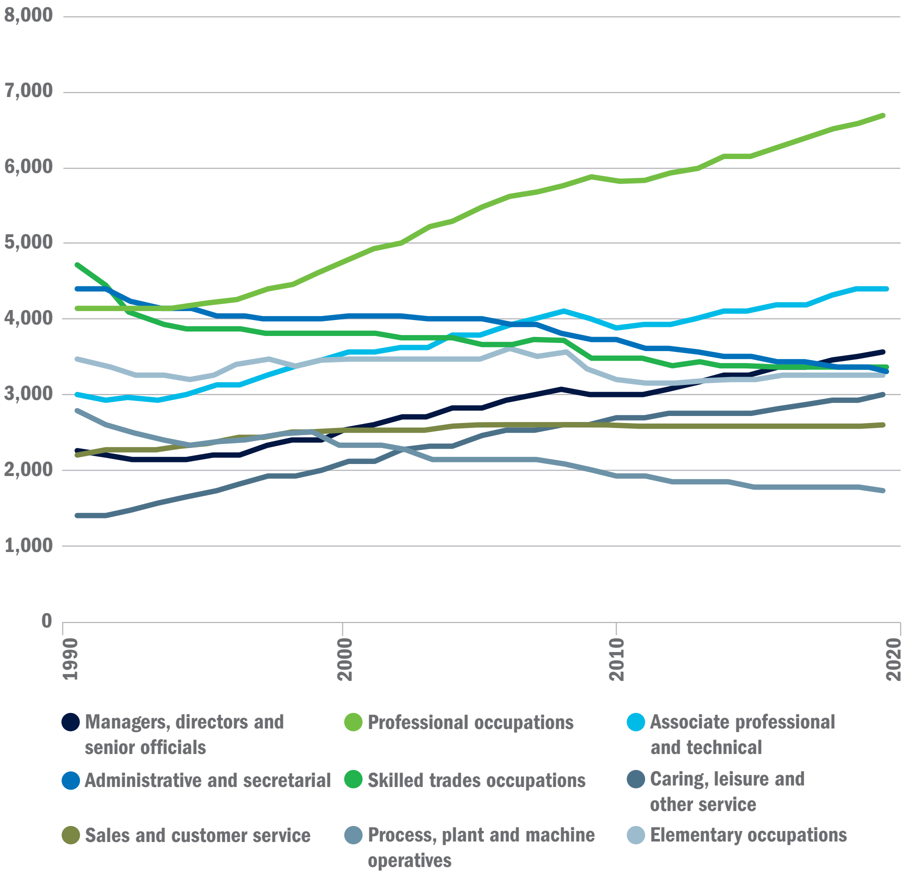
15.2 Workforce projections

According to *Working Futures 2010-2020,*[710] the total number of job openings across the UK economy is projected to be 13.9 million for this period. This demand consists of replacement demand (ie replacing those who leave the labour market), which will create about 12 million job opportunities over the 10-year period, and 1.5 million new jobs. This large demand will mean that over the next 10 years, there will be career opportunities in all areas, including industries and occupations which are in decline. Looking specifically at the SET sector, the Technicians Council has shown that there will be demand for 450,000 new technicians in these sectors by 2020.[711]

Overall, by 2020, the total number of jobs in the UK is projected to be 32 million.[712] This is slightly above the employment high point of 31.7 million achieved in 2008. However, it is well below the number of jobs projected for 2020 by the previous iteration of Working Futures, which was close to 34 million.[713]

Figure 15.1 shows the changing profile of occupations in the UK from 1990 through to 2020. It shows considerable growth in the number of workers in professional occupations to date, with this growth projected to continue through to 2020. Growth is also projected in associate professional and technical occupations from 2010 to 2020.

Fig. 15.1: Occupational trends (1990-2020) – UK



Source: Working Futures 2010-2020

15.2.1 Workforce projections for the engineering sector[714]

For this section of the report, we are using bespoke data from *Working Futures 2010-2020,* which has been prepared by Warwick University Institute of Employment Research (IER). It looks at demand for labour in the engineering sector, based on the engineering footprint,[715 716] as defined by EngineeringUK.

Not everyone working in an engineering company is an engineer. Table 15.0 provides a breakdown of demand for labour across the major occupation groups identified in SOC2010, and by those selected sub-groups which we regard as the most likely to require engineering skills. It shows the net change in the projected number of jobs in engineering companies, made up of the requirement for replacement demand (as workers leave the labour market or change industries) plus the overall recruitment requirement. Between 2010 and 2020, engineering companies are projected to see 2.74 million job openings, across a diverse range of disciplines. This represents 19.8% of all job openings across all industries by 2020 and represents a 50% churn of the entire workforce[717] who currently work in engineering enterprises (5.4 million).[718] Of these 2.74 million jobs, 2.4 million will be to replace workers who are leaving the workforce, while the remaining 350,000 will be new jobs.

In the major group occupations, 721,000 job openings are projected at a skilled trades level, 590,900 at professional level and 424,600 for managers and senior officials.

708 *Skills for a green economy,* HM Government, 2011, p25 **709** *The Further Education and Skills Sector in 2020 a social productivity approach,* LSIS, May 2011, p26 **710** *Working Futures 2010-2020 Evidence Report,* UKCES, 16 December, pxii **711** *Professional Technician the future delivering growth through skill creativity and innovation,* Technician Council, 2012, p2 **712** *Working Futures 2010-2020 Evidence Report,* UKCES, 16 December, p19 **713** *Working Futures 2010-2020 Technical Report,* UKCES, January 2012, p74 **714** Section 10.4.1 provides a breakdown of apprenticeship framework achievements by region, while section 11.5.4 provides a breakdown of degree achievements by region. **715** The engineering footprint is defined in SIC 2007. For further details see Table 17.7 in the Annex (http://www.engineeringuk.com/what_we_do/education_&_skills/engineering_uk_12.cfm) **716** Data was purchased from the Institute of Employment Research, using the engineering footprint. **717** The number of workers currently employed in engineering companies is 5.4 million. Therefore 2.74 million new job openings would represent half the current workforce. **718** See Section 2 for details on the number of workers currently employed in engineering companies.

Table 15.0 also provides a projection of the number of job openings that are likely to require engineering skills, based upon the related sub-groups within the selected major groups. This shows that by 2020 engineering companies will need to recruit 1.86 million workers who are likely to need engineering skills: pro rata, that's 1.488 million over the next eight years (2012-2020). This figure consists of a net increase of 204,400 job openings and an additional 1.66 million job openings due to replacement demand.

The occupational groups do not map exactly to qualifications. However, if we assume that the sub-groups that belong to major groups 1, 2 and 3 broadly relate to occupations that require a level 4+ qualification (HNC/D, Foundation Degree, undergraduate or postgraduate and equivalent), then Table 15.0 infers that there is a demand in engineering enterprises for 865,100 people with level 4+ qualifications over 10 years. This gives an average demand of approximately 87,000 per year.[719] The analysis in Chapter 11 indicates that the UK currently produces only around 46,000 people qualified at level 4+ each year – just over 50% of the projected demand.[720 721 722]

Similarly, if we assume that the sub-groups of major group 5 (skilled trades occupations) relate to those occupations that require at least a level 3 qualification, then we can expect demand for approximately 690,000 people qualified at level 3 over 10 years. This gives an average demand of 69,000 people per year.[723] The supply of level 3 apprentices, however, is projected to fall short of that demand: Chapter 10 indicates that the UK currently produces approximately 27,000 apprentices a year qualified at level 3.

For simplicity, the key findings from Table 15.0 are also summarised in Table 15.0(a).

Table 15.1 shows that a third (33.7%) of the total job openings for engineering companies are expected to be in construction companies, while just over a quarter (28.3%) are expected to be in manufacturing companies. Of the total recruitment requirement for 2010-2020, 91% will come from just four industry sectors:

Table 15.0: Changing composition of employment, by occupation in the engineering sector (2010-2020) – UK[724]

Major group	Selected sub-group (jobs likely to require engineering skills)	Net change by 2020 (in thousands)	Replacement demand by 2020 (in thousands)	Total requirement by 2020 (in thousands)
1. Managers and senior officials		129.3	295.2	424.6
	11 Corporate managers and directors	108.1	243.8	351.8
	12 Other managers and proprietors	21.3	51.5	72.7
2. Professional occupations		166.9	424.0	590.9
	21 Science, research, engineering and technology professionals	87.0	249.8	336.8
3. Associate professional and technical occupations		100.3	291.5	391.8
	31 Science, engineering and technology associate professionals	13.0	72.5	85.5
	33 Protective service occupations	1.5	16.8	18.3
4. Administrative, clerical and secretarial occupations		-43.7	241.6	197.9
5. Skilled trades occupations		83.0	638.0	721.0
	52 Skilled metal, electrical and electronic trades	-75.7	301.8	226.1
	53 Skilled construction and building trades	194.7	262.5	457.2
	54 Textiles, printing and other skilled trades	-43.5	52.0	8.5
6. Personal service occupations		12.4	22.7	35.1
7. Sales and customer service occupations		3.6	74.1	77.7
8. Transport and machine operatives		-111.0	278.9	167.9
	81 Process, plant and machine operatives	-125.9	198.4	72.5
	82 Transport and mobile machine drivers and operatives	14.9	80.5	95.4
9. Elementary occupations		9.1	126.0	135.1
	91 Elementary trades and related occupations	1	62	63
	92 Elementary administration and service occupations	9	64	72
Total major group		350.0	2,391.9	2,742.0
Total selected sub-group		**204.4**	**1,655.6**	**1,860.0**

Source: Working Futures 2010-2020

719 Independent research by the RAEng cites 830.000 SET professionals: *Jobs and growth: the importance of engineering skills to the UK economy,* Royal Academy of Engineering, September 2012, p23
720 This includes an estimate on engineering Foundation Degrees 721 This includes UK and international students graduating at HNC, HND, first degree, postgraduate and doctorate levels 722 It should be noted that a proportion (approximately 4000/year) of graduates studying computer science, mathematical science and physical sciences do enter engineering roles. See section 12.7. 723 Independent research by the RAEng cites 450,000 SET technicians: *Jobs and growth: the importance of engineering skills to the UK economy,* Royal Academy of Engineering, September 2012, p23 724 The occupation categories come from SOC2010

Table 15.0(a): Summary table – Changing composition of employment, by occupation in the engineering sector (2010-2020) – UK[725]

	Net change by 2020 (in thousands)	Replacement demand by 2020 (in thousands)	Replacement demand by 2020 (in thousands)
Selected jobs likely to require engineering skills	204.4	1,655.6	**1,860.0**
Jobs likely to require engineering qualifications at level 4+ (sub-codes: 11, 12, 21, 31, 32)	230.9	634.4	**865.1**
Jobs likely to require engineering qualifications at level 3 (sub codes: 52, 53, 54)	75.6	616.3	**691.8**

Table 15.1: Total recruitment requirement by major industry groups in the engineering sector (2010-2020) – UK

	Total requirement by 2020 (in thousands)	Percentage of replacement demand
Construction	924.2	33.7%
Manufacturing	776.4	28.3%
Information and communication	452.3	16.5%
Professional, scientific and technical activities	343.3	12.5%
Total requirement in engineering companies	**2,742.0**	

Source: Working Futures 2010-2020

- construction
- manufacturing
- information and communication
- professional, scientific and technical activities

In Section 2 we showed that engineering enterprises in London had the highest level of employment of all the regions within England and the other home nations, followed by the South East. Table 15.2 is structured to match the format of Section 2. It shows that although the South East was second in terms of employment in engineering enterprises, it was first in terms of the number of job openings over the next 10 years. In total, 13.6% of the 2010-2020 recruitment requirement is projected to be in engineering enterprises located in the South East. Engineering enterprises in London are set to have the second highest requirement, needing 344,800 new or replacement employees by 2020 (12.6% of the total).

Focusing specifically on those occupations within engineering enterprises **likely to require engineering skills**, we can see that the highest demand will be in the South East, with 252,400 job openings – two thirds (67.7%) of the total requirement. This is followed by London with 206,100 job openings – only 59.8% of the total requirement. Overall, two thirds (67.8%) of all job openings in engineering companies are likely to require applicants to have engineering skills.

Within the English regions, the North East has the lowest projected number of job openings, at only 76,900 of total projected openings.[726]

Projected demand for workers with engineering skills is strong in the other home nations. In Scotland, 66.6% of the total requirement is projected to come from jobs requiring engineering skills. Wales needs a higher proportion, at 73.3%, although the absolute number of workers required is lower. In Northern Ireland, 72.9% of total job openings are likely to require engineering skills.

Table 15.2 Recruitment requirement, in engineering enterprises, by home nation and English Region (2010-2020) – UK

Home nation/English region	Total requirement in engineering enterprises, 2010-2020 (in thousands)	Percentage of all requirement	Total requirement for jobs likely to require engineer skills in engineering companies 2010-2020 (in thousands)	Jobs likely to require engineer skills as a percentage of all jobs in the region
North East	107.2	3.9%	76.9	71.7%
North West	263.5	9.6%	187.1	71.0%
Yorkshire and The Humber	238.2	8.7%	152.3	63.9%
East Midlands	228.6	8.3%	158.4	69.3%
West Midlands	257.5	9.4%	179.0	69.5%
East	245.4	9.0%	172.0	70.1%
London	344.8	12.6%	206.1	59.8%
South East	372.8	13.6%	252.4	67.7%
South West	225.9	8.2%	156.6	69.3%
England	2,283.9	83.3%	1,540.8	67.5%
Wales	140.8	5.1%	103.2	73.3%
Scotland	240.7	8.8%	160.2	66.6%
Northern Ireland	76.5	2.8%	55.8	72.9%
Total	**2,742.0**		**1,860.0**	**67.8%**

Source: Working Futures 2010-2020

725 The occupation categories come from SOC2010 726 *Working Futures 2010-2020 Evidence Report,* UKCES, 16 December, pxii

Part 3 – Engineering in Employment
16.0 Concerted employer action

"Persistent poverty, increasing income inequality and slow job growth, further exacerbated by financial and economic crises and climate change – are critical constraints on economic and social progress. Promoting inclusive job-rich growth is a central challenge for all countries today. With global unemployment at historically high levels, there has never been a greater need to put employment at the centre of economic and social policies." [727]

The International Labour Organisation (ILO)

The ILO's vision, as stated above, is only going to be generated if employers are at the heart of any future economic growth, as we have said previously.

This section highlights the ways that employers and employer bodies are taking responsibility for their own destinies, using externally-provided case studies and employer cameos.

16.1 Employer demand for STEM skills

Authored by Jim Bligh, Head of Labour Market Policy, CBI

The pace of economic recovery in the UK remains slow and public spending will necessarily stay squeezed. While this makes for a challenging environment, it is one in which investment in skills is more important than ever. Over the long term in particular, the UK will need a steady supply of skilled individuals – especially those with STEM skills – to underpin its ability to compete and to drive private sector growth.

The CBI/Pearson Education and Skills Survey 2012[728] showed a continuation of previous trends – high demand for STEM skills at all levels and difficulties in recruiting the staff equipped with these skills. The message from employers responding to our survey and their priorities for action on STEM skills are clear:

- Business demands STEM skills
- Science and maths hold the key to STEM progress
- Apprenticeships can help address the gap in availability of experienced STEM staff
- Business can do more to support STEM in schools

727 http://www.ilo.org/global/about-the-ilo/decent-work-agenda/employment-creation/lang--en/index.htm **728** *Learning to grow: CBI/Pearson Education and Skills Survey 2012*, CBI, June 2012

Business demands STEM skills

The CBI/Pearson *Education and Skills Survey 2012* showed that employer demand for STEM skills remains high. Our survey showed that employers are looking for recruits with STEM skills across every level of their businesses, including apprentices and graduates, technicians and experienced staff.

Two in five (42%) of those employers who take on staff with STEM skills still have difficulties in finding the STEM talent they need (Figure 16.0) and employers report these difficulties across every level of the business. This trend is not likely to ease off – nearly half of employers (45%) expect difficulty in the near future as the economic recovery gathers momentum. This is a worry for industry, because without a steady supply of skilled individuals, private sector growth will falter.

This is even more concerning given that difficulties are particularly intense in some of the sectors that are expected to be the key drivers of the economy. For example, in manufacturing, nearly a third (30%) of firms are reporting difficulties in recruiting technicians (Figure 16.1).

For many firms, the difficulties surround attracting the right STEM-skilled candidates. The two biggest barriers employers cited were a lack of general work place experience (42%) and weaknesses in employability skills (32%). These findings highlight the need for all young people to build up an understanding and experience of the world of work.

The lack of applications reported by a third of employers (35%) and a lack of sufficient technical knowledge and skills in graduate applicants (34%) hint at deeper and still unsolved problems with the STEM pipeline.

Responding to our survey, business is clear on its priorities for action – promoting the study of science and maths, encouraging STEM-related apprenticeship programmes and encouraging links between businesses and schools.

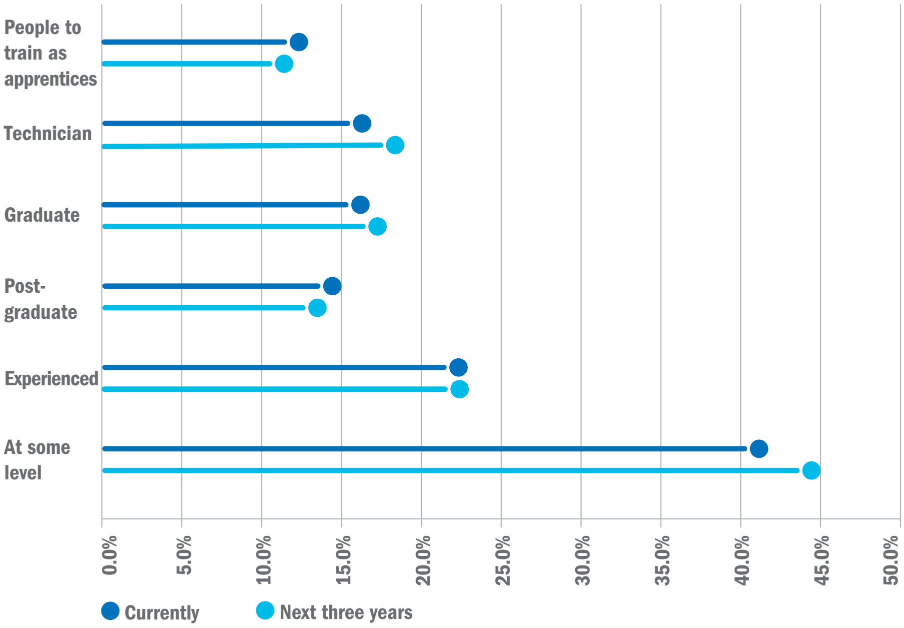
Science and maths hold the key to STEM progress

Promoting the study of science and maths is the top priority for business, with over two thirds (68%) of respondents calling for more action to promote their study. To some extent, this relies on having high quality teaching in schools, delivered by subject specialists. We know that there are still not enough subject specialists – almost one in four state secondary schools in England did not have a specialist physics teacher in 2010.[729]

There also needs to be more action to improve uptake of triple science GCSE. Triple science GCSE is the best preparation for A level study and beyond, and a third (34%) of employers advocate enrolling capable students into triple science GCSE. Despite this, only 70% of secondary schools offered the full combination of biology, chemistry and physics at GCSE in 2010.

While there are long overdue changes under way in schools across the UK, it's clear that more needs to be done to improve attainment further and faster than our international competitors. That's why this year, raising ambition for all in schools is a major priority theme for the CBI. The CBI will address the issue of whether the UK's education system is underperforming, the effects of this and what can be done to put it right.

Fig. 16.0 Difficulty recruiting individuals with STEM skills and knowledge



Source: CBI/Pearson survey

Fig. 16.1 Difficulty recruiting individuals with STEM skills and knowledge by sector

	People to train as apprentices	Technician	Graduate
Manufacturing			
- currently	20	30	26
- next three years	16	27	21
Construction			
- currently	17	16	3
- next three years	9	16	17
Engineering, high-tech/IT and science			
- currently	16	18	26
-next three years	16	31	24

Source: CBI/Pearson survey

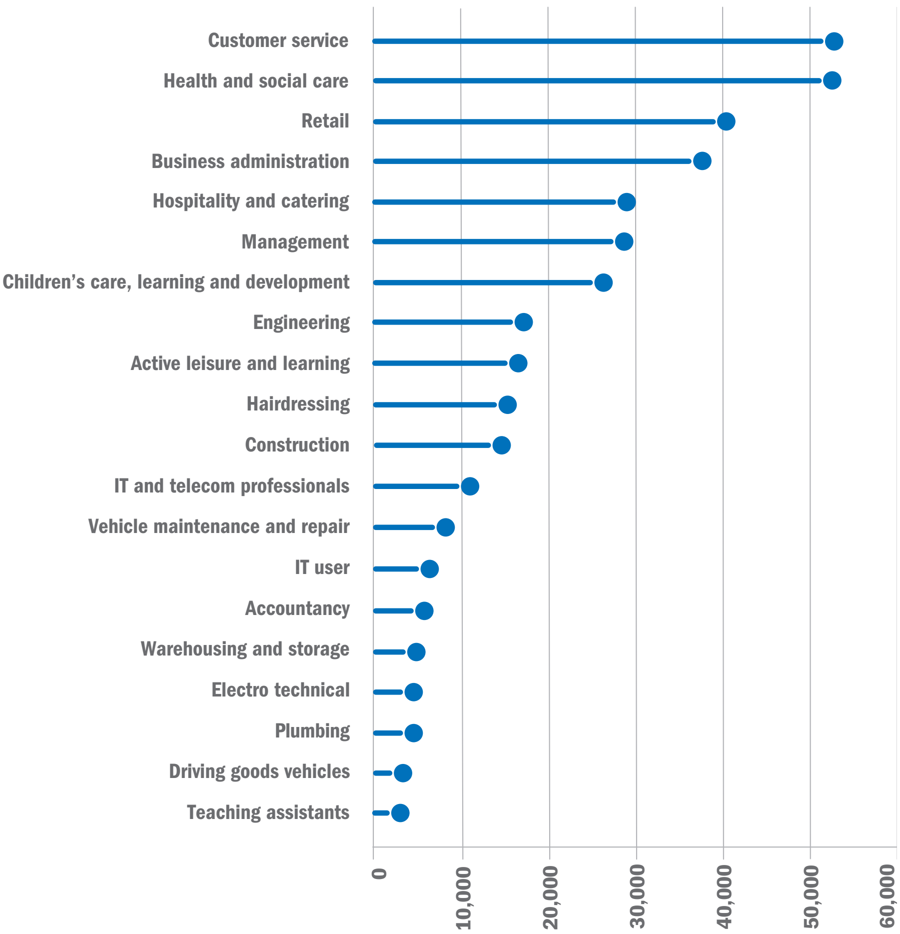
729 *Alarm sounded over demise of physics teaching*, The Independent, 3 February 2010

Apprenticeships can help address the gap in availability of experienced STEM staff

It is great news that more and more people are studying for apprenticeships – this year saw a massive 63% increase in the number of people starting an apprenticeship. However, the Government could do more to boost the number of STEM-related apprenticeships even further. For example, in 2010/11, the engineering framework received only a third of the number of starts of the most popular framework, customer service[730] (see Figure 16.2).

Fifty percent of employers told us that the Government should have a central role in supporting and promoting the value of STEM-related apprenticeship programmes. Initiatives like the £25m Higher Apprenticeships Fund are a great start, and it's right that the Government has targeted sectors with identified skills gaps. Examples of new higher frameworks being developed include energy and utilities, engineering and environmental technologies, and science. Employers are clear that the Government must do more to ensure that young people recognise the value of these routes for a successful career and of building higher level STEM skills while learning on-the-job with an employer.

Fig. 16.2: Apprenticeships starts by framework (2010/11)



Source: CBI/Pearson survey

Business can do more to support STEM in schools

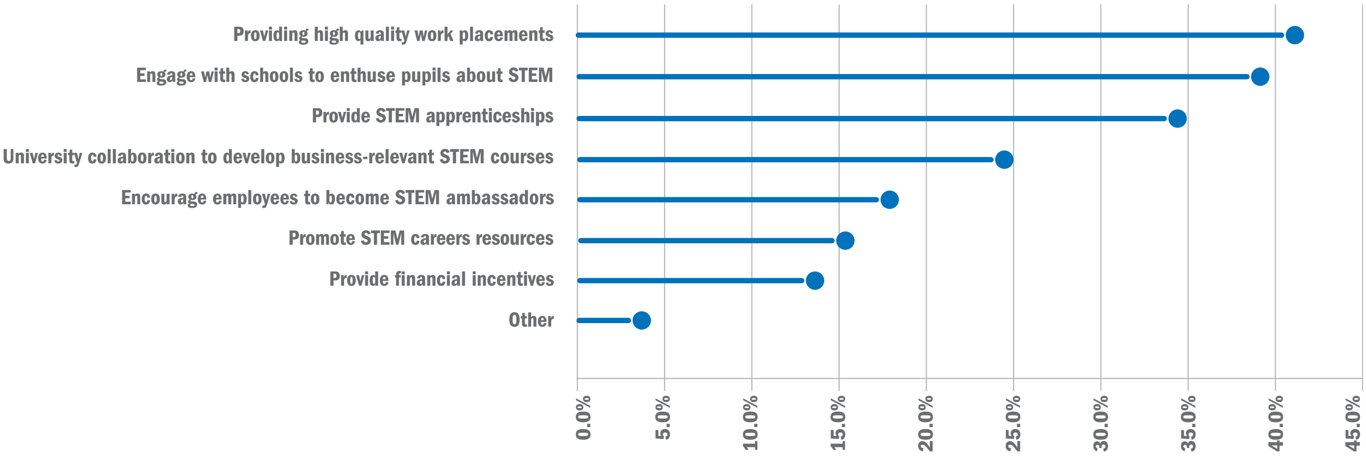
Employers know they have an important role to play in promoting the study of STEM subjects in schools. By engaging with young people, business can illustrate the diversity and range of careers on offer and can help young people to understand the practical application and relevance of what is learnt in the classroom.

Our survey showed that two thirds of employers (64%) are involved in activity to promote the study of STEM subjects. These routes vary, (Figure 16.3) but among the most common ways that business engages are the provision of work-experience placements (42%), and schemes designed to enthuse school pupils about STEM study (39%).

While this is an encouraging picture, many of these schemes are relatively small scale. There are also many more employers out there who would like to engage with schools but don't know where to start. That's why the CBI is recommending a national roll-out for some of the excellent smaller-scale projects that are already taking place, supported by a new network of 'business champions', alongside recognition for schools that do take part.

730 *Apprenticeship Statistics SN/EP/6113*, House of Commons, June 2012

Fig. 16.3: Steps by business to promote study of STEM subjects



Source: CBI/Pearson survey

16.2 Ensuring growth through employer-led skills provision

Authored by Tim Thomas, Head of Employment and Skills Policy, EEF, the manufacturers' organisation

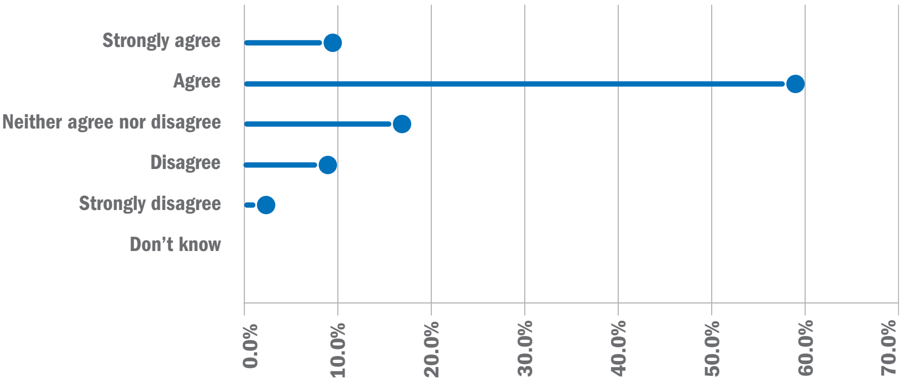
This year, the Government launched the Employer Ownership of Skills Pilot, which offers employers the opportunity to access up to £250m of public investment over the next two years to design and deliver their own training solutions.

Moves towards such models are welcomed by employers, particularly within manufacturing, where businesses have consistently argued for an employer-led system for delivering the skills business needs, now and in the future. The skills shortages within manufacturing are well documented. It is a real frustration for employers that they are unable to access the high quality skills that will enable their businesses to grow, develop and respond to changes in highly competitive global markets.

Even before the launch of the pilot, employers were coming together to address the problems of skills shortages and deliver the training to nurture these skills themselves. A recent survey of its members by EEF revealed that 60% of manufacturers agreed, and a further 11% strongly agreed, that they were addressing their skills needs more proactively now than two years ago (Figure 16.4).

An example of this can be seen in the Yorkshire and Humber region, where a cluster of employers including Davy Markham and Newburgh Engineering Ltd came together to address a persistent skills shortage.

Fig. 16.4: We are being more proactive to address our skills needs compared with two years ago



Source: EEF Skills Survey, 2012

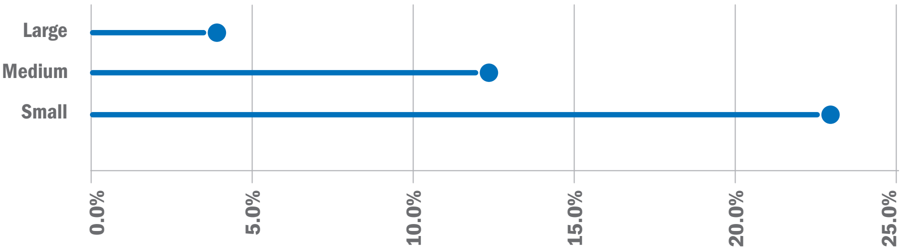
Dissatisfied with the apprenticeship provision available in their area, they put aside commercial interests, agreed common goals, and worked collectively to scope out a local model within a national framework that met their needs. They approached a local training provider that was willing, and able, to deliver the outcomes the employers needed. Throughout, they made sure that the provision was flexible enough to meet the needs of each individual employer.

The first stage of this initiative was to bring together SMEs that shared common goals and would benefit from access to skills that would allow their businesses to grow. Four businesses joined the initial discussions and shared their frustrations in: *"the supply chain of young people [coming] into engineering who had neither an appreciation of industry requirements or an understanding of the various career pathways for high calibre entrants to the industry".*

They found that larger organisations were providing in-house accredited apprenticeships leading to a formal qualification and were attracting the best candidates. This is a common theme amongst smaller sized manufacturers, with 23% recently saying they could not find enough good quality candidates for their apprenticeships, compared with only 4% of larger companies (Figure 16.5). To attract the best possible talent, they concluded that they needed to develop and deliver an SME-led apprenticeship programme that would make them collectively attractive to the best candidates.

The next stage was scoping the model. This involved visiting schools to gain the attention of teachers and pupils, and to raise the profiles of their individual businesses as well as boost the image of wider manufacturing. This form of engagement is common among employers. In its recent survey, EEF found that over half of its members (52%) currently offer factory visits or visits to schools.

Fig. 16.5: Could not find enough good candidates for number of places offered



Source: EEF Skills Survey 2012

With apprentices often starting their frameworks at the age 16, these employers decided that engagement with parents was equally important. Therefore, they developed tripartite apprenticeship agreements between the business, the apprentice, and the parents. All three stakeholders were aware of what was expected from them and what they would gain out of the apprenticeship on completion.

The apprenticeships were based on the Engineering Industry Training Board (EITB) model. Like many successful apprenticeship programmes, it included practical multi-disciplined experience, interlinked with academic teaching and delivered both on and off site. The pace of the programme was dictated by employers, with rewards targeted at effort and attainment rather than time served. This reflects workplace achievement beyond apprenticeships, where reward is based on performance and not duration of employment.

Along the way, critical decisions needed to be made, including selecting a training provider. Our skills survey revealed that only 21% of manufacturers agreed it was easier to find an appropriate training provider than two years ago, with 20% disagreeing. This suggests that many companies are still struggling to find training providers that meet their needs (Figure 16.6).

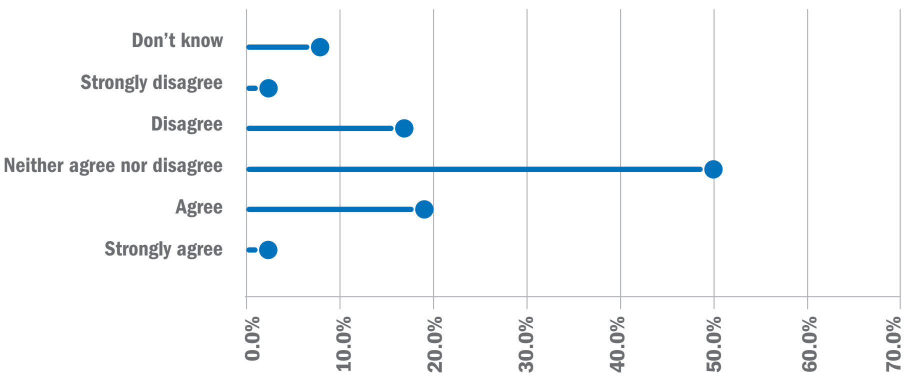
A key factor in deciding which provider to choose was their sector knowledge. On this occasion, the employers found that private sector providers demonstrated more flexibility and adaptability to meet industry needs. After careful consideration, they selected the most appropriate training provider. Working with the provider, the cluster negotiated an industry-led curriculum within a national apprenticeship framework. The training, both theory and practical, was to cover all aspects of production engineering. The model began with around 20 apprentices in its first year.

The need for flexible provision was important, as the businesses within the cluster were then able to structure their apprentice programmes to meet their individual business needs. Davy Markham, for example, offered a programme that began with in-house broad-brush training, with trainees assigned a 'buddy' for the duration of the apprenticeship. This was interspersed with blocks of practical and theory training delivered off-site by the training provider. Newburgh Engineering, on the other hand, developed a model that involved 42 weeks' theory and practical training at the off-site training centre, followed by in-house training, monitored by the provider. The common feature was that the pace of the apprenticeship was, and still is, dictated by the apprentice's aptitude, depth of knowledge and level of practical experience. Progression through the framework was subject to the business's approval, which ensured that the apprentice had the relevant skills required for the next stage of the programme.

Based on the model, the provider now has clients of all sizes and is able to deliver the skills needed by manufacturers in the local area. The employers within the cluster have a clear pipeline of talent which they can mould to their business needs. And the apprentices gain the transferable skills they need to progress in the future.

So, although we welcome funding to foster employer-ownership of skills, it is worth remembering that employers are already proactive in delivering skills themselves, frequently without additional public funding. What this case study clearly shows is that, for businesses to grow, they will always need access to a high quality pool of talent. In this case, where this was not being provided, the employers were able to develop a model that met the needs of their businesses, whilst simultaneously up-skilling the workforce, producing a positive impact on the economy overall.

Fig. 16.6: It is easier to find an appropriate training provider for our company than two years ago



Source: EEF Skills Survey, 2012

16.3 Working together to boost apprenticeships and higher skills across the UK

Authored by Bill Twigg, Apprenticeship director of Semta, Sector Skills Council for science, engineering and manufacturing

It is heartening to see the renaissance of apprenticeships at all levels. For too long they have been the poor relation to a university degree when, for many youngsters, the opportunity to earn as they learn is the right option.

We want to see more graduates enter engineering. But there are alternative routes into a career with long-term prospects for young people with good GCSEs and A levels, including maths.

Semta research indicates that industry needs to recruit and train 82,000 engineers, scientists and technicians across the UK by 2016. It also indicates that 363,000 of the current technical workforce is qualified below world-class standards and needs to be up-skilled.

We need to develop recruits to cope with expected growth and replace skills lost through retirement in an ageing workforce. There are initiatives in place to achieve this goal and, importantly, new frameworks have been developed in partnership with industry to meet the increasing requirement for high-level skills.

Doubling the number of advanced and higher-level apprenticeship registrations by 2016 is a challenging target but we are making excellent progress. We have hit 9,200 starts at level 3 and level 4 in a year. That's an additional 1,200 apprentices. So we have already met our 2012-13 target of a 25% increase on 2009/10.

It gives us real confidence that we will achieve our ambition. We are working hard to make it easier for employers of all sizes to take on apprentices, from securing quality candidates to developing frameworks that truly add value to businesses.

Semta's Apprentice Ambition, launched just a year ago in partnership with the National Apprenticeship Service and leading employers such as Siemens, Tata, Ford and Airbus, is a ten-point plan designed to increase advanced and higher-level registrations from 8,000 to 16,000.

The plan includes measures to help combat barriers to apprenticeship uptake such as attracting more quality entrants, reducing bureaucracy, developing frameworks that meet employers' needs, and improving training provision.

A great example of this is the development of two key new initiatives – the Advanced Manufacturing Engineering Higher Apprenticeship Framework (AMEHA) and the Advanced Skills Accreditation Scheme (ASAS).

The AMEHA has been designed to provide the advanced manufacturing and engineering sector with the very best technicians and engineers, combining practical skills with a Higher Education qualification. Through partnership with professional engineering institutions, successful completion of the level 6 framework results in Incorporated Engineer (IEng) status and we are working to increase the numbers taking up Eng Tech registration on completion of the Advanced (level 3) framework.

The nine Higher Apprenticeship pathways – marine, research and development, maintenance, aerospace, nuclear, mechanical, electrical/electronics, automotive and wind generation – cover a wide range of job roles and will help employers fill key skills gaps. Entry to the framework will require applicants to have achieved good A levels in science and maths or to have completed an appropriate Advanced Apprenticeship in engineering. Companies such as BAE Systems, Jaguar Land Rover, Siemens and MBDA have already recruited more than 400 apprentices for the new framework.

As for ASAS, Business Secretary Vince Cable said at its launch in June that it was exactly the sort of innovative approach needed to tackle what he described as the critical shortage of trained engineers across the UK. It will allow Semta to work with employers of all sizes across England to deliver a unique flexible programme of master's degree level training in key technology areas. ASAS will be delivered in partnership with leading universities and driven by an employer board to ensure the content truly meets business needs. It is anticipated engineers from 2,000 companies in England will be taking 5,000 master's degree modules over the next two years.

The programme focuses on delivering skills in specific, key technologies identified as critical for driving growth and productivity within UK advanced manufacturing and supply chain companies. It provides the best courses from the best sources, addressing priority skills gaps identified by employers. As there are no academic prerequisites, it allows individuals to study without having to register for a full master's programme, and it enables small and medium-sized enterprises to access individual modules as and when required.

Master's level study would normally require a first degree or significant equivalent evidence (eg professional qualifications). As an employer driven and funded programme, the only requirement for inclusion is that the employer feels the individual has the aptitude for study at master's level. This enables employers to invest in developing their existing workforce in an efficient, flexible manner, driven by business and sector need, while providing flexible progression routes for new entrants to the sector – for example, Advanced and Higher apprentices.

Only 39% of the advanced manufacturing and engineering workforce aged 25-64 have qualifications currently at level 4 or above, and only 6.9% of engineering staff in SMEs have level 5 qualifications, compared with 17% in large companies. Addressing the skills issue would improve productivity, creating high value, sustainable jobs and exports.

Realising these opportunities would result in an additional £9.4 billion for UK business in the automotive supply chain alone (currently only 36% of automotive components are produced in the UK out of a potential 80%). Similar opportunities exist in aerospace, a market worth $3.1 trillion to 2028.

The programme has the potential to transform Higher Education opportunities for all employers, particularly small and medium enterprises. It is important that employees from all backgrounds with the aptitude to develop skills are given the opportunity, which is why not basing access to master's level training purely on academic ability makes this programme so unique.

It is clear apprenticeships at all levels, but particularly Higher Apprenticeships, can stand alongside degrees as being equally important in the workplace. We all have a duty to continue to work together to improve the image of apprenticeships, to educate teachers, parents and youngsters about their worth and ensure the system remains flexible – able to adapt to the demands and needs of businesses to keep the UK at the forefront of engineering and advanced manufacturing.

16.4 Regulation of the engineering profession

Authored by Jon Prichard, CEO, Engineering Council

There are many forms of regulation within the UK, from statutory regulation that imposes legal restrictions and requirements through to self-regulation that is based on voluntary codes and practices. Statutory regulation should only exist where there is a legitimate public interest, and the UK generally prefers professions to be self-regulating. There is therefore no statutory requirement for engineers or technicians to be registered, although there are isolated areas of practice, including dams and reservoirs, aircraft maintenance and gas appliance installation and maintenance, where public registers are maintained.

The Government does however recognise the need for self-regulation. Accordingly, it awards Royal Charters to professional bodies, thereby encouraging the attainment of professional standards and the adoption of codes of conduct, which in turn provides a benefit to the public.

The Engineering Council is the chartered body that sets standards[731] for registration of competent engineers and engineering technicians on behalf of the professional engineering community: the UK Standards for Professional Engineering Competence (UK-SPEC). It maintains a register of all those who meet these standards and keeps the standards under review to ensure that they meet the needs of both business and society at large.

The process of assessment is undertaken by professional engineering institutions and societies licensed for that purpose by the Engineering Council. There are currently 36 of these.[732] The Engineering Council regularly reviews these licences and also works within international protocols to ensure that registered engineers and technicians meet internationally-agreed standards for practice.

The categories of registration set out in UK-SPEC are:

- Engineering Technician (EngTech), which requires evidence of competence, including academic knowledge and understanding, at or above level 3[733]
- Incorporated Engineer (IEng), which requires evidence of competence in practice, including academic knowledge and understanding at or above level 6 of the National Qualifications Framework, or at bachelor's level
- Chartered Engineer (CEng), which requires evidence of competence, including academic knowledge and understanding, at or above level 7 of the National Qualifications Framework, or at master's level

In addition, the Engineering Council operates the register for those that meet the ICT Technician (ICT*Tech*) standard, which is broadly equivalent to that of Engineering Technician.

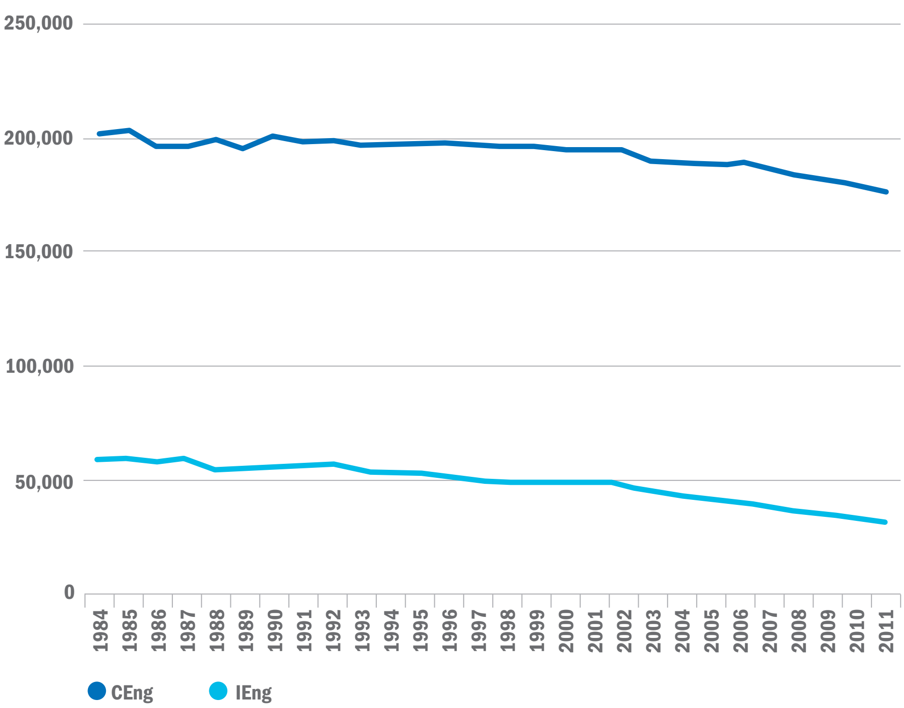
Candidates for all four registers must, in addition to demonstrating their competence to practise in accordance with the relevant standard, demonstrate that they are committed to keeping their competence current and commit to acting in a professionally and socially-responsible manner.

The number of registered engineers

The number of professional engineers in the UK economy is estimated at between 369,000[734] and 568,000.[735] The Engineering Council estimates that approximately 180,000 are registered as Chartered Engineers and 33,500 as Incorporated Engineers. The trend for the overall number of registered engineers continues to show a decline since its peak in the 1980s (Figure 16.7). This is to be expected, given registrants' age profile and making allowances for age of retirement (Figure 16.8). However, the rate of new registrations has steadily increased over the last few years. This is a positive sign, indicating that more graduates are being retained within the profession and being encouraged to become professionally registered.

The number of professionally-registered technicians (Figure 16.9) is significantly below the number of potential technicians to be found in the UK workplace. A major initiative is currently underway to address this, funded by the Gatsby Charitable Foundation.

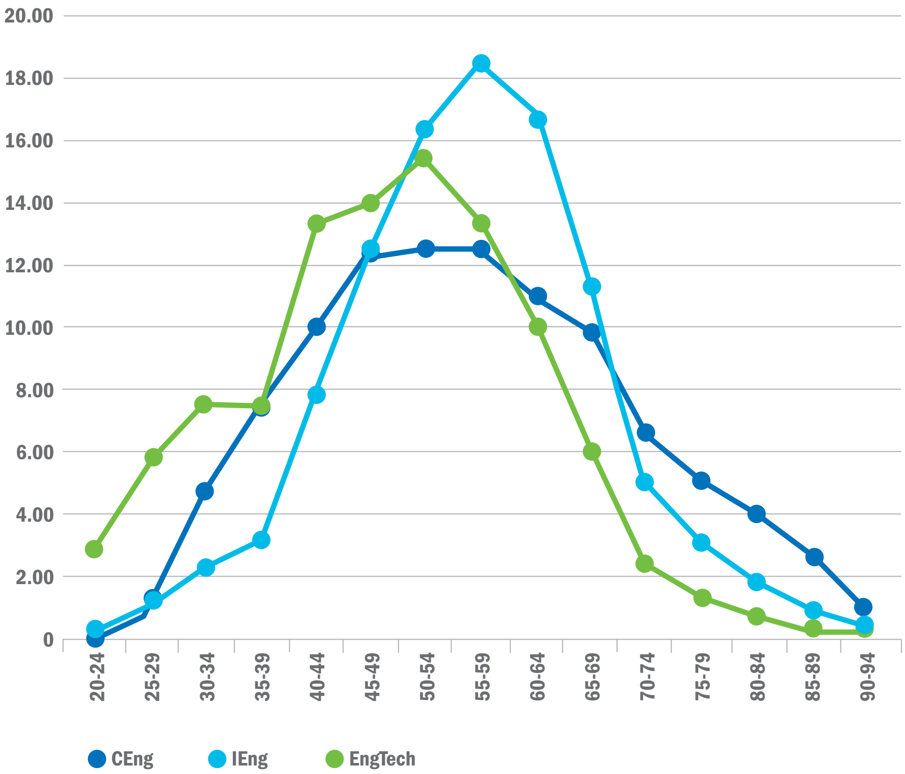
Fig. 16.7: Number of Registered Incorporated Engineers and Chartered Engineers (1984-2011)



Source: Engineering Council 2012

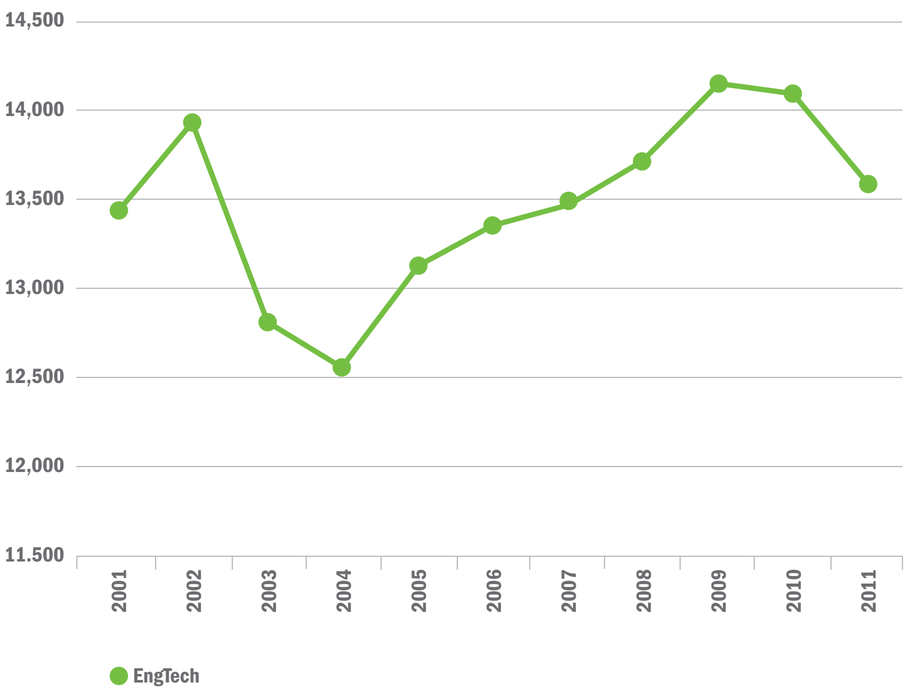
731 UK Standards for Professional Engineering Competence (UK-SPEC) www.engc.org.uk/ukspec **732** www.engc.org.uk/institutions **733** The equivalent academic standards in the Scottish Credit and Curriculum Framework are 11, 9 and 6 respectively. **734** Engineering Professionals: Parliamentary Answer 16 July 2008 (quoting LFS 2003 data) **735** Engineering L4+L5 in the economy: The Demand for STEM Graduates: some benchmark projections Rob Wilson January 2009: table 3.3

Fig. 16.8: Age distribution of Engineering Technicians, Incorporated Engineers and Chartered Engineers



Source: Engineering Council 2012

Fig. 16.9: Number of Engineering Technicians (2002-2011)



Source: Engineering Council 2012

16.5 The employer activists

Last year we stated that it will be the engineering employers themselves who will make the most significant contribution to UK economic growth. This is still true and will remain true in the future.

Certainly in terms of employers investing in developing their own capacity, a recent survey[736] by the UK Commission for Employment and Skills (UKCES) reports significant amounts of employer investment (£49bn). However, around half of this is accounted for by trainee labour costs, and around £7m by training management.

In addition to helping to rebalance the economy, employers are also seen to be pivotal in helping to redress the number of young people not in education, employment or training (NEET). Recently, UKCES called for every UK business to adopt a youth policy.[737] Its report highlights that most successful businesses already recognise the value of growing their own talent, and suggests that most companies can do at least one thing for young people in their community: from offering apprenticeships, hosting some form of work experience, visiting schools to give talks, offering teachers or college lecturers a workplace visit or mentoring a young person.

The Education and Employers Taskforce (EET) also highlights that recruiters place significant emphasis on experience, with 29% citing it as 'critical'. But despite the importance of work experience, young people are leaving education increasingly less experienced. Its report[738] points out that the practice of combining work and learning is declining. The emphasis on experience results in the 'Catch-22' situation for young people: they can't get work because they haven't got experience and they can't gain experience because they can't get work. This throws into sharp relief the importance of work experience undertaken while at school, college or university and the role that employers can play in providing such experiences.

However, it must be noted that the make-up of work experience places does not match the shape of the labour market. The EET research[739] showed that almost one in five places are in sports and leisure (28%), with just 6% in engineering and 1% in IT and manufacturing. This does not reflect the shape of the current labour market or growth sectors of the future and means that, along with overall growth in the number of work experience opportunities, a rebalancing towards growth sectors should be encouraged.

Despite these challenges, the good news is that the key role that employers can play in helping to grow the UK skills capacity has now been recognised with hard cash. The Government has announced a £250 million plan to give businesses the power to design, develop and purchase vocational training.[740]

Businesses will be given the power to design, develop and purchase the vocational training programme they need under a £250 million plan announced today by the Prime Minister. The move is designed to boost the economy and ensure that the UK workforce has the skills that businesses require for growth. The pilot has now been successfully launched, attracting 269 bids[741] from employers for the first funding round.[742]

Finally, Figure 16.10 provides some short cameos that highlight the challenges and opportunities that major engineering companies who belong to our high-level Business and Industry Panel[743] are facing over the next ten years.

736 Employer skills survey 2011: UK Results, UKCES, May 2012, p19 **737** The youth employment challenge, UKCES, July 2012 **738** Education and Employers Taskforce (EET) – Work experience: Impact and delivery – Insights from the evidence (April 2012) **739** Education and Employers Taskforce (EET) – Work experience: Impact and delivery – Insights from the evidence (April 2012), Annex 4, p14
740 http://www.number10.gov.uk/news/250m-pilot-skills-training/ **741** http://www.ukces.org.uk/employerownership/ **742** http://www.ukces.org.uk/employerownership/
743 http://www.engineeringuk.com/about_engineeringuk/panels/business_&_industry_panel.cfm

Fig. 16.10: What opportunities exist that will help your organisation achieve growth over the next 10 years?

ALSTOM

Alstom is a global player with a strong UK heart – we have over 6,500 rail transport and energy employees who are responsible for delivering and maintaining the majority of this country's rail and energy infrastructure. At present both industries are receiving unprecedented investment and this is creating exciting opportunities alongside challenges in order to meet ambitious UK growth plans. As a result we are actively offering great opportunities for graduates, apprentices, technicians, as well as providing reskilling for engineers from other industry sectors. The rail and transport markets offer incredible opportunities to make a real difference to peoples' lives – not just in the UK, but on projects all around the world.

ATKINS

Atkins is one of the world's leading engineering and design consultancies with a reputation for delivering innovative projects and developing people. As the company reaches its 75th anniversary year (2013), it is seeking to apply its wide-ranging experience to growing new markets. Atkins is also focused on its longer-term demands for new staff: participating in events aimed at raising awareness of STEM subjects among 13-year-olds prior to their GCSE choices; the continuing development of the Atkins Training Academy which supports recent graduates and experienced staff; and collaborating with University College London on the on-going Rail Management MSc. These – and other initiatives – will help to address the diverse range of engineering skills that will be required in the UK in the future.

BMT Group

BMT is a leading international design, engineering, science and risk management consultancy with a reputation for engineering excellence. We invest heavily in staff development so that we have the right skills that will help us create a world fit for future generations, as recognised in the 2012 Sunday Times 100 'Best Companies to Work For' list. For a company focused on providing innovative, high-value solutions, R&D is and will continue to also be key to our success. Our extensive R&D programme ensures products and services are designed to meet the current and future needs of our clients.

GENERAL DYNAMICS United Kingdom Limited

General Dynamics UK will look to the emerging global markets over the next ten years. The international markets will be the engine for global growth, and it is imperative companies like ours take advantage of that. Our industry is a competitive marketplace, but with the innovative defence and security solutions we offer, we remain confident of achieving growth over the next decade. We rely on the engineering skills of our employees and we'll continue to invest in them and our young UK graduates so that we remain at the forefront of this pioneering and dynamic industry.

invensys

As a leading global technology, software and consulting business serving the oil, gas, power, general process and other manufacturing industries, Invensys Operations Management differs and benefits from the highly leveraged domain expertise of its employees. We strive to retain and attract the best employees we can in order to safeguard a high quality pipeline of engineering capabilities. Additionally, programs are in place to enable up-skilling and certification of staff in key focus areas as well as employee access to over 2,000 specialised courses. We also have active community programs which invest in the localities in which we work and live.

Metaswitch Networks

Metaswitch Networks is busy overhauling the world's largest machine: the telephone network. Our expertise is sought worldwide to help communications service providers innovate their services while significantly reducing their costs of ownership. With more computing power and applications now resident on mobile tablets and smartphones, Metaswitch continues to invest heavily in developing new communications experiences that take advantage of these devices while also developing core network technologies that support them. Similarly as more communications products move into "the cloud", Metaswitch will be at the forefront of an industry that is part of the global transformation from dedicated hardware platforms, to massively-scalable, high-performance software solutions.

nationalgrid

National Grid connects people to the energy they use; at home, in our factories and offices, or for the infrastructure which is essential to our modern lifestyle. In Britain we run systems that deliver gas and electricity and are at the heart of one of the greatest challenges facing society; the creation of sustainable energy solutions and the development of an energy system that can underpin our economic prosperity. Our foremost challenge is scientific and engineering, so the supply of STEM skills is of vital importance. We therefore invest in programmes to enthuse students about science and engineering as well as grow our internal training and development schemes for all staff.

NATIONAL INSTRUMENTS

National Instruments equips engineers and scientists with measurement and control tools that accelerate productivity, innovation and discovery. Many of the grand challenges facing humanity across the globe – from access to clean drinking water to providing sufficient safe sustainable energy – can only be solved by engineers and scientists. To help the UK remain at the forefront of solving challenges in energy, transport, healthcare and communications, NI continues to invest in and support STEM education. By providing productive, industry-standard tools for students to get hands-on and "do engineering", NI enhances the learning experience, helping to deliver inspired, capable innovators, equipped to solve the engineering challenges society faces and improve everyday life.

NetworkRail

The Government's announcement to invest in the transformation of our railways provides a strong vote of confidence in Network Rail's ability to deliver sustainable economic growth. This will allow us to develop and add capacity for passengers and freight users, and complete The Northern Hub, as well undertaking the largest ever electrification programme which includes the Midland Main Line, Cardiff valley lines and extending the Great Western Main Line electrification to Swansea. We will work alongside industry partners to respond and will continue to deliver the highest possible levels of safety and performance; securing a huge range of exciting opportunities for people coming into the sector.

Schlumberger

Schlumberger is the world's leading oilfield services company supplying technology, information solutions and integrated project management that optimise reservoir performance for our customers. Consequently we have collaborated with the OPITO modern apprenticeship scheme in order to drive the recruitment and training of apprenticeships in the upstream engineering sector, as developing and retaining the workforce is crucial as we continue to take on the world's most complex energy challenges.

THALES

Thales UK sees transport and cyber security as growth markets, and will continue to need talented engineers in all our business areas – rail signalling and transport management databases, avionics, defence and security. We recruit engineering graduates and experienced engineers, particularly in software, systems, and safety engineering. We take apprentices into specialist manufacturing and rail installation, and are expecting to expand our engineering apprenticeship programme for 2013.

United Utilities
helping life flow smoothly

We are a highly technical business committed to strengthening its capability through our active engineering and technical graduate schemes and building future capacity through our mix of summer placements, internships and university partnership schemes including the Stream Industrial Doctorate Centre and a range of school STEM initiatives.

To provide excellent service to our 7 million customers in the North West of England, we employ a diverse range of technologies such as: membrane filtration, UV disinfection, chemical treatment, large scale activated sludge processes and combined heat and power; and offer opportunities spanning strategic planning, day-to-day operational management and reacting to regulatory drivers for more efficient and sustainable waste water treatment.

Annex

For the 2013 report, EngineeringUK has written the annex as a standalone, web-based document. By making the annex a standalone document, we are able to include more detailed information and will also be able to update it if required during the course of the year.

The annex can be accessed at:
http://www.engineeringuk.com/report

EngineeringUK

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