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Culture and the development of a unique sub-system for the education of engineers for industry in the U.K.: A historical study. Part 1. The culture.

John Heywood (Professor Emeritus)

John Heywood completed 60 years of membership with ASEE in June. His first paper to ERM was in 1973. He has some 190 authored and co-authored publications including 6 books on aspects of engineering education. His "Engineering Education. Research and Development in Curriculum and Instruction" received the best research publication award from the Division for the Professions of the American Educational research Association" . His most recent book Designing Engineering and Technology Curricula. Embedding Educational Philosophy was published by Morgan and Claypool as an e book this year. He is a Professor Emeritus of Trinity College Dublin (The University of Dublin) where he was for twenty years Director of Teacher Education. Prior to that he was a member of the Faculty of Engineering, Department of Industrial Studies at the University of Liverpool. He directed the first attempt at a multi-dimensional analysis of the jobs done by engineers published in 1978 as "Analysing Jobs". His particular interests in engineering are in radio astronomy and space research and he participated in one of the radio observation programmes of Sputnik I. He is a Fellow of ASEE and a Life Fellow of IEEE.

Culture and the development of a unique sub-system for the education of engineers for industry in the UK. A Historical study. Part 1. The culture

Abstract

This evidence based study is derived from other work in progress related to the history of engineering education in the UK. Its interest lies in the fact that in 1955/56 the British government created a sub-system of higher technological education in England and Wales that had as its objective, the education of highly qualified engineers and applied scientists for manufacturing industry. This sub-system came to an end in 1964/5. While it could have been the subject of an official evaluation, it was not. However, fortuitously, it was established during a period increasing interest in research in higher education, and several researches addressed various aspects of the system that, accidentally, make a retrospective, but partial informal evaluation possible..

The discussion is presented in two papers because of the structure of the conference, and the need to provide the detailed explanation of the cultural system in which the development took place which would be of substantial length. That is the purpose of this, the first paper. Together these papers have a secondary function of showing factors that contributed to the success and failure of a major innovation in order that the mistakes made will not be repeated in the future: that is to foster learning of the collective past. Their final purpose is more international collaboration among engineering educators and its research fraternity.

Since the social forces (attitudes, beliefs and values) at work in society ultimately determine the success or failure of educational innovations, part 1 (this paper) shows the importance of social class in what is valued and not valued in the English educational system. The academic is preferred to the vocational. Grammar schools and universities are associated with the academic. Technical and further education colleges with the vocational. The antecedent philosophy driving this innovation in degree level technological education, as expressed in the 1945 report of the Percy Committee on Higher Technological Education placed the Colleges of Advanced Technology (CATs) created in 1955/6 firmly in the vocational sector.

The results of the investigations carried out in the CATs reported in part 2 (the second paper) showed that schoolteachers and their pupils tended to view the CATs as second class citizens: that most students had good experiences of industrial training although many believed it could be improved, and that the curriculum offered tended to model that found in the universities. The Robbins Committee believed that the curriculum offered was of degree level standard and recommended that the CATs be given university status, which they were in 1964/5.

For the convenience of the reader part 1 is preceded by a list of abbreviations, and a time line. The research for the papers summarised in part 2 took place between 1960 and 1965. A note on problems of presenting studies about non-American systems of engineering and technological education at ASEE conferences is included in the introduction to part 1.

Abbreviation/term	Description
‘A’ Level	Advanced Level of the General Certificate of Education (GCE)- A subject specific entry examination required for entry to university. Taken at around the age of 18.
CAT	College of Advanced Technology
CNAA	Council for National Academic Awards
Dip.Tech (dip.tech)	Diploma in Technology (or course for). A degree equivalent qualification. Awarded by the National Council for Technological Awards.
EEMJEB	Electrical and Electronic Manufacturers Joint Education Board
EUSEC	Conference of Engineering Societies of Western Europe and the United states of America.
GCE	General Certificate of Education
HNC	Higher National Certificate part time course that partially met the educational requirements for membership of one of the professional engineering institutions.(see ONC).
HND	Similar to Higher National certificate but requiring full time attendance at a technical college.
NCTA	National Council for Technological Awards. An official organisation that had the authority to degree equivalent qualifications at all levels. The bachelors level was called a diploma.
NFER	National Foundation for Educational research
‘O’ level	Ordinary level of the General Certificate of Education. Taken at around the age of 15.
ONC	Ordinary National Certificate. Taken en-route to an HNC usually two years before.
Sandwich course	More or less equivalent of a cooperative course. The most popular sandwich course for the dip.tech was 6monthsd industry followed by 6 months in college in each of four years. Some began in college. The next most popular structure was two years in College plus 1 year in industry plus one year in college. The spacing of sandwich courses (structure) was a hotly debated topic.
Technologist/Technology	In the period of this study the term technologist (technology) embraced engineer (engineering). In manpower reports the majority of technologists were almost always engineers.
Industry based student	Student who is employed by a company who also pay the students course fees.
College based student	Student has to find his own training place (usually with the help of the \College) and pays his own fees.

Date	Legislation, Official Reports and key research publications (R).	Key proposals
1944	Education Act	Compulsory free education for all up to the age of 15, in grammar schools, technical schools and secondary modern schools. Selection at the age of 11 by aptitude test for grammar schools.
1945	Percy Report on Higher Technological Education	Certain technical colleges should develop high level degree equivalent qualifications for engineers for industry (design and manufacturing). An awarding body to be created for this purpose.
1946	Scientific Manpower. Report of the Barlow Committee	Nation needs to increase the supply of scientific manpower.
1950	Future Development of Higher technological Education. Report of the National Advisory Council on Education for Industry and Commerce (NACEIC).	Proposed a Royal College of technologists which would award an associate, membership and fellowship. It commended Sandwich courses and greater financial aid for advanced courses.
1951	Higher Technological Education (Cmnd 8357, HMSO)	Govt. response to the NACEIC. Accepted idea of an award granting College of technologists, and more financial aid for selected colleges.
1954	Recruitment of Scientists and Engineers. Report to the Committee on Scientific Manpower.	Study of vacancies in 50 leading firms showed recruitment 25% below requirements.
1955	National Council for Technological Awards Established	Self-governing award granting institution. Created a degree equivalent Diploma in Technology based on the sandwich principle and to be awarded for courses developed in certain colleges in the technical education sector.
1956	Whitepaper on Technical Education (Cmnd 9703)	Four tier system of technical colleges created with Colleges of Technology at the apex followed by regional colleges, area colleges and local colleges.
1961	Whitepaper. Better Opportunities in Technical education (Cmnd 1254)	Focused on reducing wastage by changing course structures and standards particularly at technician level.
1961	The Long Term Demand for Scientific manpower (Cmnd 1490)	Created a controversy because it considered that supply and demand were not much out of balance.
1962 R	Colloquium on Research in Technical Education	National Foundation for Educational Research.
1963	Report of the Robbins Committee on Higher Education (Cmnd2154)	Recommends the expansion of higher education. Particularly recommends that the Colleges of Advanced Technology become universities.
1963	Scientific and Technological Manpower in Great Britain (Cmnd 2146)	Contradicts the 1961 report. Points out inadequacies of previous surveys and concludes that there is a shortage.
1963 R	The Education of Technologists –M. Jahoda (Tavistock Press)	Study of the first year of dip.tech courses at Brunel CAT.
1964 R	The Experience of Higher Education –P Marris (Routledge)	Comparative study of the student experience in three universities and a College of Advanced technology.
1964 R	Technical Education and Training in the United kingdom. Research in Progress 1962-64.J. Heywood and R. Ann Abel. National foundation for Educational research	Four commentaries on 133 research projects complted and in progress summarised in the book.
1964	NCTA discontinued	Replaced by a Council for National Academic Awards with similar functions but across the higher education curriculum.
1965 R	Liberal Studies and Higher Technology –L. Davies University of Wales Press.	Review of theliterature and research and report of a case study
1965/66	Colleges of Advanced Technology become universities or university institutions.	

Time Line

Sources. Payne, G. L. (1960). *Britain's Scientific and Technological Manpower*. Stanford and Oxford U. P's. Heywood, J (1971). *Bibliography of British Technological Education and Training*. London. Hutchinson. Heywood, J and R. Ann Abel (1964) *Technical education and Training in the United Kingdom. Research in Progress.* Slough. National foundation for Educational Research.

Introduction: problems in the discussion of national systems of education

Engineering educators have, with one or two exceptions, shown very little interest in comparative education studies either at the level of policy, or the levels of pedagogy and student development. Similarly, engineering educators are, if Williams, Wankat and Neto [1] are correct, not very interested in research that is done in countries other than their own. While ASEE believes it should take note of research that is being done in other countries, it relieves its divisions of the obligation of so doing, by organizing a separate international day during its annual conference.

Non-US nationals presenting at a divisional meeting may find afterwards that they have not been understood, or even misunderstood. This dilemma arises partly from the expectations of both speaker and listener who are likely to believe that the language of engineering education is global and universal, and therefore, mutually communicable. Unfortunately, systems of engineering education vary considerably, and are often quite difficult to understand. They have their own language, which is culture driven. For example, the systems of assessment in the UK and US are very different and easily misinterpreted. Anyone moving between the two systems has to make considerable adjustments to their understandings. In making these adjustments they come face to face with the fact that they have to think in terms of different cultures and their associated systems [2].

This is particularly difficult for persons engaged in research in engineering education because they have an obligation to evaluate all research in their specialism irrespective of its origin if they are to assist policy making either at governmental or professional levels.

At the present time they lack any handbook that describes the many systems of engineering education, and the cultural framework of their development, that exist. In its absence conferences like FIE and the ASEE annual meeting provide venues in which networks can be established, as for example, the Research in Engineering Education Network (REEN) which is regularly hosted in different countries.

However, the structure of the major conferences in the US does not easily facilitate formal presentations by non US nationals because there is unlikely to be a widespread understanding of other systems of engineering education and their cultural origins. This creates a conflict for non-national authors. For example, they may find themselves short of time in which to present the essence of their communication because they have had to spend half of the allocated fifteen minutes explaining the educational system in which the study took place, in order for the results to be understood, but have not time left to achieve that goal.

It is for this reason that I gambled on the Division and its reviewers, accepting two papers, the first of which would describe the system. The problem with that idea is that engineering educators do not like descriptions that do not have practical outcomes. It may be objected that a description that does not take into account the culture, and therefore, have some relevance, is unlikely. This paper is the first part of just such a gamble. It is based on the assumption that the relevance of investigations (N = 15) on a particular development in technological education in England and Wales (not the UK) cannot be understood without understanding the culture, in particular the social class structure, and the historical origins in which it took place.

A second paper summarises those investigations from the perspective of educational change as envisaged in the proposals and discussions of the Percy Committee Report on Higher Technological Education published in 1945.

The national systems of higher technological education in the UK *circa* 1960

There were, and continue to be, four different national systems of education in the UK, each with its own devolved governance. They are for England, Norther Ireland, Scotland and Wales. During the period of this study, in so far as higher technological education was concerned, England and Wales were treated as a unitary system. This study is only concerned with that system.

There existed in all these systems two routes to chartered membership of an engineering institution (the nearest equivalent to Professional Engineer status in the US). The first pathway was via a university degree and industrial experience: the second pathway, was by an equivalent course obtained by part-time study in a technical college.

It should be noted that the term "engineer" is not protected in the UK or Ireland, and it is used loosely by the public. Often it is used to describe a repair person, of for example, television or washing machines.

The two pathways had their origins in the industrial revolution. The first two university departments of engineering were created in the 1830's [3]. The importance of applied science seems to have been recognised from the beginning. Indeed, it was Humphrey Lloyd, the Professor of Natural Philosophy, who in 1841 proposed that Trinity College Dublin should establish training in engineering, the teaching of which would be supported by professors (scientists and mathematicians) already in the university [4].

In parallel, in Scotland, there developed from 1821 a system of voluntary Mechanics Institutes which spread across England and world-wide. They were intended to enable the working classes to become more literate and numerate as well as to gain basic technical skills.

The emergence of a bi-partite system for the education and training of engineers

But, the attempts to make useful knowledge available to the working classes, were not, in so far as engineering was concerned, very successful. However, in 1881 a technical college was opened in London to meet a demand for training that would enhance the skills of craftsmen. But, according to Cotgrove, a system of further education began with the establishment of the Regent Street Polytechnic in 1882 [5]. Other Polytechnics were created and through their links with the University of London were able to offer degree programmes. These colleges also offered National Certificate programmes as alternatives to the Institutions examinations.

A profusion of institutions emerged, and some did some high level work at what would now be called the technologist and technician level. They were variously called Polytechnics and technical colleges. Others, more often than not called technical colleges, undertook technician and lower level work. Some technical colleges, and colleges of further education only undertook low level work. The majority of courses were evening and/or day release from work.

This remained the case until 1956 when after a decade of discussion following the recommendations of the 1945 Percy Committee on Higher Technological Education in 1945 the system was reorganised.

National Certificates and diplomas [6]

National Certificates (Ordinary- ONC and Higher- HNC) were created after World War I to provide young working men with appropriate theoretical instruction concurrently with their work. They were achievable within 5 years, but additional courses were required to obtain recognition as an Associate Member of one of the engineering institutions. There were other routes to professional membership. For instructor payment purposes in technical education an associate membership obtained in this way was considered to be equivalent to an ordinary (pass) university degree.

Higher National Diplomas were the equivalent of HNC's but obtained by full-time study at a technical college. They were not very popular.

Sources of recruitment: the school system

Peter Mandler writes, "in the last year before the beginning of the Second World War, 80% of the age-cohort still had no experience of secondary (still less of tertiary) education" [7]. In 1907 some "free" places were made available at grammar schools which were fee paying and serviced mostly the middle classes. By 1911 they serviced about 3% of 12 to 17 year olds. Mandler continued, "below this thin stratum lay a growing variety of 'central schools' and 'junior technical schools, mostly in large urban authorities that could afford them such as London and Manchester, providing technical and vocati9nal courses to age 15, aimed at skilled workers" […] " Beneath this stratum, however, lay the thickest layer-still the great majority of adolescents-who never entered secondary school at all, but who were simply retained in elementary schools until the leaving age" (p23). At the same time the further education system grew and provided opportunities for some children in this group to demonstrate their abilities.

Mandler noted that there was some foundation for the charge that the system reproduced the existing class system "which roped off 'academic' (mostly male and middle class) children from 'vocational' (entirely male and mostly skilled working-class) children from 'unskilled' (mostly unskilled working-class) children" (p 22).

The 1944 legislation which provided for secondary education for all up to the age of 15, distinguished between three types of school –grammar schools for the academically able, technical and secondary modern schools. Selection to grammar schools, which provided an entry pathway to universities, was made by aptitude tests set at age 11. Since the number of technical schools remained small, around 200, the proposed tripartite system was never really implemented.

The grammar schools with their traditional semi-classical curriculum were regarded as academic, and those who could not get into them were considered to be more suited to "practical" work, with which the term "vocational" was also associated, and "vocational education" was provided by the technical colleges. This distinction between the academic and the vocational is of considerable significance since in public thought academic study, was and is conceived to be of higher status than the vocational and the technical. Of great concern was the fact that there was a high correlation between scores on the aptitude test and social class, high scores favouring the upper and middle classes, although upper class children were generally sent to Public (private) schools (e.g. Eton).

The pernicious and persisting effects of social class on the English education system are illustrated by the quotations from 1958 and 2022 shown in exhibit 1. The first is from the well-known satire by Michael Young on the *Rise of the Meritocracy* in which he predicted that the less well educated would revolt against the meritocratic elites in 1834. Many commentators like Michael Sandel the Harvard philosopher believed that that happened in 2016 when the British voted for Brexit. Young also pointed out that "allocating jobs according to merit does not reduce inequality: it reconfigures inequality to align with ability. But this reconfiguration creates a presumption that people get what they deserve. And this presumption deepens the gap between rich and poor" (p 117, 8). Daniel Markovits considered that Young underestimated "both the powerful charisma that meritocracy would exert and the long shadow that meritocratic inequality would cast over economic and social life (p 259, 9).

The second quotation is from Will Hutton, a well-known commentator, who had been a Principal of Oxford's Hertford College.

(1) "This evocation of the past shows how great the change has been. In those does no class was homogenous in brains: clever members of the upper classes had as much in common with clever members of the lower classes as they did with stupid members of their own. Now that people are classified by ability, the gap between the classes has inevitably become wider. The upper classes are, on the one hand, no longer weakened by self-doubt and self-criticism. Today the eminent know that success is just reward for their own capacity, for their own efforts, and for their own undeniable achievement. They deserve to belong to a superior class. They know, too, that not only are they of higher calibre to start with, but that a first-class education has been built upon their native gifts. As a result, they can come as close to anyone to understanding the full and ever-growing complexity of our technical civilization. They are trained in science, and it is scientists who have inherited the earth. What can they have in common with people whose education stopped at sixteen or seventeen, leaving them with the merest smattering of dog-science? How can they carry on a two-sided conversation with the lower classes when they speak another, richer, and more exact language? Today, the elite know that, except for a grave error in administration, which should at once be corrected if brought to light, their social inferiors are inferior in other ways of well –that is, in the two vital qualities, of intelligence and education, which are given pride and place in the more consistent value system of the twenty-first century".
Extract from M.D. Young. *The Rise of the Meritocracy*. London. Thames Hudson, 1958.

(2) "The British class system continues to cast its noxious shadow. For more than a century, British working-class children and teenagers have been offered second best routes to education and training. By contrast, middle-class offspring will find their way a significant minority via the queue jumping privileges of private education – to university or a professional qualification".
"Before you object, I am conscious of eliding class and educational achievement (working-class pupils have been increasing in numbers at university and why shouldn't a middle-class child favour an apprenticeship) but in the real world, the divide between the academic and the practical tends to be shaped by background and to acquire a skill, to be an apprentice, is to come second in the British lottery at of life. The standards and quality of what is offered are rarely in the same league as what is offered academically. The extent of what is offered is cruelly financially capped".
Extract from W. Hutton. Kicking universities is no way to solve the divide between the academic and the rest. *The Observer*, 27: 02: 2022.

Exhibit 1. Illustrations of the relationship between social class and education in England.

The Sixth Form [10]

From 1951 the first five years of grammar schooling were completed by examinations for the Ordinary Level of the General Certificate of Education ('O' level GCE). Depending on their successes in these examinations students could opt for two years further study in the "sixth form" in either science, or arts (humanities or languages) and take examinations in their chosen subjects at the Advanced level of the General Certificate of Education ('A' level GCE).

'A' levels became the 'gold standard' of schooling in England and Wales. For example, at that time it was generally accepted that the standards assessed by 'A' level examinations were equivalent to those of a first year university programme in the United States, one consequence of which, was that engineering degree programmes in England were of three years duration.

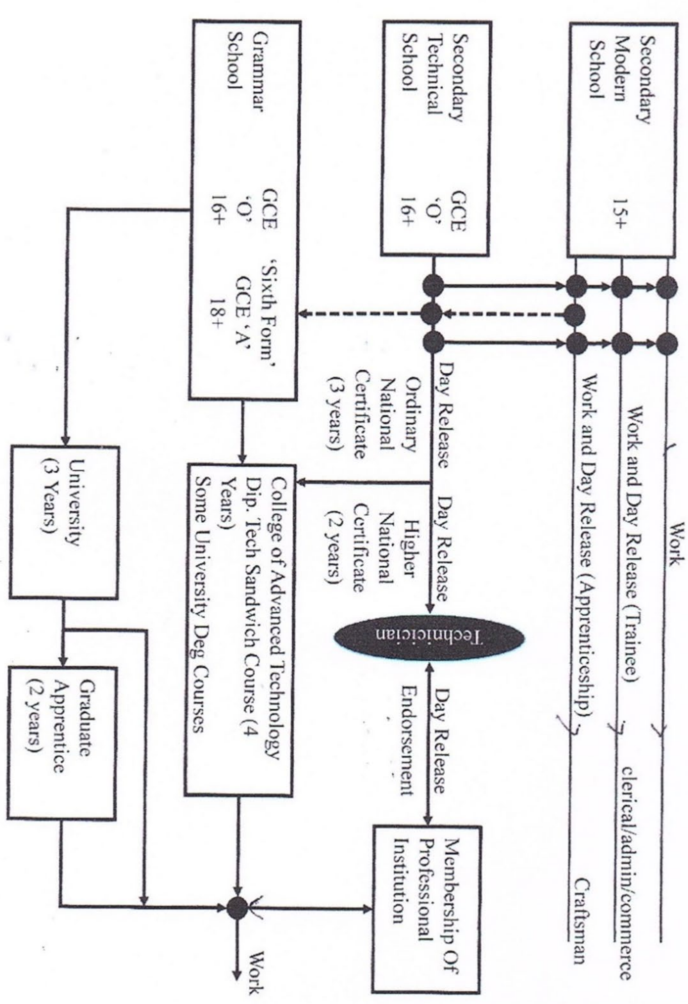
Universities exerted a downward pressure on the school curriculum because a department could set its own entry level grades. Therefore, university engineering departments were in competition with each other for the most able students. But, they were also in competition with other science departments. Engineering would be competing with physics and maths for such students. Typically an engineering department would require candidates to have three 'A' levels including maths and physics.

As a proportion of the age cohort the number of students entering university was exceptionally small. Thus, the system was highly selective, and in consequence highly competitive. It was into this system that in 1956 the upgraded technical colleges recommended by the Percy Committee in 1945 would be created.

These colleges had the advantage that they could also readily draw on students from National Certificate and equivalent courses since they were already offered by most of them. How these students rated when compared with students with 'A' levels became an issue of some importance. As exhibit 2 shows the system continued to provide a number of pathways to professional membership of the professional engineering institutions, and all that that entailed.

The Percy Committee 1944 -1945 [11]

The evidence put to the Percy Committee suggested to it, "that the position of Great Britain as a leading industrial nation (was) being endangered by a failure to secure the fullest possible application of science to industry; and second that this failure is partly due to deficiencies in education. The annual intake into the industries of the country of men trained by the Universities and Technical Colleges has been, and still is insufficient both in quantity and quality" […] "the experience of war has shown that the greatest deficiency in British industry is the shortage of scientists and technologists who can also administer and organise, and can apply the results of research to development (para 2). These deficiencies call for the attraction to our Universities and Technical Colleges of more and better students" […] "At present too large a proportion of the best output of the schools goes into non-industrial occupations, and positive steps are necessary to counteract this drift. Technological training must be conceived in terms of a combined course of works training and academic studies" […] "Full cooperation between industrialists and educators must be based upon a recognition, by both parties, of the supreme importance of increasing the efficiency of manufacturing



Very Simplified Model of the System of Further And Higher Technological Education in England and Wales Circa 1956. Supported by a system of Regional (technologist/ technician courses), Area (technician courses), and Local (craft, trade, operative courses) technical colleges

Exhibit 2 Pathways to professional qualification 1956.

processes, and of initiating new branches of technology, as an essential means of expanding the nation's export trade and advancing the standard of living" (para 3).

The Committee considered the number in each group of (1) senior administrators, (2) engineer scientists and development engineers, and (3) engineer managers (design, manufacture, operation and sales) required by industry,

Although the report uses the term "technological" in its title, it will be noted that it refers to engineers in categories 2 and 3.

The operational philosophy of the Percy Committee was that "every technology is both a science and an art. In its aspect as a science it is concerned with general principles which are valid for every application; in its aspect as an art it is concerned with the special application of general principles to particular problems of production and utilisation" (para 24). The committee concluded that because the "art" aspects were necessarily learnt in formal works training and the "science" aspects in academic study, technical colleges had in the past selected and emphasised the "art" aspect. This led them to the view that the different styles of training in the universities and technical colleges would lead to engineers with different qualities.

The committee attempted to justify its thinking on educational grounds based on the view that universities train for manpower group 2, technical colleges and universities train for group 3, while group 1 obtains its supply from persons trained in all sectors.

The committee recognised the explosion of knowledge that had taken place during the war, and took the view that all engineers trained by university or technical college require "a much longer course of combined academic study and works practice extending over at least five or six years", for neither the university nor the technical college is designed "alone to produce a trained engineer" (para 23). While they persisted with the differentiation between the art and the science of technology they considered that the main defect of technical college education was the evening structure that gave "too smaller a space to the fundamental sciences in the early stages" (para 25). The report foreshadowed the trend toward day release, and subsequently to full-time study, and it began the trend toward courses based on engineering science in the technical colleges.

At the same time the Committee was clear that a number of students should participate in "courses specifically planned without reference to existing anomalies. We would insist that such courses, whatever their length and arrangement, should be directed to the development of the highest level of teaching of the art of technology based on sufficient scientific foundation. Such courses should have a status in no way inferior to the university courses, they should require equal ability in the student; and they should afford preparation for the most advanced post-graduate studies […] what is chiefly required of technical colleges is adaptability to changing techniques and new combinations of techniques. This consideration applies with even greater force to other less well established technologies, in which it is essential that institutions responsible for teaching should be free to develop new standards by experiment. Such freedom implies not only freedom to plan their own syllabuses, but freedom also to award their own qualifications. This freedom of a teaching community to adapt its examinations to its teaching is now the characteristic mark of institutions to which is to be entrusted the development of a type of higher technological education which is, for the most part, new to this country" (para 28).

So the committee recommended that 6 colleges exclusive of the Greater London area be created to develop "technological courses of a standard comparable with that of university degree courses" (para 29).

The introduction of sandwich courses

The Percy Committee while wanting to substantially increase the amount of full-time study undertaken by technical college students wished to retain a strong element of industrial practice. It thought that consideration should be given "to a period of works practice (that would) precede as well as accompany and follow the period of academic study" (para 23).

In the decade that followed such arrangements came to be called "sandwich courses". Several arrangements were used by those seeking to offer the new diploma qualification that was introduced in 1955 (see below). These structures caused controversies within colleges and between colleges and industry. In 1961 Birmingham College of Advanced technology appointed this writer to evaluate the merits of the different structures on offer. From one perspective or another these courses were the subject of the 14 research studies that are the subject of part II.

Diploma = Degree

After a substantial debate, the Committee decided that the colleges should not award a degree because that was a characteristic of a university. Instead they should award a diploma which would be overseen (accredited) by an independent organisation (National College of Technology). On the one hand the committee wanted them to do degree level work with the freedom to develop new courses, but on the other hand it deprived them of university status while acknowledging that it should be possible for them to develop into universities. In an addendum Lord Percy wrote, "Not every college of technology will be able to aspire to University status, but it should be the policy of Government to treat them as a group and to develop from among them some major University Institutions" (para 9, Note of Dissent)

The Committee was divided on the issue of qualification. Those who were against the award of a diploma argued that the "tradition of the degree […] is so deeply implanted in the minds of grammar school students, their parents, and, it may be added the school authorities that there is very little hope of a diploma taking its place. Students will continue to seek a title which has national and international estimation and recognition, and which indicates that their technological qualification is equivalent to the award which their fellows studying Medicine, Law, Science or the Humanities can acquire" (para 62). A majority of the Committee disagreed: either they were content that the diploma would be aligned with low status technical education, and by implication fail, or they did not understand the cultural perspective. The minority were to be proved correct, which should have been no surprise in a country where status, however expressed, achievement, and social class were so closely related to the structure of education.

1945 to 1955 and the establishment of the National Council for Academic Awards

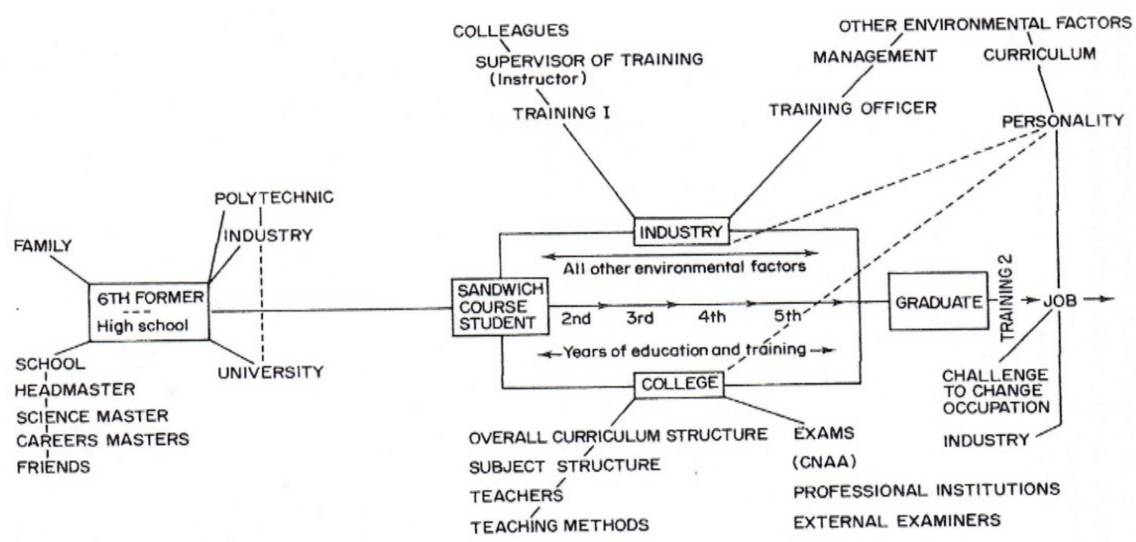
In the year following the publication of the Percy Report another Committee concerned with "Scientific Manpower" [12] wanted the number of scientists produced by the universities to be doubled. While considering what this might mean for the universities, it did endorse the proposals of the Percy Committee. It also understood an engineer to be an applied scientist.

Its chief significance seems to have been that it began a period of attempts at manpower planning which were to last for two decades, and greatly influence policy. During that period, with one exception, the message of the manpower reports was that Britain was short of qualified scientists and technologists.

In July 1955 the Minister for Education announced that a National Council for Technological Awards (NCTA) would be established “to make awards to successful students of technology at technical colleges and assist the colleges in developing and maintaining the highest possible standards in technological education.” Its first chairman was to be Lord Hives who was also chairman of Rolls Royce.

The NCTA proposed to award graduate and post-graduate qualifications. These would be called Diplomas in Technology (degree), and Member of the College of Technologists (MCT- higher degree) respectively. So the equation *dip.tech = degree* was retained.

The sub-system for the diploma is shown in exhibit 3 which shows the line of motivation of a student from school to industry via a dip.tech sandwich course.



A descriptive model of a subsystem of higher education which shows the forces acting on a sandwich (co-operative) course student in a College of Advanced Technology or polytechnic in Britain. (See Chapter 2 for a discussion of this figure.) (From Heywood, J. (1974c). *New Patterns of Courses and New Degree Courses*, Strasbourg: Council of Europe)

Figure 2

1956 and the establishment of Colleges of Advance Technology

In 1956, a White paper described the Government’s intention to improve and expand technical education facilities and opportunities [13]. It proposed a four tier system of technical colleges ranked in order of level of work, and the extent of full time study. In this context the term full-time study also embraced sandwich (co-operative) courses and block release studies. At the apex would be a small number of “Colleges of Advanced Technology” (CATs). These would be concerned primarily with the full-time education of technologists, and undertake post-graduate work and research. Next would be “Regional Colleges” that would educate technologists and technicians by full – time and part-time methods. “Area colleges” would do some technician training, and “local colleges” would primarily supply part-time studies for craftsmen and operative (see exhibit 4).

Designation	Number	Activity
College of Advanced Technology	10*	Courses at an advanced technological level including post-graduate courses and research. Dip.tech/degree
Regional Colleges of Technology	30**	Primarily with work at the advanced level with some courses at the technician level. Some dip.tech and degree, HNC
Area Technical Colleges	170	Some part-time advanced work but primarily technician and below Some HNC, ONC
Local technical colleges and colleges of further education	300 approximately	Primarily up to ONC level. Including training of craftsman

*Originally set at 8. **The actual number was not specified at the time of the whitepaper

Exhibit 4. Very simplified summary of the proposed structure of the technical college and further education sectors. A detailed summary will be found in G. L. Payne Britain’s Scientific and Technological Manpower. Stanford. Stanford University Press. 1960. Pp 279 – 301, from whom the numbers are taken.

The White paper used the EUSEC definitions of technologist and technician [14]. By incorporating the technologist definition in the 1956 White paper (exhibit 5), the government

“*The Technologist is competent by virtue of his fundamental education and training to apply scientific method to the analysis and solution of technological problems. He should be capable of closely and continuously following progress in his branch of engineering science by consulting and assimilating newly published information and applying it independently. He should thus be able to make contributions on his own account to the advancement of technology. His work is predominantly intellectual and varied, requires the exercise of original thought and judgment, and involves both personal responsibility for design, research, development, construction, etc., and also supervision of the technical and administrative work of others.*”

(a) The definition of technologist used in the 1956 White paper.

“*The technician is one who is qualified by specialist technical education and practical training to apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering, or new techniques prescribed by a professional technologist. His work involves the supervision of skilled craftsmen and his education and training must be such that he can understand the reasons for and the purpose of the operations for which he is responsible. Not all industries acknowledge technicians as such. The job, however described, may involve: the design of plant and equipment under the direction of a technologist; supervising the erection and construction and maintenance of plant; testing and surveying; inspection etc*”.

(b) The definition of a technician used in the 1956 White paper.

Exhibit 5. Definitions of Technologist and Technician in the 1956 Whitepaper

was clearly indicating that those educated to become technologists in the technical education sector would also be employable in the Percy Committee’s category 2 of engineer scientists and development engineers.

These proposals were in line with those of the Percy Committee and committed the government to the development of the technical education sector, binding the Colleges of Advanced Technology to the technical college sector with consequences for their publicly perceived status. At the same time the dip.tech and the colleges were left open systems since dip.tech courses could be offered by regional colleges. In consequence the regional colleges and the CATs were together with the universities in competition with each other for able students from the schools, as well as for places industry.

The ending of the sub-systems in 1964/65

The sub-systems of the dip. tech and the CATs, came to an end as a result of recommendations made by the Robbins Committee on Higher Education in 1963 that the CATs should become universities, and that the NCTA should be substituted in the technical and further education, and teacher education sectors by a Council for National Academic Awards (CNAA) with power to award degrees generally, and not confined to technology. The changes are shown in exhibit 6. Both Chelsea College and the Welsh CAT became Institutes of Science and Technology. The more interesting change which illustrates the high value ascribed to the academic and the low esteem of technology was that Loughborough, initially called Loughborough University of Technology soon dropped Technology from its title.

College of Advanced Technology	University	Located to
Battersea (London)	Surrey	Guildford, Surrey
Birmingham	Aston	
Bradford	Bradford	
Bristol	Bath	Bath, Somerset
Brunel	Brunel	Hillingdon, Middx
Chelsea (London)	Eventually subsumed into Kings College London University	
Loughborough	Loughborough	
Salford	Salford	
Welsh	Eventually became part of the University of Wales.	

Exhibit 6. List of CATs and the names taken on obtaining University Status

Summary

Within a unique system of higher technological education that existed in England and Wales between 1955 and 1964 a number of researches were undertaken that evaluated various dimensions of the system. A second paper (2) treats them as a whole in order to better understand the factors that led to the systems demise. Since educational systems are a reflection of the society in which they reside this paper (1) describes that culture and its attitudes to technology education in relation to the antecedent philosophy (technology education culture) that drove decision making. Any overall evaluation has, therefore, to take into account these value systems as conflict between them may be a cause of failure. One source of failure that was apparent was the discussion within the Percy Committee about the title of the award to be offered. It did not take account of changing social mores, and the low esteem attached by the public to technology education when perceived as a vocational activity.

Acknowledgements

At the time, the pathways shown in exhibit 2 were illustrated in a variety of ways. This particular version was included in J. Heywood. “Industry and the development of a new system of higher technological education in the UK 1955 – 1965” in S. H. Christensen et al (eds). *The Engineering Business Nexus. Symbiosis, Tension and Co-Evolution.* Switzerland. Springer,

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