Engineering

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THE INSPECTORATE
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THE
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EDUCATION
FUNDING
COUNCIL

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THE FURTHER EDUCATION FUNDING COUNCIL

The Further Education Funding Council (FEFC) has a legal duty to make sure further education in England is properly assessed. The FEFC's inspectorate inspects and reports on each college of further education according to a four-year cycle. It also inspects other further education provision funded by the FEFC. In fulfilling its work programme the inspectorate assesses and reports nationally on the curriculum, disseminates good practice and advises the FEFC's quality assessment committee.

College inspections are carried out in accordance with the framework and guidelines described in Council Circulars 97/12, 97/13 and 97/22. Inspections seek to validate the data and judgements provided by colleges in self-assessment reports. They involve full-time inspectors and registered part-time inspectors who have knowledge of, and experience in, the work they inspect. A member of the Council's audit service works with inspectors in assessing aspects of governance and management. All colleges are invited to nominate a senior member of their staff to participate in the inspection as a team member.

Cheylesmore House
Quinton Road
Coventry CV1 2WT
Telephone 024 7686 3000
Fax 024 7686 3100
Website www.fefc.ac.uk

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Summary

This survey reviews the quality of provision delivered by engineering departments in further education colleges. It is the second survey of engineering provision undertaken by the Further Education Funding Council (FEFC) inspectorate, the first being undertaken in 1994-95. This recent survey was based on 85 inspections of engineering carried out in further education colleges between September 1997 and August 1999 and on the results of a questionnaire completed by inspectors who visited a further 49 colleges. This survey report reviews progress on some of the key points identified in the first survey and comments on current issues relevant to the provision of engineering courses in further education colleges.

Engineering departments in further education colleges are key providers of training for engineering employees and for full-time students wishing to pursue engineering careers. Generally, departments are responsive to the needs of the engineering industry and individual students, and to public sector initiatives. Engineering departments support the specialised needs of employers by providing a range of standard and purpose-designed programmes to promote continuation training and skills updating for employees. They are also making a positive contribution to initiatives to encourage participation by students who might not normally benefit from further education, exemplified in the collaborative partnerships formed with engineering employers and the provision of a range of level 1 courses.

The proportion of grade ones and twos awarded for engineering provision between September 1997 and June 1999 has been significantly less than the overall average for all programme areas. Poor levels of achievement have been the main reason for this lower percentage. The proportion of grade 1s and 2s fell significantly in 1998-99 but the decline should be seen in the context of the more reliable and detailed information on students' achievements now available in FEFC statistics. Inspectors agreed with the self-assessment grade for engineering in 69% of the inspections of engineering. The grade given by inspectors was one grade lower than the self-assessment grade in 20% of inspections and one grade higher than the self-assessment grade in 11% of inspections. Many self-assessment reports pay insufficient attention to students' achievements and retention rates.

The quality of teaching in engineering is comparable with that in other programme areas. Teaching and learning is at least satisfactory, especially in practical workshops, but classroom teaching is often dull and uninspiring. Practical work, especially that on national vocational qualification (NVQ) courses, is generally well organised and, increasingly, students are able to take some responsibility for their own progress. The logging of evidence of the achievement of competences needs strengthening if students are to achieve their target qualification in the expected time. Most craft students in engineering departments are developing a suitable balance of practical skills and underpinning knowledge.

The overall retention rate on engineering courses has improved slightly since the first survey and is now just below the overall retention rate for all FEFC programme areas. However, the picture in many departments is still mixed and most have poor retention rates on at least some of their courses. Engineering departments have been actively involved in many of the recent initiatives to improve student retention but it is too early to say how successful they may be. The overall pass rates in engineering remain low. The pass rates for 16 to 18 year old engineering students on level 1 and level 2 courses are particularly poor. Some engineering departments have recognised this and have recently implemented a range of initiatives, including changes to the curriculum.

The mathematical ability of many engineering students continues to be a weakness. Students often lack confidence in the manipulation of equations and formulae. The number and range of examples provided for students are not always sufficient to develop their mathematical competence. Mathematical principles need to be linked more often to engineering applications to promote the relevance and understanding of mathematics. Numeracy, literacy, and information technology (IT) are key skills which all engineering departments develop, but not always systematically. The further application of computers to aid engineering processes is usually well taught. Few engineering departments have extended the development of key skills to cover problem-solving, working with others, and improving own learning and performance, as requested by industry.

The quality of engineering accommodation continues to improve. Many departments have increased space utilisation. Some have modern purpose-built engineering accommodation but in most colleges there are some areas which present a poor image and which are not representative of modern industrial practice. Engineering equipment varies in quality. The best and most modern equipment is usually associated with computer-aided engineering activities and the teaching of electronics through computer-aided learning systems. Much equipment is of satisfactory quality but is becoming increasingly dated. The resource most in need of investment continues to be general workshop machinery.

The level of administration in engineering departments has increased significantly as a result of the increase in competence-based courses and the growth of awarding and standard-setting bodies. Reductions in the proportion of full-time teachers have increased the administrative load for the remaining full-time teachers.

Engineering

Introduction

1 This is a report on the second survey of the quality of engineering provision funded by the Further Education Funding Council (FEFC). Engineering falls within the FEFC's programme area 4 and the term 'engineering' embraces all aspects of electrical and electronic engineering, manufacturing and motor vehicle engineering as well as specialisms such as marine and aeronautical engineering. A small element of engineering falls within other programme areas such as construction and science. The report comments on some of the changes found since the report on the first survey, published in April 1996, quoting from the conclusions of the first survey, where appropriate. The report also discusses other more recent issues relating to the delivery of the curriculum and students' achievements.

2 This second survey draws on the findings of recent inspections of engineering and on a special exercise involving a questionnaire and visits to selected colleges. Inspectors carried out 85 inspections of engineering in further education colleges between September 1997 and August 1999 as part of the second quadrennial cycle of inspections. Engineering departments are now required to produce a self-assessment report on the quality of their provision and during inspections, inspectors start with the self-assessment and not only assess the quality of provision but also comment on the extent to which they support the findings of the self-assessment report. The grades awarded by the inspectors are published in college inspection reports alongside comments on the self-assessment. During the 1998-99 academic year, a further 49 colleges completed a detailed survey questionnaire relating to a number of key aspects of provision in engineering departments. Inspectors made follow up visits to each of these colleges. Numerical data quoted in this report draw on information from the completed questionnaires and data provided by colleges through the individualised student record (ISR). The ISR were not available at the time of the first survey.

Engineering in the United Kingdom and the Skills Required by the Industr y

3 The United Kingdom engineering industry operates worldwide in high technology markets which include aerospace, automotive components, electronics, transport equipment, general machinery and equipment, process industries and utilities. Half of all the United Kingdom's fixed investment expenditure of £50 billion is in engineering products and engineering companies employ over 1.7 million people. Engineering output is worth approximately £160 billion, which is around 8% of the total United Kingdom gross domestic product. Over 60% of the output is exported, of which about two-thirds goes to the European mainland. Exports are worth more than £72 billion, and make up more than one-third of the United Kingdom total.

4 Predicted employment trends in engineering, 1997 to 2007, are shown in table 1. The number employed in 'engineering craft and skilled trades' is expected to fall. Owing to natural wastage, however, there will be a requirement to train people new to the industry, and as shown in the table, the demand for 'new entrant' training will far outweigh the fall in employment. A similar pattern is predicted for 'industrial plant and machine operatives'. In total, there will be a need to train approximately 350,000 new craft and operative entrants each year. Employment in the 'science and engineering associate professional and technical occupations' is expected to increase and training will be required for approximately 80,000 new entrants each year.

Table 1. Expected employment trends in engineering, 1997 to 2007

	Employment (000s)		Annual loss/gain (000s)	New entrant training including annual loss/gain (000s)
	1997	2007		
Engineering craft and skilled trades	935	790	-14.5	90
Industrial plant and machine operatives	2,003	1,861	-14.2	350
Total	2,935	2,651	-28.7	440
Science and engineering associate professional and technical occupations	675	750	7.5	80

Source: Labour Market and Skills Trends 1998/1999, DfEE

5 A profile of the qualifications held by engineering employees is presented in table 2. It shows that 81% of engineering employees possess at least a level 2 qualification and that most hold a level 3 qualification.

Table 2. Profile of qualifications held by engineering employees

NVQ level	Workers with qualifications (%)
No qualification	8
NVQ level 1 or equivalent	11
NVQ level 2 or equivalent	29
NVQ level 3 or above or equivalent	52

Source: Labour Market and Skills Trends 1996/1997, DfEE

6 In 1998, the Engineering and Marine Training Authority (EMTA) carried out a substantial labour market survey of the engineering industry in Britain. Some of the findings relating to skills and recruitment needs were that:

- 49% of the employers who had recruited over the previous 12 months had experienced difficulty in filling vacancies. Craft and operative vacancies were reported as being the most hard to fill; these included jobs for welders, machine setters, skilled sheet metal workers, machine tool operators, computer numerical control (CNC) operators and electricians. Other occupations where jobs were hard to fill included technician engineers
- 53% of engineering companies felt that the skills required of the average employee were increasing. This figure increased to 61% for establishments of 250 or more employers. In the motor vehicle sector, 91% of those surveyed felt that the skills required of the average employee were increasing.

7 Engineering employers were asked to identify their use of modern technologies. Their responses, summarised in table 3, show that large companies make a substantial use of modern technologies, whilst a significant number of small companies make no use of them.

Table 3. Percentage of companies using modern technologies, 1998

Area of technology	Companies using modern technologies (%)		
	250+ employees	<50 employees	All companies
Computer numerical control	82	42	46
Computer-aided design	90	36	43
Computer-aided manufacture	65	21	25
Computer-aided engineering	-	14	18
Materials requirement planning	70	16	22
Manufacturing resource planning	62	9	15
Statistical process control	67	11	16
Assembly line/production robotics	45	5	9
None of the identified technologies	2	39	34

Source: Labour Market Survey of the Engineering Industry in Britain, EMTA, 1998

8 The EMTA survey further identified that 33% of engineering companies believe that a gap now exists between the skills of the average employee and the skills required to meet their business needs. Literacy and numeracy skills are the major issues identified by motor vehicle companies. Table 4 further shows that the percentage of large companies reporting a skills gap is well above the percentage for all companies.

Table 4. Gaps in skills reported by companies, 1998

Nature of shortfall	Companies reporting a skills gap (%)	
	Large employers	**All employers**
Management skills	56	25
Communication skills	50	29
Computer literacy	53	35
Problem-solving skills	40	23
Team working	38	18
Conducting skills audit	28	9
Multi-skilled employees	43	21
Business planning/business development	24	10

Source: Labour Market Survey of the Engineering Industry in Britain, EMTA, 1998

9 In summary, the figures presented in tables 1 to 4 show that:

- there is a substantial demand for initial training
- there is a requirement for the updating and improvement of skills to meet the ever-changing demands of industrial practices
- the development of craft skills is still an important area of training
- broad vocational skills are required to meet the need for increased flexibility within occupational areas.

As part of the survey, this report will address how well these requirements are being met by departments of engineering in further education colleges.

Public Sector Initiatives

10 Recent public sector initiatives affecting the work of further education engineering departments include **widening participation** and **inclusive learning** initiatives funded through the FEFC, the **New Deal** funded through the employment service, and the **modern apprenticeship and national traineeship** schemes funded through the training and enterprise councils. The widening participation initiative aims to broaden the range of people who might benefit from further education. Specific engineering courses aimed at those who would not normally enter further education are usually at level 1 or below and provide employment opportunities in semi-skilled areas of work. Trainees on New Deal,

modern apprenticeships, and national traineeships normally undertake courses at levels 2 or 3 and these are intended to lead to employment opportunities in skilled and technician areas of work.

Engineering Provision in Further Education Colleges

11 In 1997-98, 365 of the 423 colleges in the further education sector had courses in engineering and technology compared with 347 of the 456 colleges in existence at the time of the first survey. The figures do not indicate an expansion of engineering provision, however. The reason for the increase in the number of colleges offering engineering is that many colleges, especially sixth form colleges, are offering courses which are identified for funding purposes as being in programme area 4 but which do not constitute a major engineering provision. One hundred colleges now have fewer than 100 students on engineering courses compared with 70 at the time of the first survey. The number of colleges with a substantial engineering provision, involving over 1,000 students, has also fallen from 123 at the time of the first survey to 72 in 1997-98. There were also approximately 500 engineering students in agricultural colleges in 1997-98.

12 Most colleges with a substantial engineering provision offer a wide range of craft and technician courses in mechanical/manufacturing engineering, electrical/electronic engineering, motor vehicle engineering, and fabrication and welding. Engineering departments generally offer computer-aided engineering courses including computer-aided drawing and machine tool programming. Short courses are offered in subjects such as hydraulics, pneumatics, logic controllers, and health and safety regulations. Few colleges have courses in other modern manufacturing technologies such as materials requirement planning, manufacturing resource planning, or statistical process control. Some colleges offer particular specialisms such as aircraft engineering, nautical engineering, and foundry work which are dependant on close links between the college and the specialist industry.

13 A significant change since the first survey has been the collaborative arrangements that colleges have established with partner organisations to provide courses away from the main college sites. In engineering, the chief partners have been industrial companies and training organisations and the work has focused mainly on national vocational qualifications (NVQs), enabling existing employees to have their work place skills assessed and accredited for a nationally recognised qualification. A significant amount of the work has been with semi-skilled workers including those who might not normally have benefited from further education. Many, as a result, have gained a level 1 or level 2 qualification. An advantage for companies is that workers are being trained to a common standard and can understand some of the wider aspects of their work. Improving the vocational qualifications of semi-skilled personnel has been an important element of the policy of companies aiming for a fully qualified work force as part of their quality improvement strategy. Often, long-serving skilled employees have also had the opportunity to obtain level 3 qualifications in recognition of the skills developed since their initial training.

Engineering Enrolments in Further Education Colleges

14 The first survey noted that:

> *recruitment to engineering courses in further education has declined steadily over the last five years: growth in the number of full-time students has been exceeded by the reduction in part-time enrolments. Both are planned to increase by about 20% in the next three years.*

15 Table 5 compares engineering enrolments for the academic year 1994-95 with those for 1997-98. It shows that there has been a 35% growth in enrolments since the first survey, much greater than the anticipated 20%. Part-time enrolments have increased markedly.

Table 5. Engineering enrolment data for the academic years 1994-95 and 1997-98

	1994-95 enrolments	1997-98 enrolments	Increase/decrease (%)
All engineering students	230,100	310,500	+35%
Full-time students	57,900	57,000	-1.5%
Part-time students	172,200	253,000	+47%

Source: FEFC strategic planning data for FEFC-funded provision in further education colleges, external institutions, and higher education institutions, and for non-FEFC funded provision in further education colleges

16 The student number data for 1998-99 compared with the 1997-98 data show:

- a 6% decline in full-time student numbers
- a 10% decline in part-time student numbers
- a 9% overall decline in student numbers.

This significant decline in student numbers in the engineering programme area does not imply a major decline in provision. During the 1998-99 year a number of qualifications were reclassified from engineering to other programme areas leading to the transfer of over 8,000 enrolments to other programme areas.

17 Some 20% of engineering students are funded by sources other than the FEFC compared with 17% of students in all programme areas. Table 6 compares data on the student population in engineering with all other FEFC programme areas. More engineering students are male than the average for all FEFC programme areas. The percentages of students aged 16 to 24 and 25 to 59 are in line with the averages for all areas. The percentage of engineering students from minority ethnic groups is below the average for all programme areas.

Table 6. Engineering student population compared with that for all FEFC programme areas

	Engineering (%)	All FEFC programme areas (%)
Male students	89	46
Students from minority ethnic groups	18	23
Students aged 16 to 24	46	44
Students aged 25 to 59	52	53

Source: ISR database, 1997-98

18 In 1997-98, students were studying for a total of 376,279 qualifications. The number of qualifications exceeded the number of enrolments because some students were studying for more than one qualification. The qualifications attracting the greatest numbers were in mechanical, aeronautical and general engineering at levels 2 and 3, in marine technology and transport at level 1, and in manufacturing at level 2. Table 7 shows the percentages of students studying at different levels.

Table 7. Engineering qualifications studied in England by level of study, 1997-98

NVQ level	Students (%)
Level 1 or equivalent	23
Level 2 or equivalent	33
Level 3 or equivalent	19
Level 4, 5 and higher education	6
Unknown	19

Source: ISR database, 1997-98

19 The first survey of engineering noted that:

> *the planned expansion is mainly in provision for students with few qualifications; lower levels of achievement on entry are already being accepted.*

The current survey shows that most engineering departments plan at least to maintain current enrolment levels. Many are aiming for planned growth, with a particular emphasis on level 1, as identified in the first survey, and at level 4. Growth can be achieved either by increasing the number of students studying for a qualification, and/or by increasing the number of qualifications for which each student is enrolled. For example, in addition to their main course, students following either practical or academic courses might also study computer-aided engineering qualifications, and students following academic courses might also study practical skill-based qualifications. Enrolments on part-time courses often depend on apprentice recruitment patterns in local companies. These patterns may vary from year to year, and within the year, thus making planning difficult.

20 Full-time level 1 courses in motor vehicle valeting and basic servicing are a current growth area. These courses are popular and successfully recruit a broad range of students including those who would not normally have benefited from further education. The courses provide students with relatively short-term goals, with a reasonable expectation of success, and with possible opportunities for progression to level 2 and level 3 courses and qualifications. The growth in level 4 courses is aimed at providing technician and degree qualifications for day-release students from local industries. The courses develop a student's academic capabilities and update their knowledge, especially knowledge of computer-aided engineering applications.

Recruitment and Entry

21 Most engineering departments market themselves by promoting a career in engineering and advertising the courses they offer. Almost all colleges offer some form of introduction to engineering activities. Often, half-day or day-long 'taster sessions' held at the college or school enable potential students to engage in some form of practical activity; for example, activities related to a particular theme such as 'Robot Wars' or the use of computer-controlled machinery leading to the manufacture of a small item. In some instances, the close links with local schools result in joint curriculum work and/or the school's use of the college's engineering resources. However, most local schools do not permit visits from college staff to develop pupils' interest in engineering or to provide information on engineering courses. Other activities designed to promote engineering include departmental open evenings, events for young females organised under the heading of Women into Science and Engineering, and engineering teachers' support for Neighbourhood Engineer activities.

One college offers an institution-wide initiative for primary schools and secondary schools in its region. 'Primary College' provides a week-long programme of practical activities involving 1,200 primary school pupils. In engineering, there are sessions in electronics, motor vehicle and mechanical practice which are very well received by the pupils. 'Secondary College' provides three-day programmes for year 11 pupils in subject areas in which they feel they may wish to pursue a career. Engineering sessions are well attended and students who have been involved in this programme are now starting to register on college courses.

A manufacturer of computer-aided machinery has promoted a scheme for providing a video link between the college and local schools. Machinery is installed in the college and pupils in the schools can observe it operating through the video link. Pupils can sometimes watch the computer-aided manufacture of components which they themselves have designed.

22 Recruiting students with good general certificate of secondary education (GCSE) and/or general certificate of education (GCE) qualifications for general national vocational qualification (GNVQ) advanced levels or national diploma courses, remains difficult. The minimum entry qualification for advanced level full-time engineering courses is four GCSEs at grade C, preferably including mathematics and science. Figures provided by the colleges in the survey show that most students who enter an advanced course directly are meeting this requirement but that very few of these students have qualifications substantially above the minimum requirement. Part-time students on advanced level courses normally have better GCSE qualifications, especially those students who have been selected for company apprenticeship schemes.

23 Mathematics is a key subject for engineering students. It was noted in the first survey of engineering that:

> *many students start their engineering studies with an inadequate grounding in mathematics and this is the subject most commonly failed in engineering courses.*

The current survey shows that most students on advanced courses have a minimum of grade C in GCSE mathematics. There is, however, a significant minority who do not including students who have progressed from intermediate level courses, mature students with few formal academic qualifications, or students who have just failed to obtain a grade C and may be expected to re-take the subject during their first year of study. Sometimes a GCSE grade C or above in science has been accepted in lieu of mathematics. Of those who have a grade C in mathematics, some may have studied the higher level GCSE and some the intermediate level. However, the intermediate level course does not provide a good foundation for engineering students because it provides only a basic introduction to algebra and trigonometry. A weak grounding in mathematics continues to provide substantial problems for the teaching of mathematics and science in engineering courses.

24 Identifying the correct level and type of course for students, especially at level 2 or below, is critical if a student is to remain motivated and is to succeed on the course chosen. Increasingly, engineering departments are specifying entry qualifications for some level 2 courses. This applies particularly to intermediate GNVQs, first diploma and first certificate courses. Typically, between two and four GCSE grade Ds or Es may be specified including mathematics and science. Selection for level 2 craft courses is less formal. It usually comprises an interview, a consideration of school reports, and judgement of a student's motivation. Many colleges provide both practical and academic courses at levels 1 and 2 so that students can be placed on a course which is well suited to their level of ability. Some colleges have extended induction periods, of up to six weeks, together with joint teaching of level 1 and level 2 courses. This approach helps in identifying the appropriate level of study for a student. There appears to be little demand for accreditation of prior learning as a means of reducing the time taken to obtain a qualification.

25 Most colleges now routinely assess the literacy and numeracy skills of full-time students on entry to the college. Those who fall below a certain level are offered additional support to improve their skills, which is a major development since the first survey. Many colleges also assess part-time students and offer them additional support if necessary. Most colleges and engineering departments use

standard assessments to identify students' abilities in one of several broad categories. Some have developed their own assessment material to try to differentiate more clearly the entry level of the student and the level of support which may be required. A number of engineering departments have adapted the assessment material, or developed their own assessments, to focus particularly on the numeracy skills required for engineering courses. Some engineering departments report that up to 90% of level 2 students are identified as needing some form of additional support. A few departments also test the mechanical and spatial abilities of prospective students, though it is not always clear how this information is used to help students. Some departments test potential electrical engineering students for colour blindness.

In one college, all full-time engineering students are assessed at entry. There is a four-part process with questionnaires covering number, writing and comprehension skills. The comprehension exercise is based on text taken from the student handbook about the students union and is therefore of particular relevance to all students. The questionnaires are marked using an automatic system and interpreted by the college admissions team. The third and fourth parts of the assessment are carried out at interview and cover speaking, listening and writing skills. Staff use a structured interview record to assess the candidate's responses to questions. Students also carry out a fixed time, free writing exercise. Criteria have been developed to identify whether students should be studying at foundation, intermediate or advanced level.

In one engineering department, a comprehensive mathematics assessment has been developed. It covers key areas of mathematics including fractions, decimals, integer form, manipulation of formulae, and trigonometry. A marking sheet has been drawn up to show clearly the strengths and weaknesses of individual students.

26 The additional support provided for numeracy and literacy skills aims to meet the needs of individual students. Most students have individual interviews at which the precise form of support they require is identified. A support programme is then drawn up which usually includes a calendar for regular reviews of progress. Additional support may be provided in the form of: extra timetabled sessions provided by a central college facility with associated staffing; extra lessons provided by engineering teachers; additional teachers joining engineering classes to provide extra help for students during normal classes. Support may be provided on a one-to-one basis or to groups of students who require similar help. Some support programmes lead to qualifications such as the City and Guilds of London Institute (C&G) Numberpower or a GCSE in mathematics. Generally, the support programmes are sensibly structured. However, their success ultimately depends upon the motivation of the students, their willingness to continue with the programme, the rigour with which progress is monitored, and the effectiveness of liaison between staff providing the support and the student's course tutor. In many engineering departments, the drop-out rate from additional support programmes is high. Additional support is more likely to be successful when:

- extra help is provided during normal classes
- students are able to work with vocationally relevant material
- help is available as and when required
- there is perceived to be no stigma attached to requiring help
- progress is monitored carefully.

Outcomes of Inspection

27 The grades awarded to engineering provision in colleges as a result of inspections are shown in table 8.

Table 8. Grades awarded to engineering provision and to all programme areas

Year	Outstanding or good (grade 1 or 2)		Satisfactor y (grade 3)		Less than satisfactory or poor (grade 4 or 5)	
	Engineering (%)	All programme areas (%)	Engineering (%)	All Programme areas (%)	Engineering (%)	All programme areas (%)
1994-95	56	71	41	26	3	3
1995-96	57	69	43	29	0	2
1996-97	53	68	41	30	6	2
1997-98	57	69	39	30	4	1
1998-99	46	63	49	30	5	7

Source: inspectorate database

28 The proportion of grade ones and twos awarded for engineering provision has been significantly less than the overall average for all programme areas. Students' poor levels of achievement have been the main reason for the lower percentage of grade ones and twos. Self-assessment reports produced by some engineering departments overestimate the quality of teaching and do not provide sufficient evidence to support judgements. Inspectors agreed with self-assessment grades for engineering in 69% of cases. Inspection grades were one grade lower than self-assessment grades in 20% of cases and one grade higher in 11% of cases. Many self-assessment reports pay insufficient attention to achievement and retention rates. In some colleges, the data sent to inspectors before inspection have provided an inaccurate picture of retention and achievement rates, mainly because the initial collection of data was incomplete. The proportion of grade ones and twos awarded by inspectors fell significantly in 1998-99. However, this decline should be seen in the context of the more reliable and detailed information on students' achievements which has become available in the form of recently published FEFC statistics.

Teaching and Learning

29 The annual profile of lesson observation grades awarded by inspectors since the first survey is shown in table 9.

Table 9. Annual profile of lesson observation grades for engineering and for all programme areas

Year	Outstanding or good (grade 1 or 2)		Satisfactor y (grade 3)		Less than satisfactory or poor (grade 4 or 5)	
	Engineering (%)	All programme areas (%)	Engineering (%)	All Programme areas (%)	Engineering (%)	All programme areas (%)
1994-95	61	62	32	30	7	8
1995-96	61	63	31	29	8	8
1996-97	60	61	29	31	11	8
1997-98	62	64	29	29	9	7
1998-99	60	65	32	29	8	6

Source: inspectorate database

30 The first survey noted that:

the general standard of teaching on engineering courses stands comparison with that seen nationally in other subject areas; practical sessions are generally of a higher standard than classroom-based sessions.

The profile of lesson observation grades for engineering continues to reflect the findings of the first survey. It has remained broadly similar from year to year, reflecting a pattern of teaching and learning that is at least satisfactory, especially in practical workshops, but that is often dull and uninspiring in the classroom. Although the organisation of teaching has generally improved over the last few years, this has yet to make an identifiable impact on achievement and retention rates.

31 Schemes of work are improving slowly although there are still many course schemes which comprise little more than a list of topics. The better schemes show:

- the sequence of topics to be covered
- the use of relevant material for teaching and learning
- a good range of activities including the use of practical activities to underpin key principles
- the appropriate use of individual, group and whole class activities.

32 Many individual lessons are planned well and the aims and objectives of the lesson are made clear to students. In the better lessons:

- teaching methods are appropriate
- teaching is well planned and materials produced to a high standard
- the differing learning needs of individual students are met
- frequent checks are made on students' learning
- frequent references are made to industrial applications
- effective use is made of demonstrations to assist students' understanding of engineering theory.

In some classes with part-time employed students, teachers make extensive use of students' experience and knowledge of their work to illustrate key points.

33 There continues to be a persistent number of lessons which are judged to be less than satisfactory. Typical weaknesses include:

- a lack of momentum in lessons
- teaching which is dull and boring

- extensive dictation or the expectation that students spend much of the lesson copying from whiteboards or overhead projector screens
- the directing of questions at the class generally rather than at individual students
- the failure to monitor individual students' learning.

34 The teaching of mathematics is reviewed regularly in many departments. Different teaching methods may be used depending on the level of course and the background of the students. Some departments split students on the same course into different groups to provide better support for those with weaker learning backgrounds. Some make extensive use of commercial learning material. This is usually well structured but it often lacks engineering examples. The better mathematics teaching makes good use of exercises which apply mathematical principles to engineering examples. The normal structure of most mathematics lessons consists of a teacher-led introduction to the topic followed by the teacher completing a typical example. The students then undertake a series of similar examples with the teacher providing support for individual students as necessary. Although in principle this is an acceptable form of delivery, it often fails to stimulate students and the number and range of examples provided is not always sufficient to develop the students' competence and confidence in mathematics. Students can usually solve straightforward problems but are often unable to manipulate equations and formulae. They often appear unwilling to undertake the extensive practice necessary to develop their mathematical skills further.

On an advanced GNVQ engineering course, students completed mathematics assignments which contained both mechanical and electrical engineering applications. One assignment made good use of workshop machinery to explore the properties of a series. The students were required to determine the relationship between the speeds of the input and output shafts of a lathe using 16 consecutive gear ratios. The speeds were measured using a tachometer and recorded, and the readings then used to determine the type of series they represented. The relationship derived was subsequently used to explore further the properties of a geometric series.

35 The teaching of engineering science subjects on engineering courses follows a format which is broadly similar to that of mathematics, but usually with the addition of some practical and assignment work. In some of the more lively teaching, practical work is used as the basis for developing the key principles. Often, however, the practical and assignment work is used only to confirm key principles. Engineering science teachers do not always make use of the mathematics being taught, so that students do not appreciate the relevance of mathematics in this context.

36 Most engineering students are taught to use information technology (IT) hardware and software. Full-time engineering courses usually include an introduction to wordprocessing, spreadsheets and databases, and many part-time students use such software in the workplace. Teachers normally require students to submit some assignments which are wordprocessed and which make use of spreadsheets and databases. Few teachers make use of spreadsheets in the teaching of engineering subjects, however. On both full-time and part-time courses the use of computing hardware and software is normally further developed to include computer-aided drawing, computer-aided machining, and the computer control of engineering/manufacturing processes. These subjects are usually taught well. Students are able to progress at their own pace and develop skills appropriate to their individual requirements. Appropriate manuals and teaching materials provide good support and students receive individual attention from teachers.

At one college, employed students can attend computer-aided drawing classes in the evenings and at weekends. The students are a mix of professional engineers, technicians, and architects. Classes are run on Friday mornings for unemployed students and there are classes throughout the week for full-time and day-release students. Staff have developed high-quality manuals which break the course down into a number of logical teaching units. Students work through the units at their own pace supported by the teacher when necessary. Relevant exercises are included in each unit to test students' understanding and progress. Students can offer themselves for the final assessment when they feel that they have reached a suitable level of competence.

37 The teaching of practical skills is usually well organised. Teachers have developed a range of relevant practical workshop tasks which students have to complete to develop their practical competences and there are extensive administrative systems that enable teachers to monitor the progress of individual students. Increasingly, NVQ work is organised so that students can progress at the rate for which they are best suited and offer themselves for assessment when they are ready. Most students are now given considerable help and support to understand NVQ procedures, especially the achievement of competences and the subsequent recording of evidence in portfolios. Once students understand the process they are usually able to manage their own work programme. Mature students, particularly, value being able to work at their own pace and take responsibility for their work programmes. One of the reasons why students do not always successfully complete their programmes, however, is that the recording of activities is not effective enough.

In one motor vehicle workshop, students studying at different levels were working concurrently at different practical activities. One group was being shown how to use a gas analyser by the workshop instructor; other students were working in pairs developing their practical skills on activities such as checking and setting the timing of a car engine; one student was working at the reception desk ordering spare parts for one of the cars; and a teacher was assessing a student on the setting of valve timing. There were also two or three mature students, on a course for unemployed adults, who were working at a much faster pace than the other students in order to obtain their qualifications within a shorter than normal period. For each activity students completed a worksheet explaining how the work had been done, stating the results of their work such as 'changed defective brake cylinder' or noting actual dimensions against those quoted in the workshop reference material stored on the workshop computer.

38 Although the full-time students in some colleges undertake work experience placements, work experience is still not a regular feature in many engineering departments. The provision of work experience is often dependent on the enthusiasm of individual teachers or the contacts they have developed. Work experience is more common in motor vehicle departments, where teachers usually have close contacts with the local motor vehicle trade.

In one college, students on a full-time two-year motor vehicle mechanics programme undertake work experience for one day a week in the second and third terms of their first year, and for one day a week throughout the second year. On Fridays an in-college workshop is organised for cars belonging to college employees. The range of placements is large, from prestige car dealers to small garages, and students who wish to do so can change their placement between years one and two. Students keep a record of their work experience in a log book.

39 On most intermediate and advanced technician courses the overall requirement for assessments is slowly reducing. There has been a reduction in end-of-unit tests and an increase in assignments. Most assignments are accompanied by criteria identifying the standards students have to achieve to gain a pass, merit, or distinction grade for their work. This is an improvement in practice since the previous survey. However, the criteria stated are often too broad. Students, for example, would benefit from greater clarity about the amount of detail required in their assignments and the expected length of reports. Work examined by inspectors shows that many teachers now routinely annotate students work with comments that will help them to improve their work and make progress.

Key Skills

40 The EMTA *Labour Market Survey of the Engineering Industry in Britain* in 1998 identified a continuing need to develop key skills. These skills are an important feature of GNVQs and of training programmes such as modern apprenticeships, and the need for students to achieve such skills has been given added prominence since the first survey. Numeracy, literacy, and IT are key skills which all engineering departments develop to some extent, but it is not always done systematically. Few departments have effectively extended the development of key skills to cover problem-solving, working with others, and improving own learning and performance, which are also important to industry. Where possible, most departments integrate the delivery and assessment of key skills with other aspects of the main subject. In some cases, however, the development of these skills is timetabled separately. For example, it is often the case in IT where the student has to learn how to use the relevant hardware and software before such use can be applied. On some practical courses, log books, which record the practical work undertaken by the student, are used well for recording evidence relating to the successful completion of key skills. Numeracy, communications, and IT are usually taught partly by engineering teachers and partly by teachers who specialise in the teaching of key skills.

Students' Achievements

41 Retention and pass rates on engineering courses in further education colleges, together with the number of students starting courses, are shown in table 10. Retention rates are derived from the number of students who attend their courses to the end compared with the number who started the course. Pass rates are based on the number of students who gain a qualification compared with the number who complete the course.

Table 10. Number of starters, retention and achievement rates by type of course

	1996			1997		
	Number of starters	Retention (%)	Achievement (%)	Number of starters	Retention (%)	Achievement (%)
Intermediate technician	4,714	75	56	4,810	75	65
Advanced technician	17,196	78	61	15,217	77	69
C&G level 1	21,203	78	55	19,346	76	54
C&G level 2	33,502	84	55	34,102	83	55
C&G level 3	7,540	86	55	6,549	85	54
NVQ level 1	1,785	87	77	2,655	80	53
NVQ level 2	14,427	76	44	16,875	76	58
NVQ level 3	5,039	82	61	11,746	85	62
Overall	105,406	80	55	111,300	80	58

42 The first survey noted that:

> *students' completion rates on some courses are poor; departments which achieve good completion rates have a number of features in common.*

The overall retention rate has improved slightly since the first survey and is now just below the overall retention rate for all FEFC programme areas. However, the picture in many departments is still mixed. Most have poor retention rates on at least some of their courses, with the lowest retention rates mainly on intermediate technician and NVQ level 2 courses. One of the main reasons claimed for students leaving courses early is that they have obtained employment. Whilst this is undoubtedly true for some students, few colleges systematically record the destinations of all students who leave their courses, so an accurate analysis is not possible. The employment students obtain may be engineering related and if the employer has a training programme they may return to the college to complete their training. Other students, however, leave for employment which is not engineering related. Additional reasons for students leaving courses include: being on the wrong course; being unhappy with the teaching; and low morale because they have fallen behind with assignment work.

43 The problem of retaining students is not confined to engineering departments. Many colleges have instigated college-wide initiatives to improve retention levels. Most of these initiatives have focused on improving tutorial support for students by: setting performance targets for each individual; monitoring their progress through regular reviews; following up

poor attendance immediately; and organising parents' evenings for the 16 to 19 year olds. Some engineering departments have reviewed their teaching methods. Many have introduced more practical work to help improve students' motivation and, hence, retention; for example, particular projects, such as building a kit car or a hovercraft, may be used to help build underpinning knowledge. Some courses have been structured so that students attend college on three or four days and are free to obtain work experience or employment on the other days. Other initiatives include: regular industrial visits; overseas exchanges; more rigorous initial assessment of students' literacy and numeracy skills; video links to local companies to enable students to talk to the staff there; and firmer procedures for the submission of work. These college-wide and engineering department initiatives are soundly based but many have only been introduced recently and it is too early to say how successful they may be.

One college has taken all-round action aimed at raising levels of retention and achievement. There is an increasing portfolio of full-time engineering courses at foundation, intermediate and advanced levels. There are clear entry requirements for each course. The admissions tutor is responsible for all admissions and is able to counsel applicants closely. Students can be placed on courses that are within their ability range, which suit their needs, and which ensure that they are appropriately and sensitively supported. Course programmes are designed to ensure as far as possible that students are engaged in activities that suit their interests and aptitudes. The college has introduced a 'five plus one' model in which every sixth week is dedicated to learner management. This involves personal tutors meeting their students to identify problem areas, agree strategies and enable students to resolve any difficulties they may have.

44 The first survey noted that:

> *examination pass rates in engineering are often low. Departments which achieve good results also have common features; good pass rates frequently go hand in hand with good completion rates.*

The overall pass rates in engineering remain low: 58% for courses completing in 1997 and 55% for courses completing in 1996. Advanced technician and NVQ level 3 pass rates have been above the average in both years but are still not good. The low overall pass rates owe much to the poor performance of 16 to 18 year old engineering students on level 1 and level 2 courses. These courses have pass rates which are significantly below the average for all programme areas.

45 These generally low pass rates are in spite of a quality of teaching which is judged to be comparable with other programme areas. The amount of assessment with which students are confronted is often put forward as one of the main reasons for poor pass rates. The amount is especially heavy on craft courses. The need for students to show that they have satisfied the detailed performance criteria for each course has increased the thoroughness of assessment but it has also increased the complexity of the administrative and recording procedures required. Students have to build portfolios of evidence to show how they have achieved the relevant competences and some of them fail to complete this process by the agreed target date. Many engineering departments provide highly successful support in portfolio building to students on company-based NVQs.

46 Another explanation for poor pass rates is that some students only want to achieve particular units of an NVQ course, or similar qualification, and do not offer evidence in support of their other units. These students are likely to be recorded on college management information systems as failing to achieve their qualification even though they may successfully have achieved the units for which they were aiming.

47 The standard of work produced by students varies from very good to less than satisfactory. Assignment work produced by part-time students is usually good; it is carefully prepared, well presented and makes effective use of IT. Often, there is good use of material drawn from the companies at which they work. That produced by full-time students is more variable in quality. The better examples match the standard of part-time students' work. However, some of the work shows little thought in its preparation, copies extensively from published material, makes little use of IT, and is poorly presented. At the end of their course, students on practical courses are confident in the workshop environment and are usually able to work to industrial standards although the speed at which they work is often below the requirements of industry. On GNVQ and NVQ courses, students' portfolios are clearly organised and generally well maintained. Engineering students' average rate of attendance at lessons was 75% in 1997-98 compared with 77% for students in all FEFC programme areas. In some colleges, the punctuality of full-time students is poor.

48 The first survey noted that:

> *teachers have developed appropriate systems for assessing and recording practical competences in those NVQs which are now available but methods for assessing knowledge and understanding are less effective.*

Most craft students who attend further education colleges are developing a suitable balance of practical skills and underpinning knowledge. The introduction of NVQs and the funding of training programmes which concentrated solely on the NVQ caused concern within the industry and in colleges at the time of the first survey. It was felt that students would obtain a limited knowledge base to underpin their practical skills and that this would hinder their future development. Many departments continue to offer the relevant C&G course alongside the NVQ to provide the underpinning knowledge. However, funding for both courses usually has to be obtained from a number of sources and not all companies and/or training agents require their trainees to undertake the relevant C&G course. Some departments provide their own internal assessments for the underpinning knowledge based on a combination of written tests, mainly comprising multiple-choice questions, and oral tests.

Curriculum Organisation and Management

49 Courses are generally well administered. Records of individual students' progress and achievement are maintained carefully. In many colleges, course teams meet regularly to review courses and to monitor the progress of their students. In some colleges, the course review process is insufficiently rigorous. For example, not enough attention is given to improving retention and achievement rates. To meet the requirements of the various examining and awarding bodies, plus their own internal requirements, engineering departments operate internal verification procedures. Most procedures are laid down clearly. Procedures for checking the quality of marking of students' work are usually adhered to, but verifiers do not always check assignments before they are given to students and it is rare for one person to have an overview of all the assessments for a particular course. In a few colleges, the course curriculum and associated teaching methods are reviewed regularly but often the role of the course leader is assumed to be that of an administrator rather than one who takes a proactive role in managing the curriculum.

50 The financial viability of courses and their relevance to local industries and students are reviewed on a regular basis. Generally departments have started more courses than they have stopped, so overall enrolment targets are still being met. Many part-time courses are

dependent on the recruitment and training patterns of local industry. Marginal courses may be dropped and replaced with courses for which there is more demand. The survey showed that most departments have stopped offering between two and five of their portfolio of courses in the last three years. The most common courses to suffer, according to the survey, were the C&G 224 electronic servicing course and various welding courses. There was no other clear pattern. Some colleges had ceased to offer the NVQ level 2 engineering foundation craft course, whilst others had just begun to offer it. This is the only one of the main suite of qualifications in the NVQ framework which has not yet been redeveloped and reaccredited using the new engineering reformation qualifications. Some had closed higher national certificates in different branches of engineering, whilst others had started specialised higher national certificates. Courses on the installation and maintenance of computers and courses associated with the performing arts, such as sound engineering and music technology, are some of the new courses being successfully introduced. In a few cases, departments had taken over courses previously provided by private training companies which had withdrawn from engineering training.

51 Managers and teachers in many colleges have developed productive partnerships with local companies, which often inform course development. Specialist courses for employees provide an additional source of income. In a few colleges representatives of local engineering employers participate actively in the annual review of the college's engineering provision.

In one college, the school of engineering operates an arrangement with a consortium of local employers to sponsor students on its full-time craft engineering course. Students are recruited by the college and six weeks into the course they are interviewed by local employers to identify who they will sponsor. Several students may be sponsored by one company; for example, a major company sponsors 10 students every year. Sponsoring companies pay students an attendance fee and the fees for an outdoor pursuits residential course which is held in Wales. The students receive the £500 a year attendance sponsorship in five £100 blocks. The students have two weeks work experience with their sponsoring company. The company receives regular reports on their students and, at the end of the course it may recruit a sponsored student, though there is no commitment to do so.

52 The content of engineering courses generally meets the needs of students and local industries. This is especially so for the training of entrants new to engineering. There is usually an appropriate range of further education courses in terms of levels and specialisms. Many departments also run higher level courses which enable part-time students to obtain higher certificates, higher diplomas, or degrees. An increasing number of colleges organise their engineering courses so that students can start their studies at various times throughout the year. Further examples of flexibility in responding to the requirements of students include: lessons arranged at times to suit the working hours of students; courses taught by engineering teachers on employers' premises; and the assessment of students' practical skills in the workplace.

In one college, the national certificate and higher certificate courses are timetabled on a rolling pattern over the day and evening so that students can start in the morning or at midday and are able to complete their chosen qualification in two years. The midday start fits in with the shift pattern of a major local employer.

53 The first survey noted that:

> *engineering departments are often major providers of the income colleges derive from sources other than the FEFC. They are responsive to industry, providing courses specially designed for their clients, but there is insufficient provision for continuation training for individual employees.*

Engineering departments continue to support the specific needs of employers. Examples include NVQs with workplace assessment supported or managed by the college, a national certificate in plant engineering for a process engineering company, a motor vehicle NVQ for a motor racing team and multi-skilling training for breweries which fits in with shift patterns.

One college provides NVQ workplace assessment for local companies. For example, it offers an assessment service for an NVQ level 1 in manufacturing operations for line operators in a local company. The operators are employed mainly on the evening shift and the college assessor is 'on-site' for two evenings a week. Individual assessments are carried out at times which fit the operators' working patterns on the production line.

At another college, the engineering department has worked closely with an office equipment manufacturer to develop the framework for its modern apprenticeship scheme and to provide NVQ courses for the company's apprentices.

54 Many departments run short courses which provide continuation training and skills updating for individuals in engineering companies. These courses support company efforts to address the skills gaps identified in the EMTA survey. Computer-aided draughting courses have been particularly popular; they are offered in the evenings and sometimes at the weekends. Many of the courses offered are short courses, or elements of courses, which develop the multi-skills capability of individuals. Typical examples are welding courses and courses in hydraulics and pneumatics. Other courses relate to aspects of health and safety and to regulations such as those covering abrasive wheels and electrical installations. Some courses cover specialist activities, for example on security alarms, or they have been developed specially for an employer, such as a computer programming course for a major electronics manufacturer.

One college designed a training programme for a major food processing company, which involved approximately 150 personnel from the company's production lines being trained to carry out minor maintenance work. The training supplied by the college included the assessment of workers' basic literacy and numeracy skills and the provision of second language support, where necessary, for the many minority ethnic workers employed on the production lines. In-company practical skills tests were also designed to assess workers' capabilities in carrying out further maintenance work.

55 The first survey noted that:

> *funding considerations that are causing difficulties to colleges include the financing of joint NVQ/GNVQ provision and courses for part-time students who are in receipt of training credits.*

The current survey showed that the financial viability of part-time courses continues to depend on local funding arrangements for national training schemes such as modern apprenticeships. Local arrangements lead to inconsistent patterns of funding especially for the day-release courses which provide the underpinning knowledge for modern apprenticeships.

56 The number of hours a student is taught varies from college to college, and by level of course. The weekly hours of study for a full-time student are usually made up of a series

of activities. The coherence of these activities within a programme which attracts funding is the main determinant of the number of hours a student is taught. Most time is devoted to teaching on the core course, typically about 14 to 16 hours a week for a craft or technician course. This time is sufficient to deliver the required subject material but it places a responsibility upon the student to undertake sufficient private study to ensure that they understand and absorb the material. In many cases, engineering students do not undertake sufficient private study. Further time currently allocated might typically include one hour for a tutorial, three hours for key skills and/or numeracy/literacy support, and three to six hours for an additional qualification such as a GCSE, GCE, or an NVQ.

57 Engineering departments are required to keep abreast of the work and associated requirements of a number of standard-setting and awarding bodies. Each of these bodies have their own systems and procedures which, in total, present a considerable administrative, and in some cases financial, burden for engineering departments. The work of standard-setting bodies, such as the national training organisations, has increased in importance since the first survey. Such bodies identify, define and update employment-based standards for agreed occupations. EMTA and the Motor Industry Training Council are the main standard-setting bodies for engineering but there are also other bodies covering specialist aspects of engineering such as chemical manufacturing and telecommunications. Awarding bodies work with the standard-setting bodies in the development of NVQs. They are also responsible for overseeing approved assessment centres. The number of awarding bodies has also increased significantly since the first survey. C&G, the Edexcel Foundation, and EMTA are the main awarding bodies with which engineering departments liaise, but other organisations include the Institute of the Motor Industry for motor vehicle engineering and the Food and Drink Qualification Council for the food and drink processing industry.

58 The Edexcel Foundation, Assessment and Qualifications Alliance, and the RSA Examinations Board (RSA) offer GNVQs in engineering and in manufacture. The manufacturing GNVQ had just been introduced at the time of the first survey. It has been used successfully in a number of colleges, mainly in conjunction with apprentice training programmes, but few colleges now offer it. The engineering GNVQs at advanced and intermediate levels are more popular and many departments now offer them as their main courses for full-time students. A significant number of departments, however, have either switched back to, or continued with, the Edexcel Foundation national diploma as their main course for full-time students. These departments claim that the national diploma has a more ready acceptance with employers and with higher education institutions. Demand for the Edexcel Foundation national certificate is still strong, attracting a mix of apprentices and mature students. Many departments who have continued with the national diploma are able to timetable joint diploma and certificate classes, making a better use of their resources and producing interesting mixes of student experience. Some engineering departments offer GCSE and GCE advanced levels (GCE A levels) in design and technology and/or electronics. These courses bring a wider range of students to engineering departments and some of the work seen on design and technology courses is innovative and visually stimulating.

59 EMTA has recently launched a new range of NVQs, replacing former qualifications at level 2 and 3. These new awards are based on revised generic standards which were produced by the Engineering Reformation Project, a two-and-a-half-year project to develop occupational standards across a wide span of

engineering activity. The courses are based on mandatory and optional units. The *Learning to Succeed* white paper signalled the eventual introduction of taught vocational qualifications covering the theory of occupational areas. The white paper also signals the possible funding of units of NVQ qualifications for adults.

Resources

60 The first survey noted that:

> *about half the colleges in the survey have made significant changes to their engineering accommodation recently; the area available has been reduced and its quality improved. Significant weaknesses in accommodation remain.*

Colleges have continued to make changes to their engineering accommodation. The current survey found that many colleges have upgraded at least some of their specialist accommodation during the last three years. The requirements of industry-led bodies to provide a realistic working environment, for example in motor vehicle engineering, have prompted engineering departments to improve the layout and appearance of motor vehicle workshops. Many engineering departments have successfully reduced the total area used for practical activities and so improved space utilisation. A few have made major changes, usually involving the rationalisation of workshops. The use of workshops covering a number of locations has been reviewed and new or re-modelled accommodation on a single site has been built. These developments have normally been funded from sources such as skills challenge and European Development Funds. Typical building costs have been £600,000 to £800,000. In most colleges, however, some engineering areas continue to present a poor image and are not representative of modern industrial practice.

61 Since the first survey, many more colleges have developed learning resource areas within engineering departments. The intention is that students use the facilities to develop their underpinning knowledge at their own pace in a manner similar to the development of practical skills in workshops. In reality, the learning material is often not suitable for this. Students' study skills need to be further developed if they are to work on their own in this type of environment. Overall, more work is required to ensure that learning resource areas in engineering successfully fulfil their intended function.

62 The first survey noted that:

> *most engineering departments have inadequate equipment for some areas of their work; the most common weaknesses are in general workshop machinery, motor vehicle stock and test gear, electronic test equipment and apparatus to support engineering science.*

Annual internal revenue allocations to engineering departments typically range from £10,000 to £50,000. In addition, college-wide bidding procedures have usually released other funds to departments to purchase capital equipment. The total amount is often insufficient to purchase capital equipment for more than one curriculum area and funds are concentrated on one particular area or on a particular category of equipment, such as computers, which can be used in a number of areas. Most funds have been used to upgrade or purchase computer-related hardware or software. None of the departments visited in the survey had established a realistic equipment replacement cycle. The resource most in need of investment continues to be general workshop machinery. It is becoming increasingly dated, is costly to maintain, and does not meet modern industrial standards. Engineering science laboratories, where they exist, are generally of poor quality. Electronic test equipment varies in quality and quantity. Most of it is satisfactory for purpose but becoming dated. Some colleges have invested in computer-based electronics teaching workstations. This equipment allows electronics to be taught by means of practical experiments and the results obtained by students are logged electronically so that teachers can monitor students' progress closely. Remote access to the electronic data is possible, through the telephone, so that students can also work independently of the teacher. The introduction of NVQs, with the associated requirement to have a minimum level of equipment, has helped to improve motor vehicle workshop test equipment although many of the motor vehicles on which students work remain out of date.

> One college has a high-technology computer-integrated manufacturing centre which is housed in a large glass-sided module within a workshop area. It presents an attractive image of modern manufacturing and is well organised. It is very well equipped with CNC machines, robots, a transportation system, a racking/storage system, and a tensile testing machine with computer printout. There are also 16 computer workstations with computer-aided design (CAD), computer-aided manufacture (CAM) and general purpose software.

63 Some colleges have benefited from donations of equipment, such as motor vehicles, or from equipment acquired at reduced cost. Many vehicle body finishing workshops use paints and paint-mixing equipment donated by manufacturers on the condition that they can use the college's facilities to demonstrate their products. Classrooms used for teaching engineering principles vary in layout and appearance from high-quality modern suites to very drab accommodation. Up-to-date displays of students' work and industrially relevant material to help promote an appropriate ambience for engineering in classrooms and other work areas are rarely found.

> The food processing industry is a key element in the economy of one college. The industry has difficulties in recruiting suitably qualified staff and accessing work-based training. Following discussions, the company and the college established a wide-ranging partnership with the aim of developing comprehensive provision for education and training. A centre of excellence was created around a computer integrated manufacturing system and the partnership subsequently obtained European funding to install two further computer-integrated manufacturing systems using production equipment of food industry standard.

64 Teachers are appropriately qualified in their subjects and most now have relevant assessor and verifier awards. Some do not possess formal teaching qualifications though newly appointed teachers are usually required to obtain a teaching qualification as part of their conditions of employment. In a few colleges, teachers are encouraged to take industrial secondment, but many teachers continue to lack recent industrial experience. The number of full-time engineering teachers has reduced in most colleges over the last three years, in some by as much as 50%. In a number of departments, the reduction is a consequence of reduced enrolments. In others, it the result of increased efficiency, with teachers required to teach for a minimum number of hours a week, typically 23 hours, in addition to their administrative duties. In many departments, the number of teachers employed on fractional or part-time contracts has increased. This has made departmental staffing more flexible and more responsive to changing patterns of enrolment. It has also meant that administrative duties, such as those carried out by a course leader, have to be undertaken by fewer full-time staff. Some departments have set limits on the amount of part-time teaching, a typical proportion being 25%. Approximately 50% of engineering departments employ one or more instructors. The instructor post is usually a 'dual appointment', with 50% of the time allocated to workshop instructional duties and 50% allocated to technician duties, normally in the same workshop. In one college, approximately 10% of the teaching is undertaken by instructors.

Conclusions

65 The proportion of inspection grade 1s and 2s awarded for engineering provision has been significantly less than that for other programme areas. The main reason has been because of the lower achievement rates of engineering students. Inspectors agreed with the self-assessment grade for engineering in 69% of the inspections but gave a lower grade in 20% of inspections and a higher grade in 11% of inspections. Many self-assessment reports pay insufficient attention to student achievement and retention rates.

66 Engineering departments in further education colleges are key providers of training for engineering employees and for full-time students wishing to pursue engineering careers. Generally, they are responding to the needs of the engineering industry, and individual students, and to public sector initiatives. Particular features of the provision are that:

- the quality of teaching in engineering is comparable with that in other programme areas. Teaching and learning is at least satisfactory, especially in practical workshops, but classroom teaching is often dull and uninspiring. In many theory lessons students spend too much time copying material provided by the teacher and there is not enough practical demonstration of underpinning principles
- practical work, especially on NVQ courses, is generally well organised. Increasingly, students are able to take some responsibility for their own progress. The logging of evidence to support the acquisition of competences is not effective enough and is hindering students' ability to achieve their target qualification in the time normally expected
- the overall retention rate on engineering courses has improved slightly since the first survey and is now just below the overall retention rate for all programme areas. However, the picture in many departments is still mixed. Most have poor retention rates on at least some of their courses
- engineering departments have been involved in many of the recent initiatives to improve retention levels but it is too early to say how successful these may be
- overall pass rates in engineering remain low and are a matter of serious concern. The pass rates for 16 to 18 year old engineering students on level 1 and level 2 courses are particularly poor
- most craft students are developing a suitable balance of practical skills and underpinning knowledge
- engineering departments are developing the key skills of numeracy, literacy, and IT, but not always systematically. Few engineering departments have effectively extended their work in key skills to cover problem-solving, working with others, and improving own learning and performance, though industry continues to call for the development of such skills
- aspects of computer-aided engineering are usually well taught but few teachers make use of spreadsheets in teaching engineering
- the mathematical ability of many engineering students continues to be a weakness. The number and range of examples provided by teachers is not always sufficient to develop the students' competence and confidence in mathematics. Many students lack confidence in the manipulation of equations and formulae. Mathematical principles are not linked sufficiently to engineering applications
- the quality of accommodation for engineering continues to improve. Many departments have improved space utilisation and some have modern purpose-built accommodation. In most colleges, however, some of the areas used for engineering present a poor visual image and are not representative of modern industrial practice

- the equipment in engineering departments varies in quality. The best, and most modern, is usually associated with computer-aided engineering activities and with the teaching of electronics through computer-aided learning systems. Much equipment is satisfactory but becoming out of date. The resource most in need of investment continues to be general workshop machinery
- engineering departments respond to employer needs by providing a range of standard and specially designed programmes to promote continuation training and skills updating for employees
- engineering departments are making a positive contribution to initiatives to attract students who might not normally benefit from further education, through their collaborative partnerships with engineering employers and the provision of a range of level 1 courses
- the amount of administration in engineering departments has increased significantly as a result of the increasing number of competence-based courses and the growth of awarding and standard-setting bodies. Reductions in the number of full-time teachers have often led to heavy administrative duties for the remaining full-time staff.

Annex

Colleges Visited

Eastern Region

Norwich City College of Further and Higher Education
Oaklands College
The College of West Anglia
West Herts College

East Midlands

Boston College
Charles Keene College of Further Education (now part of Leicester College)
Northampton College
West Nottinghamshire College
Derby Tertiary College, Wilmorton

Greater London

City and Islington College
City of Westminster College
Croydon College
Kingston College
Newham College of Further Education
Newham Sixth Form College
South Thames College

Northern Region

Darlington College ofTechnology
Northumberland College
South Tyneside College

North West

Blackpool and The Fylde College
Bury College
North Trafford College of Further Education
South Cheshire College
Wigan and Leigh College

South East

Brighton College of Technology
Brooklands College
Crawley College
Fareham College
Guildford College of Further and Higher Education
Mid-Kent College of Further and Higher Education
Northbrook College, Sussex

South West

City of Bristol College
Exeter College
Plymouth College of Further Education
South Devon College
Stroud College of Further Education

West Midlands

Coventry Technical College
Evesham College
Stoke-on-Trent College
Sutton Coldfield College
Telford College of Arts and Technology
Tile Hill College of Further Education
Worcester College of Technology

Yorkshire and Humberside

Barnsley College
Doncaster College
Leeds College of Technology
Wakefield College
York College of Further and Higher Education
Yorkshire Coast College of Further and Higher Education

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