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SKILLS DIALOGUES: LISTENING TO EMPLOYERS

2

An Assessment of Skill Needs in Engineering

Skills Dialogue

A comprehensive summary from employers of skills requirements in engineering

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Skills Dialogues – General Introduction

Skills Dialogues constitute a series of consultations with all major industrial and business sectors, leading to the production of high quality authoritative skills assessments for each of these broad sectors. Dialogues developed from recommendations in the 2nd Report of the Skills Task Force, *Delivering skills for all*, as a means of providing better quality information on changes in skills supply and demand at a sectoral level. They draw on research undertaken by National Training Organisations (NTOs) through Skills Foresight and other projects as well as a wide range of national research on current and future skills needs. Recognising the UK remit of NTOs the dialogue reports reflect the UK perspective as far as possible, although not all the available evidence which underpins the Dialogues is UK wide. Typically, the reports do not provide a region by region analysis but they do attempt to illustrate any major regional differences. The Skills Dialogues operate as a rolling biennial programme with the first full series of reports due to appear between Autumn 2000 and the end of 2001.

The purpose of the dialogues is to improve the quality of skills information available at a sector level, and to provide an effective voice for NTOs and employers in their sectors in the planning and implementation of education and training provision and in informing careers advice and guidance. They will ensure that industry sector views are well articulated and represented to major stakeholders, such as the new Learning and Skills Council (LSC) and its local arms, Regional Development Agencies (RDAs) and careers services. The dialogues are designed to draw on the work of individual NTOs but to cover broader industrial groupings, so as to aid strategic planning and make the information base more manageable.

The assessments produced through the dialogues will also directly contribute to Sector Workforce Development Plans, as the evidence on skill needs will underpin proposed action and influence the nature of relationships with key partners. These plans will form a strategic statement of NTOs' proposed activities, relationships with partners and stakeholders and targets for achievement.

Each report results from a process of consultation with the main organisations in the sector to identify the key issues, and a wide ranging analysis of existing material on skills supply and demand, and factors influencing skill trends. The evidence includes sector specific analysis from the recent national research conducted on behalf of the National Skills Task Force including the Employer Skills Survey (ESS) and Projections of Employment and Qualifications by the Institute for Employment Research as well as the NTOs' own Skills Foresight research. The material is brought together into a draft discussion document for a national seminar, which involves all the key interests in the sector, such as employers, NTOs, Further and Higher Education planning, funding and qualifications' bodies, trade unions, professional associations and government departments.

The final report takes on board the comments from all those involved in the Dialogue and provides a comprehensive analysis of the skill needs and an authoritative statement about skills trends in the sector. We hope they will be useful to policy makers and planners in other parts of the United Kingdom. For example, a series of skills monitoring and forecasting exercises are being undertaken in Northern Ireland and the work on this and other Dialogues will inform the Northern Ireland research.

Foreword

As the representative National Training Organisations for the engineering sector, we welcomed the recommendations from the National Skills Task Force to set up a programme of skills dialogues across the major industrial and business sectors, provided the reports reflected the views of those in the sector. We felt that the skills dialogues could bring valuable information and new insights on skills to those planning education and training provision.

This report has been developed as a partnership between NTOs, their employers, and Government, but has involved discussion with a wide range of partners, including some of the funding and planning bodies who will benefit from this information. It has brought together a wide range of information, including the research that we as NTOs have carried out along with new data on current and future skills needs in the sector. The result is a detailed and thorough assessment of the current and projected skill needs in engineering, which will be a valuable source of information for both planners and careers and information services.

With changes underway in post-16 education and training, it is important that NTOs and our employers work closely and effectively with both the Learning and Skills Council, once it starts work in April 2001, and with the Regional Development Agencies.

We hope that the Dialogue report, together with our own Skills Foresight reports will provide a valuable tool for all those involved in planning education and training provision to meet current and future skill needs in vital engineering occupations.

Engineering and Marine Training Authority

Engineering Construction Industry Training Board

Executive Summary

Overview

- Despite the long-term decline in much of engineering manufacturing, there continues to be strong demand for engineering skills in the UK economy, especially in the fast-growing electronics and telecommunications industries. A number of engineering employers are experiencing difficulties in filling vacancies, mainly because of a shortage of people with relevant skills and experience. Skill shortages are apparent at all levels but especially at the higher end of the occupational spectrum, among professional engineers, and also in skilled (craft) trades, including electronics and IT skills. The main skill gaps are in specific technical and practical skills areas but personal and generic skills are also in short supply.

- These are some of the key messages produced by the Engineering Skills Dialogue and presented in this report. The Dialogue is principally concerned with the demand and supply of skills in the engineering industry, though it also addresses engineering skills across the economy, but not in as much depth. It is recognised that the representation of engineering skills outside of the engineering industry is growing and that some of the issues relating to demand and supply of engineering skills in other sectors may be different from those in engineering manufacturing. This Dialogue provides some information on the broader picture but because of a lack of detailed statistical information in places, does not provide a full analysis. Also, there are noticeable differences between different engineering occupations and different engineering sectors, for example between electronics and mechanical engineering, which mean that specific supply and demand issues have more significance to some parts of the engineering industry than to others.

Engineering demand - a changing but diverse picture

- Engineering skills are required across the UK economy in a variety of sectors and are used in many and diverse ways. It is estimated that around 2.5 million people are in occupations that have some engineering component, about half of whom (1.3 million) are in substantially engineering occupations. The majority of those are found in engineering manufacturing, though a number of other sectors have substantial numbers.
- The engineering industry as a whole has shrunk and, at the same time, experienced enormous structural change over the last few decades. One and a half million jobs have been lost since 1971, though the rate of decline slowed during the 1990s and a small increase of five per cent was seen between 1995 and 1998. It is now a 'leaner but fitter' industry, and both productivity and output have been increasing in the 1990s. Despite all the upheaval it has experienced, engineering continues to make a significant contribution to the UK economy and to exports in particular.

- The shape and structure of the industry has changed in many ways which have implications for skills. There has been a shift in the occupational balance towards the more highly-skilled and educated. Jobs have become more demanding at all levels, and there is an increased use of cell and team working. There are now fewer large firms because of downsizing and more out-sourcing. Small firms in supply chains are taking on more responsibility for higher-level and more complex work, which in turn is changing their skill mix and relationships with suppliers and customers. The trend towards mergers and the internationalisation of many large engineering businesses mean that operational and investment decisions are now taken more at a global level.

- While there has been a lot of change there has also been continuity: the industry remains predominantly male, with very little part-time working or self-employment, and this is not expected to change much in the foreseeable future.
- Engineering is a world of contrasts. It comprises one of the fastest growing and best performing sectors of the UK economy (the electronics sector) and also one of the weakest performers (the metals manufacturing, moulding and fabrication sector). The skill requirements and pattern of employment of electronics are notably different from those of many other engineering sectors. So too is the pattern in the engineering construction industry with its increasing focus on managing contractor organisations. Different engineering sectors are subject to different pressures, which in turn have implications for skills. Analyses of overall trends can mask important differences.
- At a regional level, there are also considerable contrasts due to the varying composition of engineering, in terms of sectors, size breakdowns and occupation patterns, though all regions have some representation of all sectors of engineering. Key issues of strategic importance for engineering at a regional level, and priorities for regional organisations, will therefore vary accordingly.
- While, overall, engineering employment levels are broadly stable at present, the future is less optimistic on the whole. A reduction of 13 per cent in employment levels in the engineering manufacturing sector is forecast between 1998 and 2004. This will be felt differentially across the sector, and some sectors, such as electronics, are likely to continue to grow. In the wider economy, employment of engineering professionals is forecast to grow by over two per cent per annum to 2009 while a two per cent annual reduction is forecast in the employment of engineering craft and metal working skilled trades.
- However, despite these downward trends overall, there will continue to be a strong demand for training and job opportunities in engineering, as estimates of ‘replacement demand’ (ie to replace workers leaving due to retirement, career change, etc.) outweigh the negative expansion demand forecasts at all occupational levels. Some of the largest numerical net requirements to 2009 in occupations of relevance to engineering are forecast to be in the corporate manager, science and technical professional and skilled metal and electrical trade groups.

A change in skill needs too

- A number of drivers of change are acting in unison to change skill requirements in a range of jobs. These include the increased use of technology, new materials and new processes throughout industry, an increasing emphasis on customers and meeting their requirements, new working practices, and the globalisation of many aspects of business. These demand higher-level skills and education, and also greater breadth of skill and greater flexibility in the applications of skills.

- A range of new and specific technical skills is required to meet the demands of technology and of the business, but also of importance is the greater emphasis employers put on personal and generic skills in all work areas. The key role of managers and supervisors, and the importance of their generic skills, are increasingly being recognised, though perhaps not sufficiently within many small firms. The role of line manager/team leader has become increasingly critical, and requires a different mix of skills (both technical and communication skills).

- Companies are having to change their skill mix, through upskilling of existing employees and recruiting at higher levels, at a time when some are experiencing job losses in areas where more traditional skills have been deployed. Several issues have been identified in the Dialogue as needing to be addressed including:

  - *the ability of the education sector to meet this need in terms of producing the 'raw material' that industry requires*

  - *the ability of engineering to attract the highly qualified people it needs through offering appropriate employment packages, training schemes and satisfying career opportunities*

  - *the development of the qualifications framework further, especially at NVQ Level 3, to help meet industry's needs better at the intermediate level.*

- While a lot of change is happening there is also continuity, and though declining, craft skills continue to be needed (in large numbers), along with the underpinning knowledge that goes with them.

Is supply adequate?

- The number of engineering employees who hold a vocational qualification or at least a GCSE Grade C has risen significantly over the last decade, and now represents over 80 per cent of the engineering industry's workforce. This compares with 66 per cent in 1988. There were 46,000 NVQ awards made in engineering in 1998/99, a growth of 80 per cent over the previous five years. Annual output of first degree graduates in engineering and technology is just over 22,000, a similar level to 1995 though substantially higher than in 1988.

- International comparisons show that, despite the growth in output from further and higher education, the UK is still deficient numerically at the intermediate level, though on a par with most countries in terms of university engineering graduate output.

- While the supply of qualified people in engineering has been growing over the last decade, engineering has clearly not been getting its share of the growing student population. Engineering also has had problems in attracting people of sufficient calibre onto Modern Apprenticeship programmes. Several reasons lie behind these supply problems, including:
  - *a failure to attract enough of the right quality of young people to study engineering, partly due to a poor image*
  - *a declining interest in taking maths and physics at 'A' level*
  - *continuing low take-up by women on engineering courses*
  - *attractions of alternative options (especially studying IT)*
  - *more encouragement given to young people to stay on at school than to follow vocational routes which involve workplace training.*
- Engineering is also criticised for not developing personal and transferable skills sufficiently among graduates, losing too many of the most able students to other jobs (eg in IT, the City) and also failing to utilise some of the engineering graduates appropriately and develop their skills.
- Although a number of changes have been introduced to improve engineering education and put more emphasis on broadening skills and flexibility of provision, more could be done, for example in improving work placement opportunities available to graduates and undergraduates. However, an issue identified as having a negative effect on the quality of higher education is the difficulty many universities face in recruiting young engineering staff.
- In-company training activity is varied: half of small engineering firms do not provide any training to their employees; and engineering employees at higher levels are more likely to receive training from their employers. The main barriers perceived by employers to providing more training are cost and access.

Skill deficiencies

- The evidence from engineering employers shows that significant numbers have problems filling vacancies due to a shortage of people with relevant skills and experience, and that there are also areas of skill deficiency within the existing engineering workforce. These are at a range of levels, though more so in the higher skill occupations where demand is much greater.
- It is estimated that around one in six engineering employers have hard-to-fill vacancies and these are found more commonly in the engineering areas: craft, technician, professional and managerial occupations. Two-thirds of all vacancies at craft and skilled operative level are hard-to-fill ones, as are over half of all vacancies at engineering professional level. Particular areas of difficulty identified include: design engineers, CNC programmers, electrical engineers, fitters, pattern makers and CNC setters and operators.

- Difficulties are greater for engineering firms in filling vacancies at engineering professional level and in some engineering craft trades than for firms in the wider economy, with the exception of the construction industry which has the greatest difficulties. However, recruitment difficulties in engineering are more likely to be due to a shortage of people with the relevant skills and experience than to other reasons. Three-quarters of the hard-to-fill vacancies in professional and technical occupations reported by engineering employers were due to skill shortages.

- Within engineering, electronics has greater recruitment difficulties at professional engineer level and in electrical and electronic trades than other engineering sectors, though the picture is more similar in respect of shortages in other occupations.

- Engineering employers find it more difficult to recruit people with technical and practical skills than other skills. These technical skills cover a wide range and often fairly generic terms are used, eg electrical, design. Limited evidence is available which explores the nature of these difficulties in detail. It would be beneficial in helping to understand more about skill gaps and their causes if they could be unpacked more, at a sectoral or local level.

- Other areas of skill shortage are in generic and interpersonal skills, again covering a wide range. For technicians, IT and software skills are frequently mentioned, while among managers there appear to be difficulties finding people with good management skills. For craft, manager and sales occupations, communications skills are a problem.

- Skill deficiencies in the existing engineering workforce are also evident, in particular in the engineering occupations cited above as causing recruitment difficulties. One in four engineering employers considers there is a gap between the skills of their current workforce and those needed to meet their business objectives. The nature of these skill gaps also mirrors those experienced in recruitment difficulties, with an emphasis on practical and technical skills, but the personal and generic skills are also mentioned. In particular, people management skills are seen to be very important at all levels and it is here that deficiencies are commonly reported.

- Finally, skill deficiencies impact on engineering companies in different ways: primarily in the bringing of new products to market, and developing businesses, but also in their ability to meet customer service and quality objectives and operating costs. Around one-quarter to one-third of engineering employers are experiencing difficulties of these kinds because of skill deficiencies in their employees.

Conclusions

These findings have wide-ranging implications, many quite detailed and specific to particular sectors or skill levels. However, there are some important conclusions for engineering as a whole:

- There is a continuing, substantial need for training provision in engineering. Despite the long-term decline in much of the sector, there continues to be strong demand for engineering skills.

- Within the broad picture, though, provision needs to match changes in demand, reflecting for example, the growing demand at engineering professional level and in electronics and telecommunications. However, even where employment is falling, such as in craft and lower-skilled occupations, replacement demand (to replace those retiring or changing careers) is strong. There is no justification for reductions in the overall level of provision.

- It is important that course content, curriculum and qualifications reflect the way skill needs are changing. A range of new and specific technical skills are required but education and training provision needs to reflect also the importance employers attach to personal and generic skills in all areas of engineering. This applies both to initial training of new recruits to the industry and to upskilling needed by those already working in it.

This has clear implications for publicly funded education and training and for providers. However, the industry itself needs to respond - for example, by improving work placement opportunities, by improving in-company training (particularly in small firms) and by continuing to work on improving the attractiveness of the industry.

Introduction

1.1 This report, prepared by the Institute for Employment Studies, is the result of the Engineering Sector Skills Dialogue. It provides an assessment of trends in employment and skill needs, and associated issues in the engineering sector and is the second in a series of reports that will be published up to the end of 2001.

1.2 The report has brought together, research and evidence from a wide range of institutions involved in engineering and draws on national data, including the new Skills Task Force Employers' Skills Survey (ESS) and the Institute of Employment Research (IER) Projections of Occupations and Qualifications. It is principally concerned with the demand and supply of skills in the engineering industry, however it also addresses engineering skills across the economy, though not in as much depth. Some of the issues relating to engineering skills in other sectors are different from those pertaining to the engineering sector. This Dialogue provides some information on the broader picture but does not provide a full analysis, mainly because there is considerably less available information on the demand for engineering skills outside of the engineering industry.

1.3 The Dialogue has built on existing labour market research and skills information on engineering that is collected regularly and used by a range of organisations, rather than undertake any new research. The working paper was discussed at a national seminar, held on 15th May 2000, involving the relevant NTOs, employers, professional bodies, funding agencies, RDAs, representatives of further and higher education and Government Departments. This final report takes in to account comments received as a result of the seminar and from others involved in the consultation.

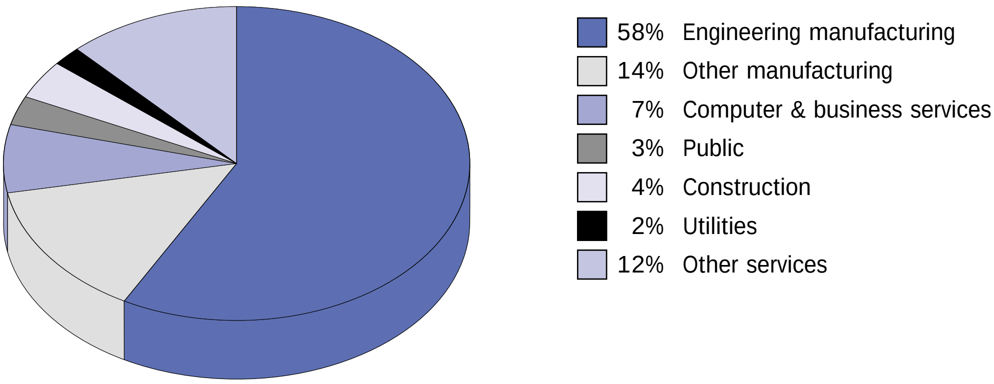
This introductory chapter provides details of the scope and coverage of the Engineering Dialogue and introduces the context, main economic trends and other factors of influence on engineering skill requirements. Discussion of the evidence on trends in demand is presented in Chapter 2, on the supply and availability of skills in Chapter 3, and on the main demand-supply imbalances in Chapter 4.

Scope and main focus

1.4 Engineering skills are represented in most sectors of the economy and are used in many and diverse ways - from the manufacture of a wide range of goods to supporting business and communications infrastructures, public health and defence. The principal NTOs with responsibility for engineering occupations are the Engineering and Marine Training Authority (EMTA), whose scope covers engineering manufacturing (employing around 1.75 million people) and the Engineering Construction Industry Training Board (ECITB), which covers the design, construction and maintenance of plant of various kinds (employing around 40,000 people). Within engineering manufacturing there are distinct sectors, including electronics and telecommunications equipment and components, aerospace, motor vehicle production, mechanical engineering and foundries. In addition, there is a large number of other NTOs (at least 25) which have an interest in engineering skills, the main ones being: the Rail Industry Training Council (RITC), nto tele.com, Electricity Training Association, PINTOG (covering chemicals and processing industries), CITB (construction), ITNTO and e-commerce NTO, and Skillset (covering the TV and film industries).

1.5 Figure 1.1 illustrates this breadth of engineering employment by showing the distribution of people employed in recognised 'engineering occupations'. While it is acknowledged that a large number of occupations have some engineering component (eg electricians, gas fitters), those included in Figure 1.1 are occupational groups identified in the Standard Occupational Classification (SOC) coding system as substantially engineering occupations, namely - professional level engineers and technologists, engineering technicians, engineering craft trades and machine operatives/assembly workers (further details of these are shown in Table A3.1 in Appendix 3). Taken together, these occupational groups make up 1.3 million out of an estimated engineering population (if all jobs with some engineering focus are included) of around 2.5 million (source: OSC Eng, 1998). The largest proportion of them (58 per cent) is found in engineering manufacturing, but a range of other sectors employ substantial numbers, in particular the services sectors (eg IT, communications, public services, utilities). The latter includes technical or engineering consultancies, and specifically managing contractors working on engineering construction projects (which fall under the scope of the ECITB).

Figure 1.1: Distribution of engineering employment



Source: LFS, 1999

1.6 Engineers at professional level are even more broadly spread, with a lower proportion in engineering manufacturing (44 per cent) and a higher proportion in the services sector, and computer and business services in particular (almost one in five). This is also reflected in the Engineering Council's membership statistics where just 25 per cent of the registrants are employed in manufacturing industry[1].

1.7 This Dialogue has aimed to cover the main sectors where engineers are employed; however, as mentioned above its main focus is on the engineering manufacturing and engineering construction industries, and their component parts (eg electronics). Some of the issues and conclusions arising from the evidence presented in the report are of relevance to engineering in a wide sense, while others relate specifically to the situation in the engineering sector. Skills issues in other sectors, including engineering skills, are likely to be discussed also in other Dialogue Reports (eg construction, processing industries, transport and information and communications technologies (ICT)).

1 Note that the Engineering Council's registrants include a wide range of disciplines and because membership is voluntary include only part of the total population. The data shown in Figure 1.1, based on the Labour Force Survey, and the Engineering Council data are not compatible.

Engineering and the economy

1.8 Engineering has traditionally occupied a major role in the UK economy, and continues to do so despite a decline in the traditional manufacturing sector. This is because, as seen above, engineering skills are utilised throughout the economy and, in particular, are key to the development of technology-based industries and services.

- Total engineering industry output is valued at around £55 billion, representing eight per cent of total UK GDP (Wilson, 2000). This accounts for more than one-third of total UK exports, with mainland Europe the main destination (EEF, 1999).
- Specific engineering sub-sectors are among the best performing UK industries: eg electronics output, which has grown massively in the 1990s, now represents one of the largest manufacturing sector outputs (more than £30 billion). It also provides significant exports (16 per cent of the UK's total in 1996) (ITCE SSG, 1999).
- Engineering contributes to the success of a range of other industries in, for example, the development of IT services and communications, new digital technologies in broadcasting, medical research, and the development of the financial systems infrastructure of the City. It is impossible to quantify this wider impact of engineering on the UK economy but it is significant and expected to increase as the pace of technology and innovation increases and applications become more widespread.

Economic and business trends

Historical perspective

1.9 Over the last two or three decades, the engineering manufacturing sector as a whole has shrunk considerably. Large scale factory closures and downsizing, a consequence mainly of the effects of two major recessions, in the early 1980s and again in the early 1990s, have led to the loss of over 1.5 million jobs in engineering since 1971. These losses have been felt more in the country's old industrial heartlands in particular, parts of the North West, North East, Midlands and Central Scotland. They have also hit more at lower skill levels (discussed further in Section 2.5) and in the traditional metals manufacture and mechanical equipment sectors.

1.10 The contrast between the newer, technology based, and the older traditional industries is an important one. For example, output in the electronics sector grew by 62 per cent between 1990 and 1998, compared with a fall of 4 per cent for manufacturing as a whole (ITCE SSG, 1999). Electronics has also benefited from major inward investment by foreign companies and from strong world market growth, in particular the European market for PC products in the 1990s. Although parts of electronics have suffered from some volatility (in particular the semi-conductor industry), overall, electronics has shown much stronger growth than the rest of engineering during the 1990s. The UK aerospace sector has also been much stronger economically than other parts of engineering. The IT and business services sectors, which employ substantial numbers of software, electronics and computer engineers, have been one of the main growth areas in the UK economy, with the IT services sector alone doubling its contribution to GDP since 1990 (ITNTO, 1999).

1.11 Alongside these overall trends have been enormous structural changes within engineering manufacturing companies due to the development and application of new technology in processes and in products, putting pressure on both investment and the need to re-skill and manage change effectively. Also, as in many other developed nations, international competition and the development of global businesses has had a serious impact.

1.12 The engineering construction sector has also been affected by similar trends - international competitiveness, the need to control costs and improve response times, and the impact of new technology (in particular ICT). Most important has been the trend for large client companies to downsize, and outsource more work, especially more repair and maintenance activities, to contractor organisations, and more recently some of the operations work also. There has been a noticeable increase in smaller repair and maintenance contracts in contrast to the decrease in large engineering and construction projects. Political factors have also had an influence, including Government energy policy, maturity of the North Sea oil market, the price of oil, and health and safety issues.

Current picture

1.13 The engineering industry is now seen as being considerably 'leaner and fitter' than it was two decades ago, and on the whole more stable economically. In terms of GDP, output has grown by 45 per cent since 1981 but productivity (GDP per head) has more than doubled, from a figure of 14.25 in 1981 to 30.28 in 1998. Various business surveys in 1999 showed a relatively stable situation overall, but they also highlighted continuing difficulties for many employers, especially in export markets. The strength of sterling is a major negative factor on which the recent spate of redundancies and of job losses in major car plants have been blamed. According to the EEF (4th Quarterly report, 1999)

> *'the engineering sector has turned the corner but recovery has yet to show any real strength … demand remains fragile and prospects uncertain.'*

The situation in early 2000 appears to have deteriorated, with output in engineering reported as falling in the first quarter (EEF, 2000).

1.14 There is also sectoral diversity: a North-South divide in new orders was reported in 1999, and also much stronger order books for the electronics and electrical equipment and automotive sectors at that time (EEF, 1999), though for the latter the situation has noticeably changed. Electronics employers (FEI) also confirm the stronger economic conditions in the electronics sector.

Future outlook

1.15 Domestic demand is expected to strengthen in 2000 leading to a small growth in engineering manufacturing output (1.8 per cent). This is despite the expected continuing adverse effects of a strong pound. Overall figures, however, once again mask different trends between engineering sectors. The mechanical, metal goods and motor vehicles sectors are all expected to contract in output between 1999 and 2000, but recover a little by the end of the year (EEF, 1999), while electronics will continue to push ahead.

1.16 Looking further ahead, according to IER macro-economic forecasts (Wilson, 2000):

- The engineering sector will continue to recover, but led by growth in electronics, and driven by technological change and strong growth in demand for communications and computer services and equipment.
- There will be a core of smaller, but leaner, industries which are likely to grow modestly, bolstered by increasing specialisation and a shift towards export markets.
- Overall engineering output (GDP) is forecast to grow at 2.8 per cent per annum to 2004 and then higher, at 3.5 per cent to 2009. This will be underpinned by high growth in technology and research and development industries.
- These trends to 2009 compare with a slightly lower growth for the whole of manufacturing, and also a lower average growth figure for engineering in the previous decade (1.7 per cent per annum, 1991-98).

1.17 According to the EEF (1997), the rate of technological, industrial and economic change is expected to quicken in the next decade, and individual businesses will need to become more competitive and more specialised. There will be growth in IT systems in all aspects of business, greater flexibility in working practices and less traditional demarcation, more 'just in time' and cellular manufacturing, and more global businesses and a greater prevalence of international supply chains.

1.18 Several sources point to continued diversity across engineering, especially by sector:

- 'Metals manufacturing, moulding and fabrication' is identified as likely to be one of the weakest engineering performers over the next decade. Like other labour intensive industries it is becoming increasingly price sensitive (Wilson, 2000).
- The foundry sector, and especially high-volume foundries have been affected in particular by the international market, and some are likely to disappear altogether or move into more specialised areas (EMTA/ADAPT, 2000).
- Electronics and telecommunications are expected to benefit from projected strong growth, especially if it moves more into higher value, 'knowledge-based' areas where it can retain competitive advantage (ITCE SSG, 1999).
- The UK automotive components industry is likely to face a slowdown in orders as a consequence of the exchange rate and difficulties in making efficiency improvements (EMTA/ADAPT LM Observatory sector reports, 2000). The latter is also likely to impact on the assembly part of the industry too.
- Vehicle assemblers are likely to take increasing advantage of international sourcing to remain cost-competitive, and thus re-think their relationship with local suppliers. This is expected to have a serious knock-on effect across UK manufacturing. There is also a threat from over-capacity in the European car manufacturing industry.
- The aerospace sector is also looking to make changes to supply chains in order to remain cost-competitive. It will increasingly look to outsource production work (eg machining) at a global level to countries where labour is cheaper (SBAC, 2000).

- There is considerable uncertainty about major building projects going ahead (eg new power stations) which affects the future outlook for the engineering construction industry (ECITB, 1999). Growth will be affected by political factors relating to investment in public transport, and energy policy.

Principal drivers of change

1.19 The main factors influencing change have already been referred to above, and will be discussed further in the remainder of the report in relation to particular skills and occupations. The main ones are competitive pressures and profitability (often blamed on the high value of sterling) and the overall drive for quality, efficiency and meeting greater customer expectations - to keep up with or ahead of the competition. Other drivers, often linked to these, include (and some of these are effects as well):

- New working practices (for example, cell and team working, clean working areas) - themselves influenced by a drive to increase efficiency; new ideas in managerial thinking; the requirements of new technologies and products.

- The growth of outsourcing and devolution of responsibilities down the supply chain - for example, in the automotive sector more work is being pushed down the supply chain leading to new skill requirements for supplier companies; and also in the engineering contracting sector (see section above).

- Technological change - leading to a shift towards higher-level occupations and greater demand for higher-level skills. Specific changes include, for example: the automation of production lines; the increased use of robotics and automated processes; development of telecommunications; the increasing use of IT in stock control systems, tele-sales and internet-sales; and the increasing amount of electronics components in equipment (eg railway signalling, digital broadcasting).

- An increasing emphasis on customer service, and customers being more demanding (eg requiring speedier response).

- Globalisation - which has affected decisions by multi-national companies about the location of key functions of businesses, and hence key skills (eg concentrating research and development in one country) also led to a growth of inward investment in the UK from foreign companies on greenfield sites which has created a focus of skilled people in certain locations. The continuing trend towards global mergers places major economic decisions relating to investment in the hands of a smaller number of companies.

- Flatter organisational structures, as a consequence of drives to control costs and increase efficiency, which lead to shorter career ladders and increased demand for management skills down the occupational hierarchy.

- Greater environmental concerns and increased safety awareness which puts attention on quality and standards, especially after major incidents involving loss of life (eg Piper Alpha for oil rig operations; Paddington rail crash for signalling).

- Social pressures, for example an increasing resistance to working in jobs that necessitate long periods away from home (affecting engineering construction sites in particular); and the need to develop better family-friendly employment policies.

Importance of diversity

1.20 Clearly, there is a diverse picture across the engineering sector with some sectors, noticeably electronics, doing much better than others. It is important also to note the diversity in terms of products and processes, and by size of establishment and business outlook. (This is often why business surveys with slightly different coverages show different results). Over two-thirds of engineering manufacturing establishments have under 25 employees, yet 25 per cent of total employment is in large engineering establishments employing 500 people or more (EMTA, 1999).

1.21 The engineering sector contains many of the most dynamic, leading edge companies in the UK today, as well as a large number of relatively low-tech, 'metal-bashing' companies. They operate in both domestic and international markets (which are subject to different pressures), and while many engineering businesses are independent, and some still family owned, an increasing number are part of large multi-national operations or international partnership arrangements. Inward investment by foreign companies (eg Japanese, Korean, American) has been a feature of the 1990s, especially in micro-electronics, consumer electronics and the automotive industry.

1.22 Thus, while there are common themes across the sector relating to business factors that affect employment and skill trends, there can be danger in over-generalisations about engineering, as individual companies can be faced with very different issues and concerns according to size, sector, region and markets. (The differences between the engineering construction and manufacturing, and between electronics and the rest of engineering have already been highlighted above). Where possible in this report, key differences between sectors of engineering have been identified, and especially between electronics and the rest of engineering, as they are thought to be subject to quite different conditions.

Demand for Engineering Skills

2.1 In this chapter we review the evidence and discuss issues relating to the demand side - the main employment patterns and trends in the sector, in particular the changes relating to requirements for skills and the underlying causes. The information on employment and demand trends is drawn mainly from the Projections of Occupations and Qualifications (Wilson, 2000), the EMTA Labour Market and Skills Surveys of 1998 and 1999, the Employers' Skills Survey (ESS) 1999, ECITB's labour market studies and the EEF's Business Trends Surveys. Information on skill trends is drawn from various, mainly qualitative, studies.

Current employment

2.2 As mentioned in Chapter 1, different definitions are used by organisations in the collection of engineering occupation employment statistics which are not comparable and thus cause difficulties in reaching an accurate estimate of total engineering employment. An occupational mapping study of the engineering sector (OSCEng, 1998) estimated a population of around two and a half million people employed within occupations that have some engineering component, of which just over 40 per cent work within the main engineering industries. Analysis of the Labour Force Survey (1999), shows 1.3 million employed in core engineering occupations (see Figure 1.1 and Table A3.1), 58 per cent of them in engineering manufacturing. Looked at another way, 1.75 million are employed in engineering manufacturing (but not all in engineering occupations, as this includes administration and sales staff) as defined by the EMTA scope, and a further 40,000 in the engineering construction industry (ECITB scope).

2.3 The Annual Employment Survey (AES) provides a breakdown of employment in the engineering manufacturing sector, though detailed sectoral information is not available every year. In 1996 there were 76,000 establishments. The key features of this employment by size and sector are:

- The vast majority of establishments are small (two out of three had less than 24 employees, and only one per cent had 500+ employees (Table A3.2).
- However, 25 per cent of all engineering employees are in establishments with 500+ employees.
- Metal products and mechanical equipment sectors are the two largest engineering manufacturing sectors (together accounting for 47 per cent of employment).
- Aerospace and motor vehicles (both sectors where economies of scale are important), have more larger sites than other sectors; metal products is more focused on very small establishments.

2.4 In terms of geographical distribution, the West Midlands is the most significant employment region for engineering manufacturing. It accounts for over 20 per cent of the total employment in England. The lowest share is found in London, and the North East (both only four per cent of the total).

2.5 The composition of the engineering industry differs within each region, though all regions have some representation of all of the engineering sub-sectors (see Table A3.3). Notable regional features are:

- Mechanical equipment, metal products and motor vehicles sectors are heavily represented in the West Midlands.
- Aerospace is focused more on the South East, South West, North West and Eastern regions.
- The South East and Eastern regions both comprise a higher proportion of electronics establishments than elsewhere.
- London and the South East account for over half of the head office employment in the engineering construction sector.
- London is the location of a high proportion of engineering and other technical consultancies and head offices.

2.6 As size of establishment varies by sector, so the sectoral composition in each region explains some of the size differences. For example, the South West has a higher proportion of employment in establishments with over 250 employees because of its focus on aerospace; while in Yorks and Humberside there are higher proportions of small firms because of the greater concentration there of mechanical and metal products establishments. It is important that regional bodies are aware of the size/sector breakdown for engineering in their region and also the differences between the regional pattern and the national picture so that key issues of strategic importance for engineering in each region can be addressed.

2.7 A breakdown of employees in engineering manufacturing by age (EMTA, 1998) shows that 15 per cent are aged between 16 and 24 years, and 35 per cent are aged 45 years or over. When compared with the British workforce, the engineering manufacturing sector has a slightly older age profile. However, it is noticeably younger in electronics, electrical engineering and motor vehicles than in other engineering sectors. The engineering construction industry has an older age profile with an estimated 48 per cent aged 45 years or more, and even higher percentages among certain occupations such as pipefitters and erectors/riggers (ECITB, 1999).

Employment trends

Past trends

2.8 As highlighted in the previous chapter, most sectors of engineering manufacturing have been experiencing reductions in employment levels for most of the last few decades. The downward trend did slow during the 1990s and there has been some recovery over the last few years. The largest falls in the 1980s were in the metals and mechanical engineering sectors, reflecting their poorer business performance. All regions lost engineering jobs but the largest reductions were in London (Wilson, 2000).

2.9 Another trend has been a reduction in the average size of engineering employers, a consequence of the earlier large-scale closures of factories, downsizing and outsourcing. This has changed the shape of the sector, such that a higher proportion of employees now works in establishments with under 250 employees (EMTA, 1999).

2.10 Since 1994, a recovery has been in place in engineering manufacturing and employment overall rose five per cent between 1995 and 1998. Most regions have seen growth in engineering manufacturing during this recent period, the exception being London (Wilson, 2000). Growth has been strongest in electronics, machine tools and motor vehicles, where inward investment by foreign companies has played a major role, and in the case of electronics in particular, where global markets have been growing at a fast rate. There has been growth also in the engineering construction industry, but this has been almost entirely due to a shift in employment from client to contractor organisations as large companies in other sectors downsized.

2.11 Looking more widely at the demand for engineering skills across the economy, sectors outside of engineering, especially the IT and business services sectors, have shown more buoyant demand trends over the long term than the engineering sector. There are now more opportunities for engineers, especially those at professional level, to work outside of the engineering manufacturing sector due to the growth and spread of technology across the economy (see Chapter 1). In the last three years (1995-98), the overall growth in employment in engineering occupations (all sectors) has been surprisingly similar to that in the engineering sector (up by 3.9 per cent overall, according to the LFS, 1995-98). However, there are considerable variations between sectors, with, for example, the IT sector having a higher growth of demand for engineers, especially software engineers, and parts of other manufacturing having much slower demand growth rates.

Current trends

2.12 Currently, the main picture is one of relative stability in the engineering sector overall, though there are signs of a return to the overall declining long-term trend. Various surveys of engineering employers show little change overall in employment levels over the last year:

- In the ESS survey in mid-1999, 44 per cent of employers in the engineering manufacturing sector reported that their total employment had not changed in the last 12 months, and slightly more reported an increase (31 per cent) than a decrease (25 per cent). Any change that was recorded tended to be ‘a little’ rather than ‘a great deal’.

- The EMTA survey undertaken earlier in 1999 also showed little change, but here the trend was more downwards rather than upwards; however, there are slight differences between the scope of the two surveys which may explain this variation.

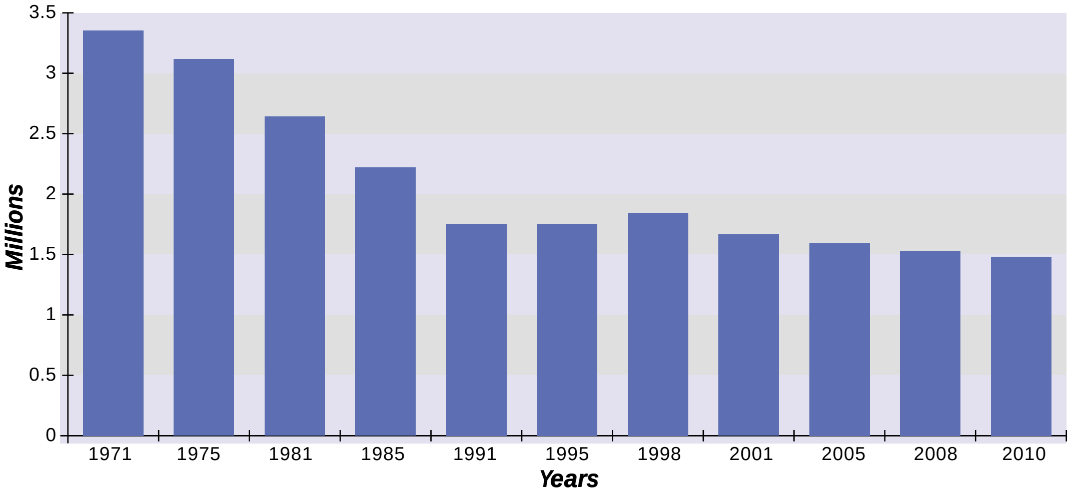
- In the 12 months to September 1999, the EEF reported a decline in engineering employment of 4.4 per cent (This estimate is based on the Labour Force Survey). Nearly three-quarters of that reduction took place in the six months to March 1999.

- There is surprisingly little difference apparent between engineering sectors: all sectors of engineering reported a decline in the 12 months to September 1999, though aerospace recorded a slight increase in the third quarter and electronics recorded least reduction in employment levels over the period (EEF, 1999). In the EMTA survey, employers in aerospace were more likely than those in engineering as a whole to report an increase over the last 12 months, but electronics showed a similar pattern to the rest of engineering. Thus, although the electronics sector is showing much stronger business growth than engineering as a whole, it is not reflected to the same extent in recent employment trends.

Employment forecasts

2.13 According to the IER's national projections, the future trend is expected to be downwards in terms of overall employment levels in the engineering sector (Figure 2.1). Between 1998 and 2009 there is a forecast net fall of 315,000 jobs in the engineering manufacturing sector, a drop of 17 per cent (Wilson, 2000). The bulk of this reduction will take place during the 1998-2004 period (13 per cent down). The decline in engineering employment contrasts with a growth of 8 per cent in employment in the economy as a whole, resulting in a further shift away from employment opportunities in engineering and towards other sectors.

Figure 2.1: Employment in engineering, 1971-2010 (millions)



Source: Wilson, 2000

2.14 Engineering sectors bearing the brunt of this forecast reduction are likely to be in traditional areas of mechanical engineering and basic metals (Wilson, 2000; EMTA/ADAPT, 2000). The EEF also report an expected fall in employment overall, by about two per cent per annum across the industry. However, electrical equipment and electronics sectors are both forecast to rise. The ECITB forecasts indicate a decline in manpower required to 2001 in the engineering construction industry.

2.15 Most regions are forecast to decline to 2004, though some only marginally (ie South West, Wales, Northern Ireland) and Merseyside is forecast to increase (though from a small base, some 30,000). The biggest percentage reduction in engineering employment, will be in London (22 per cent) (Tables A3.4 and A3.5).

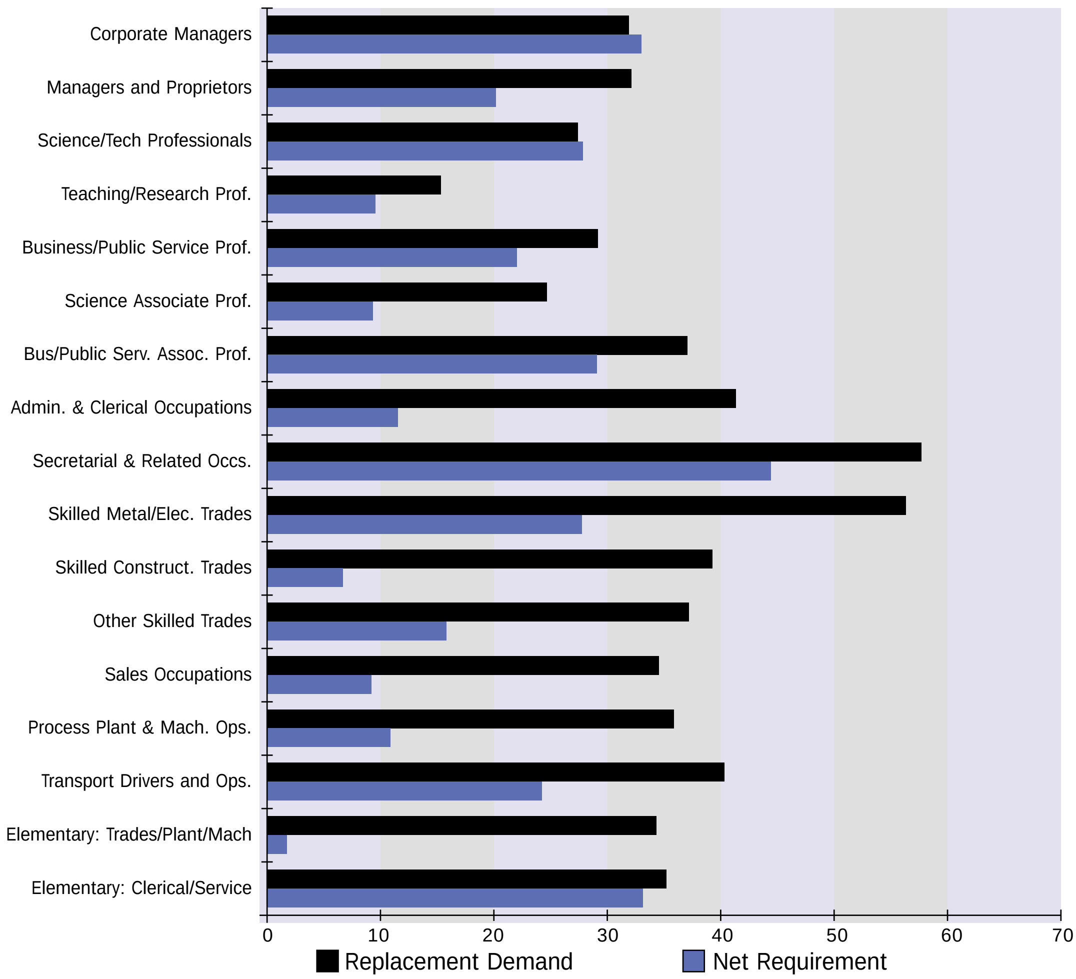
2.16 The employment reductions will be due mainly to technology change bringing about improvements in productivity, through, for example, more flexible use of labour, changes in working practices and work organisation, but changes in markets and the effects of price competition will also be factors especially in certain sectors (Wilson, 2000).

2.17 Looking at the broader picture, a smaller reduction in the main engineering occupations across the economy is forecast, down in aggregate by five per cent between 1998 and 2009. On the basis of current and past trends there is likely to be considerable variation between sectors outside of engineering. The current growth sectors of IT, business services and telecommunications are likely to continue to see growth in demand for engineers. However, detailed occupational projections at a sector level to show this more fully are not available.

Importance of replacement demand

2.18 However, this forecast reduction in employment levels does not mean that there will be fewer job opportunities in engineering in the future. Employers will need to replace workers who leave as a result of retirement and career changes. Estimates of future employment levels provide a useful indication of change, but they can give a misleading impression of future demand in terms of job opportunities and related training needs.

Figure 2.2: Replacement demand and net requirements for selected occupations in engineering sector, 1998-2009 (per cent)



Source: Wilson, 2000

2.19 In the case of engineering, the total replacement demand forecast outweighs the negative expansion demand in every occupational group, thus leading to a positive net requirement overall. It is estimated that around 370,000 new job openings will arise over the next decade in the engineering manufacturing sector. In occupational groups where significant losses are forecast (due to negative expansion demand), in particular skilled metal electrical trades, these are projected to be more than compensated for by replacement demand, mainly due to retirement. Some of the largest numerical net requirements in the engineering sector are for corporate managers (71,000), science and technical professionals (34,000), business associate professionals (32,000), skilled metal and electrical trades (109,000), process plant and machine operatives (58,000), transport drivers and operatives (34,000) and elementary clerical and service groups (52,000) (Figure 2.2).

Employment pattern

2.20 Unlike other sectors (eg in the services industries) little overall change is expected in the pattern of engineering employment in terms of employment status. It is expected to:

- remain predominantly male (over 70 per cent)
- employ mostly full-time workers (94 per cent)
- have relatively few self-employed people (only 7 per cent).

However, there will be changes in the occupational structure, and also further shifts in the size structure towards smaller firms.

Changing occupational balance

2.21 It is clear from various surveys that demand in some engineering occupations has been growing faster than others. This is generally backed up by the available statistical evidence (in the LFS) though the pattern is not entirely consistent. Looking across the economy, the employment of engineering professionals, as a group, increased by 13 per cent between 1992 and 1998, but grew at a faster rate, by 18 per cent, between 1995 and 1998. Much of this growth, however, is due to the massive growth in software engineers, up by almost 200 per cent between 1992 and 1998. If they are excluded from the total there was actually a net fall of 8 per cent in the employment of engineering professionals in the 1992-98 period, though this changed to a small (0.5 per cent) increase between 1995 and 1998. Lower-level occupations have recorded reductions between 1995 and 1998 though these varied between occupations (Table 2.1).

2.22 The occupational balance in engineering is expected to continue to shift towards higher-level occupations (in terms of skills and education levels), and reflects in part a more general pattern across the economy. Looking across the economy, the largest reductions in employment levels are expected to be in skilled metal and electrical trades. This is in contrast to engineering professionals who are expected to increase over the next decade (Table 2.2). But as shown above, even for declining occupations such as skilled metal and electrical trades (which include engineering craftsmen and women) losses are likely to be more than compensated for by replacement demand, leading to a significant number of new job openings in the years ahead.

Table 2.1 Occupational change , 1992-1998 (all sectors, SOC92)

Occupational group	Employment 1992	1995	1998	% change 1992-98	1995-98
All professional level engineers (21)	544,800	518,700	617,000	+13.2	+18.9
Software engineers (214)	59,000	76,000	171,800	+190.9	+126.0
Other professional level engineers (21 minus 214)	485,800	442,700	445,200	-8.4	+0.6
Engineering technicians/ electrical/electronic technicians (301, 302)	62,400	86,700	84,200	+34.9	-2.9
Skilled engineering operatives (51)	529,200	501,400	467,400	-11.7	-6.8
Electrical/electronic production fitters, electrical engineers (520,522)	26,500	26,800	24,800	-6.3	-7.6
Machine operatives and assemblers (84,85)	344,000	368,900	367,100	+6.7	-0.5

Source: LFS, 1992-98

Reasons for occupational shift

2.24 The reasons for this shift towards higher-level engineering occupations mainly relate to the twin demands of technology and changing business needs (eg shorter production cycles, speedier response to customer needs, discussed earlier in Section 1.19). Another important factor is the differences between sectors in their occupational patterns (see Table 2.3).

Table 2.2: Occupational projections for selected SOC 2000 occupations (3 digit) relevant to engineering

Occupation	1998 level (in thousands (000s))	2009 level (in thousands (000s))	Change 1998-2009 (in thousands (000s))	% change p.a
212 Engineering professionals	449	564	115	2.1
311 Science and engineering technicians	207	198	-9	-0.4
521 Metal forming, welding and related trades	215	169	-46	-2.2
522 Metal machining, fitting and instrument making	463	363	-101	-2.2
813 Assemblers and routine operatives	597	594	-3	0.0
812 Plant and machine operatives	334	271	-63	-1.7

Source: IER estimated based on LFS data, F92F9 Forecast

Table 2.3: Occupational profile of engineering sectors (selected occupations only, percentage of the total employed)

Occupation	Electronics	Aerospace	Motor vehicles	Mechanical equipment	Other transport	Metal Products	Basic Metal
Professional engineers	10	9	3	5	3	4	2
Technician engineers/ engineering technicians	9	11	3	7	12	5	4
Craftsmen/women	9	23	17	21	41	25	23
Operators and assemblers	34	32	46	30	12	31	40

Source: EMTA Survey, 1999

2.25 Historically, craft and lower skilled occupations have been concentrated in the more traditional end of engineering, in mechanical engineering and metal products. These are sectors which have reduced in size at a faster pace than sectors where higher-level occupations are more in demand, such as electronics and aerospace (as illustrated in Table 2.3). The latter are also identified as more likely to be growth sectors for the future, as is the business services sector which includes the engineering and technical consultancies and which is expected to continue its strong recent growth trend.

2.26 The reorganisation of work has also affected the occupational pattern, especially the trend towards outsourcing and subcontracting (see Section 1.5). For example, as mentioned earlier, large companies in the oil and gas industries have traditionally contracted out engineering construction work but are increasingly putting out more areas of work to suppliers. This affects the mix of occupations in smaller engineering contractors which has been changing over time. As contractors take on more repair and maintenance work (it now accounts for three-quarters of the business on site of engineering construction companies, ECITB, 1999) and some process operations too, they have seen an increase in employment in particular occupations, such as production process operatives. Another example is in the automotive sector where Original Equipment Manufacturers (OEMs) are subcontracting more design work to suppliers and also the production of sub-assemblies and components which they previously manufactured themselves. The first tier suppliers who previously manufactured components are only now involved in work requiring a wider range of skills, including higher-level skills (eg technician engineers) (see EMTA/ADAPT, 2000; Shackleton *et al.*, 2000).

Skill trends

2.27 There have been considerable changes in the skills needed in engineering occupations. In particular, there is an overall trend towards jobs becoming more demanding and toward skill intensification. However, it is important also to recognise areas of continuity. Although there has been a general decline in the demand for craft employees, craft skills are still very important in a number of engineering sub-sectors. Furthermore, many of the skills traditionally needed in these occupations are still very important. For example, toolmakers and welders still need many of the skills they have always needed to operate effectively. In several studies, employers reported how recruits often did not have sufficient underpinning knowledge (Dench, 1999; PRIME, 1998), largely because this had been reduced in training courses. For example, they did not understand how different materials react in different conditions. This knowledge remains very important; indeed, it is often an essential basis from which people are able to learn new skills and take on new ways of working.

2.28 A number of key themes emerge from studies exploring changing skill needs in engineering occupations. General trends in skill needs are outlined in the rest of this section, although it should be stressed that the diversity in the sector can also be seen in the way changes in skill needs vary across the sector. In the following section, more occupationally specific changes are discussed.

New and specific technical skills

2.29 Technical change is often evolutionary. However, there is a continual need for employees to keep up with a range of technical changes. This affects employees at all levels, although the complexity of change increases with the occupational hierarchy. At some levels, the need is for skills in new process technologies. Professional engineers, especially those involved in 'leading edge' and specialist activities have to keep up with innovations and developments in design, materials and other factors which influence the nature of a product.

2.30 The 1998 EMTA survey explored the extent of use of different technologies. CNC and CAD were most commonly used, by 46 per cent and 43 per cent of establishments respectively. EMTA's and other studies have shown a need for a greater requirement of skills in these areas.

2.31 Studies of the automotive industry (for example, PRIME, 1998) provide examples of the need for employees, especially those at craft and technician level, to increase the depth of their knowledge in new and developing technologies, for example robotics, and conveyor, welding and manufacturing control systems.

Computer literacy and IT skills

2.32 There is a close association between technical change and the need for greater IT skills. An increasing level of computer literacy is required of most engineering occupations, although again the complexity varies. At production levels it is basic keyboard skills and the ability to operate computerised processing technology which is important. At more senior and professional levels, computerised technology is involved in the product itself and the design process. A recent study (Shackleton *et al*., 2000) reported an increasing use of electronic data transfer.

2.33 In telecommunications and electronics, there has been a particular move away from traditional mechanical and electrical skills towards an emphasis on IT skills. This is linked to both changes in the nature of the products and in the processes of production.

2.34 In engineering construction, the impact of advanced IT and communications technologies (ITC) is having a wide impact on administration and e-commerce and also in electronics (eg in diagnostic tools). This affects all skill levels. It is becoming increasingly realistic for engineers in the engineering construction industry, for example, to work from home on a project based anywhere in the world, and the concept of virtual teams is becoming a reality (ECITB, 2000).

Multi-skilling and greater flexibility

2.35 There is mixed evidence on the extent to which true multi-skilling is occurring, although the 1998 EMTA survey found that 85 per cent of employers had introduced some multi-skilling. In more traditional activities, multi-skilling is less common. However, there is widespread evidence that demarcations between jobs are increasingly unacceptable and that, at a minimum, task flexibility is required.

2.36 A study of the automotive industry (PRIME, 1998), concluded that skilled electro-mechanical craftsmen/women needed to be multi-skilled; there was less demand for specialised trades and a greater emphasis on electronic skills. Production employees were also becoming more multi-skilled, needing more mechanical, electronic and data processing skills. Whether multi-skilled or not, people working in a range of engineering occupations are expected to be increasingly flexible. The nature of this varies from being able to work at the margins of a different specialism, to being prepared to pick up a range of different tasks, however mundane. For example, Shackleton *et al*. (2000) reports how shop floor workers are increasingly expected to multi task. This usually means being able to operate more than one machine at once. More flexible workers are also needed in the engineering construction industry, partly to help control costs but also as a consequence of investment in new technology. For example, many oil platforms are now manned by smaller teams of more flexibly skilled workers.

The ability to deal with change

2.37 Change, whether through the adoption of new technologies and working practices, take overs and mergers, and new organisational structures is a fact of life for most engineering employers. Employees at all levels need to be able to cope positively with this, whether through their general attitudes or ability to learn new skills. Managers, especially senior managers, need ‘change management skills’, enabling them to introduce and effectively manage change through their organisations. A study for the Society of British Aerospace Companies (SBAC, 2000) identifies developing change management skills as a key challenge for the future.

An ability to continue learning, re-skilling

2.38 Implicit in the areas listed above is the need for engineering employees to continue learning. Employers increasingly look for an ability to learn, but also an attitude of mind which predisposes people to be interested in and proactive about learning. There is an increased demand for advanced training to be taken in a modular way, to meet the needs of graduates to continue to update their skills regularly (and to do so more as the pace of technological change quickens).

The greater importance of personal and generic skills

2.39 Various studies report the increasing importance of these skills. In undergraduate and graduate studies, they are often described as ‘broadening skills’ and are in increasing demand by employers (and by students). They are very wide-ranging in nature, and reflect changes in work organisation and working practices (in particular moves towards cell working and emphasis on teamwork), technological change and the greater expectations placed on most employees. Overall, employees are expected to have the following skills and abilities:

- communication
- teamworking and getting on with others, including being able to work in self-managed teams
- problem-solving and diagnosis, and at professional levels, greater abilities for forward thinking and 'whole system' thinking
- taking responsibility, showing initiative and becoming more involved
- organisation and management.

Understanding the business

2.40 This has varying implications at different levels. For example, those involved in design and innovation need to understand the business and its position and aims in the wider market. However, as businesses have become tighter, leaner and placed a greater emphasis on reducing costs and increasing efficiency. it has become increasingly important that employees at all levels understand the implications of their actions, or that of their team, for others and the customers.

Customer service awareness

2.41 Engineering sectors have become much more customer-focused, and this has implications for the skills of employees. Many of these have been discussed above. For example, much greater emphasis is placed on communication skills, attention is required to delivery dates and, where a bespoke product is being made, to the requirements, interests and needs of the customer. Organisations making bespoke products or involved in supply chain activities are now under much greater scrutiny from their customers visits and audits might occur with little or no notice. All employees need to be informed and able to react appropriately to these changes.

Legislation and the environment

2.42 This is an emerging area of increasing importance for many industries. For example, it is likely to affect both design and production of cars in the future, through legislation which affects the industry directly, and also indirectly, through for example fuel emissions. Employees in a range of occupations will be expected to have the knowledge and skills to ensure that these issues are fully addressed.

Specific occupational skill changes

2.43 There have also been a number of more specific changes affecting different occupations, and these are discussed below.

Managers

2.44 With an emphasis on efficiency and competition, the key role of managers is increasingly being recognised and attention is being paid to the more generic skills that make a good manager. While technical skills and knowledge are part of this, they are not enough on their own. Managers need, for example, to be able to manage budgets, people, teams, clients and customers operate strategically as well as on a day-to-day level and show leadership. Promotion to management has traditionally been seen as the main form of recognition and reward. Some organisations are struggling with how to motivate those people who are technically excellent but lack, or are uninterested in developing, people and managerial skills while some companies, for example, have been experimenting with different promotion routes and sideways moves.

First-line managers/team leaders

2.45 The role of the team leader has become increasingly critical, and is qualitatively different from that of a traditional supervisor. Team leaders have much greater responsibility for managing their team, including project management, budgets, down time, and people management. The non-technical aspects of the job are much more important than in the past: for example, communication skills, the ability to motivate and deal with any staffing problems, including disciplinary issues. First-line managers also have significant responsibilities in training their team, and this requires skills beyond simply having the technical knowledge and expertise to do a job.

Professionals and technicians

2.46 Broader skills are needed at higher levels, technological excellence is no longer enough. For example, professional engineers in manufacturing need to be able to communicate with colleagues (junior, at same level and senior to them), and also with clients, in technical and in non-technical language. They also more often nowadays work in teams, work with production staff to address problems, and need an understanding of all or most of the production process, as well as the product.

2.47 In some sectors, there can be tensions between a requirement for specialists and generalists. For example, specialists might be needed to work with specific products and technologies, to diagnose and address deep-seated production and design problems. The automotive study (PRIME, 1998) identified a tension between specialist needs and the need for design generalists who are able to adapt to different sub-systems, emerging technologies and changes in the design stage. Other employers want professional and technical employees with general expertise so that they can work flexibly across the company. In electronics and telecommunications, graduates are expected to have analytical and conceptual abilities, to understand systems and how to integrate them (Mason, 1999b).

2.48 Employer concerns about some graduates' lack of 'work-readiness' and 'business understanding' (Mason, 1999a) may reflect the greater emphasis that employers are giving, because of commercial pressures, to seeking graduates who can 'hit the ground running'.

Production workers

2.49 The evidence on production workers is mixed. Some suggests that they are increasingly being deskilled, but other evidence suggests that they are being affected both by multi-skilling, teamworking and new technologies demanding higher-level skills. These different views again reflect the diversity within the engineering sector.
In some sub-sectors and companies, production tasks have been largely automated and deskilled. However, in others (for example, automotives and aerospace), production operatives are as affected by the demands of technological and organisational changes as are other occupational groups.

Supply of Engineering Skills

3.1 In this chapter we review the evidence on engineering supply side issues. The main focus is the output from the education system and qualification trends. Training activity, including in-company training and new Modern Apprenticeship programmes are also included.

3.2 In engineering, although the link between qualification and occupation is not as strong as in other areas, such as health or legal work, vocationally based training and qualifications have long been a feature. Certain qualifications are traditionally associated with particular occupations, especially at technician and professional levels, and can make a valuable contribution to meeting skill needs. The Engineering Council's regulations (SARTOR) for the formation of engineers specify particular education qualifications (discussed further in section 3.10). In general, however, and particularly at lower occupational levels, engineering employers do not value qualifications *per se*, but look for competent and experienced workers who may, or may not, have formal qualifications. On the whole, many have a traditional outlook towards qualifications and there is still a range of views across engineering about the value of the (not-so-new) S/NVQ framework, both positive and negative ones.

Stocks of qualified people

Past trends

3.3 The main trend is that the number of employees in engineering holding vocational qualifications is increasing (Mason, 1999a). This is in line with general trends in the employed workforce (Wilson, 2000). Though it is difficult to measure trends precisely over time because of changes to qualifications and occupational classifications, the statistics in Table 3.1 (Taken from Mason, 1999a) give a good indication of the improvements over the last ten years. The biggest change is in the percentage of the engineering workforce with no vocational qualification or general qualifications higher than GCSE Grade D or equivalent which has halved, from 35 to 18 per cent, in ten years. Those who hold vocational qualifications at higher or lower intermediate levels and degree or above have risen from 43 per cent to 53 per cent. Within this, degree level qualifications rose from 8 to 11 per cent.

3.4 This change mainly reflects the supply side of the labour market as there has been a rising level of educational attainment in the population and, in particular, increasing numbers staying on in post-compulsory education. But, it also reflects the shift in the sector towards higher-level occupations (discussed in Chapter 2).

3.5 Compared with the workforce as a whole, the percentage of graduates (1998) in the engineering sector is lower (11 per cent) than for all industries (16 per cent), but the percentage with higher or lower intermediate vocational qualifications is much higher (42 per cent) than for all industries (30 per cent). The percentages with no vocational qualifications or general qualifications higher than GCSE Grade D or equivalent are very similar (Mason, 1999a). However, again these overall figures for engineering mask differences between engineering sectors. In electronics, for example, the workforce is more polarised at the higher and lower levels: a much higher percentage of the

Table 3.1: Highest qualification held by workforce in metal goods, engineering and vehicles industries (1998:SIC80 Div 3; 1998: SIC92 Groups 28-35) percentages

	1988	*1998*
Degree and equiv. or above	8	11
Intermediate*	35	42
Basic vocational**	7	9
'A' level or equivalent	4	4
'0' level or equivalent	12	15
No voc qualification, or GCSE higher than grade D	35	18

* Includes BTEC/SCOTVEC Higher National and BTEC National awards, C&G advanced craft and craft awards, completed trade apprenticeships and equiv (1998 data includes NVQ Level 3 and 4 and GNVQ Advanced awards)

** Includes GNVQ Intermediate and Foundation awards, NVQ Level 1 and 2 (1998 data), BTEC general and first awards, SCOTVEC National Certificate modules, C&G below craft level, YT, YTP certificates

Source: from Table 10, Mason, 1999a (based on Labour Force Surveys)

electronics industry's workforce are degree-qualified (22 per cent) but slightly less (14 per cent) have no vocational qualifications or GCSEs above Grade D, compared to engineering as a whole (Mason, 1999b).

3.6 There is difficulty in making international comparisons of educational levels because of differences between countries in their educational and vocational systems. Historically, the UK engineering industry appears to have employed fewer people with intermediate qualifications than many other European countries especially Germany, but at degree level there is more similarity (see Mason, 1995; Prais, 1989). Across the whole economy, approximately 380,000 people hold degree qualifications in engineering disciplines (either single or combined with other subjects, LFS, 1999), a figure that has not changed much over the last two years. (This includes all branches of engineering but not science and technology subjects like materials).

Future trends

3.7 Looking to the future, at the higher qualification levels, the available national projections data (Wilson, 2000) show that the graduate penetration rate overall will increase from 15 per cent for all occupations in 1998 to 20 per cent by 2009. For the two SOC groups of most relevance to engineering:

- science/engineering professionals: an increase in graduate penetration from 51 to 57 per cent
- science associate professionals: an increase from 20 to 27 per cent.

3.8 This upward trend is related to 'supply' effects (ie more graduates being available and finding jobs more easily than non-graduates) but is more likely to be due to the impact of increased demand in the industry for higher educational levels (Wilson, 2000).

Participation in formal education

3.9 There are two main educational outputs in relation to qualifications of relevance to this report - from further education and from higher education. The main trends and issues related to each are discussed in separate sections below, but first we highlight some important issues for both, relating to falling interest in engineering careers.

Falling share of student population

3.10 In both sectors, there have been increasing numbers taking engineering courses over the last ten years, but they represent a falling share of the total student population. Several reasons are put forward for this:

- ***Poor image of the industry:*** This has dogged engineering for decades and appears to be as much an issue today as it was in the 1970s. A number of research studies have highlighted the industry's unattractiveness to young people, in particular its poor image as a career and also a lack of knowledge about engineering jobs and engineering/technology matters in general. A 1998 survey of Year 7-11 pupils showed that just one in seven would choose a career in engineering, and these were mainly boys (EMTA, 1998a). A recent Engineering Council survey of members showed that around one-quarter would not recommend engineering as a career to a young man or woman, and among those that would (60 per cent) 'excitement', 'pay' and 'status' were hardly mentioned as features (Engineering Council, 1999).

  Industry would like to see more initiatives to raise awareness and knowledge of engineering careers through giving school students more direct experience of the engineering industry, for example through work experience and industrial placements. A recent study on introducing Engineering GNVQ to schools showed positive benefits among those participating which included more able students not usually given the opportunity to experience vocational courses (EEF, 2000).

- ***Choice of options:*** Another reason for the declining interest in engineering courses relates to the limited numbers choosing mathematics and science subjects at school. Though numbers have been growing, only half of 16 year olds get GCSE maths Grade C. Only around ten per cent of the cohort go on to study maths at 'A' level (AEB). Maths 'A' level awards have remained broadly static, but physics has declined by 13 per cent between 1993 and 1997, though the trend has since levelled. There is a perception that science and maths 'A' levels are harder and less interesting than others (Sharp *et al.*, 1996). The majority of engineering courses at universities, especially the top ones, require maths and physics 'A' level, and often a third science 'A' level (Steedman *et al.*, 2000). Then, for those with maths and science qualifications, there are other alternative career options to consider. Computing and IT subject areas are often seen as more attractive in terms of graduate salaries and career prospects (ITCE SSG, 1999). Many do not require maths 'A' level, in contrast to engineering.

- ***Changing pattern of study:*** The Government's focus on encouraging more young people to stay on at school and progress to higher education is thought to have had a detrimental effect on the 'vocational route'. There has been a shift in the balance of post-16 education towards higher education study caused by increased staying on rates at school and the rapid expansion of higher education in the early 1990s, along with changes in perceptions of the status of different qualifications. Thus, people who previously may have taken vocational qualifications at FE college (eg HNC, NVQ Level 2/3), on a part-time or full-time basis, are more likely nowadays to stay on at school and aspire to a university place. Those who take HNC/HND qualifications usually end up completing a degree. Employers often comment about the disappearance of the 'traditional FE student'. There is also a noticeable lack of progression between the NVQ lower levels (commented on by Engineering Council, 1998). Furthermore, the new GNVQ qualifications have established themselves more as a route to HE entry. Compared to many other countries, the UK has less output at sub-degree level. In the case of France, for example, these increase engineering entrants by a factor of three (Steedman, *et al.*, 2000).

In its initial proposals in response to the final report of the Skills Task Force, the Government intends to strengthen the vocational route and encourage greater participation in vocational learning by developing career ladders of progression in vocational study or apprenticeships through to foundation degrees. It is also focusing expansion of higher education in general at sub-degree level (in response to the Dearing Report on HE, 1997). The Engineering Council is also aiming to address the perceived imbalance in the supply of engineers, which is weighted towards the higher (Chartered) level, through its new regulations, SARTOR 97. These have the broad support of the industry. The regulations are designed to improve access to Chartered and Incorporated status from different starting points, including FE qualifications.

- ***Low take-up by women:*** Only 11 per cent of engineering students in FE colleges are female (Individual Student Record [ISR]) and 14 per cent of undergraduates in higher education (UCAS, 1999); a situation which has changed little during the 1990s. The main reasons relate to the two above (image and alternative, more attractive, options). Interestingly, women are much better represented at 'A' level in physics and maths (23 per cent and 36 per cent respectively of the total awards are to women) suggesting that the 'put-off' factors are working at both earlier and later decision-making stages. Differences are also apparent between disciplines: chemical engineering does much better than other engineering disciplines with 24 per cent of degree places taken by women.

Further education

3.11 The FE sector continues to be in a state of flux due to changes in funding systems, qualifications and types of provision. These, together with re-classification of engineering subjects in student statistics and movements of programmes between the FE and HE sectors, make it difficult to gain a clear picture of long-term trends relating to engineering. However, work by the FEFC to improve the available statistics, and a recent report on the engineering programme area (FEFC, 2000) have made it possible to identify the following trends and issues:

- In 1997-98 7.2 per cent of the 4.4 million FE students were on engineering courses.

- The vast majority (80 per cent) study part-time.

Table 3.2: Full-time and part-time Engineering Students 1989-1999 (includes period before incorporation, numbers rounded to nearest 100)

Year	Full-time	Part-time	Total
1988-89	28,200	190,300	218,500
1992-93	43,300	158,900	202,200
1996-97	62,900	243,400	306,300
1997-98	57,000	253,500	310,500
1998-99	53,300	228,600	281,900

Source: FEFC, 2000

- While numbers on engineering courses grew in the first half of the 1990s, there has been a decline of six per cent since 1995/96 (Table 3.2). This compares with a growth in overall FE student numbers of 14 per cent.
- Full-time study has been declining overall in recent years (six per cent), but the rate of decline in engineering has been much steeper (down by 20 per cent).
- Part-time students in engineering have also declined slightly but only from 1997/98, previously they were increasing (Table 3.2).
- A large number of engineering related courses are offered by colleges. Almost 900 engineering related qualifications are on the FEFC's student database (the ISR - Individual Student Record), and 86 per cent of FE colleges offer some engineering provision. This ranges from foundation through to intermediate and advanced courses and also HE programmes (mostly HNDs), and courses are of varying durations. There are concerns about the viability (in terms of cost effectiveness and maintaining standards) of this wide range of provision at so many colleges.
- There is variation between regions. Greater London, North West and South East have the highest percentage of national full-time provision (15-16 per cent each), East Midlands has the lowest percentage (7 per cent). West Midlands and North West have the highest percentage of national part-time provision (15-16 per cent each) while the lowest is in Greater London (8 per cent). To some extent these differences reflect the pattern of engineering employment across the country and the regional economic trends.
- North West and West Midlands have experienced the greatest decline in full-time students, while other regions have been more volatile especially in regard to part-time study.
- Growth in enrolments has been much stronger at Level 1 (83 per cent) than at Level 3 (just 5 per cent) over the last four years (Table 3.3). GNVQ courses in engineering represent a very small number of enrolments, only about one-sixth of those on BTEC courses.
- Looking to the future, college strategic plans suggest a projected growth in engineering students of five per cent over the next two years.

Table 3.3: Engineering enrolments by Notional NVQ Level, 1994-98

NVQ Level	1994-95	1995-96	1996-97	1997-98
1	48,195	62,035	76,782	88,361
2	85,944	94,674	114,570	124,239
3	66,759	67,377	69,012	70,241
H Higher NVQ Level 4 or above	24,637	21,360	20,080	20,646
X Unassigned to level usually because not known at entry	40,985	72,343	59,547	72,792
Total number of engineering enrolments	***266,520***	***317,789***	***339,991***	***376,279***

Source: FEFC, 2000

3.12 By 1998/99, a total of 276,000 NVQ awards have been made in the engineering framework area. This comprises 10 per cent of all NVQ awards (source: NISVQ). In 1998/99, 46,000 NVQ/SVQ awards in engineering were made compared with 38,000 in 1994/95, an increase of 20 per cent. Over half of these awards in 1998/99 were at Level 2 (29,000) and most of the remainder at Level 3 (15,000).

3.13 In addition, 51,000 other vocational awards in engineering were made in 1998/99. Approximately 13,000 of them were at Levels 4 and 5, 15,000 at Level 3 and the remainder, 23,000, at Levels 1 and 2.

Higher education

3.14 As indicated above, there has been an enormous expansion in higher education over the decade. Undergraduate entrants more than doubled between 1988 and 1998 and the participation rate for young people increased from 15 per cent of 18/19 year olds in the 1980s to over 35 per cent today (UCAS, 1999; HESA, 1999). However, engineering has not shared in this expansion to the same extent as other subjects. After peaking in 1993, at just over 21,000 acceptances from UK applicants to full-time engineering degree courses, the numbers started to decline, though the situation has become more stable in recent years. The number of engineering undergraduates in total has decreased by 10 per cent between 1994/95 and 1997/98 while the total number of undergraduates (all subjects) has increased by 10 per cent, and numbers on popular subjects such as computing have increased by almost 20 per cent (HESA, 1999). Graduate output in engineering and technology disciplines was 22,000 in 1995, an increase of 55 per cent since 1988. However, growth in output in all subjects was slightly higher at 79 per cent.

Table 3.4: Annual output of first degree graduates by selected subject groups, UK 1995-98

	Mechanical engineering	Electrical engineering	Electronic engineering	All Engineering & technology	All subjects
1995	3,468	1,204	3,585	22,083	237,798
1996	3,673	1,281	3,824	23,318	251,248
1997	3,827	1,037	3,923	23,017	255,260
1998	3,913	1,014	3,853	22,574	258,753

Source: HESA Annual Reports on students in the HE institutions, 1996-99

3.15 Recent trends at a more disaggregated level, show that total graduate output in engineering and technology increased slightly between 1995 and 1997, but fell back in 1998 (Table 3.4). A seven per cent growth in electronics engineering graduates was recorded between 1995 and 1996, but since then numbers have been almost static.

3.16 The main reason for this decline is viewed as being the unattractiveness of engineering as a subject to study and as a career (see Section 3.10 above). Steedman et al. (2000) attribute it to the decline in well qualified candidates, notably at maths and physics 'A' level (see above), though they acknowledge that there are other factors causing engineering courses to struggle to attract candidates from the limited pool of talent available. There is evidence from other studies also about the quality of undergraduate entrants to engineering (see for example Mason, 1999a; Jagger and Connor, 1998). Measured by 'A' level points, there is considerable variation in the entry standards of university engineering courses and a wide range of 'A' level scores are recorded overall:

- Twenty-six per cent of 'A' level entrants to engineering degrees in 1997 had 26+ points, above the average for all subjects (24 per cent). It was a similar figure in biological and physical sciences but lower in mathematical sciences (44 per cent) and humanities (31 per cent).

- But almost one-third of 'A' level engineering entrants had scores of 15 points or fewer, which compares with around 20 per cent for law and other humanities subjects (Mason, 1999a).

3.17 The Engineering Council's new SARTOR 97 regulations are designed to address this variation between departments: some are now being accredited for graduates seeking the lower Incorporated Engineer membership, not Chartered Engineer. One of the criticisms of the new SARTOR, however, is that it is based on input measures ('A' level equivalent points) and that there is no measurement of output standards of graduates. The latter is currently the subject of further consultation.

3.18 A number of studies of employers have highlighted criticisms about the quality of new graduates, including engineering graduates, especially in terms of their lack of personal transferable skills (AGR, 1999; Mason, 1999a). Employers report how many engineering and technical graduates are deficient in communication and interpersonal skills, and an apparent 'mismatch' in the extent to which graduates are 'work-ready' and understand how business operates. This partly reflects a greater expectation by employers of new graduates' work-relevant skills developed in their degree studies.

3.19 Unemployment of engineering graduates is slightly above the average, despite the reported high demand from employers, especially from electronics employers. In 1998, unemployment of new engineering and technology graduates (HESA, 1999) stood at 6.6 per cent, slightly higher than the average of 5.7 per cent. Electronics engineering graduates had a slightly higher unemployment figure, 8.4 per cent. It is not clear why the unemployment rate for engineering is higher and it seems rather at odds with the recruitment experiences of many employers. Also, according to studies of financial rates of returns for graduates, relative returns on engineering degrees rose by 1.5 per cent after inflation during the 1990s while average returns for all graduates were not above inflation (Hansen and Vignoles, 1999.). One possible explanation may relate to the perceived poor quality of some engineering graduates who are more likely to find difficulties obtaining employment. According to a DTI sponsored study (DTI/CEL/Barclays, 1999) unemployed engineering graduates tend to be older, achieve a lower class of degree and are less likely to have relevant work experience.

3.20 There is a need (expressed by the Engineering Council and employers) to improve the work experience available to undergraduates, and also to newly graduating engineers. As a consequence of the lack of 'quality' work experience provision, some engineering graduates end up in non-engineering occupations, which can be interpreted as being a loss of some of their investment in education. Some effort is being made to address this through the development of Graduate Apprenticeships and transferable training loans. The DTI study also highlighted the lack of work experience among graduates from pure science programmes (eg physics, maths).

3.21 One issue affecting the quality of undergraduate education is the difficulty which universities experience in recruiting sufficient young lecturers and researchers in engineering. As shown earlier in Chapter 2, salaries are lower for engineers in teaching, and the low stipends for PhD students have also been criticised as being unattractive.

Flows out

3.22 An issue frequently raised by employers is that the best engineering graduates are frequently 'lost' to the profession because of more attractive salary and career opportunities offered by, for example, the City. Recent research by Mason (1999b) confirms this trend exists to some extent, especially the flow of electronics engineers into IT areas. The First Destinations of Newly Qualified Graduates Statistics (HESA, 1999) show that just over half of the engineering and technology graduates who enter UK employment, go into professional level occupations and a further 14 per cent go into associate professional jobs. Thus a substantial number take up other jobs, in manager and administrator occupations (12 per cent) and a range of lower-level jobs (19 per cent). These appear unrelated to engineering, though the available statistics do not make it clear exactly what proportion is actually 'lost' to the profession. By discipline, mechanical engineers are more likely to take up professional level occupations than electronics engineers who are more likely to work in a wider range of occupations (HESA, 1999). By sector, there is little evidence of a 'drain' of engineers into the financial sector *per se* - only three per cent of the engineering and technology graduates in 1998 who entered UK employment went into financial activities. However, substantially more (26 per cent) joined the 'business services' sector (which covers property development, retailing, business and research activities) and 33 per cent joined manufacturing industry. Others were spread in small numbers across a range of sectors. By discipline, electronics engineers and civil engineers were more likely to join the business service sectors (around one-third of each did so) than other engineers.

3.23 A specific type of flow is 'brain drain' - the leaving of highly qualified people to work abroad, often in the USA. This has been a periodic feature of the highly qualified scientific labour market, in particular specialists such as biotechnologists, particle physicists, etc. In engineering it is less of an issue, though there have been well-publicised cases of individuals (eg in electronics engineering, robotics, etc.) who have left to work abroad, usually for considerably more money and better conditions. There is also increasing potential for mobility across Europe. The outflow to the USA is expected to grow, in particular in shortage areas such as IT skills, as it has recently relaxed immigration rules to help ease problems in the domestic labour market.

3.24 There is also a kind of 'reverse brain drain' as many EPSRC-funded research assistant posts at UK universities are filled by foreign nationals, from the EU, the Middle East and South East Asia. These often then stay on to develop long-term careers in the UK. This is because an academic career is less attractive to UK graduates who can earn more in the engineering industry or business services, and many engineering postgraduates do not stay in the academic sector.

3.25 Flows between regions within the UK are likely to be more of an issue, especially in the relatively mobile professional level population. There have been problems in the past relating to the North-South divide because of housing cost differentials.

Postgraduates

3.26 Postgraduate education represents a small proportion of the total supply at the higher level (8,000 students out of the total of 35,000 in engineering, mostly on MA and MSc courses or modules). But it has an important role in the advanced training of engineers, in the maintenance of the research base in engineering, and also in innovation through technology transfer.

3.27 Since the 1970s, the postgraduate sector has grown and changed substantially so that it now encompasses a much greater variety of programmes and delivery mechanisms (Jagger and Connor, 1998). There is much more part-time provision and more short courses specifically geared to the needs of industry, and fewer one year full-time MSc courses. The EPSRC, the main public funding source, plays a relatively small role now in funding postgraduate training of engineers and it has moved over the years to providing more flexible resources to universities for training. An increasing volume of support comes from industry through student sponsorship, especially for part-time study and for individual modules taken by employees as part of Continuing Professional Development (CPD). The EPSRC's newly introduced Masters Training Packages are designed to reflect the changing requirements of employers and give individual institutions/departments more flexibility in provision. This can include support to a range of full-time and part-time courses, and modular study, provided according to student and employer demand.

3.28 The EPSRC has also responded to demands, both at master and doctorate level, for postgraduates to have more industrial experience and 'broader' skills, by introducing a new Engineering Doctorate (EngDoc) scheme. This is designed for people seeking a career in engineering research management. Doctorate students are based in (and sponsored by) companies for four years, and the programme provides a blend of research training and work experience. Established as a pilot programme in 1992 at five centres, it has been expanded to ten centres since 1999, with 100 studentships per annum. Further expansion is planned from 2001, with up to 150 studentships at 15 centres.

Training programmes

3.29 In addition to issues around formal qualifications affecting the skill base of the sector, there are other aspects of supply relating to work-based or company provided training.

Modern Apprenticeship

3.30 Modern Apprenticeship (MA) was introduced to engineering in 1996. It is generally regarded favourably, and seen as being more flexible than the traditional apprenticeships, having potential for progression to higher qualifications. To date there have been over 20,000 enrolments in the engineering manufacturing sector, which represents around ten per cent of all MA starts. In addition, there have been 150/200 places per annum in the engineering construction sector (managed by ECITB). The majority of MA recruits are male and they tend to be younger (more aged 16 and 17 years) than for the industry as a whole.

3.31 Numbers are perhaps not as high as EMTA and many in the engineering manufacturing industry would wish (only around 7,000 new starts per year) and completion rates are also quite low (32 per cent), though this figure is better than the average for all sectors. These compare with much higher student numbers in colleges (see above) and higher achievement rates of young people at Level 3 engineering qualifications. In engineering construction, the MA is organised differently, with apprentices being 'employed' by the ECITB, and their training managed closely. Completion rates are much higher (at 86 per cent), but here, too, there are concerns about the calibre of intake, despite large numbers of applicants across the country (c.2000).

3.32 Reasons for low take-up are related to a number of factors. The main one is likely to be higher staying on rates at 16 combined with the poor image of engineering and work-based learning. The higher calibre potential apprentices opt to take further qualifications (and are encouraged to do so by their schools and colleges). It is not helped by the relatively poor (and in EMTA's view often biased) careers advice and guidance on engineering and work-based training in manufacturing given to young people (see above). An additional negative factor is the age restriction at 19 years for TEC funding. In the past, there may have been some antipathy towards MAs from some employers because of their dislike of the NVQ framework (Senker, 1996) but that is thought to be less of an issue today. However, some employers in the engineering construction industry are concerned about the lack of flexibility of the NVQ framework, especially at Level 3 which is the required output for MAs. More breadth of competence, rather than the depth currently prescribed, would meet their needs better.

Other training

3.33 There is a range of other training provided, both on and off-the-job, often done in a more informal way (ie not leading to a qualification) and of short duration, which is also a component of the supply side, and where there are issues affecting skill deficiencies. It is not easy to find reliable statistics which show trends in the amount of training being given to different occupations in engineering. The recent People Skills Scoreboard (EMTA/EEF, 1999) provides some benchmarking data but the coverage is still relatively small, though growing (505 companies employing 236,000 in 1999) and has existed for only two years. It suggests that:

- off-the-job training amounted to an average of £700 per employee, a figure that has changed little since the previous year (when the first Scoreboard was undertaken)
- training spend as a percentage of payroll was 2.7 per cent in 1999
- each employee received an average of 2.5 days per year off-the-job training, and 1.56 days on-the-job training
- the more dynamic, more technically complex, sectors, such as aerospace have the highest investment in training while the basic metals and metal products sectors have the lowest.

3.34 The EMTA 1999 survey also provides information on training. Almost two-thirds of employers had funded or arranged training (off-the-job or on-the-job) for their employees in the previous year. Almost half of these were small site employers (5-24 people). However, this does mean that half of the small companies in the engineering sector are unlikely to be undertaking or funding any training, in contrast to the position among the large companies where nearly all were funding or providing training for their employees. Training occurred within all occupational groups but more companies provided training to managers, admin/clerical staff, craft workers and assembly/operator staff.

3.35 The statistics from the Labour Force Survey (LFS) also provide some evidence on training activity. For those in the relevant engineering occupations (see Table A3.1), the percentage receiving training in the previous 13 weeks ranged from 31 per cent of those in professional level occupations to just 13 per cent for those at assembler/operative level (Sep 99 LFS). On the whole, training activity declined as skill level declined. By sector, there were some variations, especially between manufacturing and the public sector (or previously publicly owned). Considerably higher percentages of engineers working in public administration and defence and in the public utilities (electricity, gas, water) reported being in receipt of training than those in the engineering manufacturing sector. This was evident for professional, technician and craft level occupations. There was very little difference between different engineering sectors, however, with no evidence that hi-tech sectors such as electronics were providing more training to their employees than more traditional engineering sectors.

3.36 Looking over the last five years (1995-99), there is no discernible trend apparent in the LFS data relating to training given to people in engineering occupations. While there are slight variations from year to year, the percentages in the relevant occupations receiving training from their employers have changed little over the period. There are no comparable data available prior to 1995.

3.37 One of the impacts of the economic cycle (highlighted in Chapter 1) has been that during times of recession, employers made cutbacks to training budgets, especially the relatively long craft and technician training. In aggregate these have had a profound impact on the supply of skills to the industry (Mason, 1999a). In particular the closures of some large company training facilities during the 1980s recession, and the reluctance of some of the large companies to continue previous practice and train in excess of their needs, have been a major disadvantage to small firms. Recent financial difficulties experienced by Engineering Group Training Schemes, which serve to provide training to small firms, have added to the problem. The evidence from the LFS relating to training differences between the public utilities, which on the whole are more profitable than most of engineering manufacturing, add weight to the argument which links attitudes towards training provision to profitability.

Recruitment and Skill Deficiencies

4.1 This section explores the extent and nature of skill gaps, based on the available evidence on recruitment difficulties and hard-to-fill vacancies, and employer views about the proficiency of their workforce. Evidence is drawn mainly from the EMTA surveys and a sector analysis of the national Employers' Skills Survey (ESS), as these are the two main sources of quantitative evidence on engineering skill problems. For this reason, this chapter is more focused on the engineering manufacturing sectors than some of the previous chapters. Various NTO Skills Foresight reports and a number of other mainly qualitative studies have also been used.

Historical overview

4.2 Traditionally, the main area of recruitment difficulty and skill shortage problems in engineering has been in the craft and skilled trades. This is a recurrent theme in the literature over many decades. It has been caused by a combination of events, including: employer decisions to cut back on expensive craft training during periods of deep recession (see end of previous chapter); the demise of the traditional craft apprentice training route; the closure of large company off-the-job training centres which specialised in foundation craft training; and the loss of many experienced and skilled craft workers to other sectors during the recessionary periods (to take up other jobs and these people did not return when the climate improved). There have also been shortages highlighted from time to time in the professional and technical occupations (eg electronics and software engineers in the first IT boom in the late 1980s). In recent years, several reports have highlighted worsening problems at associate professional level (ie technician engineer) (see for example DTI and Engineering Council). Another area giving concern is the lack of generic skills of managers (see ECITB Skills Foresight report).

Recruitment and vacancies

4.3 A range of different sources of information has been drawn on to provide an overall picture of the level of recruitment and where difficulties are experienced. The various surveys ask different questions, have varying coverage and have been conducted at different times. The timing of a survey is perhaps particularly crucial, as the level of recruitment and, very importantly, recruitment difficulties, is cyclical. There is, however, evidence that, given competitive pressures and the impact of technological and organisational change, recruitment difficulties are more deep-seated. Even at times of relatively low recruitment, the filling of certain types of vacancy remains problematic.

4.4 The EMTA annual surveys collect information on the extent of recruitment in engineering manufacturing. In the year up to February 1998, 66 per cent of establishments had recruited some staff; 63 per cent in the following year. A labour market survey conducted for the rail industry in late 1998 reported 69 per cent of respondents recruiting in the previous year (RITC, 2000).

4.5 Another way of looking at recruitment is the number of employers with vacancies at a particular point in time. The EMTA surveys found a slight decline in the proportion of employers with vacancies at the time of the survey; 21 per cent in 1999 compared to

28 per cent in 1998. The national Employers' Skills Survey (ESS) showed that 27 per cent of engineering manufacturing establishments had some vacancies at the time of the survey (late 1999), compared to 32 per cent of the whole sample (ie employers across all sectors). This suggests a slightly lower level of recruitment activity in engineering, which is what would be expected given its greater economic difficulties (see Chapter 1). As expected, larger establishments were more likely to report having vacancies and also larger numbers of vacant positions.

4.6 Employers in the ESS were more likely to be recruiting at craft and operative level than in other occupational areas (Table A3.6 in Appendix 3), but this is linked to the higher levels of employment in these occupations. When the number of vacancies is related to the number employed in each occupation, a fairly consistent level of recruitment appears to be occurring across all occupations. Vacancies represented between one and three per cent of employment in each occupation.

4.7 In total, an estimated 25,000 vacancies were reported by engineering employers in the ESS (weighted data). This represents 1.8 per cent of total employment. This is lower than the equivalent figure for all industries (3 per cent).

4.8 Electronics had similar vacancy levels overall compared with engineering as a whole, but at an occupational level more differences were evident:

- vacancies at engineering professional level represented 13 per cent of total vacancies in electronics compared with 8 per cent in the rest of engineering
- vacancies for assembly/line workers represented 15 per cent of vacancies in electronics compared with 10 per cent in the rest of engineering.

Recruitment difficulties

4.9 Of greater interest for this Dialogue are the extent and nature of difficulties in recruitment rather than vacancy levels. The majority of surveys use hard-to-fill vacancies as a proxy for this. While hard-to-fill vacancies are clearer to define than 'skill shortages', there is still some ambiguity around their definition. For example, in the ESS, employers reporting hard-to-fill vacancies were asked 'broadly speaking how long has a vacancy in each occupation lasted', and a pattern of considerable variation emerged:

- Eight per cent of employers with hard-to-fill vacancies for professionals reported that they had taken up to one month to fill, 53 per cent one to three months and 18 per cent more than six months.
- Sixteen per cent of employers reported that their hard-to-fill vacancies for technicians took up to one month to fill, 21 per cent more than six months.
- In craft occupations, 22 per cent of employers reported hard-to-fill vacancies taking up to one month and 30 per cent more than six months to fill.
- By contrast, the majority of operative vacancies (42 per cent) lasted up to one month and 11 per cent more than six months.

4.10 This does raise the issue of what is meant by hard-to-fill vacancies. Do they take longer to fill than usual for a vacancy in that occupation; are they filled, but by people who are not fully suitable; is extra effort required to fill these posts? Not all hard-to-fill vacancies are caused by skill related reasons (see below), they may be due to, for example: the company's location, pay being offered, employment conditions or working hours.

Level of hard-to-fill vacancies

4.11 Between the EMTA surveys in 1998 and 1999, there was a reduction in the proportion of engineering employers reporting hard-to-fill vacancies, from 49 to 32 per cent. But according to ESS, a smaller proportion of engineering employers has hard-to-fill vacancies: 16 per cent. ESS was conducted later than the 1999 EMTA survey and the lower level of hard-to-fill vacancies may indicate a further decline in the buoyancy of the sector[1]. Engineering employers reported almost 12,000 of their vacancies as being hard-to-fill, 46 per cent of all vacancies (ESS data).

4.12 The proportion of engineering employers reporting hard-to-fill vacancies in the engineering sector was the same as for all employers in the ESS; so too were the relative proportions of vacancies that were hard-to-fill ones. Similarly, comparing employers in the 1999 EMTA survey (25+ employees) with all employers in the Skill Needs in Britain Survey (IFF, 1998), shows similar levels of hard-to-fill vacancies. This suggests that recruitment difficulties overall are not any greater in engineering compared to other sectors. Nevertheless, having around one-sixth of engineering employers reporting hard-to-fill vacancies at a time when the sector is not particularly buoyant is a serious issue and may suggest possibly more deep seated issues around the availability of skills. Some of the establishments in the ESS case study research reported that they were currently in the trough of a recession and that if demand picked up to any significant extent, then they expected recruitment problems to significantly intensify.

Sector differences

4.13 Employers in different sub-sectors of engineering are experiencing varying levels of recruitment difficulties, and also different kinds of difficulty. The 1999 EMTA survey found that employers in the motor vehicles sector were most likely to have hard-to-fill vacancies, followed by mechanical equipment and electronics. A SBAC study, conducted in 1997 in the aerospace sector, reported 62 per cent of employers having hard-to-fill vacancies over the past 12 months and 53 per cent at the time of the survey (SBAC, 1998). The ESS, however, showed very little difference between electronics and the rest of engineering both in the proportion of employers reporting hard-to-fill vacancies and in the proportion of vacancies reported that were hard-to-fill ones. This seems somewhat at odds with reports from electronics employers of the greater difficulty being experienced there. However, more detailed analysis at an occupational level shows a different picture.

Occupational differences

4.14 Looking in more detail at the ESS analysis by occupation, a fairly consistent picture emerges relating to differences between occupations (see Table 4.1). There are four occupations where the greatest difficulties are being experienced:

1 The much higher proportion of employers reporting hard-to-fill vacancies in the EMTA survey might also be partly attributable to differences in sampling and coverage between the two surveys.

Table 4.1: Distribution of hard-to-fill vacancies by occupation in the engineering sector

	Employers with hard-to-fill vacancies as a percentage of those with vacancies in each occupation	Base: number of employers with vacancies	Hard-to-fill vacancies as a percentage of vacancies in each occupation	Base: number of vacancies
Managers and administrative	48	862	43	1,314
Professional	51	946	53	2,418
Technical and scientific	47	862	49	1,833
Clerical and secretarial	34	1,083	26	1,660
Craft and skilled operative	64	3,011	65	6,384
Sales	37	938	38	1,799
Operative and assembly	51	2,679	37	8,905
Other manual	44	343	35	1,003

Source: ESS, 1999

- craft (65 per cent of vacancies are hard-to-fill)
- professional (53 per cent)
- technical/scientific (49 per cent)
- managers (43 per cent).

4.15 This generally reflects the findings of the EMTA surveys: the majority of hard-to-fill vacancies identified there were in technician, craft and professional occupations. The main difference is the lower level for managers. EMTA (1999) attribute this to the greater likelihood of managers being recruited internally. However, both the EMTA survey and the ESS survey vary in their depth and coverage, which also may explain the different responses.

4.16 Table 4.1 illustrates how different measures or indicators of the importance of hard-to-fill vacancies can provide varying pictures. For example, although a relatively high proportion of employers reported hard-to-fill vacancies in operative jobs, when the actual number of hard-to-fill vacancies is related to vacancies in these jobs, they appear as less problematic. This suggests that problems in filling operative jobs are more widespread across employers but are of lesser importance overall. This can also be seen in Table 4.2 where vacancies and hard-to-fill vacancies in each occupation are expressed as a proportion of the total for each category. This indicates the greater problems in craft and skilled trades in particular (25 per cent of all vacancies are in craft occupations but 35 per cent of hard-to-fill vacancies).

Table 4.2: Employment, vacancies, hard-to-fill vacancies and skill shortages by occupation, for the engineering sector (percentages)

	Employment	Vacancies	Hard-to-fill vacancies	Skill shortages*
Managers and administrative	13	5	5	4
Professional	11	10	11	14
Technical and scientific	7	7	8	10
Clerical and secretarial	9	7	4	3
Craft and skilled operative	24	25	35	40
Sales	4	7	6	6
Operative and assembly	27	35	28	21
Other manual	7	4	3	2
Total numbers	**1,434,571**	**25,350**	**11,727**	**6,726**

* hard-to-fill vacancies which are due to one of the following skill related reasons: low number of applicants with required skills, lack of work experience, lack of qualifications company demands.
Footnote: All percentages do not add to exactly 100, due to rounding.

Source: ESS, 1999

4.17 Although there appears to be little difference between electronics and the rest of engineering in the overall incidence of hard-to-fill vacancies (see above), differences emerge at a more detailed occupational level. Table 4.3 shows the incidence of recruitment difficulties by expressing hard-to-fill vacancies as a percentage of vacancies for each engineering occupation by sector. It also shows the total number of hard-to-fill vacancies. Engineering occupations have been identified at a SOC92 two-digit code level. While some of these codes have wider boundaries than engineering skills (eg SOC30 includes scientific technicians, IT staff) they are the best that can be used at this level (three digit SOC breakdown produces too small numbers).

4.18 Comparing electronics and the rest of engineering, it is clear that recruitment difficulties are greater for electronics companies at professional level and also for electrical and electronic trades, although similar for other engineering occupations (Table 4.3). Looking beyond the engineering manufacturing sector to other manufacturing, construction and business and IT services, where engineering skills are also required in significant numbers (see Chapter 1), shows that:

- At professional engineering level, recruitment difficulties are greater in electronics and construction than elsewhere.
- Construction appears to be suffering considerably more than other sectors for all engineering occupations, and especially in electrical, electronic and metal forming, welding trades.

Table 4.3: Hard-to-fill vacancies as a percentage of vacancies in engineering occupations in different sectors

	Electronics	Rest of engineering	Other manufacturing	Computer & business services	Construction
Professional - engineering technical (SOC21)	61	49	45	47	62
Assoc prof/scientific technicians (SOC30)	50	49	35	56	69
Metal machining, fitting etc. (SOC51)	57	51	66	58	67
Electrical/electronic trades (SOC52)	94	74	*	61	86
Metal forming, welding, and related trades (SOC53)	*	75	60	*	88
Metal working process operatives (SOC84)	*	62	67	*	*
Assemblers/ lineworkers (SOC85)	37	38	52	74	*
All of the above engineering occupations	58	56	53	55	82
Total number of hard-to-fill vacancies in these engineering occupations	1,553	5,767	2,379	4,877	5,783
Total number of hard-to-fill vacancies	**2,650**	**9,286**	**22,885**	**32,181**	**19,223**

* too small cell size, fewer than 250 vacancies (weighted)

Source: ESS, 1999

- Other manufacturing and computer and business services also have more problems in these craft trades than other occupations.
- Computer and business services appear to have more recruitment problems in assembly work, than at the professional engineering level.

4.19 It is worth noting however, although these other sectors require engineering skills, the level of hard-to-fill *engineering* vacancies compared to *all* of their hard-to-fill vacancies is considerably lower than that for the engineering manufacturing sector.

Graduate recruitment difficulties

4.20 There are frequently reported difficulties by graduate recruiters in engineering and technical disciplines (see for example, AGR annual surveys). In a recent survey of employers of technical graduates covering a number of sectors (Mason, 1999c), 41 per cent of recent recruiters reported they had some difficulty in meeting their recruitment targets. Employers experiencing the most serious difficulties were in electronics, with 20 per cent reporting it was very difficult to meet recruitment targets compared with 11 per cent for all recruiters, and just 5 per cent in the financial sector. The main disciplines in shortage for most sectors were electronics, IT and computer science. Similarly, the main areas of technical expertise lacking were software, IT and electronics.

Table 4.4: Main causes of hard-to fill vacancies by occupation, identified by engineering employers (percentage of employers citing each reason)

	Low number of people with required skills	Low number of applicants generally	Lack of work experience	Lack of qualifications
Managers	42	28	33	6
Professionals	56	26	21	13
Technician/ scientific	45	23	30	9
Craft	50	27	25	13
Operative	42	31	23	6

Source: ESS, 1999 (see more detail in Table A3.8)

Skills related hard-to-fill vacancies

4.21 A number of themes emerged when employers in the ESS were asked the reasons for hard-to-fill vacancies, but the main one related to skill shortages. The three causes identified as being more important to employers than the others (see Table A3.8 and Table 4.4) are:

- Low numbers of applicants with required skills (rather than qualifications) - this affects most occupations but especially professional and craft, over 50 per cent of employers (Table 4.4).
- Low numbers of applicants generally - again affecting most occupations (26-31 per cent of employers).
- Lack of work experience - particularly for sales (40 per cent), and also manager and technician vacancies (one-third).

4.22 A fourth cause, lack of people with required qualifications, also featured as being of importance, but less so than the three identified above. Other causes were irregular and anti-social hours when recruiting managers, professionals and technicians, and attitudinal and motivational issues in relation to managers, sales and operative applicants (Table A3.8).

4.23 Taking the skill-related reasons together (ie low number of applicants with required skills, lack of work experience, and lack of qualifications employers demands) and applying them to the hard-to-fill vacancies reported, gives greater emphasis to the problems at professional, technician and craft occupations level (see Table 4.2). Three-quarters of hard-to-fill vacancies in professional and technician occupations, and almost two-thirds in craft and skilled trades were attributed to ‘skills related reasons’. This compares with 42 per cent in operative and 44 per cent in clerical work.

4.24 The EMTA surveys also asked employers with recruitment difficulties about the reasons for these. Although it is difficult to make direct comparisons with the ESS results, the overall themes are similar:

- the majority of EMTA survey respondents attributed their difficulties to a lack of applicants with the required qualifications and skills (53 per cent of those with recruitment difficulties);
- this was followed by a general lack of applicants (24 per cent) and applicants lacking the necessary work experience (18 per cent).

4.25 The SBAC survey in aerospace (SBAC, 1998) also provides a similar picture, with the main reasons for recruitment difficulties being 'not enough suitably skilled people, people lacking practical skills and a lack of people interested in the type of work'. This study also identified competition from other employers as a cause of recruitment difficulties.

4.26 ECITB in their Skills Foresight report (ECITB, 2000) identify the main areas of skill shortage in recruiting craftspeople to onshore sites, especially in key trades such as welders and pipefitters. Offshore, the calibre of applicants to supervisory and other senior positions is also reported as a concern, as is a shortage of highly specialised engineering skills in head office functions.

Pay levels

4.27 Changes in pay levels can also be used as an indicator of trends in the labour market for certain occupations. In particular, a tightening of the labour market can be indicated by high wage inflation. There are various sources of information on pay levels of engineers, covering different groups of workers and different time periods though little of what is available supports the evidence of skill shortages among different engineering groups. It mainly highlights differences between electronics and other engineering sectors, and also shows the wide range of pay levels for different occupational groups, especially those in professional engineer jobs.

4.28 Taking the whole of engineering first, the level of pay settlements reported by EEF member companies (covering a wide range of engineering activities, wider than manufacturing) remained relatively stable over the last six months (EEF, 2000). The three month moving average was at around 2.6 per cent (just above the Government inflation target of 2.5 per cent). There has been a high level of reported pay freezes in engineering, averaging one in six of all settlements, which are thought to reflect the more difficult economic climate of the last 12 months or so.

4.29 Throughout the 1990s, pay settlements in engineering have been below those in the wider economy, and since 1996, the gap between pay settlements in engineering and the services sector has grown.

4.30 Earnings data for different groups of engineering employees show that:

- The largest increases in the six month period (March-Sep 99) have been in the electrical and electronic equipment sectors (based on NES data reported in EEF, 2000), supporting other evidence of more shortage problems there.

- Among professional engineers, electrical engineers were the highest earning group (average gross including overtime, £32,000) followed by software and electronic engineers (£31,000), both occupations in high demand.

- Engineering directors received the highest increases in average earnings (ten per cent), and their average salary was just over £66,000. The highest bonus payments (as a percentage of salary) were also concentrated at the top end of the pay structure (REL, 1999).

- The Reward Group's latest survey on the electronics industry showed that pay awards averaged four per cent over the year to August 1999. The median salary of directors was a little over £73,000, while supervisors/senior technicians earned £17,000. As might be expected the range of salaries was much greater at the higher end of the pay structure.

- The Reward Group's survey also showed that, at all levels, pay in the software industry was higher than in the electronics components industry. The lowest paying electronics sector was automatic test equipment. Directors working on computer software earned 28 per cent more on average than their colleagues in electronics components.

- Analysis of data from the New Earnings Survey over time (1989-98) shows that wage increase levels for engineering occupations have shown a similar pattern to all occupations of initial relatively high increases in the 1989-91 period and then rapidly falling away during the early 1990s with a slight recovery from 1995. There are variations between engineering occupations with, in some years, wage level increases generally above the all occupation average, and in others below it, but with no obvious trend patterns over time.

- Comparisons over time (1989-1999) with all occupations show that median earnings of Chartered Engineers have grown at around the same rate as all occupations but median earnings for Incorporated Engineers have grown more slowly.

- The Engineering Council's most recent survey in April 1999, showed a considerable salary differential between Chartered Engineers (average salary of almost £45,000) and Incorporated Engineers (£33,000) and Engineering Technicians (£29,000). Earnings of Chartered Engineers however varied considerably by type of work with the highest median pay reported by Directors/Chairmen (£54-56,000) and the lowest by those in teaching (£32,000), maintenance repair (£32,000) and design work (£33,000). (Earnings here are basic salary plus bonuses).

- Compared to the salaries of other professional groups, salaries of Chartered Engineers are on a par with those of architects. Although salaries have been growing fast in the IT industry, average salaries of systems development people are still below that of Chartered Engineers.

- The Institution of Electrical Engineers (IEE) Salary Survey shows that nearly a quarter of their members work in the electronics, computer and telecommunications equipment industries but these are not the most highly paid (total median remuneration £35,700). Pay was highest for members in the financial services sector (£50,000) though this represented only a tiny proportion of members, and also high for those in broadcasting, telecommunications and postal services where membership is greater (£44,000). It was lowest in the electrical machinery and equipment sector (£31,000).

- Recent research on wage relativities of engineering and computer science graduates shows that both groups earn a relatively large wage premium compared to some other degree subjects (notably arts and humanities) but similar in magnitude to that for physical science, and lower than the top earning subjects of medicine and mathematics (McIntosh, Hanson and Vignoles, 2000).

- But the same research also found clear evidence that the relative wage premium for an engineering/technology degree has increased during the 1990s at an approximate rate of 1.5 per cent above the rate of inflation. As overall graduate wages have been keeping pace with inflation, and taking into consideration the reduction in supply of engineering graduates and continuing high demand (highlighted in earlier chapters), it suggests that market forces have been operating, improving the attractiveness of engineering in terms of earnings.

4.31 There are no separate data relating to pay trends for craftsmen/women which provide any evidence in support of shortages there.

Skills required

4.32 The ESS goes further than simply identifying hard-to-fill vacancies, exploring in more detail the skills which are hard to find. A number of points emerge from asking employers which skills in particular they find hard to find in different occupations. Key findings are shown in Table 4.5 and the full analysis in Table A3.7 in Appendix A3. The main points are:

- The overriding evidence of a lack of technical and other practical skills, in almost all occupations, but especially in the professional, technical, craft and operative occupations.

- A lack of advanced IT and software skills amongst technicians, and also managers and professionals. A lack of basic computer literacy amongst clerical and sales job applicants.

- The relative importance of deficiencies in communication skills, among managers, but also clerical and sales applicants; also, customer handling, numeracy and problem solving skills.

- A shortage of managerial skills amongst applicants to managerial jobs.

- Applicants to sales jobs seem to lack the widest range of skills, including those generally regarded as core to selling, for example, communication, technical and customer handling skills. Management, numeracy, problem solving and basic computer literacy were also reported to be lacking.

Table 4.5: The skills that engineering employers find it most hard to find in manager, professional, technician and craft occupations (full details for all skills that are hard to find and all occupations shown in Table A3.7)

	Managers	Professional	Technicians	Craft
Advanced IT and software skills	14	15	30	6
Other technical and practical skills	59	47	74	73
Communication skills	36	8	9	11
Team working skills	23	8	6	15
Problem solving skills	29	15	14	16
Management skills	43	13	13	6

Source: ESS, 1999

- A close association identified between the skills reported to be lacking in applicants and those reported to be increasingly needed (see Section 2.27, Skill Trends).

4.33 Other studies look at the nature of hard-to-fill vacancies in different ways. For example, the SBAC 1998 study reported that hard-to-fill vacancies were almost exclusively in the engineering area, and the most commonly mentioned were: CNC machinists, software engineers, skilled technicians and design engineers. The ESS case study report (Shackleton *et al.*, 2000) concluded that the recruitment of shop floor employees was largely not a problem, with recruitment being confined to local labour markets. The main problems were at higher-level occupations, particularly professional engineering graduates with four to five years commercial experience. There was a shortage of professional engineers with a combination of specific technical skills, commercial awareness, project management skills and other 'soft' people management skills. It also found that the labour market was very tight for particular engineering specialisms, including systems analysts and design engineers, creating high wage inflation. A small scale study of the electronics sector (covering 15 companies) identified production technicians, GSM engineers, IT engineers and design engineers as being in short supply and constraining business (Senker and Brown, 1998).

4.34 The available information on recruitment difficulties suggests both a number of common themes, but also diversity across the sector. There is a general theme of there being a lack of suitably skilled and experienced people in the labour market. Although 'generic skills' or Key Skills are reported to be lacking, there is a consistent picture across all occupations of a lack of technical and practical skills. While some studies have started to analyse in greater detail the nature of these skill needs, more information is needed from employers about what skills, of a specific technical nature and for which jobs, are really in short supply. It is in this respect that there is diversity; in the technical and practical skills needed by different occupations and in different sectors. It should be acknowledged, however, that it can be difficult for employers to define precisely what kind of technical skills are likely to be needed two or three years ahead, especially in fast moving electronics and IT areas. This is why it is important to ensure that people have a base of skills and underpinning knowledge so that they can readily retrain to meet the needs of new technological developments.

Impact of recruitment difficulties

4.35 Hard-to-fill vacancies across most occupations, not just in the most skilled and higher level occupations, cause difficulties for engineering employers in relation to various aspects of business (Table A3.9). Several important areas are identified from the ESS:

- delays in developing new products
- loss of business or orders to competitors
- difficulties in meeting customer service objectives
- increased operating costs.

Very few employers reported that hard-to-fill vacancies had no impact.

4.36 The ESS engineering case study report (Shackleton *et al.*, 2000) reported the crucial importance of product innovation for long-term survival, and these data give some support to this. Delays in developing new products were reported as a consequence of hard-to-fill vacancies in nearly all occupations by between 40 and 56 per cent of employers with such vacancies (see Table A3.9).

4.37 Recruitment problems among sales, professional and technical staff had an impact on maintaining shares of business and competition: 51 per cent of employers reported an impact here of hard-to-fill sales vacancies, as did over 40 per cent in respect of hard-to-fill craft, technician and professional level vacancies. The growing importance of meeting customer requirements is also confirmed in the ESS. Over 50 per cent of engineering employers reported an impact on meeting customer service objectives of having hard-to-fill vacancies in manager, technician, craft and operative occupations.

4.38 The ESS data also confirm that vacancies at all levels are expected to impact negatively on performance and competitiveness now and in the future. Similar themes arise as those highlighted above, though increased operating costs appear as more important. This may reflect the current preoccupations of many businesses with price competition, which is adversely affecting their business performance.

4.39 The consensus of opinion among electronics employers surveyed by Senker and Brown (1998) was that the UK remained a 'favoured location' for high technology investments. However, there was growing concern that perceived shortages of labour, in particular a decline in the output from the education system and the quality of engineers being produced, might compromise this. Multinationals might look more to investing in new plant in other countries rather than in the UK.

Skill gaps

4.40 The other aspect of skill deficiencies is the existence of skill gaps amongst those already employed by an organisation. Given the extent of change in technology, working practices and skill needs, it would be surprising if there were not some element of deficiency amongst employees. Skill gaps in some establishments might be seen as a positive indicator of dynamism and change, as skill acquisition is unable to keep up with the speed of technological, product and organisational change. However, it is usually viewed more negatively as a limiting factor on businesses.

4.41 Just over one-quarter (26 per cent) of employers in the 1999 EMTA survey reported the existence of a gap between the skills of their current workforce and those needed to meet their objectives. This was slightly lower than in 1998 (32 per cent). Again, this is perhaps a surprisingly low percentage given the evidence from other studies that skill gaps have been having a detrimental effect on the engineering sector's success and progress. Those employers reporting a skills gap were asked in which occupations these gaps were having the greatest impact on the business:

- 43 per cent reported craft occupations
- 25 per cent operators and assemblers
- 23 per cent technicians
- 15 per cent professionals
- 11 per cent managers.

Table 4.6: Extent to which employees in each occupation are fully proficient at their job (row percentages, each row is based on establishments with that particular occupation)

	All	Nearly all	Over half	Under half/ very few
Managers	65	26	7	2
Professionals	69	25	5	2
Technical and scientific	65	27	6	2
Clerical	70	23	5	2
Craft and skilled operative	57	33	9	1
Sales	66	27	6	2
Operative	52	36	10	3
Other manual	6	26	7	2

Source: ESS, 1999

4.42 Again, these data need to be interpreted in the context of employment distribution. A smaller proportion of establishments employ professionals and technicians rather than craft and lower-skilled employees, and the concentrations of employment in specific occupations vary, and therefore to some extent so does their perceived importance to an employer. It is not possible to look at this in the EMTA survey analysis. The evidence from other sources suggests that the importance given to problems at craft and operator level may be overstated in the EMTA survey and the technician and professional problems understated. However, in the engineering construction industry it is clear from the ECITB's research that the main weaknesses are seen across a range of craft areas including welding and pipefitting, and in the flexibility of skills.

4.43 The ESS approaches this issue differently, looking at the extent to which employers think that staff in each occupation are fully proficient. Generally high levels of proficiency were reported amongst all occupational groups (Table 4.6). A lower proportion of employers said that all their craft and operative employees were proficient when compared with their other workers. The SBAC survey conducted in 1997 in the aerospace sector found that 30 per cent of respondents believed that the skill levels of their employees were 'medium to low' and 25 per cent that the quality of their employees was 'medium to low' (SBAC, 1998).

4.44 It has been questioned whether managers are fully able to report the extent of skill deficiencies, in particular amongst themselves. A circular situation can arise, whereby some managers do not have the necessary skills and abilities both to take an organisation forward and to identify skill gaps amongst their workforce. Indeed, the ESS engineering case study report (Shackleton *et al.*, 2000), concludes:

'Nearly all the case studies recognised that they had skill deficiencies within their organisations but it was evident that certain of the case studies found it difficult to articulate the extent of these gaps and the reasons why these skill gaps had arisen. … The fact that very few of the case studies identified that they were experiencing management skill gaps is perhaps indicative of the fact that these crucial skill areas may well remain unnoticed at the establishment level.'

4.45 When seeking evidence of specific skill shortages, the EMTA surveys illustrate the importance of shortages in technical and engineering skills. Deficiencies in technical and practical skills were most commonly reported in all engineering sub-sectors, which suggests a wide range of specific needs (see Table 4.7). Very few studies have really addressed these sector specific needs. The 1999 survey did explore technical deficiencies in greater detail. The most commonly reported skill gaps were CNC machine operations; mechanical engineering and CAD/CAM/CAE.

4.46 The ESS asked those respondents who did ***not*** report all or nearly all of their employees as being fully proficient a series of questions to explore the nature and impact of this lack of proficiency (but, as Table 4.6 shows, the proportion of engineering employers who were asked this question was very small). Nevertheless, some interesting points emerge relating to where there was a lack of proficiency overall (though it is not possible to undertake a sectoral breakdown, as in Table 4.7, with these ESS data):

Table 4.7: Areas of skill deficiency in existing workforce reported by engineering employers, analysed by sector (numbers in brackets are percentages of establishments reporting skill gaps)

Metal products	1. Practical skills (68) 2. Multi-skilled employees (41) 3. Skilled craftspeople (40) 4. Computer literacy (30) 5. Communication skills (24) 6. Personal skills (23)	***Electrical engineering***	1. Practical skills (55) 2. Computer literacy (42) 3. Communication skills (39) 4. Management skills (35) 5. Personal skills (32) 6. Skilled craftspeople (29)
Mechanical engineering	1. Practical skills (63) 2. Computer literacy (41) 3. Communication skills (34) 4. Management skills (29) 5. Skilled craftspeople (26) 6=. Personal skills (25) 6=. Problem-solving skills (25)	***Motor vehicles***	1. Practical skills (67) 2. Multi-skilled employees (44) 3. Problem-solving skills (42) 4=. Communication skills (41) 4=. Computer literacy 4=. Personal skills (41)
Electronics	1. Practical skills (53) 2. Computer literacy (39) 3. Communication skills (34) 4. Management skills (33) 5. Personal skills (32) 6. Problem-solving skills (27)	***Aerospace***	1. Practical skills (54) 2=. Computer literacy (38) 2=. Problem-solving skills (38) 4. Skilled craftspeople (35) 5. Management skills (32) 6. Communication skills (29)

Source: Mason, 1999a derived from EMTA (1998, Table 6.4)

- ***A failure to train and develop staff:*** reported most frequently, and across nearly all occupations. In particular it was reported as the most important cause of a lack of proficiency amongst managers, professionals, technical and scientific staff, sales, operative and other manual employees.

- ***The introduction of new products or services, new working practices and new technologies:*** the next three commonly reported causes. These were generally important reasons for a lack of proficiency across all occupations but were slightly less important amongst sales and other manual employees. The introduction of new technology was the most important reason amongst clerical employees.

- ***Recruitment problems, poor labour retention, inability of workforce to keep up with change, and inability of older staff to acquire necessary knowledge and skills:*** these factors were reported by between one-fifth and one-third of employers in each occupation.

4.47 The types of skill deficiencies amongst existing employees were on the whole similar to those found in relation to hard-to-fill vacancies. However, technical and practical skills were reported to be lacking amongst specific occupations, rather than across the board. They were most likely to be lacking amongst professional, technical, craft and operative staff; those most closely involved in the design, innovation and production processes. Also, employees across all occupations were reported to be lacking a range of generic skills. For example:

- Between one-third and half of employers thought that employees in each occupation lacked problem solving skills.
- Sixty per cent reported a lack of proficiency in management skills amongst managers. Between one-fifth and one-third reported a lack of management skills in other occupations.
- Communication skills were thought to be lacking by 61 per cent amongst managers, 50 per cent amongst sales employees and between one-third and 47 per cent in all other occupations.
- One-quarter reported a lack of literacy skills amongst operatives and one-fifth amongst other manual employees.

These internal skill deficiencies again include many of the skills which are reported to be increasingly important amongst engineering employers.

4.48 Case studies and qualitative studies have explored these issues in greater depth, and similar themes emerge though rather more emphasis is generally put on the non-technical skill deficiencies than it is in the survey data. The ESS case study research (Shackleton *et al.*, 2000) identified skill gaps relating mainly to intermediate/technician occupations, team leaders, management and professional occupations. At the intermediate/technician level, these 'team leader' skills included motivational skills, communication skills, an ability to forward think and to think strategically. At the professional and managerial level, the skills gaps were associated with people who did not have the required combination of technical and non-technical skills. In the non-technical skills area, skills identified were project management and people management skills and possessing a rounded level of commercial awareness. More serious, possible emergent, skill gaps were seen as being senior management's ability to drive the business forward and transform business systems (eg manufacturing processes) for competitive advantage. Themes emerging from other studies include:

- improve communication skills, and develop leadership skills and change management skills in the aerospace sector (SBAC, 2000); and
- project management, and a lack of leadership particularly, at high levels in head office companies in the engineering construction industry. This includes the inability of senior managers to recognise skill needs, weaknesses in generic management, and a failure to develop older engineers to get the best out of the available new technology (ECITB, 2000).

4.49 As in the recruitment problem area, there is relatively little detailed information on the precise gaps in 'technical and practical skills'. What evidence there is suggests that these vary by occupation, sector and individual employer. Interviews conducted for the West Midlands Automotive Skills Taskforce do provide more detailed information on the nature of technical skills needed, although these relate only to one sub-sector. These included: assembly techniques; ergonomics; robotics; diagnosis; maintenance and repair; spot welding; process and production management.

Impact of skill gaps

4.50 The impact of skill gaps can be difficult to identify, and may not emerge for some time. It can be relatively straightforward to identify deficiencies at production level, due to deadlines not being met, high levels of wastage etc. but other deficiencies are less easy to identify. Their impact might not be obvious until a company flounders, or loses market position. Furthermore, given the many pressures experienced by the industry, identifying the contribution of skill deficiencies is complex.

4.51 As with the impact of hard-to-fill vacancies, there were some differences between the impact of internal skill deficiencies between occupations in the ESS. When engineering employers were asked about how a lack of proficiency in each occupation was affecting the establishment, some themes emerged:

- Skill deficiencies were most commonly causing difficulties in meeting customer service objectives, and this was caused by deficiencies in all occupations.
- Increased operating costs and delays in developing new services were the next most commonly reported impacts. Deficiencies amongst operatives were most frequently reported to be leading to increased operating costs.
- A loss of business or orders to competitors was being caused by between one-fifth and one-quarter of employers with deficiencies in most occupations. However, 38 per cent with deficiencies in managers and 57 per cent in sales employees reported this negative effect.
- Difficulties in meeting quality standards were reported by between one-quarter and one-third of employers experiencing deficiencies in each occupation.

4.52 Table 4.8 illustrates the possible future impact of skill deficiencies. These data suggest a lesser impact than current deficiencies. However, the question was asked in a different way, and employers might rationalise their response. Over four-fifths reported that none of the possible impacts would occur as a result of skill deficiencies. Nevertheless, the data in Table 4.8 do suggest a range of negative impacts on the performance of more than half of engineering employers over the next few years. The anticipated impact of skill deficiencies is slightly greater in engineering compared to all sectors in the economy.

Table 4.8: Impact of skill deficiencies over the next two or three years

	Engineering (%)	*All employers (%)*
Increased operating costs	33	26
Difficulties meeting customer service objectives	32	29
Loss of business or orders to competition	28	22
Delays developing new products or services	27	19
Difficulties introducing technological change	22	16
Difficulties meeting required quality standards	20	22
Difficulties meeting new working practices	20	18
Withdrawing from offering certain products or services altogether	14	11
None of the above	43	49
Weighted base	30,545	533,572

Source: ESS, 1999

Looking to the future

4.53 Much of the data on recruitment difficulties and skill deficiencies groups 'technical and practical skills' into one category. The 1999 EMTA study does begin to unpack this, however, the number of respondents becomes very low when this is done. It is identifying the precise technical and practical skills which will be needed in the future, especially if, or as, different sub-sectors grow and decline. What is also clear from the data reviewed is that the range of generic skills, identified to be of growing importance in Chapter 2, will remain important.

Table 4.9: New or additional skills needed to move to higher quality product

	Engineering (%)
Technical and practical skills (non-IT)	71
Team working skills	64
Management skills	56
Problem-solving	54
Customer handling	54
Communication skills	50
Basic computer literacy	43
Advanced IT or software skills	36
Numeracy skills	34
Literacy skills	33
Other	3
Weighted base	22,013

Source: ESS, 1999

4.54 The ESS asked employers if they were about to implement new higher quality product areas or improve the quality of their existing operations. Just over one-quarter of engineering employers reported plans to move to higher quality product areas. The implications of moving to higher quality product areas is that different skills will be needed, and respondents were asked which new or additional skills would be required to do this (Table 4.9).

4.55 Once again, the overriding importance of technical and practical skill emerges, although we are unable to unpack the precise nature of these. However, Table 4.9 also illustrates wide ranging requirements for additional or new skills and reflects a number of themes identified earlier in this report. In particular, additional or new teamworking, managerial, problem-solving, customer handling and communication skills will be required to enable employers to improve quality.

4.56 Those with no plans to introduce higher quality product areas were asked if they had plans to achieve greater efficiency within their existing products. Table 4.10 reports the skills needed to achieve this greater efficiency. The pattern of need is very similar to that illustrated in Table 4.9. However, technical and practical skills emerge as even more important in increasing efficiency, while new or additional generic and management skills are slightly less likely to be required.

Table 4.10: New or additional skills needed to achieve higher efficiency

	%
Technical and practical skills (non-IT)	80
Team working skills	53
Problem solving	49
Customer handling	42
Management skills	40
Communication skills	36
Basic computer literacy	33
Numeracy skills	28
Literacy skills	25
Advanced IT or software skills	25
Foreign language skills	10
Other	5
Weighted base	29,065

Source: ESS, 1999

Appendix 1: Contributing Organisations

The following organisations contributed to the Dialogue Process in various ways: through providing specific labour market information, making available copies of reports, giving their views on issues, participating in the seminar and commenting on the draft report. The authors of this report are grateful for their valuable help and assistance in the project.

Advantage West Midlands

British Aerospace

Birmingham & Solihull TEC

Bolton Training Group

Business Link Birmingham

BMW Group

Brunel Training Group

Cambridge Econometrics

CSEU

Coventry and Warwickshire Chamber of Commerce

DTI

EdExcel

East Midlands Development Agency

Engineering Council

Engineering Employers Federation (EEF)

Engineering Construction Industry Training Board (ECITB)

EMTA

EPSRC

FEFC

Federation of Electronics Industries (FEI)

Frederick Wooley Ltd

Havering College

HESA

IMI

Institute for Employment Research, University of Warwick

Institute of Mechanical Engineers

ITNTO

Marconi Naval Systems

METCOM

National Federation of Engineering Colleges (NFEC)

North West Development Agency

nto tele.com

NTO National Council

One North East

PINTOG/Chemical Manufacturing and Processing

Rail Industry Training Council (RITC)

Rolls Royce Aerospace Group

South West RDA

Royal Academy of Engineering

Science, Engineering Maths and Technology Training Network

Skillset

Skills Unit, Department for Education and Employment

Society of Motor Manufacturers and Traders

ST Microelectronics Ltd

West Midlands Automotive Skills Taskforce

Wolverhampton Chamber & Business Link

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Appendix 3: Additional Tables

Table A3.1: Distribution of the main groups of engineering occupations in different industries, September 1999

SIC code	Sector	Professional level Engineers and technologists (SOC 211-213, 215-219)*	Engineering technicians and electrical / electronic technicians (SOC 301 and 302)	Machine setters, toolmakers, fitters, etc. (SOC 51, 520, 522)	Machine operatives and assemblers (SOC 84 and 85)
27-35	*Engineering manufacturing*	159,700	30,400	304,600	283,000
15-26,36	*Other manufacturing*	40,000	7,400	78,700	54,300
10-14	*Extraction industries (coal, gas, oil, etc.)*	4,300	2,100	6,300	400
40,41	*Utilities (electricity, gas, water)*	10,600	2,300	8,100	0
45	*Construction*	20,200	10,200	24,700	3,100
64	*Post. Telecomms*	13,900	3,300	1,600	500
60-63	*Transport*	14,100	800	7,400	0
65-67	*Financial services*	1,400	500	0	400
72-74	*Computer and business services*	69,000	3,900	19,600	3,500
75	*Public admin, defence*	11,500	5,900	7,200	0
80,85	*Education, health*	8,200	4,100	3,700	500
01-05, 50-55, 90-99	*The rest*	15,500	9,900	58,400	13,000
All		***368,400***	***80,800***	***520,300***	***358,700***

* Software, systems and computer engineers (SOC 214) are usually classified as IT occupations and have been excluded as they will be discussed in the ITCE Dialogue. Similarly SOC 210 (civil and structural engineers) is excluded because it is in the construction sector Dialogue

Source: Labour Force Survey, 1999

Table A3.2: Percentage of establishments in different sectors analysed, by size of establishment

Sector	5-24	25-49	50-249	250-499	500+
Basic metal manufacture	54	21	23	2	1
Metal products	73	15	10	1	0.1
Mechanical equipment	65	17	15	2	1
Electronics	63	15	18	3	1
Electrical equipment	59	18	18	3	1
Motor vehicles	61	14	17	4	4
Aerospace	46	15	23	7	9
Other transport equipment	71	11	14	2	2
All sectors	**67**	**16**	**14**	**2**	**1**

Source: AES 95 (in EMTA, 1998)

Table A3.3: Percentage of establishments in different sectors analysed, by region

Sector	NE	NW	Y/H	EM	WM	SW	East	L'dn	SE	Wales	Scotland
Basic metal manufacture	2	10	13	8	32	5	7	4	7	6	7
Metal products	4	12	11	9	22	7	9	6	10	4	6
Mechanical equipment	4	12	12	10	1	8	10	6	12	3	7
Electronics	3	10	7	7	9	8	15	10	21	5	6
Electrical equipment	4	12	8	7	13	9	12	8	17	5	5
Motor vehicles	4	13	10	11	19	8	10	5	1	5	5
Aerospace	2	15	3	2	9	14	19	4	25	1	6
Other transport equipment	2	7	7	10	11	15	11	4	17	5	13
All sectors	**4**	**12**	**10**	**9**	**18**	**8**	**10**	**7**	**13**	**4**	**6**

Source: AES 95 (in EMTA, 1998)
Footnote: percentages do not all add to 100, due to rounding

Table A3.4: Engineering employment trends in each English region (thousands)

Years	London	SE	East	SW	WM	EM	Y+H	NW	M'side	NE
1971	389.6	411.5	279.7	201.3	578.6	219.4	240.4	307.6	100.9	165.4
1981	251.7	357.7	258.4	200.0	424.2	197.0	190.3	238.4	61.9	140.7
1991	117.5	250.6	194.3	160.9	322.2	146.8	150.9	185.8	40.7	83.2
1995	88.1	225.5	169.4	151.9	303.6	141.2	139.2	167.1	31.2	75.6
1998	85.4	237.9	178.8	166.4	305.4	149.9	147.6	167.6	31.0	83.3
2004	66.3	208.8	154.3	157.7	263.4	127.9	133.3	142.2	32.3	72.5
2010	55.0	193.4	139.1	154.2	246.0	119.3	129.8	127.8	34.6	70.9

Source: IER Projections, 2000

Table A3.5: Engineering employment trends in UK countries

Years	Wales	Scotland	N Ireland	England
1971	125.7	265.4	49.2	2894.4
1981	104.5	197.1	40.0	2320.3
1991	86.1	149.8	32.6	1652.9
1995	91.0	140.3	33.4	1492.8
1998	94.5	140.8	35.6	1553.2
2004	85.1	120.6	33.9	1358.7
2010	79.0	108.3	31.8	1270.3

Source: IER Projections, 2000

Table A3.6: Distribution of vacancies by occupation

Occupation	Employers with vacancies in each occupation, as a percentage of those employing each occupation	Weighted base (ie number of employers employing each occupation)
Managers and administrative	3	30,134
Professional	5	15,166
Technical and scientific	6	11,421
Clerical and secretarial	4	22,991
Craft and skilled operative	12	20,610
Personal service	1	1,467
Sales	6	9,451
Operative and assembly	14	13,871
Other manual	3	9,321

Source: ESS, 1999

Table A3.7: The skills that employers find it hard to find in different occupations

	Managers	Professional	Technicians	Clerical	Craft	Sales	Operative	Other manual
Basic computer literacy	3	4	11	25	4	21	6	-
Advanced IT and software skills	14	15	30	8	6	3	5	-
Other technical and practical skills	59	47	74	29	73	43	62	49
Communication skills	36	8	9	28	11	34	12	-
Customer handling skills	16	10	9	14	4	23	1	-
Team working skills	23	8	6	5	15	17	14	-
Foreign language skills	14	4	3	1	2	15	-	-
Problem solving skills	29	15	14	6	16	16	14	-
Management skills	43	13	13	2	6	23	8	-
Numeracy skills	11	2	8	16	9	12	11	8
Literacy skills	11	-	2	9	10	3	6	8
Other	3	4	8	10	15	12	13	1
No specific skills	2	10	2	4	3	1	4	7
Don't know	18	22	14	23	9	8	18	39
Weighted base	408	481	409	369	1,913	350	1,368	149

Source: ESS, 1999

Table A3.8: Causes identified by employers of hard-to-fill vacancies by occupation

	Managers	Professional	Technicians	Clerical	Craft	Sales	Operative	Other manual
Too much competition from other employers	9	6	14	6	13	10	15	3
Not enough people interested in this type of job	19	7	7	11	26	13	34	48
Company does not pay enough	6	6	9	16	11	12	13	9
Low number of people with required skills	42	56	45	38	50	42	40	26
Low number of applicants with required attitude, motivation or personality	18	8	8	17	14	23	20	11
Low number of applicants generally	28	26	23	24	27	18	31	27
Lack of work experience	33	21	30	7	25	40	23	12
Lack of qualifications	6	13	9	2	13	13	6	-
Company location	3	4	4	5	<1	2	3	13
Irregular/anti-social hours	14	14	11	3	6	4	7	-
Unattractive conditions of work	6	1	5	7	1	1	3	-
Other	-	-	-	-	2	-	-	-
Don't know	-	10	9	14	5	9	3	14
Weighted base	408	481	409	369	1,913	350	1,368	149

Source: ESS, 1999

Table A3.9: Impact of recruitment difficulties in different occupations

	Managers	Professional	Technicians	Clerical	Craft	Sales	Operative	Other manual
Loss of business or orders to competitors	24	40	43	11	43	51	33	45
Delays in new product developing	42	56	56	20	46	42	45	40
Withdrawal from certain markets	2	23	11	4	19	12	16	38
Difficulties in meeting customer service objectives	51	42	56	25	60	37	63	38
Difficulties meeting required quality standards	30	25	22	16	24	10	21	10
Increased operating costs	33	37	35	35	53	32	55	55
Difficulties introducing technological change	28	27	33	20	26	20	21	33
Difficulties introducing new working practices	35	18	19	17	23	13	22	44
None of these	2	1	2	-	1	-	<1	-
Don't know	10	9	12	49	9	15	11	34
Weighted base	**408**	**481**	**409**	**369**	**1,913**	**804**	**1,368**	**149**

Source: ESS, 1999