REPORT
FROM THE
INSPECTORATE

Curriculum Area
Survey Report

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Engineering

THE
FURTHER
EDUCATION
FUNDING
COUNCIL

THE FURTHER EDUCATION FUNDING COUNCIL

The Further Education Funding Council 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 every four years. It also assesses and reports nationally on the curriculum, disseminates good practice and gives advice to the FEFC's quality assessment committee.

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SUMMARY

In 1993, 1.9 million people, 7.8 per cent of the United Kingdom workforce, were employed in engineering-related activities. The proportion of the national gross domestic product contributed by the engineering and manufacturing sector has been steadily declining. Technological change and pressure to reduce labour costs are expected to result in a further fall in the numbers employed within the sector. However, within this overall decline, employment at technician and higher grades is expected to grow.

Total enrolments to engineering courses fell continuously between 1989 and 1995 mainly due to a significant reduction in the number of part-time students. However, some colleges have achieved growth during this period. Between 1993 and 1995 there was an increase in the number of full-time students and colleges' strategic plans predict future overall growth particularly at foundation level. The sustained lack of demand over recent years has led to the closure of specialist facilities in some departments.

Industry now requires a workforce with greater adaptability and higher level skills. Increasingly, employers expect workers to carry out a wide range of tasks. Employees require good communication, mathematical, information technology and interpersonal skills, the ability to take initiatives and solve problems. The challenge for the colleges is to recruit the students and to provide the education and training which meet these requirements.

Recent large-scale industrial closures and redundancies have made a career in engineering unattractive to many young people, and departments find difficulty in attracting students with good grades at GCSE. At present, departments are expanding the

provision for entrants with limited qualifications. Students are being accepted on to engineering courses with lower entry qualifications than in the past. The mathematical ability of students at entry is often weak.

The most successful engineering departments are those which have built strong links with employers and schools and which offer courses in a wide range of specialisms, at different levels and in a variety of attendance patterns. In such departments students are able to choose courses which match their abilities and aspirations and provide opportunities to progress to higher level courses or employment. Engineering departments are responsive to the needs of industry and are often able to earn significant amounts of income from services and courses designed specifically for industrial clients.

The general standard of teaching on engineering courses is satisfactory. The profile of inspection grades is similar to that of most other programme areas. In about 61 per cent of classes, the strengths clearly outweigh the weaknesses. However, many departments have failed to modify their teaching methods, or to increase the learning support they provide, to take account of students' lower levels of achievement at entry. The teaching and assessment of practical work is generally more effective than the teaching and assessment of theory.

The long-established system of craft-related engineering qualifications is being superseded by NVQs. The introduction of GNVQs in engineering and manufacturing has encountered difficulties. The GNVQs in manufacturing have failed to attract many students and there have been difficulties in implementing the pilot GNVQs in engineering.

Engineering is an expensive subject. It requires large, sophisticated equipment. Some colleges have found it difficult to sustain their engineering courses given the low number of students they recruit. Most colleges have outdated equipment in at least one of the engineering subjects. The accommodation dedicated to engineering has been reduced in many colleges. Although the quality of the remaining space has often been improved, much engineering work still takes place in poor surroundings.

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INTRODUCTION

1 This report comes at a time of challenge and change for providers of engineering education and training. The proportion of the national gross domestic product contributed by the engineering and manufacturing sector has declined. Industry now requires a workforce with greater adaptability and higher level skills than in the past. After initial hesitancy, the long-established system of craft-related engineering qualifications is being superseded by the National Vocational Qualifications (NVQs). The General National Vocational Qualifications (GNVQs) in manufacturing have not found wide acceptance and there have been difficulties implementing the pilot GNVQs in engineering. The designation of colleges as further education corporations, and the funding methodology of the Further Education Funding Council (FEFC), have focused attention on the relatively high delivery costs of engineering programmes. The engineering provision in some colleges has continued to decline and some specialist facilities have been closed down or may close.

2 The findings of this report draw on a number of sources. Inspectors carried out 157 inspections of engineering in further education colleges between September 1993 and August 1995 as part of the quadrennial cycle of inspections[1]. The quality of the engineering provision in each college has been assessed and graded and the grades published in college inspection reports (annex A). During 1994-95, a further 42 colleges completed a detailed survey questionnaire relating to engineering resources and students' achievements. Inspectors made follow-up visits to each of these. The numerical and statistical data quoted in this report are based primarily on the survey. Discussions were held with representatives from organisations with an interest in engineering education and training (annex C).

ENGINEERING SKILLS REQUIRED BY INDUSTRY

3 In 1993, 1.9 million people, 7.8 per cent of the United Kingdom workforce, were employed in engineering-related activities. Technological change, and pressure to reduce labour costs, are expected to result in an overall decrease of around 8 per cent in this figure by the year 2001. However, within this overall decline, employment in technician and higher grades is expected to grow at a rate of about 2 per cent a year, which is well above the economy-wide average growth of 0.8 per cent a year for all sectors[2].

4 Increasingly, engineering employers expect workers to carry out a wider range of tasks and prefer to retrain existing personnel rather than create new posts. Employees therefore need to be adaptable and to have the potential to develop. They require good communication, mathematical, information technology and interpersonal skills[3]. They also need to have qualities of leadership, be able to show initiative and creativity, have analytical and problem-solving capabilities and the ability to work in a team. The Board of Trade's publication, *Competitiveness: Helping business to win*, and its successor, *Competitiveness: Forging ahead*, encourage industry to improve the skills and qualifications of the workforce in order to remain competitive. The Engineering Council, and others interviewed during the survey, look to the colleges to meet the increased need for lifelong learning for those employed in the engineering industry. A steering group, Action for Engineering, sponsored by the Department of Trade and Industry (DTI), recognises the need for better deployment of engineering staff for wealth creation. It is identifying initiatives which include helping industry, colleges

and other training providers to work together to improve the supply and quality of technicians and supervisors. The appropriateness of the current range of engineering qualifications is also being reviewed.

5 A nationwide survey of small and medium-size enterprises, undertaken by the Engineering Council, has indicated concern with the way all sectors of education prepare young people for careers in engineering. It concluded that a misguided view of industry and engineering is being fostered, and that education is not aligned to industry's needs[4]. On the other hand, inspections have identified many examples of collaboration between colleges and industry that have led to the development of tailor-made courses. In one example, the students on a GNVQ manufacturing course spend most of their time working in small and medium-size manufacturing companies and each of the mandatory units is delivered through assignment work in a particular company.

6 Representatives from the DTI and the Engineering Employers' Federation (EEF) have expressed the view that the engineering industry requires an increase in the standards of technical education and training if it is to meet the expected demand for more high-level, adaptable technicians. Industry still needs traditional craftspeople, but with a broader range of skills. Representatives of industry who were interviewed as part of the survey welcomed new courses, such as the GNVQs in engineering, which have a broad approach and emphasise skills with a wide application. They believe that the inclusion of elements of design processes, materials costings and management, and commercial practice make such courses particularly relevant to industry. They are also clear that a good mathematical background is essential to progress in engineering education and employment.

ENGINEERING PROVISION IN FURTHER EDUCATION COLLEGES

RANGE OF THE PROVISION

7 The further education sector offers courses covering the broad spectrum of engineering disciplines. In 1994-95, 347 of the 456 colleges in the further education sector had courses in engineering and technology, compared with 356 in the previous year. One hundred and twenty-three colleges each have more than 1,000 engineering students, whilst 70 colleges have fewer than 100. Many of the small providers are sixth form colleges which usually offer only General Certificate of Education advanced level (GCE A level) courses in electronics and/or technology. Agricultural colleges sometimes have engineering courses relating specifically to the maintenance of equipment associated with the land-based industries.

8 The majority of colleges with substantial provision have a range of courses in mechanical/manufacturing engineering, electrical/electronic engineering, motor vehicle work, and fabrication and welding. Most run courses in computer-aided design. Individual vocational areas often have a number of sub-specialisms. For example, motor vehicle work may include courses in light and heavy vehicle repair and servicing, bodywork repairs, vehicle parts, motorcycle maintenance and management.

9 A number of industrial, examining and awarding bodies are involved in offering engineering qualifications. Their requirements are often not consistent, and a large department[5] may need to be familiar with the syllabuses, regulations, and quality assurance mechanisms of most of them. The Business and Technology Education Council (BTEC) and the City and Guilds of London Institute (C&G) are the two main awarding

bodies in the sector. Both now offer GNVQ programmes, as does the RSA Examinations Board (RSA). Most workshop-based mechanical engineering training leads to NVQs awarded by the Engineering Training Authority (EnTrA) although other organisations, such as the Marine and Engineering Training Association (M&ETA), also award NVQs. Motor vehicle qualifications may be awarded by the C&G, BTEC, RSA, the Road Transport Industrial Training Board Services Limited (RSL) or the Institute of Motor Industries (IMI). Fabrication and welding courses can lead to certification by the Welding Institute, the East Midland Further Education Council (EMFEC) and others, as well as C&G and EnTrA. Most of the national examining boards offer General Certificate of Secondary Education (GCSE) and GCE A level awards in technology and/or electronics.

LEVELS OF PROVISION

10 Foundation courses are intended for students with no formal entry qualifications. The survey showed that only about one in four engineering departments offer courses at this level. Foundation courses may be part of a general college-wide scheme. For example, one full-time, college-wide foundation course leads to a number of RSA certificates, including options in practical electronics and motor vehicle work. Foundation level courses often attract unemployed adults as well as school leavers. They normally include a high proportion of practical work which is complemented by work in the core skills of numeracy and literacy. Students succeeding at foundation level are able to progress to intermediate level provision. Over half the colleges in the survey offer a four-day-a-week workshop training course aimed at NVQ level 2, usually accredited through EnTrA or M&ETA. This is often called an engineering foundation course. Students on this course may also be taking a separate general education course one day a week.

11 Intermediate level courses are offered by more than four-fifths of engineering departments. Examples include the BTEC first certificate (usually part time) and first diploma (usually full time), GNVQ intermediate, NVQ level 2 and equivalent C&G courses. They do not have formal entry requirements laid down by the awarding bodies and colleges' entry requirements vary. Where the college is able to offer a variety of courses at intermediate and foundation levels, students can be guided to a course which suits their levels of achievement and ambition. For example, some departments require GCSEs for entry to their BTEC first certificate and diploma courses, and this often results in better completion and success rates.

12 Advanced level courses are intended for students with grades A to C in at least four GCSE subjects, or those who have successfully completed a related vocational course at intermediate level. Most departments offer one or more BTEC national certificates, diplomas, GNVQ advanced or equivalent C&G courses at this level. Students who succeed on advanced level courses are qualified to take a higher education course, or to enter employment as technicians. Enrolments on access courses, designed specifically to prepare adults for entry to higher education, have been important growth areas in some departments. About half the colleges in the survey offer such provision. There is no formal entry qualification for access courses. They include 'year zero' courses which guarantee entry to an associated university degree programme. Many of the entrants are unemployed prior to joining these courses.

13 More than two-thirds of the colleges in the survey offer part-time higher education courses such as those leading to BTEC higher national certificates. Entry to these is usually from a related BTEC national award. However, departments sometimes widen opportunities for students by encouraging entry from C&G

advanced programmes; additional courses in mathematics are usually provided to support these students. Some colleges operate full-time programmes leading to higher national diplomas, funded by the Higher Education Funding Council for England. A minority of colleges provide part, or whole, degree courses franchised from, or validated by, universities.

14 About a quarter of the departments surveyed have courses, or course elements, that are designed specifically for students with learning difficulties and/or disabilities. Most commonly, they are offered for students designated as having emotional or behavioural difficulties. Few engineering departments have appropriate facilities for students with physical or sensory disabilities. Most claim that such students can be supported, although very few were seen during inspections.

RECENT DEVELOPMENTS

15 The introduction of engineering NVQs has been slow. Manufacturing, motor vehicle maintenance and repair, electrical installation and other areas of work are now partially included in the NVQ framework. The awards at NVQ levels 3 and 4 are not yet fully developed. Some areas, such as electronic servicing, have yet to be included at any level. However, most colleges are now able to deliver courses up to NVQ level 2 in a number of engineering disciplines. An increasing number of departments are involved in assessing the levels of skill in the local workforce in order to accredit employees with an appropriate NVQ. In these cases, college-based assessors advise on what further training and testing are required and the college is contracted to deliver these, often on site. Such work is usually associated with major employers.

16 GNVQ manufacturing courses were piloted in 1992-93 at intermediate and advanced level. This qualification is often related to non-engineering areas; for example, bakery, clothing

and pharmaceuticals. Engineering departments in the pilot scheme experienced considerable difficulties in delivering and assessing the courses satisfactorily. Recruitment was poor and enrolments in the further education sector remain low. In 1994-95, about 300 students were enrolled on 30 foundation level courses, 280 on 28 intermediate level courses, and 250 (only 54 in the second year) on 21 advanced level courses. In all, there are approximately 2,100 registrations on GNVQ manufacturing courses, more than half of them in secondary schools. Some courses include extra studies in mathematics and science in order to facilitate students' progress to an engineering course in higher education. For example, one student achieved an Engineering Council 'Top Flight' award to an accredited degree course. A number of GNVQ courses have been developed in conjunction with local industries.

17 In 1994-95, some colleges offered GNVQ pilot courses in engineering at intermediate and advanced levels. Those taking part in the 113 pilot schemes, involving about 2,500 students, have had mixed success in delivering and assessing the courses. Early indications are that pass rates in the externally-set assessments are poor, particularly at advanced level, although students often produce a high standard of course work. The National Council for Vocational Qualifications has taken urgent action to review the tests. From September 1995, GNVQ engineering became widely available. The number of centres doubled and over 7,500 students were registered on GNVQ engineering courses. BTEC's recent decision to continue with its national diploma awards has been welcomed by a few colleges that feel the GNVQ does not adequately replace existing courses in their pattern of provision.

18 A number of other general matters relating to engineering GNVQs and NVQs remain unresolved. Among these are:

- the funding arrangements for a joint GNVQ/NVQ programme. (Such programmes would be appropriate for aspiring technicians as the NVQs can provide practical and workshop elements to complement the GNVQ)
- the future of some part-time courses that were previously delivered jointly with full-time programmes but do not meet the GNVQ requirements
- the appropriateness of the GNVQ as a route to the existing range of part-time and full-time higher education courses.

19 A number of colleges are involved with Training and Enterprise Councils (TECs) in piloting modern apprenticeship schemes. The schemes are particularly effective where GNVQ engineering is offered as part of the modern apprenticeship and provides a focus and direction for the GNVQ. One programme, developed with the Rover car company, enables students to gain both GNVQs and NVQs. Many companies are reluctant to pay the cost of the full-time training which is involved in modern apprenticeship schemes and there is inconsistency between TECs in the proportion of these schemes for which they provide funds. Most companies preferred the former arrangements under which some of the costs were met by the FEFC.

COURSES FOR SPECIFIC INDUSTRIES AND EMPLOYERS

20 The close relations between many colleges and their local industries have enabled specialist courses to be developed in partnership. Examples of good collaborative course developments leading to national qualifications are found in all regions. One college has been contributing for seven years to a training scheme for multi-skilled maintenance technicians, which

includes intermediate, advanced and higher level courses. Some students have progressed through the further education components of the scheme to related engineering degree courses at a local university. Courses are sometimes delivered at the students' workplace; for example, one NVQ level 2 course, recruiting about 60 students a year, is based at an aircraft manufacturer's premises. Most engineering departments also provide at least a limited range of bespoke courses and other services for industry, the charges for which reflect the full cost of delivery.

21 The contraction of some industries has meant that the further education and training provision for them is being concentrated in very few colleges. For example, courses associated with mining are largely limited to one institution. Courses for the maritime and offshore sector are concentrated in five main centres. The international reputation of three of these centres has enabled them to recruit from overseas. Without the overseas students, the courses (and thus the resident expertise) might be endangered. Three of the four colleges that deal with foundry engineering work are considering closing their courses because of low recruitment. It is possible that only one centre will survive.

22 Engineering departments are increasingly providing courses specifically related to management. These are usually restricted to general programmes certificated by the Institute of Quality Assurance and specialist courses relating to the motor trade. Most colleges offer general management courses through other departments. There are few other opportunities for the continued professional training of experienced technicians and craftspeople.

ENROLMENT AND FINANCIAL ISSUES

23 All colleges in the sector are under pressure to increase enrolments. Growth is required to sustain or improve their funding from the FEFC and other sources. There is also a commitment to increased participation set out in the national targets for education and training. The colleges' engineering departments are usually expected to contribute to this growth. There were 289,000 students on engineering and technology courses in 1994-95 (annex B). From 1989-90 to 1993-94, engineering enrolments declined by about 10 per cent and this continued the following year with a reduction of a further 2 per cent. In 1994-95, the number of full-time students was about 67,000, an 11.7 per cent increase on the previous year, whilst the 222,000 part-time students represented a 5.5 per cent decrease on 1993-94.

24 College strategic plans indicate an intended growth in national engineering enrolments of about 23 per cent for full-time students and 20 per cent for part-time students over the next three years. Many engineering departments plan to achieve part of this growth by extending the full-time provision for students, including school leavers, with limited qualifications. These foundation programmes provide important new pathways to more advanced studies but they are unlikely to impart sufficient skills to improve students' short-term job prospects significantly. An analysis of the entry qualifications of students following technician and craft courses indicates that the drive to sustain or improve recruitment has been accompanied by a decline in the average level of achievement of those accepted.

25 Engineering is an expensive subject area. Even with healthy course enrolments, the size of groups participating in practical activities is necessarily limited by safety considerations. Many

programmes require access to large or sophisticated equipment. The FEFC and other agencies, for example some TECs, recognise this by assigning a higher weighting to engineering than to most other courses in their funding methodologies. However, some colleges still find it difficult to sustain engineering courses with small student numbers. As a consequence, a significant number of colleges in the survey have stopped offering some major specialisms, such as motor vehicle studies.

26 There is considerable variation in the amount of income engineering departments attract from sources other than the FEFC. Table 1 shows the annual income per full-time equivalent student, based on departments' total enrolments. Some departments are reducing their efforts to provide courses that would be funded directly by industry. Instead, they are offering FEFC-funded courses which are tailored to local industrial needs but carry a nationally-recognised qualification. This can be financially attractive to employers although they may not meet their needs ideally. Enrolments on such courses count towards the college's growth targets that have been accepted by the FEFC.

Table 1. Non-FEFC income in the engineering departments included in the survey

Source of income	Average per full-time equivalent (£)	Maximum per full-time equivalent (£)
Courses, and other work, directly funded by industry	182	845
TEC-funded training for 16 to 18 year-old students	223	1,225
TEC-funded training for adults	49	600
Other grants, gifts, etc	38	524

27 Colleges are concerned about the recent changes to the funding arrangements for training credits. By the end of the summer term 1994-95, the position relating to the fees for 16 to 18 year-old students on day-release courses was still not fully clarified. Engineering departments have often had a high proportion of day-release students and the fee income from these students formed a large part of the overall income earned by the departments. The payment of these fees is now the responsibility of the TECs in consultation with the student's employer. The level of this funding has fallen significantly and several colleges have begun redundancy procedures for teachers and other staff, because they predict a fall in demand for this provision.

COURSE STRUCTURE

28 Departments differ considerably in the way they structure similar courses. For example, in the colleges surveyed, full-time students following an engineering BTEC national diploma course were in direct contact with a teacher for between 15 and 27 hours a week. The average contact time was 21 hours. Generally, at least one hour a week was devoted to personal or group tutorial work. About a third of colleges quoted course hours which included the time during which students worked on their own using engineering equipment and resources. This time has been included in the data only if support was provided by a specialist teacher.

29 Table 2 illustrates the variation in the delivery of national diploma courses in engineering.

Table 2. Time spent on various activities in the national diploma courses in engineering

	Workshop hours	Laboratory hours	Classroom work, supported work and tutorial hours	Total hours
Average	4	4	13	21
College A	1	5	16	22
College B	7	3	11	21

30 Many departmental managers do not keep track of the balance of teaching methods that their staff use. For example, one head of department was unable to make any estimate of the breakdown for the courses in his department; it was assumed that each teacher used an appropriate mix of activities in their teaching.

31 A similar variation was seen with part-time, day-release courses. Here the contact time between teachers and students averaged eight hours a week but ranged from between six and 10 hours a week in different colleges. In many departments, the weekly contact time has fallen by between 30 and 40 per cent over the last 10 years.

32 In order to control costs college managers are, increasingly, specifying the maximum number of hours a week that students can be in direct contact with a teacher. Such constraints cause particular problems to managers of engineering courses who have to maintain an appropriate level of practical work in environments that require close supervision. However, the need to re-think course delivery can improve the students' learning experience. For example, in one college, the maximum contact time allowed for a full-time course was 20 hours. Lecturers at the college redesigned their national diploma course to have 18 hours of contact time, and this allowed the students to benefit

from extra academic tutorials and an open-access electronics workshop in the evenings. These were supported by teachers and were also made available to students from other courses.

33 Most engineering courses include a separate mathematics element designed to support the specialist work and to assist students' progress. However, many students enter these courses with an insufficient grounding in arithmetic, algebra and trigonometry. They have often studied GCSE courses in which these topics are not adequately covered. Mathematics is the subject most commonly failed by students on engineering courses. Diagnostic tests, such as those devised by the Basic Skills Agency, are increasingly being used to detect these and other weaknesses. Remedial work to improve performance is most likely to be effective if its vocational relevance is clear. For example, engineering students who are weak at mathematics are more likely to respond to a tailor-made programme specific to engineering rather than a GCSE mathematics course.

34 Engineering courses often have a formal requirement to develop skills in written and oral communication, and in information technology. These skills are sometimes assessed early in the course in order to detect individual weaknesses. Some colleges and awarding bodies require other personal skills to be developed such as initiative, leadership and the ability to work in groups.

35 It is becoming more common for engineering courses to be broken down into units. In many cases, individual units are taught and assessed over a single term. This arrangement has proved useful for students who only wish to study certain units, or those who need to repeat a unit they have previously failed. However, the teaching of separate units of mathematics or science is only effective if their relevance to the rest of the course is regularly reinforced. This is not always done.

TEACHING AND THE PROMOTION OF LEARNING

36 Engineering inspectors observed 2,869 learning sessions between September 1993 and July 1995. The distribution of the grades that were awarded is shown in table 3. The descriptors for each grade are given at annex A. In total, 61 per cent of sessions were considered to have strengths which clearly outweighed any weaknesses (grades 1 and 2); less than 7 per cent had weaknesses which outweighed the strengths (grades 4 and 5). These proportions are broadly in line with the distribution of inspection grades for all subjects.

Table 3. Engineering class observation grades between 1993-94 and 1994-95

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total
Number	398	1,348	938	170	15	2,869
Percentage	14	47	33	6	< 1	100

37 Teaching in workshops and laboratories is generally good. Students who choose to study engineering usually have a natural affinity with practical work, and they enjoy and benefit from it. The lessons that were graded 1 or 2 include a disproportionate number of practical sessions. In many of these classes, students are able to work alone on individual tasks. In most sessions in engineering workshops, students perform individual jobs in stages, using a range of machinery. In computer-aided design classes, each student usually has a computer workstation and follows a self-teaching manual containing progressive tasks. Well-equipped general electronics laboratories often contain a large number of identical sets of equipment that allow each

student to work individually. In these situations, students are able to progress at a pace best suited to their needs and can usually only move on to the next task when the previous task has been completed satisfactorily. This encourages learning and maintains students' self-esteem by giving them some control over their progress. Such teaching is most effective when certain tasks have to be performed against time constraints. For example, in many motor vehicle and electrical installation NVQ classes, students practise competences with no time limitations, but time constraints are introduced once the student is ready to have a competence assessed.

38 Classroom sessions are generally of a weaker standard. They received a disproportionate number of inspection grades 3 to 5. Engineering teachers, like their students, are often more at ease in a practical setting. The development of some fundamental subjects, such as engineering science, is too often over-theoretical and remote from the main focus of the course. Successful teaching seeks to make the necessary underpinning knowledge and understanding directly relevant to the students. In the best classes, lecturers draw on their own and the students' experiences to enliven the learning. Teachers of motor vehicle classes for part-time students are particularly adept at this. They use technical, often humorous, examples from their own garage experiences and invite students to contribute to discussions by describing examples of their own or details of the particular models on which they work. The best lessons are planned in considerable detail. In one electronics theory class, the lesson plan included aims, approximate timings, questions to be answered, and tasks to be set. The lecturer's lively delivery and direct questioning of individual students produced excellent responses. The lesson was punctuated by a series of short tasks set to timed deadlines. It was conducted with humour and the lecturer showed an appreciation of students' questions and answers.

39 There are some common weaknesses. In workshop sessions, teachers too often allow students to complete 'job planning' schedules after they have completed the task. Classroom sessions sometimes include extended periods of copying from the board or overhead projector screen. Few teachers make sufficient use of information technology to collect, use or display data in either practical or classroom sessions.

40 Many departments have developed appropriate systems for assessing and recording the development of the practical competence needed to gain an NVQ. However, a few have poorly designed or over-complex arrangements. Various methods are used for assessing knowledge and understanding on NVQ courses. In the better schemes, teachers question students during their workshop training, record responses carefully, and require the students to complete written assessment exercises. In some schemes, however, students are required to complete only pre-printed workbooks that contain background information and structured questions. Such workbooks are common in motor vehicle NVQ courses. Students can do what is required simply by copying from class notes, or even from the workbook itself. On the GNVQ engineering pilot courses, the recording systems used by teachers and students are sometimes not clear enough to enable achievements to be verified satisfactorily by a third party.

RESOURCES

STAFFING

41 The number of full-time engineering teachers in the further education sector has fallen considerably over the last decade; many colleges have offered early retirement incentives. One college has reduced its full-time teaching staff from 28 in 1990 to

13 in 1995. The overall position appears to have stabilised in the last three years.

42 The few new teachers who have been recruited often bring with them fresh ideas and up-to-date industrial experience. For example, the personal contacts of one new teacher from the motor industry have resulted in a group of NVQ level 2 motor vehicle students acting as the support team for a rally car entered in national events. The students strip, inspect, service and test the vehicle, vying with each other to attend the rallies as mechanics.

43 There are too few female teachers of engineering to provide the role models and support which would both help female students and demonstrate that engineering is relevant to males and females. The highest proportion of female engineering teachers in any of the colleges inspected was about 6 per cent. Managers often attempt to redress the imbalance by using women teachers in supporting subjects, such as mathematics, and as course tutors.

44 Overall, about 12 per cent of engineering teaching is delivered by part-time staff. In the colleges surveyed, the proportion ranged from zero to 30 per cent. The picture has changed considerably in individual colleges over the last three years. One department with declining enrolments has reduced by four-fifths the proportion of work undertaken by part-time teachers. In contrast, another department has tripled the contribution of part-time teachers. Where the proportion of part-time teachers is particularly high, the burden of administration and management for the full-time team is often excessive. Part-time teachers frequently work in the engineering industry and their knowledge of current industrial practice enables them to make a valuable contribution to courses. Some colleges employ visiting lecturers to address specialist topics directly related to

their jobs in industry. Among the colleges in the survey, there was no clear link between the proportion of teaching carried out by part-time staff and students' achievements. Three colleges with good results had more than 20 per cent of the curriculum delivered by part-time staff. Others with equivalent results used part-time staff for less than 10 per cent of the teaching.

45 About one in five of the colleges in the survey employ instructors/demonstrators, at lower rates of pay than teachers, to deliver some of the engineering curriculum. This compares with one in 20 three years ago. In virtually all of these colleges, the percentage of the curriculum delivered in this way is increasing. Generally, the role of the instructor/demonstrator is to supervise students in the workshops and instruct on the use of specialist equipment. Inspectors found no evidence that the overall quality of the courses was reduced where instructors were used in this way. Two colleges with good examination results employ instructors/demonstrators to deliver more than 20 per cent of their engineering provision.

46 On average, the colleges in the survey employ one specialist technician for every 43 full-time equivalent students, although this ration ranges from 1:23 to 1:90. Practical classes are usually more effective when the teacher is assisted by a technician and the two work together as a team. Whilst the level of technician support for lecturers in the classroom, laboratory and workshop is often good, clerical and administrative support for the lecturers' roles as tutors and course managers is inadequate. It is not unusual for one secretary/administrator to support all the teaching staff in a department of 20. Many of the routine tasks undertaken by teachers would be more efficiently, and probably more effectively, carried out by trained office staff.

47 Teachers generally hold appropriate qualifications for the courses they teach. Some colleges will need to raise the level of teachers' professional qualifications in engineering if they are to expand their higher level work in line with their strategic plans. In the colleges surveyed, an average of 35 per cent of full-time teachers have specialist first degrees and a further 31 per cent hold higher national certificates or diplomas. The proportion of staff who are graduates varies widely between colleges. For example, in one sixth form college, all the technology teaching staff have degrees. In another college which has predominantly NVQ and C&G part-time courses almost all the teachers, appropriately, hold advanced craft qualifications.

48 About 70 per cent of full-time engineering teachers have a teaching qualification, though the proportion in the colleges surveyed ranged from 7 per cent to 100 per cent. The students' examination results were not necessarily better in those colleges where the proportion of trained teachers was higher.

49 The extent to which teachers are qualified to assess and verify GNVQ and NVQ awards varies widely. At the time of the survey, a third of engineering teachers, on average, held assessor awards. In some departments none, or very few, are yet qualified, whereas in other departments all are qualified assessors. The college in the survey which has been most active in this area also has one-third of its teaching force qualified to act as external assessors or verifiers. This provides a valuable opportunity for teachers to learn about developments and standards in other colleges, and enables them to assess competence in the workplace.

50 Staff development programmes continue to be focused on preparation for the introduction of GNVQs and training for assessor/verifier awards; only a minority of colleges have also

maintained a good programme of technical updating. Although more teachers are now involved in course management, training for management tasks is uncommon. Secondments to industry were rare and there were no secondments from industry to the engineering departments in the colleges surveyed. In many colleges, individual staff maintain good contacts with industry through visits associated with student training placements. Some teachers are particularly active in liaising with industry. They maintain good personal contacts and are able to develop specific training programmes to meet individual companies' requirements. The delivery of these courses often brings other teachers alongside practising engineers or technicians.

EQUIPMENT AND LEARNING RESOURCES

51 The engineering equipment in most colleges has been upgraded, at least in part, even during a period when enrolments have declined. In about half the colleges inspected between 1993-94 and 1994-95, there were notable strengths in some aspects of the equipment base. In about one in 10 colleges it was generally poor and most colleges had weaknesses in some areas.

52 General engineering workshops nearly always contain much old equipment which only remains serviceable through light use and careful maintenance. Electrical and electronic engineering workshops and laboratories sometimes have outdated and unreliable measuring equipment. Engineering science rooms often have had little recent investment. The demands of NVQs have resulted in increased expenditure in many motor vehicle workshops, for example, to provide modern vehicles and create realistic garage reception areas. Resources for specialist aero-mechanics/technicians courses generally need upgrading.

53 Computer-aided design equipment is often of good industry standard; many colleges are the main suppliers of training for industry in this area of work. The associated numerically-controlled manufacturing equipment is expensive and therefore more dated; most colleges are still dependent on the machinery provided through government-funded schemes some years ago. Outmoded computer equipment is still sometimes in use. This is acceptable in some specific applications but its use in the teaching of wider engineering applications work is not representative of modern industrial practice.

54 The equipment base is funded in different ways. In some colleges, costs have been at least partly met through income earned directly from industry. For example, one college with a strong maritime provision has maintained an excellent specialised telecommunications suite in this way. Grants from government and European Union initiatives have also been influential in areas where there has been significant industrial decline. A computer-based flexible electronics laboratory was installed in one department as a result of receiving approximately £100,000 from European Union sources. Gifts, loans, or generous discounts from industry have been important in enabling some colleges to acquire high-quality equipment. Manufacturers and local motor vehicle dealerships sometimes supplied modern vehicles, engines and test equipment free or on indefinite loan.

55 Only a few colleges have formal replacement programmes for their engineering equipment. There is widespread opinion among heads of engineering departments that there is little point in drawing up a realistic replacement programme because insufficient funds are likely to be available to carry it out. Students frequently comment on equipment which they perceive to be outdated or of poor quality. They make adverse

comparisons with the equipment available at their place of work or that used by private training providers.

56 Many college libraries have inadequate stocks of modern engineering textbooks and journals. It is common to find volumes that have not been issued for many years or relate to areas of work no longer covered by the college. Good librarians liaise with course teams to ensure that stock is kept up to date. Their staff actively support teaching, for example by preparing and reserving learning resource materials in readiness for student assignments.

57 Colleges often have learning centres which, as well as being traditional libraries, house information technology equipment, audio and video-tape facilities and paper-based learning materials. About one in 10 colleges in the survey had learning resource centres specifically for engineering. Some of these have an extensive range of workbooks and other materials that enable engineering students to work on their own. However, some departments which deliver a significant proportion of the curriculum through learning resources designed for students to work on independently have not invested sufficiently in engineering-related learning materials and staff training. In the last few years, an increasing number of colleges have invested in computer-based teaching equipment for subjects associated with electronics. Students welcome the opportunity to learn on modern equipment but, in general, the systems are not being used to their full potential.

ACCOMMODATION

58 About half the colleges in the survey have altered considerably their engineering accommodation over the last five years. A further quarter have significant changes firmly planned.

The alterations have frequently resulted from a college-wide rationalisation prompted by changing enrolment patterns or the closure of some engineering specialisms. The overall area available for specialist engineering work has, in many cases, been considerably reduced, but the outcome is often that there are higher-quality spaces which are used more effectively. In a few cases, major building programmes are under way. One college is constructing an impressive new technology centre for its engineering and construction provision at a cost of some £11 million. The centre is sited on a new industrial technology campus and its design ensures good access for students with restricted mobility.

59 Alterations to accommodation frequently result from changes to the curriculum and its delivery. For example, many colleges are modifying their existing workshops in order to deliver NVQs in electrical installation and motor vehicle work. Classroom facilities that are integral with, or adjacent to, practical rooms are increasingly common. They allow background knowledge, and writing and numeracy skills, to be more easily developed in parallel with practical competences.

60 Significant shortcomings remain in the accommodation used by many engineering students. Classrooms sometimes lack basic teaching aids, wall displays and material that relate to the subject being taught. The general engineering workshops frequently have a dowdy appearance. Opportunities are often missed for using corridors and public spaces near engineering rooms to promote the excitement of the subject. In some colleges, major parts of the engineering teaching take place in industrial units that are held on short-term leases.

RECRUITMENT, COMPLETION AND SUCCESS

RECRUITMENT

61 Recent large-scale industrial closures and redundancies have made a career in engineering unattractive to many young people. Departments report particular difficulties in attracting students with good GCSE grades. Half of the colleges in the survey saw a reduction in the number of full-time equivalent students recruited between 1992-93 and 1994-95. In a quarter of the colleges, the reduction was more than 10 per cent. The majority of recruits are male; in 1993-94 only 8 per cent of students enrolled on FEFC-funded engineering courses were female.

62 About a quarter of the colleges in the survey achieved a growth in full-time equivalent enrolments of more than 20 per cent between 1992-93 and 1994-95. These colleges were distinguished by a number of common features, including:

- active links and special initiatives with schools. For example, second-year, full-time students at one college assist school teachers with science and technology classes and schools near another college benefit from the use of a well-resourced drop-in centre which helps them to cover aspects of national curriculum technology
- a wide choice of programmes at all levels, including provision suitable for students with low prior achievements
- close involvement with industrial partners. For example, higher level courses in mechatronics and tunnelling technology have been developed by one department in consultation with local businesses

- strong links with local training agencies or the college acting as a managing agent
- clear progression routes between courses and initiatives to promote access to higher education institutions. For example, one department's close links with universities has resulted in a local agreement on entry arrangements, and tutors from the universities attend parents' evenings.

COMPLETION

63 On some courses, many engineering students fail to complete their studies. Table 4 gives completion rates for courses ending in 1994 in the colleges surveyed. There has been little change in these rates over the last five years. In comparison, the average completion rates for these types of courses in the further education sector as a whole is about 70 per cent[8].

Table 4. Completion rates for the 43 colleges included in the survey

Course type	Minimum (%)	Maximum (%)	Average (%)
One-year, full-time, intermediate level	54	100	73
One-year, part-time, intermediate level	50	100	83
Two-year, full-time, advanced level	23	90	62
Two-year, part-time, advanced level	46	100	76
Two-year, part-time, higher level	33	100	78

Note: Completion rates relate to the percentage of students enrolled on the course at 1 November who attend until the course ends

64 Part-time students are often in employment or full-time training. Their motivation is generally higher than that of full-time students, and their employers or training companies monitor their progress and attendance closely. As a consequence, average completion rates are higher on part-time than on full-time courses. Some full-time students transfer to more appropriate courses, leave for jobs, or leave to join training agencies. For example, on one BTEC national diploma course, 12 of the 34 students attending on 1 November 1994 had withdrawn from the course by 1 February 1995. Five of these had found employment or training places; the college expected the majority of these to re-enrol on part-time courses in 1996.

65 Such explanations do not account for the wide variations in completion rates shown in table 4. Colleges which are most successful in retaining their students often have features in common. These include:

- a wide range of courses at each level which allows students to choose a course which is most suited to their abilities and aspirations
- an admissions system that provides advice from both the engineering department and the college careers service
- close involvement of the parents and employers of 16 to 18 year olds through initial interviews, open evenings, and progress reports
- diagnostic screening during the induction process to identify particular weaknesses or learning difficulties
- timetabled learning support that is specified in students' learner agreements and is carefully monitored by tutors
- systems which detect and rapidly determine the reasons for student absence

- regular, structured, individual interviews with personal tutors, which are used to review progress and develop personal action plans
- ready access to teaching staff outside timetabled course hours.

SUCCESS

66 The majority of students enrol on courses marketed as leading to a specified qualification within a defined length of time. Many colleges now have learner agreements with each student in which these targets are stated. One indicator of the success of a course is the proportion of enrolled students who achieve the course qualification within the specified time. Measured on this basis, success rates are very low on many engineering courses. A sample of the information collected in the survey, relating to courses ending in 1994, is shown in table 5.

Table 5. Success rates for the 43 colleges included in the survey

Course type	Minimum (%)	Maximum (%)	Average (%)
One-year, full-time, intermediate level	14	74	46
One-year, part-time, intermediate level	25	94	60
Two-year, full-time, advanced level	5	89	48
Two-year, part-time, advanced level	17	80	55
Two-year, part-time, higher level	19	97	64

Note: Success rates relate to the percentage of students enrolled on the course, on 1 November 1992 (for a two-year course) or 1993 (for a one-year course), who obtained their target qualification by 1 September 1994

67 Colleges are beginning to use cohort success as a performance indicator and the low success rates have been a spur to identify causes and take remedial actions. However, few colleges calculate the rate over the full length of a two-year course, preferring to use a year-by-year measure. This gives a distorted picture since second-year groups often contain extra students in addition to the original cohort. For example, one college recruited only eight students to a two-year national diploma course in 1992. Of these, six succeeded (a 75 per cent cohort success rate). However, in 1993, five new students joined the second year of the course and 12 others joined the group for various periods to take particular units of the course.

68 The most commonly quoted indicator of success is the proportion of students who, having completed the course, achieve the target qualification. This 'pass rate' is also poor on many courses. The average pass rate for students on all vocational courses in the further education sector is 77.5 per cent[9]. Table 6 shows figures derived from the survey for courses ending in 1994.

Table 6. Pass rates for the 43 colleges included in the survey

Course type	Minimum (%)	Maximum (%)	Average (%)
One-year, full-time, intermediate level	15	100	63
One-year, part-time, intermediate level	40	98	72
Two-year, full-time, advanced level	17	100	77
Two-year, part-time, advanced level	33	95	71
Two-year, part-time, higher level	50	100	82

Note: Pass rates relate to the percentage of students who completed their course in 1994 and who achieved their target qualification by 1 September 1994

69 The most common reason given by college staff for poor pass rates is that the pressure to increase enrolments has caused colleges to take students with lower qualifications. However, colleges have to acknowledge that students have a right to expect that they will be placed on courses which offer them a reasonable chance of success. Decisions about recruitment criteria cannot be taken in isolation from decisions about curriculum design, teaching methods and learning support. If a college or a department decides to admit students with lower entry qualifications, it should expect to modify its teaching and increase the level of learning support to reflect the different characteristics of its students. Many engineering departments have not addressed these issues.

70 A factor which contributes to the low pass rates is the number of separate assessments that have to be passed in order to qualify for an award. For example, a student on a BTEC national diploma course may have to pass 16 different units. A student on a part 2 C&G mechanical craft studies course has to pass 12 written examinations, as well as practical assignments, to obtain an award. Pass rates on individual units are often high (above 90 per cent). Some departments have, in the past, reported their performance in terms of unit pass rates and this has disguised some poor course results. It has become accepted in some departments that pass rates calculated at the end of the normal course duration will be low and that students will either resit one or more of their assessments or re-attend part of their course. In effect, their course is being extended.

71 Some departments consistently achieve good results across all courses. Colleges that have good pass rates are often those which recruit successfully and where the completion rates are above average. The majority of colleges with high levels of

achievement in their engineering courses had contact hours at or above the average. The successful courses are often distinguished, not only by the common features that lead to good retention, but also by:

- teaching of high quality
- well-organised, integrated work experience arrangements for full-time students
- course teams that meet regularly, review their activities closely and monitor student progress carefully
- effective quality assurance procedures which involve the collection and analysis of performance data and of students' opinions
- appropriate accommodation and equipment.

72 The completion, success and pass rates shown in tables 4, 5 and 6 indicate that many engineering students are not receiving a satisfactory experience during their time at college. Too many of those recruited drop out before the end of their course. Too many of those completing their course fail to achieve their qualification on time.

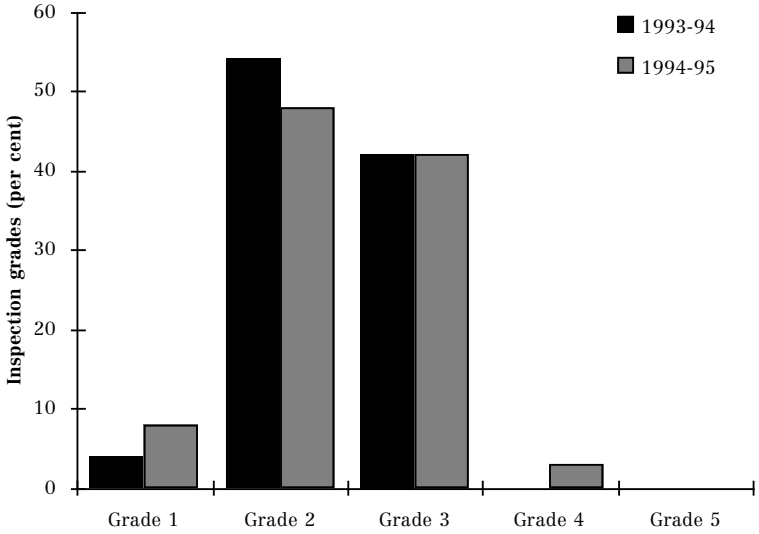
CONCLUSIONS

- 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 per cent in the next three years
- the planned expansion is mainly in provision for students with few qualifications; lower levels of achievement on entry are already being accepted
- about one in four engineering departments achieved a growth in recruitment of more than 20 per cent over the last two years; common features in these colleges included active links with schools, strong partnerships with local employers and a wide choice of courses at a variety of levels
- 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
- many students start their engineering studies with an inadequate grounding in mathematics and this is the subject most commonly failed in engineering courses
- 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
- 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

- 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
- GNVQs in manufacturing are attracting few students and the GNVQs in engineering have yet to be fully established
- 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
- 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
- student completion rates on some courses are poor; departments which achieve good completion rates have a number of features in common
- 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.

PUBLISHED GRADES FROM INSPECTIONS OF ENGINEERING, 1993-94 AND 1994-95

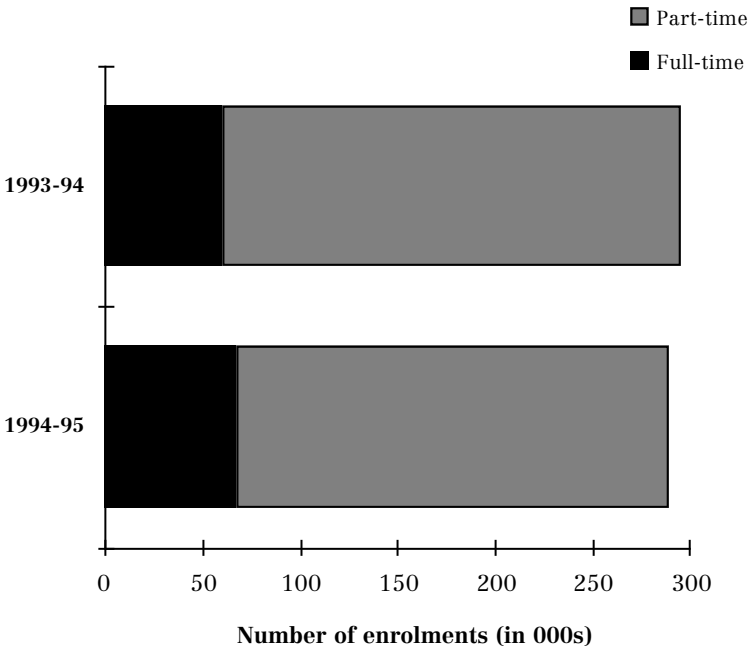


Source: inspectorate database, July 1995
Sample size: 1993-94 = 50, 1994-95 = 79 assessments

Grade descriptors

Grade 1	Provision which has many strengths and very few weaknesses
Grade 2	Provision in which the strengths clearly outweigh the weaknesses
Grade 3	Provision with a balance of strengths and weaknesses
Grade 4	Provision in which the weaknesses clearly outweigh the strengths
Grade 5	Provision which has many weaknesses and very few strengths.

ENGINEERING STUDENT ENROLMENTS, 1993-94 AND 1994-95



ORGANISATIONS CONSULTED DURING THE SURVEY

British Petroleum (BP)

Department of Trade and Industry (DTI)

Engineering Council (EC)

Engineering Employers Federation (EEF)

Engineering Services Standing Conference (ESSC)

Engineering Training Authority (EnTrA)

Further Education Development Association (FEDA)

Marine and Engineering Training Association (M&ETA)

National Forum for Engineering in Colleges (NFEC)

Women Into Science and Engineering (WISE)

ENDNOTES

1. *Assessing Achievement,* Council Circular 93/28
2. R. A. Wilson, *Review of the Economy and Employment 1994: Occupational assessment*, Institute of Employment Research, 1994
3. *Competence and Commitment*, Engineering Council, 1995
4. *Skills and Enterprise Briefing*, note prepared for the Department of Employment and the Engineering Council, August 1994
5. In this report 'department' also covers sections, faculties and schools within colleges.
6. National Advisory Council for Education and Training Targets, May 1995
7. FEFC statistical records
8. FEFC statistics, ISR 1994-95 at 31 July 1995
9. Department for Education and Employment performance tables 1995

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