THE ENGINEERING COUNCIL

TECHNOLOGY AT A-LEVEL

Alan Smithers and Pamela Robinson

GETTING IT RIGHT

First published September 1992

ISBN 0 95166113 2

Foreword

In May 1992 The Engineering Council published its report "Technology in the National Curriculum" which gave an analysis of the development of technology in schools and identified the problems associated with it. This report has had a major impact and helped to convince the Secretary of State that the legislation should be revised. A review by HMI is now under way and they are required to report to the Secretary of State by October 1992.

One of the main recommendations of the eight-point rescue plan proposed in the report "Technology in the National Curriculum" was that there should be clear progression in content with the subject acting as a stepping stone to higher education and employment.

It was therefore a logical step to ask the same authors, Professor Alan Smithers and Dr. Pamela Robinson of the Centre for Education and Employment Research, University of Manchester, to investigate what is happening with regard to technology at A level. They were also asked to consider what could be done to secure A level Technology as an important, worthwhile and valuable subject in its own right.

The authors have again produced a comprehensive report which I see as an important contribution to the national debate on technology in schools. I strongly commend it to Government and its advisory bodies, the National Curriculum Council and the School Examinations and Assessment Council, and the Examination Boards.

This report is the second in The Engineering Councils series on technology as a school subject. We are publishing it because we firmly believe that technological capability is the key to the UK's socially-responsible wealth creation and the quality of life for its people.

Denis E Filer CBE TD FEng
Director General, The Engineering Council

Contents

Introduction

1. The main point about A level technology is that there is no A level technology. Unlike, say physics, there is no one clearly recognised and recognisable subject. This is curious since the importance of a well-developed ladder from school to higher education is self-evident. Technology has now been made one of the subjects of the national curriculum 5-16 and it has long been part of higher education. But the vital stage in-between - education 16-19 - as for other subjects has been largely left to its own devices. What this amounts to in practice for technology is a heterogeneous collection of studies from diverse origins attracting, even now, rather few students. Neither are there clear pathways from technology in school to employment.

2. How has this come about and what can be done? In this paper we consider - through reviewing the development and take-up of the examinations, visits to schools, and interviews with pupils, teachers and higher education admissions tutors[1] - why there appears to be no obvious stepping stone from technology in the national curriculum to technology in higher education.

Evolution of A-Level Studies

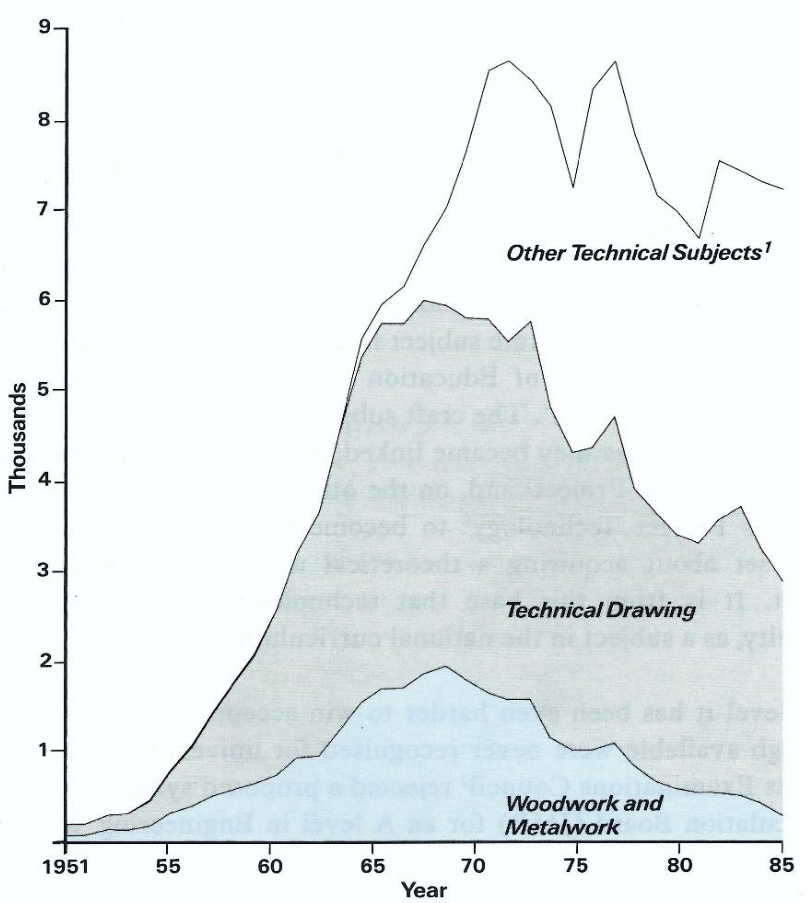
3. The evolution of school subjects in the 'technology area'[2] came about as described in Technology in the National Curriculum[3]. Woodwork and metalwork were first introduced into elementary schools just over a hundred years ago, and technical drawing was made a separate subject in 1898. This configuration still existed when the General Certificate of Education (GCE) came into being in 1951 and was included in its provision[4]. The craft subjects, however, were never happy with their status. In the sixties they became linked, on the one hand, with design through the Keele Handicraft Project[5] and, on the other, with technology through the Schools Council's Project Technology[6] to become Craft, Design and Technology, CDT, which set about acquiring a theoretical underpinning and defining itself as a subject. It is from this base that technology is emerging, not without some difficulty, as a subject in the national curriculum.

4. At A level it has been even harder to win acceptance. Woodwork and metalwork although available were never recognised for university entrance. The Secondary Schools Examinations Council[7] rejected a proposed syllabus in 1956 from the Joint Matriculation Board (JMB) for an A level in Engineering Workshop Theory and Practice as unsuitable for academic study, and while an A level in Applied Mechanics and Drawing was entertained it was only on the grounds that it might be suitable for students who found pure science too difficult.

5. GCE A-level examinations are the direct descendant of university entrance examinations and play an important part in allocating students within a specialised and selective system. They epitomise high level academic - that is to say primarily analytical and writing - skills. Even the more applied and practical areas of higher education, like medicine, engineering and architecture, recruit on academic attainment. Would-be practical subjects at A-level have therefore tended to present themselves as academic.

6. Approaches to technology have been of two kinds: the science-based and the craft-based. Perhaps the best example of the science-based is Engineering Science which was put together in the late sixties by a group of dedicated enthusiasts as an alternative to physics on the entirely logical basis that while pure science is essentially about understanding, engineering is mainly about arriving at practical solutions[8]. But, although painstakingly constructed and given appropriate support through textbooks, laboratory and coursework materials, and teacher training, it did not catch on. The total entry never rose much above 450 and it has now dwindled to a handful. This is largely because it was conceived as a direct competitor to physics, the established market leader, which could provide all the opportunities that engineering science could and moreover kept more options open. The unequal struggle has been conceded and the JMB is now pinning its hopes on an applied version of physics called Physics B.

Figure 1: A Level Entries in Practical Subjects



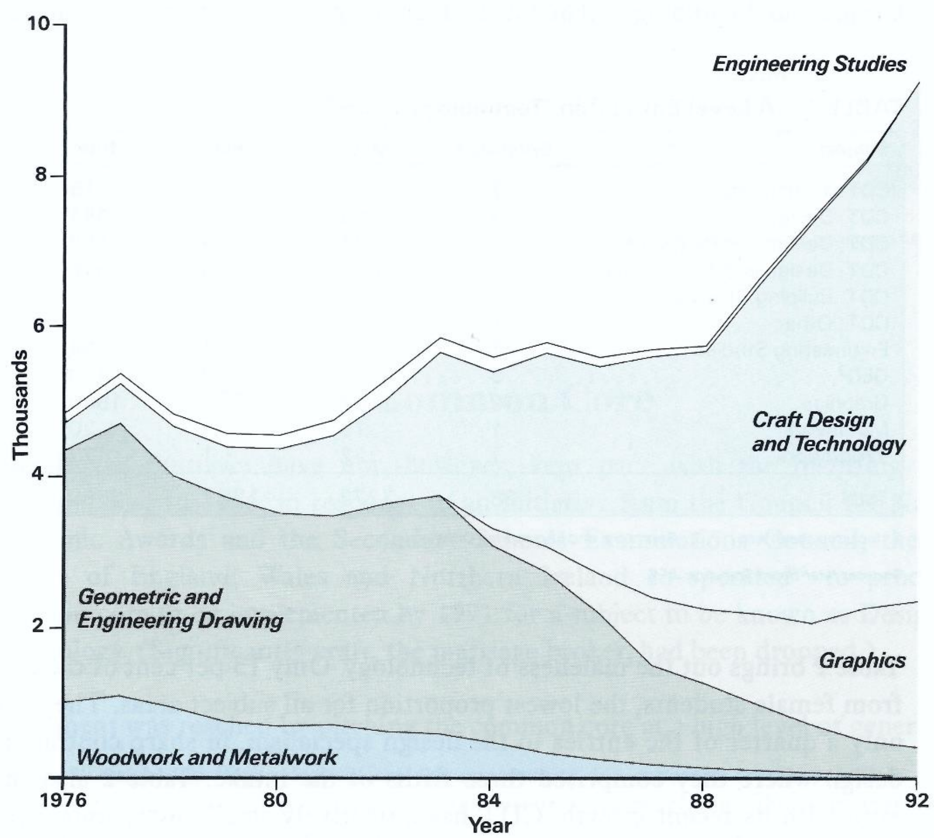
1. Heterogenous category also including 'other science' subjects.

Source: *Statistics of Education, School Leavers*, DES; data not available beyond 1985; from 1978 England, up to 1978 England and Wales.

7. The other main approach has been craft-based. Developments down the school were followed at A-level where CDT again became the generic title. However, unlike engineering science which had an explicit purpose, in CDT the main impetus came from changes pre-16 and it was never made clear how it was to combine with other A-levels or where it was to lead in higher education.

8. The quantitative impact of these developments can be seen in Figures 1 and 2. Figure 1, which takes the story to 1985, shows that woodwork/metalwork and technical drawing, present from the start of A-levels in 1951, reached peaks of about 2000 and 4000 respectively in the late sixties from which they have progressively declined. But tucked away among 'other technical subjects' (which also includes 'other science subjects') are the science-based and craft-based initiatives.

Figure 2: A Level Entries in 'Technology'



Source: Data compiled by HMI using SEAC categories.

9. We can follow their progress in the more detailed analysis of Figure 2, based on data compiled by Her Majesty's Inspectors (HMI) using the School Examinations and Assessment Council's (SEAC's) categories. The decline of woodwork and metalwork continued to the point where they were withdrawn in 1991, and the falling away of technical drawing (geometric and engineering drawing in SEAC's terms) has been offset, to some extent, by the introduction of graphics. But, most interestingly, in Figure 2 we can see the fate of the science-based and craft-based approaches: engineering studies failed to establish itself while CDT has grown but only from about 400 entries in 1976 to nearly 7000 in 1992, spread across 20 syllabuses.

The Current Position

10. The heterogeneity of CDT is evident in Table 1 which shows the most recent listing in *Inter-Board Statistics*[9] In 1991 there were 8569 entries in the 'technology area' across 38 syllabuses including CDT: Technology; CDT: Design; CDT: Design and Realisation; CDT: Design and Technology; CDT: Building Studies; CDT: 'Other'; and, in addition, Engineering Studies; Geometric and Engineering Drawing; Graphics; Metalwork; and Woodwork. As diverse as this is, it represents some slimming down from 1990 when 8100 entries were scattered across 51 syllabuses. The apparently tidy pattern involves some potentially confusing classifications. The syllabus commonly referred to as 'Cambridge technology', for example, with about 600 entries, appears not as CDT: Technology but as CDT: Design and Technology. (The CDT: Technology is the Northern Ireland syllabus.)

Table 1: A Level Entries[1] in 'Technology', 1991

Subject	Syllabuses	Male	Female	Total	% Female
CDT: Technology	2	18	0	18	0.0
CDT: Design	3	1498	486	1984	24.4
CDT: Design and Realisation	1	134	18	154	11.8
CDT: Design and Technology	12	3092	418	3510	11.9
CDT: Building Studies	1	196	21	217	9.7
CDT: Other	1	286	46	332	13.9
Engineering Studies	1	31	3	34	8.8
GED[2]	5	410	29	439	6.6
Graphics	10	1567	273	1840	14.8
Metalwork	1	18	2	20	10.0
Woodwork	1	22	1	23	4.3
Total	38	7272	1297	8569	15.1

1. Includes absentees. 2. Geometric and Engineering Drawing.

Source: *Inter-Board Statistics*, AEB.

11. Table 2 brings out the maleness of technology. Only 15 per cent of the entries were from female students, the lowest proportion for all subject areas. They contributed only a quarter of the entries to the design specialism, in sharp contrast to art and design where they comprised three-fifths of the intake. Table 2 also shows that, even with its recent growth, CDT has a relatively small entry, amounting to only about a fifth of that in physics and a ninth of that in maths. (In 1991 there were also only 418 AS entries in the technology area compared to 1988 in physics and 13,523 in maths.)

Table 2: A Level Entries[1] in Selected Subjects, 1991

Subject	Male	Female	Total	% Female
Technology	7,272	1,297	8,569	15.1
Physics	34,104	9,892	43,997	22.5
Chemistry	26,626	18,502	45,128	41.0
Mathematics	50,443	25,166	75,611	33.3
Computer Studies	7,095	1,681	8,776	19.2
Business Studies	8,248	7,811	16,060	48.6
Art and Design	7,062	11,047	18,110	61.0
Home Economics	128	3,555	3,683	96.5

1. Includes absentees.

Source: *Inter-Board Statistics*, AEB.

12. Entries by school or college shown in Table 3 reflect the uncertain beginnings. A-levels in the technology area tend to be under-represented in independent and grammar schools, and more common in comprehensives and, to a lesser extent, the sixth form colleges. Interestingly, they are also thin on the ground in the Further Education colleges, where presumably technical abilities are developed mainly through other types of qualification.

Table 3: Technology at A-Level by Centre, 1991[1]

School or College	Technology		All Subjects	
	N	Per cent	N	Per cent
Comprehensive	4,392	52.9	247,444	35.4
Grammar	575	6.9	67,100	9.6
Secondary Modern	93	1.1	5,235	0.7
Sixth Form College	1,537	18.5	94,024	13.5
Independent	938	11.3	108,113	15.5
FE	476	5.7	129,234	8.5
Tertiary College	180	2.2	31,356	4.5
Others[2]	111	1.3	16,535	2.4
Total	8,302	100.0	699,041	100.0

1. For those who received a result; does not include absentees.
2. Private candidates and miscellaneous (ESN, maladjusted, physically handicapped, community home, borstal, prison, and tutorial college).

Source: *Inter-Board Statistics*, AEB.

A Common Core

13. *Inter-Board Statistics* have not, however, kept pace with the re-titling of the examinations. In 1986, in response to an initiative from the Council for National Academic Awards and the Secondary Schools Examinations Council, the GCE Boards of England, Wales and Northern Ireland co-operated[10] to produce a common core to be implemented by 1991 for a subject to be known as Design and Technology. (Significantly craft, the marriage broker, had been dropped.)

14. Agreement was reached by pitching the common core at a high level of generality:

> "Design and Technology offers the opportunity for exposure to the processes involved in beneficially harnessing the resources of people and the earth they inhabit, through the creation of appropriate artefacts and/or systems. A course based on the Design and Technology core will: (i) enable students to participate in the process of designing and whilst doing so, exercise responsibility towards identifying and meeting needs in the made world; (ii) provide the opportunity for students to exercise initiative, imagination and resourcefulness, to acquire inter-disciplinary skills and knowledge in the pursuit of designs; (iii) encourage students to develop critical awareness of the made world, and learn how they can be constructively involved in influencing it."

The core has two sections: designing and resources. Design is taken to be an interactive process involving investigation and planning, specification, generation, synthesis, making, evaluation and communication. Resources are sub-divided into technological understanding (for example, materials, control systems, energy and environment), aesthetic awareness (for example, the perception and appreciation of line, shape, form, proportion, space, colour, movement and texture) and constraints (for example, those arising from costs, skills, resources and time).

15. The common core is intended to constitute at least 60 per cent of the assessment. Beyond that there is scope for some specialisation which can be marked by endorsing[11] the title as in Design and Technology (Design), Design and Technology (Technology) and Design and Technology (Communication).

One Subject?

16. Although apparently specifying a subject the common core allows considerable scope. We can see this in the detail of, for example, Cambridge Design and Technology (Technology) and Oxford Design and Technology (Design).

Design and Technology (Technology)

17. The Cambridge syllabus regards technology as the application of science and maths:

> "The acquisition of a good level of mathematical, scientific, design, communication and practical skills is necessary to achieve the depth of understanding required. Considerable importance is placed on the application of scientific principles and technological concepts within the design process when solving practical problems."

The examination is based on coursework carrying 45 per cent of the total marks, and three written papers, the common core, 25 per cent, and two options from four - structures, automation, electronics, materials processing - each counting 15 per cent. In the common core paper the candidates are asked in four hours to tackle one from five design problems, for example, a device for weeding from a raised bed, an arrester to prevent a door slamming, an external lighting system for a house, a starting gate for motor cycle races, and a personal attack alarm.

Design and Technology (Design)

18. In contrast, the Oxford syllabus does not specify mathematical and scientific understanding but states that it has been "designed for students with a good all round general education at 16+". There are three components to the examination: a written paper, 40 per cent, a case study, 20 per cent and a project, 40 per cent. The written paper, incorporating the common core, is in two sections with a total of five questions to be answered in three hours. The first section is concerned with "understanding of the effects of design placed on the designer by such aspects as conservation, ecology, energy and visual awareness". A typical question asks the candidate to discuss technology in relation to pollution and the use of non-renewable energy sources. The second section examines "the relationship between the designer, materials and manufacture". A typical question would be about the design of packaging.

19. Even with the common core there is a very different 'feel' to the papers. Design in the double-barrelled (or triple-barrelled) titles is a potential source of confusion since it has a number of meanings. As well as being an integral part of technology it can refer to aesthetic expression and also to a movement associated with the Design Council involving identifying needs, thinking creatively and communicating ideas. Design and Technology can therefore legitimately go in a number of different directions. Attempting to underline the importance of design to technology by including it in the title paradoxically may only serve to undermine.

Design and Technology in Practice

20. The variation in Design and Technology suggested by the examination papers is borne out in practice. As the school studies in the four boxes show, the teachers can come from craft, art and engineering backgrounds. Some courses emphasise technology, others design. In some cases, the subject can only be taken in combination with maths and physics and the students are expected to have excellent grades; in others, design and technology is Hobson's choice, taken as one of a pair of A-levels the student has just scraped into. The students' projects range from dance displays to sophisticated inventions good enough to be patented and marketed. Their intended destinations diverge sharply between the technology-based and the art-based. One wonders how sensible it is to attempt to encompass all this variety within a single subject.

Sixth form college on the fringes of a large conurbation. Approximately 970 students on roll.

This large sixth form college formerly a grammar school is able to offer several different technology courses. There are A-levels in Design and Technology, and in Graphical Communication, both with the London Board, and ASs in Design and Technology (Systems) and Electronics with the JMB. The head of technology was originally trained as an electronics engineer and teaches mainly the AS Electronics course and contributes to the A level Physics course (Physics B) which is set in an engineering context. For him technology as it is now is bipolar:

> *"What we are talking about really is the dichotomy between a sort of art-based definition and an engineering definition which is of course very mathematical. I think that there are two populations of students, one whose interests lie on the artistic design side with a little bit of technological and engineering input and I think that the old design and technology courses are suitable for them, whereas for those who are going into academic engineering we think that the new AS technology courses are very useful."*

ASs in technology were introduced to popularise the subject without threatening the traditional science combinations, since parents and students want a 'safe' A-level combination.

About 40 students were doing A level courses, spread evenly between Design and Technology and Graphical Communication, with about a fifth girls. Ten students, including two girls, were taking AS Design and Technology (Systems) and 26 AS Electronics, again with two girls. The six students interviewed were all on the A level Design and Technology course, five boys and one girl. They had had difficulty with their GCSEs. Three of the six had obtained maths and physics GCSE grade C only with re-sitting. One student had still not succeeded in obtaining a maths grade C, two others had maths but no physics, only one had passed maths (B) and physics (C) at the first attempt. The average for the group across all subjects was grade D. Half the students were combining design and technology with only one other A level, graphical communication or computer studies. The teacher was at pains to point out that the group was poor by comparison with other years. He blamed the college for not promoting the technology courses and believed the academic high-fliers were directed into the traditional sciences.

Project work was popular but there were reservations about the theory side, particularly the electronics, which those without a good grasp of physics at GCSE were finding difficult. The projects included a photographic tripod with a remote control unit for wild life photography, a stabilizer for a camcorder, a device to help the breathing of young children with cystic fibrosis, a software package for a CNC milling machine, a street cleaning machine, and an air conditioning device using aromatherapy.

Two of the students were aiming for TV and film studies in higher education, and one each for architecture, industrial design, and teacher training. The other was planning to go straight into employment - in the motor trade.

Mixed comprehensive school serving large commuter village and surrounding rural area. Approximately 750 pupils aged 11-18 on roll, of whom 110 are in the sixth form.

The school offers the Oxford design syllabus with which the head of technology has been associated from the pilot stage. He was trained as a designer:

> *"I qualified as a designer before coming into education and got my PGCE with the art people, and so from a professional point of view I came into education going to be an art teacher, but the first job I went for, they saw my folder, and because I was a product designer they said we don't fancy you teaching art, do you fancy teaching CDT? So I had a career change when I took up my first teaching job."*

The course attracts about ten students a year, about a quarter girls. Of the seven students we interviewed, four were combining design with maths and physics, and three with only one other subject - two with geography, and one graphics (the other subjects had been dropped). The students mainly had As and Bs in maths and double-award science, and eight or nine GCSEs with an average score above C.

The projects tackled were very varied. They have included such things as a child's car seat, a customer's trolley for a garden centre, a staircase wheelchair lift, a paint-tray for use on ladders, and items of clothing for people with disabilities. Public awareness issues have been tackled through animated cartoons for toddlers on road safety, a dance to warn of the dangers of drug abuse, and health posters. Current projects include a trolley-container to take equipment to equestrian events, and a 'concept' television:

> *"Well, your average TV is just a black box in your sitting room and this is something a bit more exciting, getting away from the black box image. It's the casing rather than the electronics, I'm not doing anything to them. It's nothing like a TV apart from it's got a screen. Most of it is made of steel tube - a bit of perforated steel and a lot of plastic."*

Two of the students were hoping to go on to degree courses in mechanical engineering and one an HND. Other students were aiming for architecture, town and country planning, and interior design. The student taking design with graphics was undecided but thinking of going straight into employment.

The head of technology took the broad view:

> *"I have a very wide spread of ex-pupils. A lot are professional designers, but some line up A level design with maths and physics and go into various fields of engineering."*

He was expansive and believed technology could encompass textiles, art and home economics which would widen its appeal and encourage more young people to take it up. The main drawback he foresaw was the lack of suitably experienced and qualified staff.

Voluntary aided 11-18 comprehensive school on the outskirts of a large town. It is boys only 11-16, but the sixth form is mixed. Approximately 880 on roll of whom 280 are in the sixth form.

At present there is no technology in the sixth form. Until recently the only course offered was A level Woodwork, but in 1991 the syllabus was finally withdrawn. The head of technology, a craft teacher, was dismayed that his skills no longer appeared to be needed. He insisted woodwork was not chosen as a make-weight to add to other A-levels but as a base for proceeding to specialist courses in furniture production and management. It was however attracting only two or three boys a year.

After rejecting some of the new courses in design and technology because he and his colleagues in the department did not feel competent to teach them, he is hoping to introduce an AEB syllabus from I992. This is a design and technology course which, in his view, places a greater emphasis on the practical and making aspects. The teacher summed up his philosophy:

> *"I came out of industry years ago. I've been teaching for 25 years and I do realise the importance of skills, whether it's geographical skills, map reading or whatever. In a technology department the skills are 'making'. To be able to design you must be able to make first because you can't design if you don't know the limitations of the tool you can use and the materials you can use. I accept the fact that a lot of people will say that I have the ostrich approach."*

Independent boys' school located in large metropolitan area. Approximately 1000 pupils aged 8-18 on roll, of whom 150 are in the Junior School and 250 in the sixth form.

The Cambridge Board's technology course has been running since 1986. The head of technology has a CDT background but including maths and engineering. For him, technology at A level is the applied side of maths and physics and should provide a good grounding for entry into engineering.

The intake is limited to about ten boys a year. Technology is offered only to those also studying maths and physics at A level. Of the six we interviewed all had GCSE grade As in both physics and maths except for one B in maths, and all had nine or ten subjects with an average grade above B.

The course starts with a six-week introduction in the school workshops which provides enough basic 'know-how' and gets across the importance of accuracy. The rest of the first year concentrates on the core syllabus with work starting on the option topics - which the school has chosen as electronics and structures. Much of the second year is spent on individual projects, including in this group a device for controlling the level of the grill in a barbecue so it moves up and down according to the heat, a mobile ladder to allow access to high ceiling areas, a cheap method of tightening wheel nuts on cars accurately, a diver propulsion unit, and an electronic speedo for a wind surfer. The department likes to equip itself with machinery and computer software found in real-life working conditions, and it provides a consultancy service testing materials for local industry.

Five of the six boys we interviewed were wanting to go into engineering higher education, one each into aeronautical, general and electronic engineering, and two, mechanical engineering. The other had been awarded an RAF scholarship and hoped to become a pilot or a flight engineer. They thought technology would be useful for their chosen careers and would give them an edge with admissions tutors. But there was some disappointment at how little admissions tutors seemed to know about A level design and technology:

> *"It was pretty unfortunate that they didn't take any notice that we were doing technology, that we've got so much background. They didn't know much about it. We could have been doing French for all they cared. "*

The main attraction of the course for all the boys was the opportunities it offered for practical work:

> *"Well, I've always liked, as I said, taking things apart and it's helped me to understand a bit more and the electronics I've got a lot out of that because last year I built lots of electronic gadgets, tachometers in cars and all sorts of things. My bedroom is covered in soldering iron. It's what I enjoy doing and now I know what actually happens it gives a bit more validity."*

Acceptability to Higher Education

21. One of the points which came through strongly in the school studies was the ambivalence of higher education. It is a problem which has long existed. Ten years ago a report on Technology in Schools (1982) by HMI[12] pointed to the reluctance of some universities to accept CDT. It cited lack of knowledge about content and unfamiliarity with syllabus changes as being all too common, with the result that institutions "may be losing students with distinctive abilities". Teachers, it said, complained with some bitterness that engineering departments were "on the one hand paying lip service to the need for design capability in students and on the other hand giving greater weight to the possession of an A level in pure science". The recent ACOST Report[13] (1991) suggests the problem still exists.

22. Penfold[14] in his comprehensive review argued that A-level CDT led nowhere - except to train as a CDT teacher. He quotes an exasperated head of department:

> "Without the acceptance of the subject at A-level as an entry qualification for graduate courses at Universities and Polytechnics you are living in cloud cuckoo land. It would seem the only area that accepts these subjects are teacher training institutions so that they can train more people to teach Design and Technology. Even if Design and Technology at A level is combined for example with maths and physics, those students would get places on the strength of their maths and physics alone."

23. Officially Design and Technology is as acceptable as other A-levels in terms of the general entry requirement. But differences emerge in relation to particular course requirements. The universities' handbook[15] for 1992 lists 724 first degree courses in engineering and technology. Five hundred and twenty-four (69.6%) indicate that they require a minimum of maths and physics/chemistry. In other words for the great majority design and technology at A level would be acceptable only as a third A level, as conceivably would any other subject. In the former polytechnics most of the engineering courses (183 out of 217) would accept design and technology as a second A-level alongside mathematics.

24. Admissions tutors, the gatekeepers of higher education, appear reluctant to accept design and technology at A level seemingly because they know little about it and have doubts about its rigour:

> "I would say that I, like many others, am not really aware of what's in them. I think perhaps greater publicity or more information about them would be useful. Now I suppose in part that is up to somebody like me to write off to the Boards and say, 'look, what is in your syllabus?' but if there were a greater awareness of what's in them that would be handy."
>
> *(Civil Engineering, University)*

> "I don't think it is analytically rigorous enough. That is where we like to see some competence. If they can't do mathematics then they can't speak to us because mathematics is the language and physics is the laws. Technology does it a little bit, they look at materials and design and that sort of thing, but again it's not quite enough. We could take them, no problem. As long as they can matriculate they can come in, but let's be honest, we can't fool the students. We are straight with them and it's pointless bringing them in and then failing them."
>
> *(Mechanical Engineering, University)*

25. In recruiting on A-level maths and physics, higher education engineering and technology departments are seeking to attract about half the total output in competition with medicine, the sciences themselves, business studies and other subjects[16]. Since many of these are preferred alternatives it is perhaps not surprising that there should be difficulties for engineering. A broader base building on national curriculum technology is urgently required, but attempts so far have not been encouraging and admissions tutors incline to the view that anything would have to be an addition to maths and physics and not instead of them:

> "As far as developing subjects like technology it's almost avoiding the main issue. If people can't do maths and physics then it's a case of saying 'are those people ever going to be up to it?'."
>
> *(Applied Physics, Polytechnic)*

Policy Pointers

26. What then is to be done and how is technology to establish itself in the evolving framework of education 16-19? Our analysis suggests that there are three main issues: (1) what is technology to be as an A-level subject; (2) how is A-level technology to be combined with other subjects; and (3) what is the relation to be between technology at A-level and technology in national vocational qualifications?

Identity

27. The great difficulty with the 'technology area' at A-level is that hardly anyone seems to know what it is or how it is expected to fit in. It lacks a clear concept and identity. Tortuous labels like Design and Technology (Technology), Design and Technology (Design) and Design and Technology (Communication) not only tend to get stuck on the tongue but leave the 'subject' largely unrecognised in higher education.

28. A-level technology is not alone in lacking a sharp focus: it shares this with technology in the national curriculum. But here the Secretary of State has acted. Following the criticisms of HMI[17] and The Engineering Council[18], and advice from the National Curriculum Council[19], HMI have been asked to undertake an urgent review which can form the basis of a new Statutory Order:

> "The principal objectives of the review will be to specify more clearly the skills and knowledge which pupils should acquire at each stage so that progression can be secured, to enhance the practical element, and to improve the manageability of the curriculum in the classroom."[20]

This is very much along the lines of the eight-point rescue plan proposed by The Engineering Council, which moves from specifying the content as a practical organisation of knowledge and skills to seeking to ensure a supply of appropriately qualified teachers and adequate resources.

29. A-level technology should be the stepping stone from technology in the national curriculum to technology in higher education. The review of technology 5-16 therefore has implications for technology at A-level. We recommend that SEAC should invite the Examination Boards to devise syllabuses for A/AS technology that lead naturally from the national curriculum and are acceptable to higher education.

30. National curriculum technology does at least have a clear and unambiguous label - Technology - and we think that this would be appropriate at A-level also. The explicit linking of design and technology, D & T as it is sometimes called, is believed to be a source of strength, reinforcing the importance of design to technology. But while accepting its centrality, we wonder if the joint title works in the way intended. Investigation is integral to the sciences, yet the need is not felt to label physics, for example, as Investigation and Physics. Investigation is taken for granted. Perhaps in the early days it was necessary to continue to emphasise the importance of design, but we believe that sufficient progress has been made towards a maturity whereby it is accepted that Technology implies design.

31. Labelling the A/AS subject Technology would not only improve recognition, but also contribute towards clarifying the concept and establishing an identity. 'Design' has a number of meanings and putting it jointly in the title is an open invitation to go off at a tangent. There are some who welcome the ambiguity. They argue that no A level should be single-routed and by mixing design in the wider sense with technology the 'subject' can be made to appeal to more students, particularly young women. But trying to cater for two largely separate populations - those headed for engineering and those headed for art - on the one course serves only to confuse. Technology properly constructed could itself open a number of doors and attract on its merits students of both sexes. We would therefore suggest that A-level studies in the area follow the national curriculum in taking the name Technology.

Combination with Other A-levels

32. If A/AS level Technology were to be developed along these lines (leaving open the possibility also of advanced studies in Design), what part would it play in progression to higher education? Clearly, learning the lesson from engineering science, there does not appear to be room for it as an alternative to physics, so the question becomes: how could it be accommodated with maths and physics?

33. Since engineering higher education already recruits from a very narrow base - mainly those with both maths and physics at A level - it could be argued that to expect technology as well would narrow it even further, and since it is difficult to recruit now wouldn't it become even harder? Moreover, a requirement for three specified A-levels would severely restrict students' options, effectively compelling them to decide for or against engineering when choosing their subjects at age 15.

34. We accept the force of these arguments but believe that the changed circumstances brought about by technology being part of the national curriculum and the trend towards more breadth in the sixth form creates a new situation.

35. The UK finds it difficult to attract as many applicants as it would like to technology courses in higher education. Comparisons of graduate output[21] with, for example, Japan and Germany suggest that this may have more to do with relative preference for the pure as against the applied than the attractiveness of the sciences overall. Technology in the national curriculum is a major opportunity to adjust the balance and if it can be got right all young people will have the chance to experience the fun and satisfaction of applying knowledge and making useful things that work, and to discover whether their talents lie in that direction. It is likely that in future many more young people will be wanting to take the subject further and it is vital that good A/AS studies are in place to carry them on to higher education.

36. At present, engineering higher education tends to recruit mainly on the basis of maths and physics. In *Technology in the National Curriculum* we suggest that this is because engineering departments in higher education see themselves as concentrating on 'the class of problems' that constitutes, for example, mechanical or electrical engineering, and look to the schools to provide the knowledge base. They are therefore recruiting mainly on academic attainment and we would argue that the basis for selection would be greatly improved by the evidence of capacity for synthesis, applying and making, such as could be provided by a technology A-level.

37. Under present arrangements, where sixth form students normally take only three, perhaps four, A-levels, to require maths, physics and technology might be thought unduly narrowing. But the need for broader and more flexible studies at A-level is widely accepted, and it is the government's policy to encourage AS examinations alongside A-levels. We would suggest that in these circumstances technology could appropriately be taken as part of some combination involving maths and physics with higher education departments recommending an acceptable grouping of As and ASs, leaving room for students to take other subjects as well. If the Higginson[22] proposal for five A-levels had been accepted, maths, physics, and technology could have been three of the subjects, with two still available for students to pursue other interests and keep options open. That opportunity was not taken but it should be possible to work out something similar with As and ASs.

Relationship with Vocational Qualifications

38. This report has been primarily concerned with technology at A-level. But within the developing structure of education 16 - 19 technology at A-level has also to be seen in relation to technology in vocational qualifications. In broad terms A-levels are intended to be mainly for those who are clear they want to move on to higher education, general national vocational qualifications (GNVQs) for those who want to keep their options open between higher education and employment and within a field of employment, and occupationally-specific NVQs for those with definite intentions or who have already entered employment but who might wish to go on to higher education later.

39. Already the vocational route is an important source of recruitment to technology in higher education. In 1989, 12.5 per cent of all acceptances in engineering and technology in universities, and 33.0 per cent in polytechnics, were on the basis of vocational qualifications[23]. In recent years the Business and Technology Education Council national diploma has emerged as a practically-based alternative to A-levels with awards doubling from 1984 to 1990[24]. In engineering, the BTEC awards not only serve as an important element in technician-level training but also as a means of progressing to higher education.

40. In the current HMI review of national curriculum technology the terms of reference include:

> "to design a framework for short courses at key stage 4, which maintains the basic conceptual approach of the Order, but offers within it a range of choices able to meet the needs of pupils of different interests and abilities and flexible enough to permit extension into a combination with other - particularly vocationally-oriented - areas of work or study."

It looks as if the government is returning to its original view that there should be opportunities for some specialisation from age 14, with technology in the national curriculum leading not only to A-levels but vocational qualifications. The Engineering Council should therefore keep under scrutiny how technology is to have a presence in NVQs. In particular, it should be concerned with how BTEC national diplomas and certificates, important at various levels in the profession, are to be incorporated into the NVQ structure, and with the new qualifications, for example, the proposed GNVQ in manufacturing systems, that are to be created. It is important that all the qualifications should provide a basis for progression as well as specific skills.

Recommendations

41. The logic of the analysis suggests that it is important to build on national curriculum technology to create clear pathways through to higher education and employment. Specifically we recommend:

- there should be A/AS level syllabuses in technology consistent with the national curriculum subject as it is to be re-defined, and acting as a stepping stone to technology in higher education;
- that the subject at A/AS level should bear a simple label – we suggest Technology -- so that it has a sharp focus and is readily recognisable;
- that A/AS technology should not be seen as being in competition with physics but as something that could be - but not have to be - taken with it;
- that schools should make use, where possible, of the opportunities afforded by AS examinations to ensure that sixth form studies are not unduly narrow and to enable students to keep options open;
- that engineering and technology departments in higher education should look for evidence of abilities in applying, synthesising and making - such as could be provided by A/AS technology – as well as the maths and pure science on which they have traditionally recruited;
- that due regard be paid in vocational qualifications to providing a platform of general education for progression to the next stage as well as specific mastery;
- that technology at A/AS level and technology in general and occupationally-specific NVQs form part of a framework of ladders and bridges which leads naturally from the national curriculum to higher education and employment;
- that the eight-point plan advocated for the rescue of national curriculum technology[25] applies with as much force to A/AS level technology, including the recommendations relating to the supply of appropriately qualified teachers and the provision of adequate resources.

42. An overall strategy for education 16-19, perhaps more appropriately education 14-19, is urgently required. As it is emerging it involves A/AS examinations, GNVQs and occupationally-specific NVQs, perhaps held together by an over-arching Advanced Diploma. It is vital that technology should be adequately represented among all three and that there should be sound stepping stones from technology in the national curriculum to higher education and employment. Stepping forward in this way would enable more young people to discover and express their talents, make for a better balance between the pure and applied sciences, help to bridge the academic and vocational, and bring benefits to individuals, the economy and us all.

Notes

1. Visits were made to eight schools and colleges – four sixth form colleges, three 11-18 comprehensives and an independent school. All but two were mixed, the independent school was single-sex boys and the other, a voluntary aided comprehensive, was boys only up to the sixth form which took both sexes. Six of the eight institutions had large sixth forms. Information was obtained from teachers in charge of technology and from pupils. Fifty pupils on the second year of A level course were interviewed. The interviews were semi-structured concentrating on subject choices, reactions to the course, intended destinations and GCSE performance. Acceptability to higher education was studied through the annual publications, *University Entrance 1992 The Official Guide* and the *Polytechnic Courses Handbook 1992 Entry*, and interviews with admissions tutors in engineering and technology related subjects. Thirty tutors from four institutions – two universities, a polytechnic and an institute of higher education - were asked for their views.
2. 'Technology area' is the category used by the Evaluation and Monitoring Unit of the School Examinations and Assessment Council.
3. Smithers, A. and Robinson, P. (1992). *Technology in the National Curriculum*. London: The Engineering Council.
4. At their height in the mid-sixties there were over 18,000 O-level entries in woodwork and 14,000 in metalwork, and technical drawing climbed to over 60,000 (about 7 per cent of the age group) in 1982.
5. Eggleston, S.J. (1976). *Developments in Design Education*. London: Open Books.
6. Schools Council (1967). *Technology and the Schools Project Technology Pilot Study Report*, Number 6. London: Schools Council.
7. The Secondary Schools Examination Council was the forerunner of the Schools Council which itself was superseded by the School Examinations and Assessment Council.
8. Carter, G., Heywood, J. and Kelly, D.T. (1986). *A Case Study in Curriculum Assessment: GCE Engineering Science (Advanced)*. Manchester: Roundthorn Publishing Ltd.
9. *Inter-Board Statistics* prepared by the Associated Examining Board on behalf of the GCE Examining Boards in England, Wales and Northern Ireland uses the classification of syllabuses provided by the School Examinations and Assessment Council.
10. A statement of the agreed common core in *Design and Technology, Common Cores at Advanced Level, First Supplement (November 1987)*, prepared by the GCE Examining Boards of England, Wales and Northern Ireland is available from the offices of the GCE Boards.
11. Syllabuses labelled Design and Technology without endorsement are also available, with those of the London and Joint Matriculation Boards attracting most candidates. Unlike Cambridge Design and Technology (Technology) and others such as the JMB's Design and Technology (Technology Systems), prior levels of knowledge of maths and science are not specified although a good grounding in CDT at GCSE is advised by the London Board . The structure of the examination is similar for both the London Board and the JMB. There are two written papers one in design and the other in technology, and a project which carries 50 per cent of the total marks (JMB) or 30 per cent (London). The London Board's design paper involves selecting one brief from four - for example, the different forms of single beds, the use of practical activities as an aid to learning in English or mathematics in infant classrooms, methods of testing continuity in a variety of electrical devices and components, and the marketing and promotion of restaurants and cafes. Similarly, the technology paper in addition to a compulsory section on the common core offers a choice of questions on two out of design and technology in society, materials, electronics and microelectronics, and mechanisms and energy.
12. DES (1982). *Technology in Schools*. London: HMSO.
13. ACOST (1991). *Science and Technology: Education and Employment Working Group Reports*. London: Cabinet Office, para 3.1.2.
14. Penfold, J. (1988). *Craft, Design and Technology: Past, Present and Future*. Stoke: Trentham Books, p.66.
15. CVCP (1991). *University Entrance 1992 The Official Guide*. London: The Association of Commonwealth Universities.
16. Smithers, A. (1990). Patterns of participation in engineering higher education. In: *Engineering Futures*. (Edited by Gareth Parry). London: The Engineering Council.
17. HMI (1992). *Technology - Key Stages 1, 2 and 3: A Report by HMI on the First Year 1990-91*. London: HMSO.

18. Smithers, A. and Robinson, P. (1992). *Technology in the National Curriculum*. London: The Engineering Council.

19. National Curriculum Council (1992). *National Curriculum Technology: The Case for Revising the Order*. Advice to the Secretary of State for Education, May 1992. York: NCC.

20. DES Press Release 168/92: Patten launches wide-ranging review of school technology.

21. See Smithers, A. and Robinson, P. (1991). *Beyond Compulsory Schooling*. London: Council for Industry and Higher Education, para 9.6 and Chart 9.2.

22. Higginson Report (1988). *Advancing A-levels*. London: HMSO.

23. Smithers, A. (1991). *The Vocational Route into Higher Education*. Manchester: School of Education, University of Manchester.

24. Smithers, A. and Robinson, P. (1991). *Beyond Compulsory Schooling*. London: CIHE, Chart 8.2.

25. Smithers, A. and Robinson, P. (1992). *Technology in the National Curriculum*. London: The Engineering Council, para 62.

ISBN 0 9516611 3 2

10 Maltravers Street, London WC2R 3ER
Telephone: 071 240 7891