

MEETING THE CHALLENGE: DEMAND AND SUPPLY OF ENGINEERS IN THE UK.

Institution of
**MECHANICAL
ENGINEERS**

Improving the world through engineering

The Institution of Mechanical Engineers would like to thank the following people for their assistance in developing this report:

- Dr Colin Brown FIMechE
- Dr Robin Clark FIMechE
- Prof. Steve Culley FIMechE
- Claire Donovan
- Prof. Matthew Harrison MIMechE
- John Lowe FIMechE
- Prof. Fred Maillardet FIMechE
- Bob McGrory
- Andrew Medd FIMechE
- Prof. Alan Roach
- Susan Scurlock
- Tom Toolan FIMechE

This report outlines evidence regarding current shortages of graduate engineers. The challenge of forecasting numerical demand for graduate engineers in the UK, not just in engineering, is highlighted in the context of an increasingly complex and rapidly changing global economy. Problems faced in supplying sufficient engineering graduates to meet a future demand are explored. A distinction is drawn between skills shortages and skills gaps.

This report has been produced in the context of the Institution's strategic themes of Energy, Environment, Education and Transport and its vision of 'Improving the world through engineering'.

CONTENTS

02

**EXECUTIVE
SUMMARY**

04

INTRODUCTION

08

**DEMAND FOR
ENGINEERS AND
ENGINEERING SKILLS**

12

**FACTORS THAT
AFFECT DEMAND**

16

**SUPPLY OF
ENGINEERS AND
ENGINEERING SKILLS**

20

**FACTORS THAT
AFFECT SUPPLY**

21

CONCLUSIONS

22

RECOMMENDATIONS

23

REFERENCES

Engineering makes a vital contribution to the UK's economy, helping maintain the country's position as the 4th largest economy among the OECD and the 6th largest in the world. The UK's engineering-based sectors consist of over 800,000 businesses, employing nearly six million people, including 2.5 million in manufacturing, and generate revenues in excess of £1,000 billion each year (nearly half from manufacturing).

Engineering's contribution to society and the economy has been explicitly recognised by recent UK governments. Factors such as the 2008 financial crash, long-term campaigning on the part of employers and the engineering profession, and advice from influential Select Committees^[1] have helped raise its profile.

The Institution of Mechanical Engineers welcomes this shift in recognising the valuable contribution engineering makes to the economy. The Institution also welcomes developments aimed at providing the skills needed to grow the engineering and manufacturing sectors. These include the focus on demand-led skills provision, more apprenticeships and the investment in National Skills Academies.

However, much remains to be done. Difficult economic conditions are likely to continue for the foreseeable future making it increasingly important that Government creates a strong, definable vision for the UK economy, with engineering central to its success. This plan is outlined in the Institution's Engineered in Britain campaign, which identified a target of 20% of GDP being contributed through manufacturing. This would require roughly 50% growth in manufacturing output. The campaign also found considerable public support for greater investment and growth in manufacturing.

To ensure engineering and manufacturing play a greater role in the UK economy, it needs a future supply of engineers with the right skills, in the right place at the right time. Skills shortages and gaps have a detrimental effect on the development of economic sectors and limit the UK's ability to innovate and grow. These effects are exacerbated as global competition for engineered goods and engineering services increases.

Demand for Engineering Technicians and Graduates

The demand for Engineering Technicians, in terms of current and future requirements, is significant. In 2009, 37% of 'hard-to-fill' vacancies were for "skilled trades people" – broadly level 3 Technicians.^[2] Demand for Technicians will continue to rise in many sectors, driven by the increasingly technological nature of the economy and a notable move towards high-value market strategies.^[3]

This report, however, focuses on graduate engineers, the supply of whom will be key to future economic growth. Generating more engineering graduates could become increasingly difficult. Key factors affecting future supply could include changes in Higher Education funding and the increased demand for those with engineering skills from non-engineering employers. These, along with other pressures, may limit the availability of graduates entering the profession and therefore inhibit sector growth.

Forecasting the Future

Forecasting future skills demand, particularly in response to economic growth, is complicated and speculative. Economic uncertainty and unpredictable technological and socio-political changes combine to make the production of meaningful and reliable economic and labour force predictions difficult – even at the very top level.^[4] To predict the number of engineers needed over time is even more difficult.

Forecasts of future skills needs are therefore useful only as identifiers of broad future demand rather than as planning tools for specific education and training provision. That said, forecasts suggest that the UK needs to more than double the number of engineering graduates if it is to meet likely demand in the period to 2017. Although predictions and projections vary according to which report is read, they share a common theme – a high and growing demand for engineering skills in the coming years from both engineering employers and the wider economy.

The evidence available suggests that skills shortages in engineering are running broadly in line with the economy as a whole, despite anecdotal and perceptions-based views to the contrary. However, if the UK hopes to maintain its global economic position, it will need to make a step change in the number of engineering graduates entering the profession. If we fail to do this, the UK is unlikely to be able to address the major economic, transport, energy and environmental challenges that it faces over the coming decades.

RECOMMENDATIONS

Skill shortages are a national issue which requires coordinated solutions. A long-term partnership is needed between Government, employers and relevant support organisations with each understanding and playing its role (Table 1).

The Government should provide a vision for the nation and lead in identifying engineering skills demand and frameworks that underpin their long-term supply and use. The Institution of Mechanical Engineers believes Government should:

- Publish a clear cross-departmental vision for UK engineering skills needs that informs business, education and training planning;
- Engage the engineering community to produce a plan to raise the profile of engineering in education curriculums at all ages;
- Adapt the successful Skills for Scotland programme for the rest of the UK to contribute to skills utilisation.

Engineering employers should recognise that a demand-led system brings additional responsibilities as well as potential benefits. The Institution believes industry should:

- Coordinate skills investment with supply chains to ensure long term benefits for all;
- Invest in work-place and business-practice culture change to attract more young people, including more women, into engineering;
- Promote engineering and the study of subjects that lead to engineering as part of their Corporate and Social Responsibility programmes.

The profession and other support organisations should help identify skills needs and promote learning and skills validation. The Institution believes the profession should:

- Work to create more robust and reliable predictions of future skills needs;
- Create more flexible routes into engineering including those for late entrants;
- Coordinate an industry-led careers service to attract more graduates into engineering occupations.

Table 1: Stakeholder Partnership Roles

Governments	Employers	Support organisations
Vision for progress	Employment culture change	Predictive labour market data
Environment for progress	Investment in supply chains	Skills validation
Framework for long-term skills supply	Better use of skills	Life-long learning

INTRODUCTION

THE VALUE OF ENGINEERING SKILLS

The UK is the 6th largest economy in the world and the 4th largest among the 34 OECD nations. The World Economic Forum Global Competitiveness Report ranks the UK as the 12th most competitive world economy.^[5] For context, the UK is ranked 22nd by population and 77th by geographical area.^[6]

Engineering makes a major contribution to this level of economic performance, recognized by the inclusion of engineering in the Higher Education Funding Council for England (HEFCE) list of strategically important and vulnerable subjects.^[7] Engineering is vital to sectors such as energy production and supply, defence, transport, communications and health. It therefore underpins our national infrastructure as well as our economic prosperity and is the foundation of our quality of life. Within the UK, engineering-based sectors between them:^[8]

- Constitute over 800,000 VAT/PAYE registered businesses;
- Employ about six million employees, about 2.5 million of whom are employed in manufacturing; and
- Turnover about £1,063 billion per year, nearly half of which is attributable to manufacturing.

Engineering's contribution to the UK economy is, however, much greater than these data suggest. Policy makers and the general public alike readily acknowledge that engineering ingenuity underpins the supply of energy, transport and telecommunications, clean water and food. Less well known are the roles it plays in transforming public health, banking and public sector services for example. Engineering reaches beyond its traditional applications and also sustains the service sector and public sector – particularly through innovation in the technologies that underpin service activities.^[9] As Accenture put it in the introduction to their Technology Vision 2011^[10] report: “*technology trends are not isolated and are intimately intertwined with business and societal trends*”.

Engineers at all levels are critical for success. We know that demand for Technicians, in terms of current and future shortages is significant. In 2009, 37% of hard to fill vacancies were for “skilled trades people” – broadly level 3 Technicians.^[11] Demand for Technicians is rising in many sectors driven by the increasingly technological nature of the economy and a notable move towards high-value market strategies.^[12] This report, however, concentrates on the demand and supply of engineering *graduates*. Graduate level skills will be central to driving innovation and growth through high skills technologies in our increasingly knowledge based economy.

They may well be under increased pressure, however, due to changes in Higher Education funding and they are the subject of considerable demand from non-engineering employers.

“““

SUSTAINED ECONOMIC GROWTH IS FOUNDED ON DISCOVERIES AND DEVELOPMENTS MADE USEFUL THROUGH ENGINEERING DESIGN AND PROCESSES.

WHAT DOES THE FUTURE HOLD?

Innovation has always been, and continues to be, integral to creating value. So then, are the skills that support innovation, including skills in science, technology, engineering and mathematics.^[14] However the economic and political frameworks change, sustained economic growth is founded on discoveries and developments made useful through engineering design and processes. In this way we add value to natural resources. This requires engineering creativity and competence – based on knowledge, understanding and judgement.

It is likely that the next 30 years will see technological changes at least as great as those of the last 30. At present the considerable majority of innovation takes place in highly-developed economies.^[15] However, large areas of the world are developing rapidly and, as they do, their ability to innovate increases.^[16] Global competition is therefore increasing and maintaining our position in the world economy is becoming more difficult.

It is widely recognized that shortages of people with the right skills can have a significant impact on the day-to-day running of a business. Such shortages also affect businesses' ability to innovate and grow. Meeting employers' skills needs is therefore essential to our economic success^[17] and to maintaining international competitiveness. To do this we must ensure that we have the best possible understanding of our likely skills needs allied to an ongoing supply of people with appropriate engineering skills. Failure could lead to the UK being overtaken in the competition for economic advantage.

In recent years public policy debate has become increasingly demand led, focusing more on how best to match the demand for economically useful skills with the supply of people who have those skills. Demand can be represented in various ways. With regard to engineering we see, for example, a "strong preference" from business for graduates from science, technology, engineering and mathematics (STEM) subjects.^[18] – engineering being a critical part of this. Ensuring that we have the supply of engineers that we need, with the right skills, is therefore a major concern for the UK as a whole as well as for individual companies.

A common perception is that we are living with a demand for engineers and engineering skills that we cannot meet. Is this correct? If so, what can we do about it? If not, should we be concerned about the future?

Technological changes in the last 30 years include:

- Internet browser and html
- Mobile phones
- E-mail
- Magnetic Resonance Imaging (MRI)
- Microprocessors
- Non-invasive laser/robotic surgery (laparoscopy)
- Light-emitting diodes
- GPS systems
- Photovoltaic solar energy
- Large- scale wind turbines
- Bio-fuels

“““

IT IS LIKELY THAT THE NEXT 30 YEARS WILL SEE TECHNOLOGICAL CHANGES AT LEAST AS GREAT AS THOSE OF THE LAST 30.

DEMAND FOR ENGINEERS AND ENGINEERING SKILLS

SHORTAGES V GAPS

“Skill” can be described as *ability* with reference to the task needing to be performed, and the level of competence required.^[19] Skill is, therefore, the ability to perform a task at the required level of competence. Demand for skills is defined in terms of the jobs that employers want done and is expressed either in terms of immediate and unfulfilled need or as a prediction of anticipated future shortage. It can be identified at national or regional level.

Imbalance in the demand for and supply of skills essentially takes two forms; “shortages” and “gaps”. The two terms are often used interchangeably which can confuse debates about causes and possible solutions. Definitions of “shortage” and “gap” are subject to debate but for the purposes of this report we use the following.

Skills shortage: a situation in which employers are unable, or find it difficult, to find and recruit qualified and experienced people to specific roles. Factors that can lead to skills shortages include:

- New technology or business processes requiring new skills not yet catered for in the education and training system;
- New projects/product lines creating a surge (sometimes short term) in the demand for existing skills that the supply system cannot match;

- Entrants to the employment market choosing other careers;
- Qualified people unwilling to work in a given sector; this could be for many reasons including changing social attitudes (e.g. level of support for nuclear power);
- Business-specific issues, including firm-specific/highly-specialised skill needs, insufficient salary offered, undesirable location, poor recruitment processes; unattractive working conditions.

Skills gap: where people employed do not have all the skills needed to perform the tasks required by the employer. Factors that can lead to skills gaps include:

- Technologies being introduced, the very newness of which means that initially few are familiar with them or their applications;
- Employers, being unable to find skilled applicants, recruiting workers who need further training and/or experience to meet the firm's skill needs for the occupation;
- New employees who are still adjusting to a new company.

“““

SKILL IS THE ABILITY TO PERFORM A TASK AT THE REQUIRED LEVEL OF COMPETENCE.

ENGINEERS IN THE ECONOMY

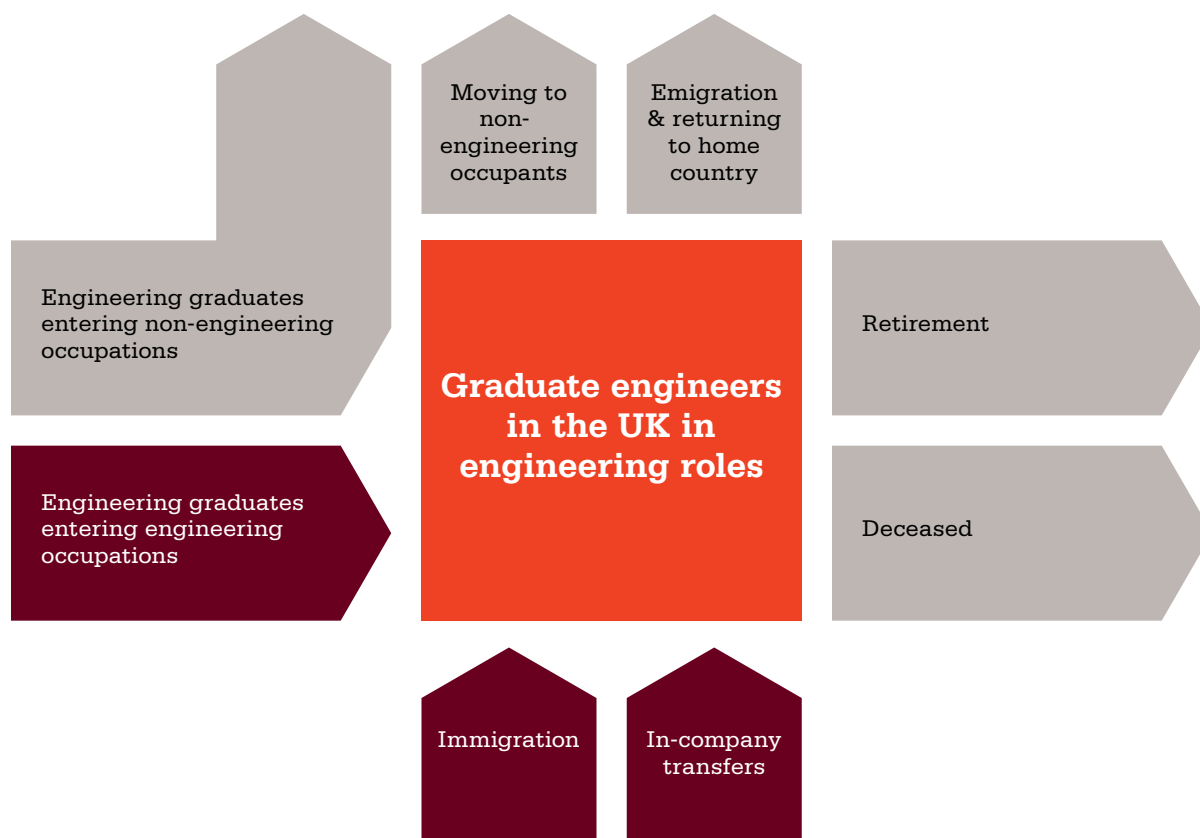
To understanding demand we first need to identify where engineers are currently employed. In the UK economy there are, depending on the definition used, between 369,000 and 568,000 engineers among whom approximately 180,000 are registered as either Chartered Engineers or Incorporated Engineers.^[20] These engineers enter and leave engineering occupations in a number of ways (**Figure 1**).

Employment data does not, however, show how many *engineers* are employed or needed in any given sector. Rather it categorises occupations in broader terms such as “professional, technical and scientific” or by qualification level such as “level 4”.

We have noted the pervasive nature of modern engineering. Practising engineers work within a wide range of occupational categories, as do people who hold engineering qualifications but for whose job an engineering qualification is not a pre-requisite. This is shown, in part, by the fact that at least 8 of the 24 Sector Skills Councils have an interest in professional engineering skills. Across a number of sectors, a small number of specific highly skilled occupations are required, which in some cases are critical to the relevant industry or sector. These include electrical power engineers for the electricity supply industry, and chemical engineers in the process industries.

The available data on graduates makes no distinction between those engineers who must have studied, for example, Aeronautical Engineering or Mechanical Engineering in order to do their jobs from those for whom any science, technology, engineering or mathematical degree will suffice. The Engineering Council 2010 survey of registered engineers (**Table 2**) illustrates the distribution of engineers throughout the economy.

Figure 1: Summarised flow of graduates to and from engineering roles (not to scale)



Women are under-represented in engineering in the UK; we have the lowest percentage of women in engineering (8.7%) within the EU (the highest with 30% is Latvia).^[13] Research by the Equal Opportunities Commission.^[21] found agreement that there are a number of major barriers confronting organisations seeking to challenge gender segregation, including traditional attitudes regarding proper jobs for women and men, social stereotypes, the poor image of some sectors, the attitudes of employers. Other evidence^[22] suggests that a significant barrier to the flow of women into SET is the simple fact that men are dominant numerically. Women who are interested in engineering stand out increasingly as they

progress through the education and training process and are seen to believe they do not belong in this ‘male space’. There is evidence to suggest that engineering employers with a predominantly male workforce have embedded corporate cultural norms and values which are often alien to female employees.^[23] This factor alone dissuades many women from entering or, vitally, remaining in engineering occupations as opposed to remaining in the sector but in non-engineering occupations. Initiatives such as the SET Fair Standard, which the Institution has used, could play a prominent role in helping create workplaces that are attractive to all.

Table 2: Employment sector by section of registration
Source: Engineering Council Survey of registered Engineers (2010)

	Total %	Chartered Engineer %	Incorporated Engineer%	Engineering technician %
Energy/gas/oil/petrochemicals	15	17	11	8
Construction/distribution	13	13	10	13
Manufacturing	12	13	13	9
Transport	9	8	8	18
Armed forces/defences	8	7	11	9
Utilities	7	7	6	5
IT/Computing/software	5	6	2	1
Local authority	5	3	11	7
Higher education	4	4	2	1
Communications	3	3	3	2
Government agency	3	3	2	3
Health	2	1	3	3
Agriculture/food industry	1	1	1	2
Banking/finance	1	1	1	1
Schools	1	1	1	2
Further education	1	0	2	4
Central government	1	1	1	1
Other	9	8	11	11
Not stated	2	2	2	1

“““
THE UK HAS THE LOWEST PERCENTAGE OF WOMEN IN ENGINEERING (8.7%) WITHIN THE EU.

DEMAND INDICATORS

Employer surveys, which are fundamentally perceptions-based research, tend to reflect the views of larger employers or their representative bodies who are more able to respond to questionnaires and find the time to be interviewed. Larger companies clearly play a vital role in stimulating business through their supply chains. However, approximately 90% of engineers in the UK work in businesses with nine or fewer employees and a turnover of under £2 million.^[11] Employers are not a homogenous group; in reality, their view on what they need from graduates varies by size of business and which level and type of manager is questioned. Assessment of demand that adequately takes account of the wide diversity of employers has so far proved elusive.

Engineering Council data shows that between 2007 and 2010 the average salaries of registered engineers rose despite growing unemployment during the period.^[24] This might suggest a buoyant market for engineers. However, we should note that:

- about 13% of registrants saw their base salaries fall while some, government employed engineers for example, saw their salaries rise;
- nationally, median earnings rose during the same period by 9.19% indicating that engineers' salaries were, in effect, simply keeping pace.

The list of Tier 2 Shortage Occupation Lists produced by the Migration Advisory Committee (MAC)^[25] offers an insight into demand, in the short term at least. Inclusion on the list indicates the occupation is skilled, suffering from an immediate labour shortage, and that it is sensible to fill the vacancies using labour from outside the European Economic Area. When introduced in 2008 the occupations included accounted for about 1 million jobs (4% of the labour market). In 2009 and 2010 the lists accounted for just 500,000 jobs. In 2011 the government accepted MAC recommendations to remove 71 professions and eight job roles from the list. This proposal was intended to meet the government's objective of raising the skill level of Tier 2 to National Qualifications Framework level 4 and above (NQF4). The MAC estimates that these recommendations will mean Tier 2 applicants coming into the country via the shortage occupation route will only be eligible for approximately 230,000 jobs (less than 1 per cent of the labour market).

Despite considerable publicity in the past few years about skills shortages, UKCES states that for the general economy, even allowing for the effects of the economic recession, *“Overall, skills shortages are relatively small, affecting only a minority of employers.”*^[26] In reaching this conclusion UKCES carried out horizon-scanning analysis,^[27] drawing in a number of other studies, together with material taken from sector skills assessment reports (produced by Sector Skills Councils). Separately Careers Scotland concluded that, in Scotland *“Skill shortages are uncommon – they are equivalent to around one percent of employees.”*^[28]

“““
**OVERALL, SKILLS
SHORTAGES ARE
RELATIVELY SMALL,
AFFECTING ONLY
A MINORITY OF
EMPLOYERS.**

Table 3: Engineering Skills vacancies in the English economy
Source: Engineering UK2011

% of establishments with at least one:	All establishments	All engineering establishments
vacancy	12%	8%
hard to fill vacancy	3%	3%
skills shortage vacancy	3%	2%

EngineeringUK assesses how engineering fits into the wider picture on skills shortages by reference to the National Employer Skills Survey.^[29] Levels of “hard to fill” and “skills shortage” vacancies in establishments within the engineering sector are very close to the rest of the economy (**Table 3**). In Scotland the picture is similar; Skills Development Scotland states that, *“Skill shortages are a special kind of hard-to-fill vacancy. They are not generally prevalent in the Scottish labour market. The picture across the UK is broadly similar.”*^[30] They also note however that when a business has a vacancy which is hard-to-fill, the impact can be severe. The two percent of engineering establishments with skills shortage vacancies experience their greatest need in respect of skilled trades-people, professionals and associate professionals. For professionals the most common area of skills deficiency are technical, practical or job-specific skills and are due to a shortage of applicants.

Notwithstanding the fact that there will be pockets of shortage, by sector, geography, by skill level and for particular skills, the situation seems to be that, *“the recruitment difficulties expressed by employers are broader concerns about a lack of well rounded candidates with technical skills, broader competences, such as mathematical capability, and practical work experience.”*^[31]

FUTURE DEMAND

We have already stated that we would benefit from anticipating our future need for engineering skills. Forecasting future demand for engineers is, however, complicated and somewhat speculative. The government, which has a vested interest in using demand as the basis for managing supply (and, therefore, the costs and benefits of supply) consider that, *“Any numerical estimate of future demand for STEM qualifications – and particularly specific STEM subjects – will be highly speculative.”*^[31] Skills in Context recommended that it would be more productive to focus on developing adaptive capacity rather than *“crystal ball gazing.”*^[32]

Very few factors are relatively straightforward to identify and assess when forecast. We can, for example, predict with some accuracy the number of engineers needed to replace those who are retiring. Other issues, growth in known and long-standing business sectors for example, are uncertain and so must be estimated. Some important factors, however, are more difficult even to estimate, including:

- Sudden and unpredicted technological breakthroughs that rapidly create new industries (e.g. mobile communications), change the shape and scale of others (e.g. agriculture) and alter business models (e.g. internet-enabled businesses);
- Changing social attitudes, such as increasing demand for “green” products, which can radically alter customer behaviour;
- The impact of the increasingly interdependent global network of cultural, political, economic and legal influences within which our employment decisions are made;
- Short-notice changes in Government policy, such as the decision to invest in nuclear power; and
- Large companies arriving/departing the UK impacting on suppliers.

Even identifying areas of economic and employment growth carries risk. Unpredicted change has been a characteristic of economic development during the last couple of centuries and is likely to continue as a feature of economic and technological progress. Few predicted for example the meteoric development of the mobile telecommunications industry before it occurred. As an indication of areas of future demand, and although they make no employment predictions, the Technology Strategy Board identified the following areas as those which it would prioritise:^[33]

- Advanced materials
- Bioscience
- Built environment
- Creative industries
- Electronics, photonics and electrical systems
- Emerging technologies and industries
- Energy generation and supply
- Environmental sustainability
- High value manufacturing
- High value services
- Information and communication technology
- Medicines and healthcare
- Nanotechnology
- Transport

Employers (engineering and others) consistently identify a future demand for STEM graduates^[34]. Their combination of numeracy and technical skills is attractive^[35] and will be increasingly useful in the advanced and rapidly changing labour market of the future.^[17] However, projections of demand for STEM/engineering graduates vary.

The Institute for Employment Research, for example, publishes demand assessments under the title *Working Futures*, the latest being for 2007–2017.^[36] They predict an overall demand by 2017 for 514,000 additional “Science/Technology Professionals.” Of these 192,000 (37%) represent growth while the others (63%) represent replacements for those retiring from the workforce. The corresponding figures for “Associate Professionals” (SOC 31) are 206,000 additional, of which 40,000 (19.5%) represent growth. Note, however, that the figures for “retirements from the workforce” include, “those employed one year ago who have retired from employment either temporarily or permanently.” This includes leavers for career breaks, illness and “family formation.”

The, now replaced, Department for Innovation, Universities and Skills (DIUS), the Council for Industry and Higher Education and EngineeringUK commissioned the Warwick Institute for Employment Research (IER) to prepare benchmark projections for the demand for those with graduate level qualifications in STEM subjects.^[37] These projections are provided by main STEM category, including engineering at NCQF level 4 – for which they forecast a need for 220,000 between 2007 and 2017. Using this data and making some simple assumptions we can estimate the implications of these demand projections on the supply of engineering graduates (Table 8; see page 22). On this basis we suggest that annual graduations need to more than double – starting immediately – to meet the forecast.

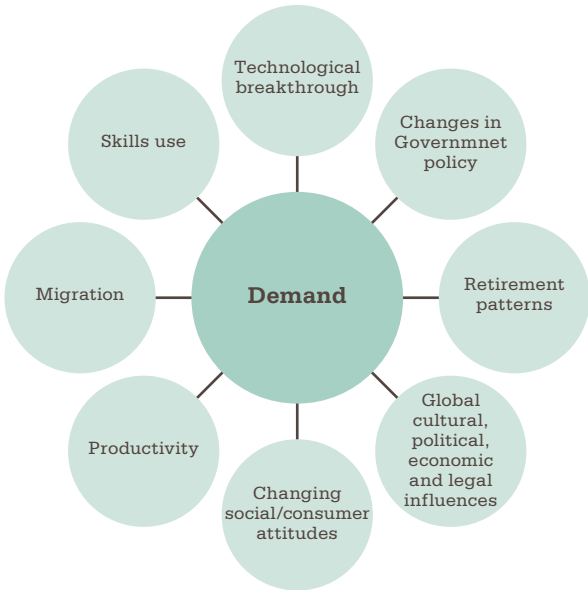
Caution is, however, important when using numbers as anything other than indicative of general trends and tendencies. While most agree that the need for engineering talent will increase, there is little if any agreement about predictions of the number of engineers needed by most sectors. DIUS suggested that, “...any numerical estimate of future demand for STEM qualifications – and particularly specific STEM subjects – will be highly speculative” and noted that employers they had consulted were of the opinion that, “...it was not possible to make sensible forecasts over a period of 5–10 years.”^[37]

What we can say with certainty is that we will need more engineers in the near future. Irrespective of how its economy develops, the UK needs engineers to design, build and maintain its infrastructure; to provide new products and services to sell to others; to ensure we are well defended; and to provide us with the food, power, transport and entertainment we expect.

FACTORS THAT AFFECT DEMAND

Assessing current demand is complicated by a wide range of factors each of which can affect the overall picture of skills demand (**Figure 2**). It is not within the scope of this report to discuss all of these, however, the following are worth noting.

Figure 2: Factors affecting skills demand



PRODUCTIVITY

Despite the major contribution engineering makes to the UK economy employment levels have declined by about 40% since 1988, against a background of a rise in UK general employment of 10%.^[38] In part this is due to the well reported migration of many manufacturing enterprises. It is, however, also partly attributable to increased efficiency and productivity per unit of resource – often embracing new technologies – which is a natural consequence of engineering practice.

Table 4: Manufacturing output gross value added (GVA)
Source: ONS, series: QTPI (manufacturing), ABML (total economy) HM Treasury GDP deflator

	Current prices £billion	2009 prices £billion	Manufacturing as % total
1979	47.5		25.8
1989	111.1	200.8	23.5
1997	150.2	199.7	20.3
1998	152.0	197.7	19.4
1999	151.2	192.5	18.4
2000	150.0	188.8	17.4
2001	149.2	183.9	16.4
2002	146.3	174.9	15.3
2003	144.8	168.0	14.3
2004	145.7	164.8	13.6
2005	148.1	164.2	13.3
2006	151.5	162.9	12.8
2007	154.7	161.6	12.4
2008	150.3	152.5	11.6
2009	139.9	139.9	11.1

Thirty years ago in the carpet making industry 3 or 4 people were employed to keep each loom running. A large number of people would also have been employed to rectify (by hand) faults in the finished carpet. Now one person operates 3 or 4 looms while fewer people are employed to remedy faults (still corrected by hand) as the number of faults coming off the loom has reduced.^[39] In the UK the car and electronics^[40] industries are typical sectors in which dramatically increased productivity is associated with falling employment, while volume has been maintained or increased. This clearly benefits the UK in terms of taxation and balance of trade but it also reduces employment levels. The UK manufacturing sector provides a clear example of this; *output* has risen steadily since 1979 (**Table 4**) while manufacturing *employment* has declined over the same period (**Table 5**).

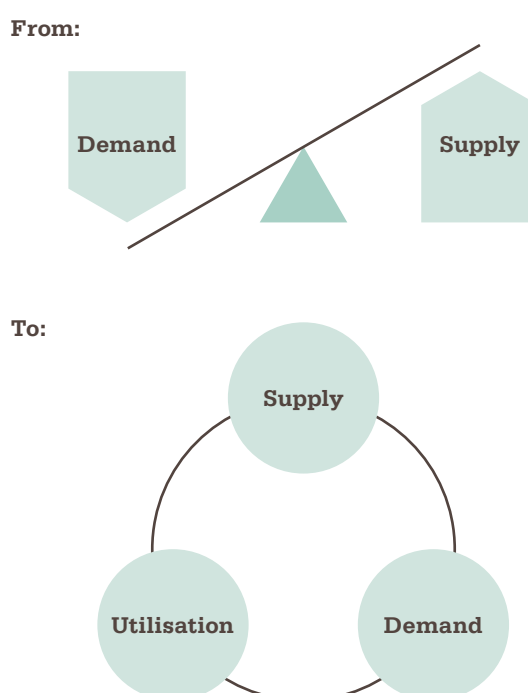
Table 5: Manufacturing workforce, seasonally adjusted
Note: Data taken on March of each year
Source: ONS, Workforce Jobs by Industry, table 6 series: JWR7 (Manufacturing), DYDC (total economy)

	Manufacturing 000s	Total 000s	Manufacturing as % total
1981	5,820	26,425	22.0
1991	4,667	28,589	16.3
2001	3,873	29,920	12.9
2006	3,045	31,517	9.7
2007	2,988	31,793	9.4
2008	2,906	32,038	9.1
2009	2,686	31,696	8.5
2010	2,570	31,242	8.2
2009	2,543	31,354	8.1

SKILLS UTILISATION

One emerging theme is the need to pay increased attention to how employers make better use of the skills already available to them – to foster innovation and drive business performance.^[41] This thinking is gaining ground in government^[42] and across Europe.^[43] The principle that best-use must be made of available skills underpins the Scottish Government's lifelong skills strategy, Skills for Scotland^[44] and is referred to in Skills for Growth – The National Skills Strategy.^[45] The idea is that as well as considering the supply of skills we also need to consider how we can help businesses to make best use of the skills available to them. The debate is moving from balancing demand and supply to balancing demand supply and utilization.

Figure 3: Moving from balancing demand and supply to balancing demand supply and utilization:



Skills in Context,^[46] produced by the Centre for Enterprise Research links skills, enterprise and economic development and was the basis for the Scottish Government's strategy. It suggests that jobs are not necessarily being redesigned to make best use of improvements in qualification levels amongst employees. So, for example, the rise in qualification levels has not been accompanied by an increase in the control employees can exercise over their jobs – despite the fact that more skilled jobs typically require a higher level of individual decision-making over tasks. The end result of this thinking is that *“Simply adding more skills to the workforce will not secure the full benefit for our economy unless employers and individuals maximise the benefits that they can derive from skills. Furthermore, how skills interact with the other drivers of productivity, such as capital investment and innovation, is crucial.”* Organisations and individuals will only reap the full benefits of skills investment when workplaces fully enable staff to also use their skills effectively.

By way of illustration, the Scottish government identified a series of actions to make better use of skills in the workplace.^[47] The rationale is that effective skills use involves developing skills in ways that best enable their effective application in the workplace. However, it also crucially depends on organisations embracing workplace cultures that enable people to perform at their best. This has many aspects to it, including:

- business/organisational ambition;
- leadership and people management practices;
- effective employee engagement;
- job design that encourages autonomy;
- how well learning is transferred to the workplace setting; and
- effective equality, diversity and healthy business practices.

“““

ORGANISATIONS AND INDIVIDUALS WILL ONLY REAP THE FULL BENEFITS OF SKILLS INVESTMENT WHEN WORKPLACES FULLY ENABLE STAFF TO ALSO USE THEIR SKILLS EFFECTIVELY.

CHANGING SKILL NEEDS

New jobs and new skills are continually emerging. As they do the skills needs of employers change to suit changing business processes, technological developments, customer demand, tax and other legal frameworks and a host of other factors. Increasingly engineers need to be multi-disciplined. In 2007, *Educating Engineers for the Future*^[48] identified the future engineering graduate as needing to combine three roles;

- Specialist (technical expert);
- Integrator (operating across boundaries); and
- Change-agent (providing creativity, innovation and leadership).

So, for example, engineers in the medical technology industry require skills in nanotechnology, design, use of biomaterials, software and IT together with expert knowledge of their own discipline.^[49] UKCES cites SEMTA and others as stating that for successful development of the industrial biotechnology industry, graduates and post-graduates will need to have multidisciplinary experience wherever possible as industrial biotechnology crosses the boundaries between such areas as biology, genetics, microbiology, chemistry and chemical engineering.^[17] The increasingly changing skill sets that engineers will need simply make it more important that businesses know how to best adapt and make use of those skills.

CHANGING RETIREMENT PATTERNS

Previous retirement patterns are unlikely to continue. The rapidly diminishing proportion of the working population covered by final salary schemes means that more engineers will be relying on defined contribution or stakeholder pension schemes, which in recent years have generated slim returns on investment. In addition, the age at which the state pension starts to be paid is rising. Together these facts are likely to encourage a growing number of engineers to remain in employment longer – changing retirement patterns and acting in effect as an additional supply. Already there are signs that these changes are influencing the behaviour of professional engineers. The Engineering Council 2010 survey of registered engineers indicates that fewer Chartered and Incorporated Engineers had fully retired, partially retired or taken early retirement than was the case in 2007.^[50] This is in the context of an aging engineering workforce.

SUPPLY OF ENGINEERS AND ENGINEERING SKILLS

COMPULSORY EDUCATION

At a young age children enter the education system and progress through a series of phases and transition points. When they leave they either move into work, training, an additional period of education or a combination of these. During this time they will have been through a formative period of personal development in which they will have been exposed to a range of social influences and educational experiences. At the same time they will have passed through key gateways; the decisions they make can irreversibly determine their future life and career opportunities.

The supply of graduate engineers is influenced by a range of factors (**Figure 4**). It is, however, ultimately dependent on the supply of young people who perform well in the required A level (or equivalent) subjects. In turn this depends on the choices made and performance at GCSE (or equivalent). Underpinning all of this is the motivation of children towards STEM which is affected by a plethora of factors, educational and social.^[51] Attracting young people into engineering is a challenge for many developed countries, although to differing degrees.^[52]

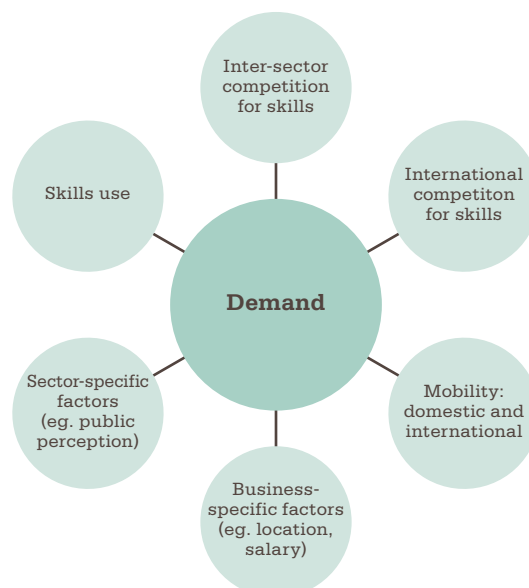
Awareness of engineering as a possible career option for children in the UK is generally very low, particularly amongst younger groups.^[53] The term “engineering” does not appear among the subjects to which they are exposed. Careers in engineering, therefore, typically build on early engagement and progression in science and mathematics. An influential US study published in 2006^[54] highlighted the clear connection between early interest in science, achievement in mathematics (at age 13–14) and persistence in engineering to degree level.

The debates about the issues that can affect the uptake of the subjects needed for progress into engineering occupations are well rehearsed. These include:

- Shortages of specialist teachers in science (especially Physics) and mathematics
- Insufficient real-world relevance within STEM subject curricula
- The transmissive rather than participative nature of teaching at secondary school
- Insufficient opportunity for hands-on, or experiential learning
- Cultural influences (e.g. media, peers, parents, role models)

While Mathematics and Further Mathematics have increased in popularity since 2002 Physics has hovered around the 30,000-student level (currently on a gradual increase) in England (**Chart 1**). That said, these students represent a small percentage of the students in the year cohort. In 2006 for example there were 645,000 students in England of whom about 4.6% studied A level Physics – a key subject for entry to an engineering degree. In Scotland, the percentage of students taking the Physics Higher was similar. Not surprisingly, the more “science” A level passes a student achieves the much more likely they are to study a STEM subject at University; from 2% of those with no A science level passes to 91% of those with 4 science A level passes.^[31]

Figure 4: Examples of factors affecting skills supply



“”
AWARENESS OF
ENGINEERING AS A
POSSIBLE CAREER OPTION
FOR CHILDREN IN THE UK
IS GENERALLY VERY LOW.

HIGHER EDUCATION

Engineering education is the bedrock on which high-quality engineering competence is built. Of course, the newly graduated engineer needs extensive knowledge and practical skills and that is where training is important. Education during these formative years will, however, establish the principles that will guide engineers through their ever-changing careers. A professional engineer takes around eight years from entering university before they are fully functioning, assuming they receive good professional development support, and early exposure to responsibility and experience.

Although the numbers applying to study non-engineering subjects have risen faster, there are positive signs of growth in those applying to study engineering. Since 2005 the number of applications to most engineering disciplines has increased (**Chart 2**). Applications to study Mechanical Engineering have increased in line with the overall rise in applications to undergraduate study; 31.7% compared to 33.5%. It is now the top engineering discipline, ranked by number of applications.

HESA statistics show that UK domiciled engineering students make up a steady percentage (about 70%) of all engineering students. This is confirmed by analysis by student domicile of accepted applicants through UCAS. These indicate that the health of engineering is being maintained among UK students while the growth is in non-UK domiciled students. It seems likely that the engineering profession's considerable efforts to promote careers in the discipline have helped to sustain demand in the UK.

We can compare the percentage of all undergraduates studying engineering manufacturing and construction with that of other countries. This is not an exact comparison, as content and categorisation of degrees varies by country. We can, however, see from UNESCO data (**Table 6**) that the percentage for the UK is among the lower percentages for a selection of our international competitors. By comparing this with the contribution made by manufacturing to GDP we see that the relationship between them is not direct. Although an analysis of this is beyond the scope of this report factors explaining this will include the nature of manufacturing activity and the degree to which engineers are used elsewhere in the economy.

Chart 1: A levels taken (All UK/Male/female)
Source: JCQ

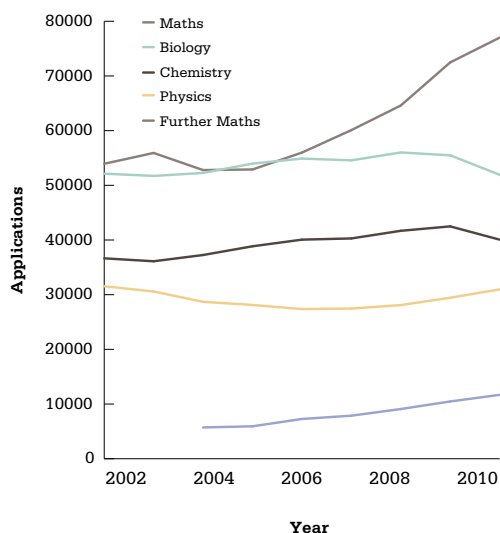


Chart 2: Top five engineering disciplines by number of applications. Source: UCAS

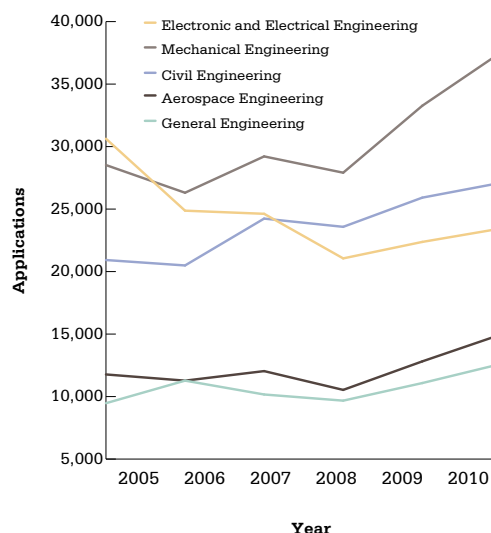


Table 6: Percentage of graduates in engineering manufacturing and construction
Sources: 1. Graduate data from UNESCO Institute for statistics, Global education digest 2009; *Based on UNESCO figure for total number of graduates and 650,000 engineering graduates (www.engineeringinchina.net); 2. GDP data from United Nations Statistics Division (http://unstats.un.org/unsd/snaama/dnllist.asp)

Nation	Graduates in engineering manufacturing and construction (%)	Manufacturing output as % of GDP (2009)
USA	7	12.3
UK	8	10.0
China	11*	41.1
Germany	13	17.1
France	16	9.6
Russian Federation	22	13.2

“”

A HIGH PROPORTION OF ENGINEERING GRADUATES ARE ‘LOST’ TO ENGINEERING ON GRADUATION.

GRADUATE DESTINATIONS

Those with high levels of skill in STEM subjects often do not work in STEM specific occupations. DIUS found that just under half of those with STEM degrees worked in STEM occupations, even though these occupations often carried an earnings premium.^[31] EngineeringUK, however, suggest a slightly higher figure of around 60%. Allowing for differences in how occupations are classified these still indicate that a high proportion of engineering graduates are “lost” to engineering on graduation. The 40% to 50% of engineering & technology graduates who follow non-engineering careers bring value to other areas of the economy. However, they also represent a lost resource to engineering.

It could be assumed that increased applications for engineering degrees will translate into a rise in the number of graduates entering engineering occupations on graduation. Demographic trends imply, however, that there will be a decline of 9% in the numbers of young people aged 15 to 24 between 2010 and 2020. In addition, 80 per cent of our 2020 workforce is already in work^[55]; this indicates a tightening in the supply of engineering graduates and technicians in years to come.

So, an increase in the proportion of engineering graduates entering engineering occupations could go some way to alleviating future shortages. In 2007 CRAC^[56] found that overall 86% of engineering students intended or probably intended to pursue a career in engineering. The percentage of females not wishing to pursue an engineering career rose from the second year of the degree course; for males this change occurs later, after placement. Importantly, it was noted that the profile of engineering employers is static or even declines in the final year of study. In contrast, the profile of major accountancy firms rises significantly. The Department for Business Innovation & Skills drew similar conclusions in March 2011.^[57]

Clearly there is more that could be done to co-ordinate the recruitment efforts of engineering employers so that they raise their profile as employers of choice among final year engineering students. This issue appears to be becoming more urgent as the percentage of students applying for jobs at the very beginning of their final year is increasing; from 25% in 2001 to 37% in 2010.^[58] We should also recognise that students have access to high quality information about careers from attractive employers. The profession should make available information for students to address their needs.

GREATER FLEXIBILITY OF PROVISION

While it can be argued that universities must become more responsive to the needs of employers, some relevant tensions must be recognised. Employers are not a homogenous mass. While they have some knowledge, understanding and skill needs in common, some are quite specific. Graduates from most university engineering degrees go to work with a wide range of employers in a range of occupations (engineering and non-engineering). Each of these demands a different skill set. Meeting those demands in detail presents a real problem. Employers must, and generally do, accept responsibility for developing some of the skills they need in their graduates.

Historically higher education (HE) has been – or has been seen to be – relatively inflexible, taking a long time to adjust degree content, teaching and learning styles and facilities to better suit the changing demand of industry. In contrast industry survives by responding rapidly to changing conditions. In recent years much has been done to bring HE and industry together and the HE sector is increasingly responsive to the demands of industry through, for example:

- industrial advisory panels on degree programmes
- visiting professorships
- industrial fellowships
- industry led projects, and
- shared facilities
- greater use of learning, at higher levels, in the workplace

Of particular note are the MSc and BEng in Professional Engineering introduced recently through the Engineering Gateways project; a partnership between the Engineering Council, professional institutions and universities. The programmes provide routes to registration through work-based learning. The work-based learning framework provides a way to concurrently acquire and utilise underpinning knowledge, understanding and skill-sets in work in order to meet academic requirements and demonstrate competence.

Such work-based routes offer a relatively cost effective way of developing knowledge and building on existing competences. They therefore offer the potential for engineers, including those working in smaller organisations, to achieve registration and so improve their professional standing. Employers will also benefit through the development of their workforce in areas directly relevant to their business.

Key features/benefits of the work-based Learning Contract are:

- flexible, individually designed programmes, unique to each participant's needs and situation;
- recognition and accreditation of appropriate previous learning;
- option to attend taught modules;
- access to university learning resources;
- supervisor support throughout the programme.

FACTORS THAT AFFECT SUPPLY

INCREASING COMPETITION FOR GRADUATES

"The war for talent is intensifying." So starts *Talent Wars: The struggle for tomorrow's workforce*.^[59] A wide range of sectors are engaged in offering solutions to present and or predicted skills shortages and gaps. For example, a recent report by PriceWaterhouseCoopers identifies a growing problem with recruiting "quality talent" to the insurance industry.^[60] So any discussion about engineering's ability to attract graduates must recognise that competition from other sectors for graduates will increase as the numerate problem-solver characterised by engineering (and STEM) graduates is in demand.

The UKCES National Skills Audit^[27] makes it clear that many sectors, whether or not they specifically target engineers, can offer attractive salaries that divert engineering graduates from engineering roles. This should concern "traditional" engineering employers. Employment of science, technology engineering and mathematics (STEM) professionals in the service industries is growing rapidly. According to the Royal Society, the majority of STEM graduates are now entering jobs classified as being in the service industries;^[61] although what proportion of these that require engineering qualifications and competences is not known. Engineering graduates are recruited into non-engineering occupations by a wide range of employers who use their numerate problem-solving skills, and who are prepared to train them in their own specialist technologies.

This puts pressure on the ability of companies' to recruit UK engineering graduates into engineering occupations. At the same time, the ability of multinational and transnational employers to internally transfer staff between countries where they have bases or activities can help alleviate their recruitment difficulties. However, it can also undermine the UK graduate's position in the UK market. Demographic trends are likely to intensify the competition. There is a predicted decline of 9% in the numbers of young people aged 15 to 24 between 2010 and 2020 and 80% of our 2020 workforce is already in work.^[62]

“ ”

THE WAR FOR TALENT IS INTENSIFYING.

MOBILITY

Engineering skills are highly portable internationally, more so than some other professions such as Law. Not surprisingly then international mobility for professional engineers is continually increasing. Some measure of this change is indicated by the increased activity under the international competence recognition protocols such as the Washington Accord and the FEANI Index.

The availability of high bandwidth internet access means that engineering design and project management can now be carried out anywhere in the world. At the same time physical engineering activities can be carried out across borders so that, for example, sub-assemblies can be manufactured in one country and assembled in another. This has brought some advantages to consumers by driving down costs and making more high quality manufactured good available at lower prices. One effect of this has been to increase the availability of engineering skills in other countries. This has increased the pool of talent available internationally, including to companies in the UK. Increasingly these potential employees can fill engineering roles either in their home country (i.e. through off-shoring) or by coming to work in the UK; both cases affect employment patterns in the UK.

Within the UK, business location can affect recruitment for some sectors and employers. Employers located in areas which well-qualified potential employees find unattractive, for reasons such as remoteness or, at the other extreme, high house prices, can find it difficult to recruit. Consequently certain regions have a greater 'pull' to potential employees (or students) than others and in some areas there can be a 'clustering' effect between universities and business that reinforces this.^[63] Added to this is the real problem with recruitment that increases in inverse proportion to company size; large, "blue chip" companies have multiple applications from appropriately skilled engineers while smaller companies have insufficient applications. In both cases time and cost are added to the recruitment process – although the business outcomes are substantially different.

CONCLUSIONS

Balancing short term demands for skills with the long term supply of those skills is a major undertaking that requires an understanding of where in the economy there will be growth, what transformative changes are likely to occur and how skill-needs will change over time.

Overall there is little, if any, quantifiable evidence of a general shortage of graduate engineers in the UK. Experiences will of course vary by individual company, geography, sector, and over time. Shortages are likely to emerge, as new industries develop, or engineering graduates continue to be drawn away to non-engineering careers. However, changes in retirement patterns mean that some projections of shortages arising from retirement over the next 10 to 15 years may be less acute than expected.

We can be confident, however, that we will see an increasing demand for people with STEM skills in general and engineering skills in particular. The demand is likely to come from employers in both engineering and non-engineering sectors. It is also likely to be amplified as our pursuit of a low carbon economy is ratcheted up.

This will occur in a period when the number of young people entering the workplace will decline and competition for all graduates, and especially STEM graduates, will increase. Data shows, however, that the number of applications from UK domiciled students for engineering courses remains static. Hence a major challenge is to ensure that more young people, including more women, choose to study STEM subjects at school so that they can and do study engineering at university and, ultimately, pursue engineering careers. At the same time we will need to make sure that we are making the most of the skills available to us through effective management, business organization – including supply chain management.

Ensuring we understand demand as much as possible and create a commensurate supply is a challenge for us all and so the solution requires a co-ordinated approach. A long term partnership is needed between Government, employers and relevant support organisations, each understanding and playing its roles.

Table 7: Stakeholder Partnership Roles

Governments	Employers	Support organisations
Vision for progress	Employment culture change	Predictive labour market data
Environment for progress	Investment in supply chains	Skills validation
Framework for long-term skills supply	Better use of skills	Life-long learning

“““

THERE IS A PREDICTED
DECLINE OF 9% IN THE
NUMBERS OF YOUNG
PEOPLE AGED 15 TO 24
BETWEEN 2010 AND 2020.

RECOMMENDATIONS

The Government should provide a vision for the nation and lead in identifying engineering skills demand and frameworks that underpin their long-term supply and use. The Institution of Mechanical Engineers believes Government should:

- Publish a clear cross-departmental vision for UK engineering skills needs that informs business, education and training planning;
- Engage the engineering community to produce a plan to raise the profile of engineering in education curriculums at all ages;
- Adapt the successful Skills for Scotland programme for the rest of the UK to contribute to skills utilisation.

Engineering employers should recognise that a demand-led system brings additional responsibilities as well as potential benefits. The Institution believes industry should:

- Coordinate skills investment with supply chains to ensure long term benefits for all;

- Invest in work-place and business-practice culture change to attract more young people, including more women, into engineering;
- Promote engineering and the study of subjects that lead to engineering as part of their Corporate and Social Responsibility programmes.

The profession and other support organisations should help identify skills needs and promote learning and skills validation. The Institution believes the profession should:

- Work to create more robust and reliable predictions of future skills needs;
- Create more flexible routes into engineering including those for late entrants;
- Coordinate an industry-led careers service to attract more graduates into engineering occupations.

Table 8: Estimating the implications of demand projections for the supply of engineering graduates

DIUS projects a demand for NQF level 4 engineers (demand through replacements and expansion) between 2007 and 2017 of:	220,000
EngineeringUK ^[11] report that about 63% of UK domiciled engineering graduates enter engineering & technology occupations on graduation. Assuming this ratio remains constant, we can estimate the total number of engineering graduates needed to meet the above projection (220,000 graduates entering engineering occupations).	349,200
From this we can subtract:	
1. The number of engineering graduates known to have left university in the four years from 2007 to 2010	(47,400)
2. The number of engineering graduates predicted to graduate in the seven years from 2011 to 2017. This is calculated using an annual average of 12,000 (for reference the actual number of graduations in 2010 was 11,800).	(84,000)
Between them these add up to:	(131,400)
Subtracting 131,400 from 349,200 leaves a balance of:	217,800

This is the estimated number of graduates that would be needed to meet the IER forecast of demand by 2017, and beyond current graduation levels.

To meet this demand we would have to increase annual engineering graduations from about 12,000 per year to about 31,100—with immediate effect.

Notes:

1. We have assumed that the data relates to UK domiciled engineering graduates as these make up the vast majority of engineers employed in the UK.
2. The projection of demand takes no account of recent macroeconomic changes in the economy; it also assumes current patterns of behaviour continue.
3. Numbers are rounded to the nearest hundred.

REFERENCES

- 1 **MPs slam government engineering policy: New Civil Engineer** (27 March, 2009, www.nce.co.uk/1996016.article)
- 2 **Engineering UK 2011**
- 3 **The future demand for technicians and underlying STEM skills** (M Spilbury and R Garrett, UKCES, 2010)
- 4 **Quantitative Assessment of Occupational Skills Shortages: the impossible challenge?** (The Semta PowerPoint template for generic use, Eur Ing Dr. Matthew Dixon, Semta Fellow, SKOPE/SKOPE Research Fellow, SEMTA)
- 5 **The Global Competitiveness Index 2010–2011** (World Economic Forum)
- 6 www.worldatlas.com/aatlas/populations/ctypopls.htm
- 7 www.hefce.ac.uk/aboutus/sis/
- 8 **Engineering UK 2011: Pt1** (Engineering UK)
- 9 **Hidden Wealth: The contribution of science to service sector innovation** (The Royal Society Science Policy Centre, July 2009)
- 10 **Technology Vision 2011; The technology waves that are reshaping the business landscape** (Accenture, 2011)
- 11 **EngineeringUK 2011**
- 12 **The future demand for technicians and underlying STEM skills** (M Spilbury and R Garrett, UKCES, 2010)
- 13 Louisa Kirwana, Dr Anil Kapur & Neil Randerson, **An investigation into why the UK has the lowest proportion of female engineers in the EU** (EngineeringUK, April 2011)
- 14 Charles Levy & Laurence Hopkins, **Shaping Up For Innovation: Are we delivering the right skills for the 2020 knowledge economy?** (The Work Foundation, September 2010)
- 15 Shane Tomlinson, Pelin Zorlu and Claire Langley, **Innovation and Technology Transfer: Framework for a Global Climate Deal** (An E3G report with contributions from Chatham House, November 2008)
- 16 Soumitra Dutta, **The Global Innovation Index 2011; Accelerating Growth and Development** (Soumitra Dutta, INSEAD, 2011)
- 17 **A Theoretical Review of Skill Shortages and Skills Need** (UKCES Evidence Report 20, May 2010)
- 18 **Building for Growth: business priorities for education and skills; Education and skills survey 2011** (CBI; May 2011)
- 19 **A Theoretical Review of Skill Shortages and Skills Need** (UKCES Evidence Report 20; May 2010)
- 20 **EngineeringUK 2011**
- 21 Dr Wendy Faulkner, **Genders in/of Engineering – A Research Report** (Science Studies Unit, University of Edinburgh, March 2006)
- 22 **ASL Sector Skills Agreement employer research** (Inverness, 2005/6)
- 23 Analysis of data from www.ukrc4setwomen.org/html/research-and-statistics/statistics/set-occupations-2009/ (downloaded 23 April 2009)
- 24 **Analysis of The Annual Survey of Hours and Earnings (ASHE)** (Office for National Statistics, www.statistics.gov.uk/StatBase/Product.asp?vlnk=13101)
- 25 **New recommendations to raise UK shortage occupation list to higher skills level**; downloaded from www.government-news.co.uk/border-agency/201103/new-recommendations-to-raise-uk-shortage-occupation-list-to-higher-skills-level.asp#; downloaded on 14 July 2011.
- 26 **Ambition 2020: World class skills and jobs for the UK, Key Findings and Implications for Action** (UKCES)
- 27 **National Strategic Skills Audit for England 2010** (UKCES)
- 28 www.careers-scotland.org.uk/WhichCareer/Trends/KeyMessages/SkillShortages.asp
- 29 **UK CES** (<https://ness.ukces.org.uk/default.aspx>)
- 30 **Skills Shortages and Managed Migration: Talking Points** (Skills Development Scotland)
- 31 **The Demand for Science, Technology, Engineering and Mathematics (STEM) Skills** (DIUS; January 2009)
- 32 **Skills in Context: A Briefing prepared by the Centre for Enterprise** (Futureskills Scotland; 2007)
- 33 www.innovateuk.org/ourstrategy/our-focus-areas.ashx
- 34 The CBI's 2011 Education and Skills survey states that 41% of all businesses have a preference for STEM graduates
- 35 **SET for growth: business priorities for science engineering and technology** (August 2010)
- 36 **Working Futures 2007–2017** (Warwick Institute for Employment Research, July 20011)
- 37 Rob Wilson, **The Demand for STEM Graduates: some benchmark projections**; Warwick Institute for Employment Research; January 2009
- 38 **Skills and the future of Engineering in England; The full Sector skills Assessment for Semta's Engineering sectors in England** (Semta; December 2008)
- 39 **Engineers And Engineering In The UK Today – A Response From The Chamber Of Commerce Herefordshire And Worcestershire To The Enquiry By The House Of Commons Select Committee On Innovation Universities And Skills** (www.hwchamber.co.uk/UserFiles/File/Engineers%20UK.pdf)
- 40 "The UK electronics industry has high levels of productivity and consists of numerous SMEs, with niche market capabilities" **Competitiveness in the UK electronics sector** (DTI 2005, <http://bit.ly/a3x84z>, 13 Aug 2010)
- 41 Buchanan, J., L. Scott, S. Yu, H. Schutz and J. Jakubauskas, **Skills demand and utilisation: an international review of approaches to measurement and policy development** (OECD Local Economic and Employment Development [LEED] Working Papers, 2010/4; 2010)
- 42 **Skills for sustainable growth; Strategy Document** (Department for Business Innovation and Skills)
- 43 **Skills Supply and Demand in Europe: Medium Term Forecast up to 2020** (CEDEFOP, 2010)
- 44 www.scotland.gov.uk/Topics/Education/skills-strategy
- 45 **Skills for Growth – The National Skills Strategy** (Department for Business, Innovation and Regulatory Reform, 2009)
- 46 **Skills in Context: A Briefing prepared by the Centre for Enterprise** (Futureskills Scotland, 2007)
- 47 www.scotland.gov.uk/Topics/Education/skills-strategy/making-skills-work
- 48 **Educating Engineers for the 21st Century: The Industry View** (Henley Management College (for the Royal Academy of Engineering); March 2006)
- 49 **Strategic Skills Needs in the Bio-medical sector: Medical Technologies and Pharmaceutical Industries** (Hogarth, T., Bosworth, D., Davis, C. and Price, S; Quoted in UKCES National Skills Audit 2009)
- 50 **Report For The Engineering Council**; June 2010; ERS Research (see: www.engc.org.uk/ecukdocuments/internet/document%20library/2010%20Survey%20of%20Registered%20Engineers.pdf)
- 51 **When STEM A question of age** (Institution of Mechanical Engineers, 2009)

- 52 S SJoberg and C Scheiner **How do learners in different cultures relate to science and technology?** (Asia-Pacific Forum on Science and Learning, Volume 6, Issue 2,December 2005)
- 53 **When STEM; A question of age** (Institution of Mechanical Engineers, May 2010)
- 54 R T Tai, C Q Liu, A V Maltese, X T Fan **Planning early for careers in science**; Science 312 [5777], pp. 1143–1144; 2006)
- 55 **Ambition 2020, The 2010 Report, Key Findings and Implications for Action** (UK Commission for Employment and Skills)
- 56 **The career thinking of UK engineering undergraduates** (CRAC Ltd, 2007)
- 57 **STEM graduates in Non-STEM jobs**,BIS Research Paper No.31; March 2011
- 58 **The UK Graduate Survey 2011** (High Flyers Research, May 2011)
- 59 **Talent wars, The struggle for tomorrow’s workforce: A report from the Economist Intelligence Unit** (The Economist Intelligence Unit, 2008)
- 60 Christopher Box, Ron Collard, Henrick Van Cappelle, **Tomorrow’s workforce: Securing the talent to succeed** (Intelligence Digest, PriceWaterhouseCoopers)
- 61 **Hidden Wealth: the contribution of science to the service sector innovation** (Royal Society, July 2009)
- 62 **Ambition 2020, The 2010 Report, Key Findings and Implications for Action** (UK Commission for Employment and Skills)
- 63 **National Strategic Skills Audit for England 2010** (UKCES)





The number of education reports submitted in the wake of a firing incident for education was

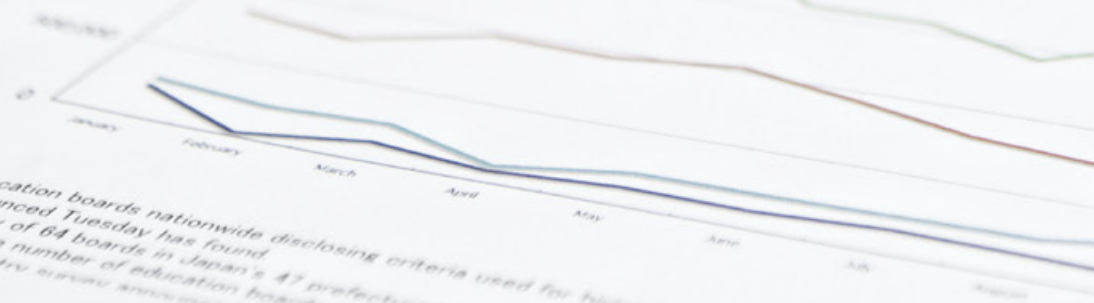
According to the records of the Ministry of Education, the number of reports submitted in the wake of a firing incident for education was 1,000 in January, 1,200 in February, 1,100 in March, 1,300 in April, and 1,400 in May.

**Institution of
Mechanical Engineers**

1 Birdcage Walk
Westminster
London SW1H 9JJ

T +44 (0)20 7304 6862
F +44 (0)20 7222 8553

education@imeche.org
www.imeche.org



The number of education boards nationwide disclosing criteria used for hiring teachers has more than doubled in a ministry survey announced Tuesday has found. According to the survey of 64 boards in Japan's 47 prefectures and 17 major cities, 98 have recently decided to disclose criteria used for hiring teachers. The number of education boards nationwide disclosing criteria used for hiring teachers has more than doubled in a ministry survey announced Tuesday has found.