Higher Technological Education and British Policy Making: A lost opportunity for curriculum change in engineering education

Dr. John Heywood, Trinity College-Dublin

John Heywood MA MSc LittD (Dublin) M.Litt (Lancaster). Professorial Fellow Emeritus of Trinity College – The University of Dublin and formerly Professor and Director of Teacher Education in the University (1977 – 1996).

In addition to a higher doctorate he is the holder of a Masters degree in engineering education (MSc). He is a Fellow of the Royal Astronomical Society, a Fellow of the American Society for Engineering Education, a Senior Member of the Institute of Electrical and Electronic Engineers, a Fellow of the Chartered Management Institute, and a Licentiate and Fellow of the College of Preceptors.

His major studies are co-authored book "Analysing Jobs" about what engineers do at work; three editions of "Assessment in Higher Education"; "Learning, Adaptability and Change; the Challenge for Education and Industry" and the American educational research award winning "Engineering Education: Research and Development in Curriculum and Instruction" published by IEEE/Wiley. He is a recipient of a Science, Education and Technology Division Premium of the London IEE for his contribution to engineering education.
Higher Technological Education and British Policy Making: A lost opportunity for curriculum change in engineering education?

Abstract

The opportunity for technical colleges in England to undertake a radical change in the curriculum came when in the nineteen-fifties a select group of these institutions (Colleges of Advanced Technology) had their status raised to offer a degree equivalent diploma for the education and training of engineers and technologists for industry. While there were differences between the programmes offered and university courses they were not radical. With the exception of compulsory liberal studies and a sandwich (cooperative) structure the engineering courses mirrored those from which they were supposed to differ. The question this paper seeks to answer is why this opportunity was not taken?

It is argued that the reasons for this lost opportunity to develop a new curriculum lie deep in the culture that formed the values and beliefs of educational policy makers during the industrial revolution. A divorce emerged between the academic and the practical in which training for industry was not considered to be something that universities do. By the end of the nineteenth century a technical education sector had developed in spite of very poor support from industrialists. Some students in Polytechnics were able to pursue studies for degrees of the University of London.

The policy makers who suggested the new framework (The Percy Committee) came from the educational élite that valued the pure as opposed to the practical. They were focused on the need to increase the qualified workforce and paid no attention to the structure of the sub-system they were proposing and how it would exchange with the system of higher education per se. Thus universities would train the research and development workers of the future and the technical colleges the engineer managers to degree level. They should be awarded a diploma but it would have degree status which would be achieved by a longer period of academic study interwoven with works hitherto been the practice of part-time day release education. A counter culture developed in the colleges as the staff sought the status of universities for their institutions. At the same time it is by no means clear that they would have been able to develop a radical alternative since there was little in the way of a substantial philosophy or educational theory to guide thinking in a radically new direction.

The paper is presented in the form of a historical narrative. The principal threads (culture, social class, status, sub-system and available knowledge) are brought together in a final section that also considers implications for the present. The paragraphs have been numbered for the convenience of cross referencing to this final section.
1 Background

1.1. By 1944 when the committee under the chairmanship of Lord Eustace Percy was appointed higher technological education in Britain had evolved into two sectors. There was a small university sector. Apart from the universities in Scotland and Northern Ireland (one), Oxford and Cambridge, there were eleven civic universities and four civic university colleges (later to become universities) offering degrees in science and engineering. In parallel with these universities was a parallel sector of technical colleges that offered training for operatives at one end of the spectrum, and at the other end of the spectrum qualifications for those seeking to become professional workers especially in engineering and technology through learning while earning. For curious reasons the former was often referred to as the private sector and the latter as the public sector. The latter were financed almost exclusively by local government. The former received considerable financial support from the government administered by a University Grants Committee (UGC). Crudely stated the universities provided or were said to provide a full-time liberal education which because of selection and relative wealth gave vent to middle class aspirations while the technical colleges offered part-time evening classes for the working and lower middle classes who could not or did not aspire to university education. Lucky ones with benevolent employers would be allowed a day off work per week to attend day classes, and it was not uncommon for students pursuing a professional qualification to attend college for one day and two evenings per week. Even more strange was the fact that a small number of these colleges offered programmes for degrees of the University of London.

1.2. As long ago as the fifteenth century the Colleges of Physicians and Surgeons had been founded although the surgeons did not receive a Royal Charter until 1800 but with it was the power to conduct examinations. Both colleges opposed the request by the Society of Apothecaries to award licences on the basis of a written examination but the Society was successful and in 1815 it was given the power to award a licentiate to those who had passed a written examination and completed a five year apprenticeship. The standard qualifications for a general practitioner became those of the Apothecaries and the Surgeons. This meant that a qualification was available to medical schools and encouraged their development in London and other cities of the realm. In 1818 Charing Cross Hospital was created as an integrated medical school and hospital. Armytage [1, p 169] considers the 1815 statute to have been one of the most significant of the century. The implications for engineering were certainly profound because a precedent was established whereby persons seeking to establish themselves as a profession could seek a charter that would enable them to licence those they examined who were successful independently of the universities.

1.3. Although University College London had established a chair of engineering in 1827 it is not clear whether it was taken up although a second appointment in 1841 was. In the meantime engineering schools were established in 1838 at the University of Durham and
King’s College London, and they were followed in 1841 by Trinity College Dublin. The year before a chair had been established at Glasgow University but the holder was not made welcome! [2, p2]. Cox notes that “in Britain and Ireland civil, as distinct from military engineers, normally learned their profession by means of an apprenticeship to an experienced master. This was in contrast to France where in 1795 the École Polytechnique had been established and had set a model for the scientific education of engineers in Europe and America.” [3, p 1: see also 4]. The great civic (red brick) universities were founded from the middle of the century. Even so the number of engineers produced through their departments of engineering was small.

1.4. In parallel during the nineteenth century there evolved a system of voluntary elementary education that had begun in the eighteenth century. It had a religious orientation and particular mention should be made of the Sunday School Movement that had as its objective the teaching of children from the poorer classes to read the Bible. But from 1795 some schools for industry were created that had as their objective the teaching of trades and manual skills “to encourage the habits of industry.”[5, p 12]. Otherwise secondary education was confined to private academies inhabited by middle class children. It was in these academies that that training in mathematics and science was to be found. Cotgrove points out that while training in science declined in the public schools and universities, interest in the practical applications of science had begun in the eighteenth century and that indicative of this was the founding of the Royal Society of Arts, Manufacture and Commerce in 1755. The Royal Institution founded in 1810 was focused on chemistry and the “diffusion and extension of useful knowledge in general”[6]. The aim of making useful knowledge available to the working classes was acted out in Mechanics Institutes founded by middle class philanthropists between 1824 and 1851. They failed to attract the mechanics for who they were intended, and ended up as literary and philosophical institutes for the middle classes. Subsequently there was a growth in the number of evening classes devoted to the teaching of the principles of science. They were not allowed to teach trades and craft. But other institutions responded to the demand for training that would enhance the skills of craftsmen, and in 1881 a technical college was opened in Finsbury (London) that was devoted to technical studies.

1.5. Cotgrove considers that when the Regent Street Polytechnic in London was founded by Quintin Hogg in 1882 with a focus on trade classes and different approaches to instruction and the level of instruction, it marked the development of a system of further education [5, p14]. Soon more Polytechnics were created in London. But some of these Polytechnics began to offer higher and university work which they were able to do through links with the University of London. There was a controversy about this and Quintin Hogg argued that Polytechnics should not undertake such studies. As Cotgrove puts it their task was a task of “rescue”. Against this Sidney Webb the social reformer and founder of the London School of Economics who was Chairman of the London Technical Instruction Committee disagreed with those “who feel vaguely that University instruction is not for the poorer classes” (cited by Cotgrove 5, p 64). By 1910 these Polytechnics had nearly 1000 university students on
their books. The Regent Street Polytechnic was eventually to follow suit and this writer was among those who benefited from that development.

1.6. With some fluctuations the numbers remained about the same until the second-world war.

1.7. In parallel with these historical developments were changes in the attitudes of the professional engineering institutions to examinations. The Institution of Civil Engineers was founded in 1818. The Mechanicals were founded in 1847 and the Electricals in 1871. In 1870 the Civil Engineers introduced their own examinations. In this respect they were followed by the Electricals and Mechanicals. Immediately after the first-world war (1918) the Electricals and Mechanicals agreed to participate in a scheme of National Certificate examinations administered by the Ministry of Education and set at ordinary and higher levels and attained after continuous part-time study, three years for the ordinary level and two more years for the higher level. A full time course of three years duration was available in some colleges and students who successfully completed the course were awarded a National Diploma. In order to get full exemption from the examinations of the professional institution other examinations called “endorsements” had to be taken [7, p 201 ff].

1.8. The output of engineers reported by the Percy Committee in 1945 is shown in exhibit 1. Twelve years later in 1957-5,544 engineers entered all of the thirteen recognized engineering institutions. Of these 1,900 gained full or partial exemption from the institution examinations by means of a university degree and, 2,057 by means of a Higher National Certificate [7, p 215]. For purposes of teachers pay in technical college’s membership of an institution obtained by national certificates with endorsements was considered to be the equivalent of an ordinary degree.

1.9. Although this was the situation that faced the Percy Committee it also had to face the attitudes and beliefs that had developed in the preceding period which may be counted as the two hundred years of the industrial revolution.

**Exhibit 1. Output of engineers, 1939 (Percy Report)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>University first degree including Mining and Naval Architecture but not Metallurgy</td>
<td>700</td>
</tr>
<tr>
<td>Higher National Certificates in Technical Colleges.</td>
<td>1,053</td>
</tr>
<tr>
<td>Higher National Diplomas in Technical Colleges.</td>
<td>39</td>
</tr>
<tr>
<td>Internal degrees of the Universities of London, Manchester and Durham in Technical colleges.</td>
<td>140*</td>
</tr>
<tr>
<td>External Degrees of the University of London.</td>
<td>100</td>
</tr>
</tbody>
</table>

*also included in the 700.

2 Attitudes to technical education and training
2.1 Cotgrove has shown how the character of technical education was something pursued after a day’s work, “much of it continuative of elementary education for those who had received little or no secondary instruction, shaped by the examination needs of ambitious students rather than the needs of industry, provided and financed on a local basis by local education authorities” [5 p16]. For many it acted as a “rescue” agency. Cotgrove asked why it was that extension in technical instruction was so slow in spite of public interest in its development?

2.1. Although there was continuing interest in the applications of science, science had very low status in the education system and a distinction between the classical and science curriculum emerged in the 19th century that had not been present in the 18th century when science and technical studies were widely taught. “But classical education divorced from science became a sign of social privilege and science became identified with useful knowledge to be studied as a vocational subject rather than as part of liberal education” [5, p16]. As Lord Hailsham the grandson of Quintin Hogg put it when Minister of Education “It was not quite nice to be studying science. It was almost eccentric to have a bent for mathematics” [7, p15]. That this remains the case is demonstrated by attempts to show that liberal education is incomplete without the study of technology [8]. However, as Cotgrove points out the low status of science studies at Oxford and Cambridge “released them from objections against other forms of education for the working classes, that they would raise the labourer above his station” [5 p17]. Thus in the early schools for industry stress was placed “on forming those habits of obedience and industry which the factory system demanded of its labouring classes” [5, p 17].

2.3. The significance of social class factors in the development of the British system of education should not be underestimated. But the technical colleges and their alternative route to professional status became a means of working class social advancement. Lilley argued that the decline of Britain in the 19th century, the second half of the industrial revolution, was as much due to social class as it was to anything else. “What factors make one society eager to innovate and leave another content with what it has inherited? Much of the answer would seem to lie in the class structure of society. A particularly relevant point concerns the extent to which those who derive unearned wealth from industry, and who thus command resources that could be used for its further development, themselves take direct responsibility for the actual processes of production” [9, pp 36 & 37]. Barnett considered that of all the grievous long-term handicaps that was a legacy of the first industrial revolution “one of the most pervasive and the most intractable was that of a workforce too largely composed of coolies, with the psychology and primitive culture to be expected of coolies” [10, p187] confined in ghettos “much like the townships in which the bantu coolies of South Africa still live today” [10, p 189]. Barnett’s point is that the exploitation of the workers created a working class – “and working class they and their children would always remain” [10 p 193] devolved of “personal capability in the course of generations of life in overcrowded and insanitary housing” [10, p 200]. Clearly one of the factors contributing to this state of affairs was lack of education.
2.4. Lilley argued that the maintenance of technological progress is dependent on the ample use of science and, the educational system that provides the qualified men and women to initiate this utilisation. It is evident that the British were very slow to realise the practical possibilities of scientific discoveries. For example it took forty years for Faraday’s discoveries to be realised in the dynamo. Lilley cites the case of the synthetic dye industry where British discoveries were taken over by the Germans and a large chemical industry established. One of the reasons given for this was the academic attainment of and the large numbers of people working with appropriate qualifications in German industry [9, p61 ff]. But writes Lilley, the origins of German pre-eminence in chemicals has, “its origins in German national pride trying to re-assert itself after the ignominies of Napoleonic defeat” [9, p 65].

2.5. One reason for this British attitude to science may well have been the ease with which the key innovations that drove the development of the cotton industry in the 18th century were made by persons without much scientific training. Hobsbawn made the point that they were “exceedingly modest, and in no way beyond the scope of intelligent artisans experimenting in their workshops, or the constructive capacities of carpenters, millwrights and locksmiths […] even its scientifically most sophisticated machine James Watt’s steam engine required no more physics than had been available for the best part of a century” [11]. The same point is made by Lilley who said that “three generations of “practical man” had been making very good profits, and the role played by science in even a small proportion of these was far from obvious. The methods that had made Britain the workshop of the world could surely be expected to keep her so. Why take a risky gamble (as it would seem) on the brains of a laboratory egg-head?” [9, p64]. “The chief obstacle to the scientific training of managers of the numerous small chemical and colour works in East London and the tanneries in Bermondsey, is their rooted disbelief in the value of such training” so reported the LCC Special Committee on Technical Education in 1892 [5, p 25]. Experience was valued so that when Burns investigated the electrical and electronics industry in Scotland in the nineteen fifties he found that those engaged in research could not communicate with those engaged in production and manufacture. The former were university trained the latter were persons who came from the shop floor. They spoke different languages [12]. This attitude toward experience continues to this day and is to be found in the training of teachers in England where watching a supposedly good teacher is valued and much theory regarded as nonsense. That experience is ultimately an inhibitor of innovation does not seem to be widely understood [13].

2.6. Science did develop in the universities and early in the twentieth century scientists working in England gained Nobel Prizes. Developments by scientists during the second world war showed the value of science, so that when George Payne wrote a report for the US President’s Committee on Scientists and Engineers in the late nineteen-fifties he said of British science “Quantitative strength is also matched by qualitative strength. British scientists enjoy an enviable reputation. In the thoroughness of their training (universities) and the quality of their work they are at least the equal of any similar group elsewhere. From a productivity point of view –if one can speak of productivity in connection with the pursuit of
pure science - the British have good grounds for satisfaction. Their weakness, from an economic point of view, has been that the outlook of Britain’s scientists was often uncomprisingly “pure”. Not only a predeliction for pure science, but an overt disdain of applied science, was for years fostered by the universities and became a characteristic of British mores. As an American sociologist [R. L. Meier] observed in a critique of British research: “Many scholars intentionally select subjects which in their judgment have no foreseeable application”. This attitude began to change before the war and has since been considerably softened […] It remains true, however that British university scientists confine themselves to the strictly scientific aspects of industrial problems and concern themselves only to a limited extent with developmental and production problems […] [7, pp 32/33].

2.7. Writers on the industrial revolution make it clear that it was economic activity that was paramount. It was demand that drove the need for invention. However, while individuals evidently wanted to invent, as is evident from the large number of patents secured, they were not always turned into innovations if by innovation is meant the successful application of an invention [14]. Sometimes there was a delay between the invention and its general use that may be attributed to inadequate expansion of the market. Inventors were dependent on the entrepreneurs for the development of and creation of markets and employers wanted things that worked, and they had seen that what worked, were inventions by skilled people who had little scientific knowledge. As the examples show their attitude conveyed in no small measures to their managers was one of apathy toward technical instruction. Cotgrove sums up the position at the beginning of the twentieth century thus: “the neglect of scientific instruction in the 19th century produced generations of employers who failed to appreciate the place of scientific and technical knowledge in industry. This situation has been perpetuated by industrial recruitment and promotion policies. The tradition of vertical mobility and the preference for practical experience rather than theoretical training has not favoured the recruitment of academically qualified scientists and technologists to the various levels of management, while a seat on the board was more likely to be achieved via the office than the workshop, through family connections, or from the public schools (fee paying) and older universities where stress was on the arts and the humanities. While a predominantly non-scientific higher management was unconvinced of the value and practical applications of science and technology, the demand for scientifically technically trained man-power was small and amply met by existing output” [5, p187]. These attitudes persisted into the 20th century and must have concerned the Percy Committee in its deliberations.

3 Early twentieth century developments in education

Barnett, Lilley and others argued that a major reason for German technical superiority in the second-half of the nineteenth century was the British failure to take education, let alone technical education seriously except in so far as it was an upper middle and upper class activity undertaken in the public schools. Compulsory elementary education was not introduced until 1870 many years after Germany had taken the same step. Barnett in a vociferous criticism of the liberal education views of Matthew Arnold and John Henry Newman, claimed that they high-jacked the public school curriculum, and Arnold’s views which were particularly evangelical held sway. Moreover, they persisted into the twentieth
century, and also within the grammar schools right up to the 1944 Education Act when R. A. Butler the Minister spent much of his time negotiating the Act with the religious authorities. Prior to that, he had a year earlier stalled criticism of the failure of Government to do much about technical education by establishing the Percy Committee on Higher Technological Education [7, p 289]. But within the Education Act a tripartite system of schooling is proposed that still placed technical matters in a lower place than the academic and the so called ‘liberal’. Following a report from another Committee in 1938 (The Spens Committee) Butler opted for three types of secondary school, grammar, technical and modern. They were supposed to have parity of esteem but there would have to be selection for the grammar schools by means of an aptitude test (commonly known as an IQ test). The grammar schools would be the vehicles for preparation for university. The grammar schools were for those with an academic and bookish orientation. The other schools were for those with a practical problem solving bent. Since the tests correlated fairly well with social class the grammar schools favoured the middle classes but also the brightest of the working class and thereby provided some social mobility. In 1944 there was no discussion of the curriculum and another committee was charged with this duty. It focused on the grammar school curriculum re-emphasising the value of the Christian interpretation of life. And so, the practical by which is also meant the technical (technological) was given less status than the academic by which is also meant the pure.

4 The Percy Report and its manpower projection.

4.1. The committee began by categorizing the types of technologist that industry required, a task that would inevitably mean that it would have to consider the roles of the universities and technical colleges in meeting the needs when defined. The five categories were:

1. Senior administrators.

2. Engineer scientists and development engineers.

3. Engineer managers (design, manufacture, operation and sales)

4. Technical assistants and designer draughtsmen

5. Draughtsmen, foremen and craftsmen.

4.2. The committee felt that group 5 fell outside its remit. Of group 4 they wrote that they were “outside the limits we have set ourselves with this report.” It is of interest to note that although the report uses the term “technological” in its title it refers to engineers in categories 2 and 3. It began a focus on qualified manpower that was to continue and to be at the expense of technicians as Cotgrove [5] has argued. The committee accepted figures for the annual output of engineers given to them by the professional institutions, and argued that an output of 3000 should be maintained for at least ten years. These would be in the traditional forms of engineering, that is, civil, electrical and mechanical. Subjects like production and control engineering were not considered part of undergraduate studies. The technical colleges would have to provide upwards of 1500 and many of these would have to be for category 3 after
allowance had been made for the expansion of university departments. The committee forecast the need for courses in industrial administration.

4.3. The war had left the nation with a situation that required an “energetic expansion, both in accommodation and staff, which will tax to the full the resources of universities and technical colleges, coupled with adequate arrangements for keeping a close watch on the demand which this programme is intended to meet.” These proposals were supported by the Barlow Committee in 1946 when it reviewed the Nation’s manpower needs [15].

5 Percy Committee and the need for different styles of education and training

5.1. 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.” From which they 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 that the different styles of training in the universities and technical colleges would lead to engineers with different qualities.

5.2. 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.

5.3. 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.” 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.” The report foreshadowed the trend toward day release and subsequently to full-time study, and began the trend toward courses based on engineering science in the technical colleges.

5.4. Of the 1500 engineers to be trained by the technical colleges the Percy Committee thought that 1000 should be trained via the Higher National Certificate route. But 500 or so should have a course of higher technological education that required continuous full-time study over substantial periods. They did not specify a particular structure although it is clear that the period of academic study should be no less than that for a university degree in aggregate interwoven with planned courses of works practice. They suggested that the period of academic study might be between 24 and 30 weeks per annum.

5.5. 150 of 500 students who should receive higher technological training would do so by means of external degrees although the committee thought these were an anomaly.
“University degrees should not be granted purely on examinations, or in respect of courses conducted solely in the evening or on the basis of part-time day release. We recognized however, that there may be justifiable exceptions to this general rule.” For the remaining 350 students they desired “to see 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 to 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.”

5.6. 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.” These colleges should be relieved of elementary teaching duties (ie manpower levels 4 and 5). The committee debated long and hard about what the qualification to be awarded by these colleges should be called. They firmly rejected the idea that it should be a degree. “The objection to the degree is twofold. It would not receive the support of the universities and would not provide technological education with its own hallmark.” So the equation- diploma = degree, was born, together with the principle that these technological institutions should produce engineers of a different quality to those of the universities [16].

6 From 1945 to 1956

In 1949 The Advisory Council on Scientific Policy took an opposite view and recommended that the increase in the number of persons required for industry should be provided by the universities. “There is an urgent need in industry for an increase in the number of men of the highest quality who have received an education up to university honours standards in pure as well as in applied science. For a variety of reasons we are agreed that the foundations of such an education could only be laid in universities where teaching and research in the fundamental sciences are carried out.” [17]. Therefore, the development of higher technological education should be the responsibility of the University Grants Committee. So much for the belief in the need for different styles of teaching and curricular! The Conservative Government that followed in 1951 went along with this policy, and at the same time invested £15 million in Imperial College. In this respect it is fairly clear that the Government had been influenced by the examples of MIT and Cal.Tech. It did agree that the technical colleges would have some role in higher technological education. Some colleges would receive an additional grant for advanced training. Cotgrove explains the change in policy that was to come in a White paper in 1956 as being due to the publicity given to a
report on the Soviet system of Scientific and Technical Training [18] in a speech by Sir Winston Churchill. To quote Cotgrove –“it would appear that great significance was attached to the political implications of the fact that Britain was being threatened in the scientific and technical field.” [5, p 176]. But some change was predicated earlier in 1955 when a council for the award of high level diplomas was announced.

7 1955 and the Formation of the National Council for Technological Awards.

Following the recommendations of the Percy Committee, the National Advisory Council on Education for Industry and Commerce recommended an expansion of technical education and the creation of a Royal College of Technologists. No action was taken on this matter until July 1955 when the Minister for Education announced that a National Council for Technological Awards 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.

In keeping with the proposals in the Percy Report while the Council would 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.

8 The 1956 White Paper on Technical Education [19].

8.1. The White paper set out to describe the Government’s intention to improve and expand technical education facilities and opportunities. 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 full-time study 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. Next would be “Regional Colleges” that would educate some technologists and technicians by full – time and part-time methods. “Area colleges” would do some technician training, and “local colleges” would be primarily for part-time studies for craftsmen and operative.

8.2. The White paper defined the terms technologist and technician taking its definitions from EUSEC which it subsequently used in the 1959 Crowther report [20] on the education of the 15 to 18 year old population, and a White paper “Better Opportunities in Technical Education” published in 1961 [21]. They originated with the Conference of Engineering Societies of Western Europe and the United States of America (EUSEC) in 1953 as definitions of professional engineers and technicians and are shown in exhibits 2 and 3 [22]. The Americans did not adopt these definitions [23]. While official and professional circles accepted these terms some industrialists did not [24]. They did not want their hands to be tied in how they employed engineers. The White paper foreshadowed the stratification of courses into discretely organized channels that became a reality in 1972. In a word, persons pursuing Higher National Certificate courses would be deemed to be on a technician route. However, in 1956 they continued to follow that route to professional recognition. By incorporating the
In the White paper the government was clearly indicating that those educated to become technologists in the technical education sector would be employable in the Percy Committee’s category 2 although this point does not seem to have been picked up in the literature. It has considerable implications for the curriculum. It should be noted that in this definition and the earlier forecasts of the Percy and Barlow committees it was not thought that women should become engineers.

“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.”

Exhibit 2. 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”.

Exhibit 3. The definition of a technician used in the 1956 White paper.

8.3. In sum the intention of developing Colleges of Advanced Technology (CATS as they were called) was that they would ultimately enjoy a status comparable with that of a university. Nevertheless, the government of the day confirmed its intention of creating a dual system of education at the highest level and this remained in place until 1992. However, the operational philosophy was one of expansion and not difference. There was, inevitably, competition between these colleges and the universities for resources [25].

8.4. In the event the government decided to develop eight technical colleges and polytechnics into Colleges of Advanced Technology. Five of these were in the provinces and three in London. Subsequently another technical college in London was upgraded to this status. A surprising selection was that of the Chelsea College which while almost of all of its students pursued studies for London University degrees did not offer any courses in engineering and technological subjects. The other two London polytechnics, Battersea and Northampton, had students who were also in pursuit of degrees in engineering programmes. These institutions were not asked to change their programmes to offer the new diploma although they offered diploma programmes alongside degree courses.
9 The National Council for Technological Awards (NCTA) and the curriculum

9.1. The National Council for Technological Awards founded the year before the 1956 White paper had already begun to draft the regulations that institutions would have to meet if their courses were to be approved for the award of a Diploma in Technology. These regulations which took into account the resources required for programmes were very beneficial to the Colleges since while they were under Local Authority management the Local Authorities felt obliged to respond positively for the requests that were made for funding. For example library facilities and staffing were greatly improved [25, p 146]. The facility of the NCTA was not confined to the Colleges of Advanced Technology. Some Regional Colleges could and did apply to have their courses approved by the NCTA thereby introducing an element of competition between the CAT’s and the remainder of the technical college sector. Neither were the CATs required to offer only courses for the award of NCTA qualifications. They could continue to offer programmes for University of London degrees. Thus, in those that did there was an element of competition between the diplomas and degrees.

9.2. Whereas the Percy Committee’s recommendations had been made in respect of engineering and engineers the NCTA was given a brief that would allow it to offer diploma’s in the traditional sciences as applied and mathematics. But there its remit ended. It was not allowed to offer awards in the humanities and social sciences. The purpose was to produce scientists motivated to apply their knowledge to the solution of industry’ problems. Therefore, all the diploma programmes were required to be sandwich (co-operative) courses. But there was no requirement that they should all have the same structure. There were many variants, the most common of which was the 6 month in industry/6 month in college by four year programme, commonly known as a “thin” sandwich course. There was a “thick” variant that required the students to do one year in industry prior to two years in college, which were to be followed by another year in industry and a final year in college. The structure of sandwich courses caused difficulties for some industrialists (see below).

9.3. Panels were convened in each of the subject areas which had to validate the submissions made. In addition to details of the syllabuses (lists of content), information about tuition hours per subject, timing of the subjects in the course, qualification details of the staff who would teach on the programme and detailed information about the resources that would support them had to be given in the application for recognition of a course. The panels were made up of experts from both academia (more often than not the universities) and industry. The extent to which courses could be innovatory was determined by these panels, and while there was some innovation the evidence is of a general “curriculum drift” toward mirroring university courses. Given the number of teachers who had experience of or who were currently teaching at this level this was not perhaps surprising [25, p 297]. But, it was a cause of complaint by some industrialists (see below).

9.4. The principles of examining were the same as those for the universities. That is the examination papers and assessment procedures would be approved by an external examiner who would also validate the marks by inspection of the candidates’ scripts [26]. The external examiners (more often than not university professors) had to be approved by the NCTA.
programme would be approved for five years [25, pp 144–146]. It was up to the external examiners to ensure that it met the required standard, that is, parity with the equivalent programmes offered by universities [25, pp 306–312].

9.5. In 1955 the Institute of Adult Education published a major study of liberal education in technical colleges [27]. It undoubtedly influenced the Ministry of Education in 1957 to make liberal studies a compulsory component of courses in technical colleges [28]. It is not perhaps surprising given these views and their cultural antecedents that the NCTA should require Diploma in Technology courses to include a substantial programme of liberal studies. The Colleges of Advanced Technology were faced with a culture, so well illustrated in the Percy Committee report that technical institutions could not compete with the university environment. University students did not need a liberal education because of the environment too which they were exposed. Moreover the environment of the CATs would be restricted primarily to technological courses so the mixing that students would experience would be among students of similar interests and drives. Moreover, although never discussed, students from the lower middle and working classes catered for by the technical institutions required programmes of liberal studies to offset the advantages of those who had studied at public schools and/or who had the advantages thought to be provided by the universities. These programmes proved to be very controversial among the student body even though many would say they had benefited from them [29, 30]. Many students viewed them as taking time away from lectures that could have been devoted to their technical studies.

9.6. The NCTA required all students to complete a major project in their final year of study. It could take at least a fifth of students contact time (ie one day per week). The opinion at the time was that they were very successful. For the most part the large scale nature of these projects did provide a key difference between these courses and their university equivalents but substantial projects were done in some university programmes that were as profound [25, pp 317–365. 31, (university), 32 (technical college)]. It was within the projects that attention could and was paid to design and creativity and much was made of these dimensions (see below).

9.7. Finally, the major difference between university courses and the sandwich courses of the dip.tech was the compulsory industrial training with its intention of being planned. But even then two or three universities had had experience of running sandwich courses and many had arrangements with industry whereby a student did one year in industry before the three year university course and one year after it concluded but it did not count toward the degree qualification which the industrial training did for the dip.tech, the degree being awarded at the end of the university course. From the perspective of a company such courses were much cheaper than a diploma in technology course.

10 Criticisms of the dip.tech

10.1. It has been noted that there were criticisms of the structure of sandwich courses and the syllabus. Primarily these were made by organizations in the electrical engineering industry both directly to colleges and through their representative organization the Electrical and
Electronic Manufacturers Joint Education Board (EEMJEB) [33]. Of the first thousand to graduate from the diploma courses about a third were supported by members of this Board. Their complaint was that while they supported the 6 x month x 4 yrs structure it overloaded their training systems during the time the students were in their firms. They wanted the colleges to offer two courses per year so that the training places were always filled. In the jargon of the time these were called end-on sandwich courses. They were supported by some of the Principals of the CATs who believed this arrangement would double the numbers through their colleges. However, one research unit that looked at this problem found there was no evidence that firms would double their recruitment if they entered into such an arrangement [25]. Indeed there was not a great deal of evidence to support the view that there was a shortage of qualified manpower [34]. EEMJEB caused the government to create a committee to look at this problem but its work was overshadowed by the public discussion that a Committee on Higher Education had caused (see below). In any event the merging of the big three electrical firms in the nineteen-sixties led to a major reduction in the support they gave for training and the departments of electrical engineering in several of the colleges had to look for students elsewhere.

10.2. The second complaint related to the syllabus. EEMJEB said they were very much like a university degree and they planned to get their members to draw up syllabuses which could be put to the CATs. There was some innovation and development in the Colleges but equally there were innovations and development in the universities but it was not major curriculum innovation. An important complaint against both the universities and CATs was made in a paper in Universities Quarterly by George Bosworth, an engineer who was Director of Personnel and Training of the English Electric Co [35]. He seems to have come to the belief that the remedies in curriculum would or could not be achieved within the undergraduate curriculum because when he chaired a committee on the education and training requirements for the electrical and manufacturing industries the remedies proposed by the committee related mainly to post-graduate training [36].

10.3. Beyond the fact that many teachers in the CATs had experience of teaching at degree level the teaching staff in the colleges, whether or not they had taught at that level were anxious to demonstrate that dip.tech = degree for if that were true they had an unanswerable case for these institutions to become universities. So what was the evidence that the Committee on Higher Education had that led them in 1963 to propose that the CATs become universities.

11 Standards

11.1. First were the standards for approval set by the NCTA, the quality of the membership of its subject panels and the quality of its external examiners. Second was the quality of teachers in the colleges, as measured by their qualifications. Third, were the resources available to them (laboratories, libraries etc).

11.2. No attempts were made to compare the relative standards of students coming from the universities with degrees with those from the CATs with diplomas. There were, however,
studies of the relative performance of students who came directly from school with ‘A’ level entry qualifications and those who came from industry with National Certificate qualifications. Put crudely, those from the schools were somewhat better at mathematics and science and had covered more than those with a National Certificate whereas those with National Certificates had better practical understanding [37]. A major cause of student failure was mathematics particularly in the first year.

11.3. Allowance was made for the differences between the two groups in teaching particularly in the first year so as to enable students to make the transition to the new style of course, and some colleges made special provision so as to solve this problem in the first academic period. The National Certificate students did not necessarily perceive these differences to be disadvantageous because some of them felt they had an advantage over the other students in engineering subjects [25, pp 253 ff]. Overall the performance of National Certificate students compared favourably with those of university students [25, p 259 and 38].

11.4. One department of mechanical engineering introduced two levels of mathematics after the students had followed a common program in the first academic period. In general about a fifth of students required considerable help with mathematics during their first year. It was apparent that there were similar problems in the United States [39]. There were a number of surveys of the uses of mathematics in particular engineering and science subjects [e.g., 40]. A question which continues to be asked was put by Sir Frank Mason in his presidential address to the Institution of Mechanical Engineers. He asked “are we losing a lot of good potential engineers by pitching our mathematics requirements too high?” He was not the only senior engineer to ask this question which has not gone away and is as relevant now as it was in 1965 [41].

11.5. More generally standards would not be revealed by comparison of the differences between syllabus $x$ in a university and the corresponding syllabus $y$ in a CAT. That would only yield differences in content.

11.6. A comparison of examination papers and the marking of those papers would have been the only true indicator of comparative performance. But this was not done. The NCTA accepted the word of the external examiners and did not enquire further. One study at the time did obtain the opinions of thirty-three external assessors. Although small, it was relatively representative across the subjects, but that is the most that can be said. Most of the examiners came from the universities and Fellows of the Royal Society were among them. So it was pre-supposed that the standards of the dip.tech were being compared with those of university courses. There were also external examiners from industry who were new to the process and who were cautious about the judgments they made. When summarising the findings of that study, the investigator wrote- “there was no reason to suppose that the standards of the dip.tech were greatly different to those of technological degrees awarded by the universities” [25, p 316].

12 The 1963 watershed
In 1963 a committee on higher education (the Robbins Committee) that was appointed in 1961, just five years after the 1956 White paper reported [42]. With little attempt to formulate a policy to guide its work it recommended the rapid expansion of higher education. It accepted evidence that the CATs should become universities and by 1966 the charters enabling them to become universities were being issued. The argument that since these colleges had proved they could do work of degree level standing they should have the same freedom to design, examine and offer courses that universities had was accepted. Coupled with the view that the committee had that there needed to be an immediate expansion in the number of university places which should be available to anyone who was qualified for them by ability and attainment it was inevitable that the Committee should recommend that the CAT’s become universities. But the Robbins Committee proposed what came to be known as a dual system of higher education. It recommended that the regional colleges (all to be called polytechnics) should be allowed to offer degrees across the spectrum of subjects. For this purpose the NCTA would be transformed into a Council for National Academic Awards (CNAA), and the regional colleges would merge with local institutions such as Colleges of Art and Teacher Training colleges to give them the broad base required [43]. Moreover, even then it was evident that the transformation was incomplete because it was inevitable that in spite of opposition, given the history of the CATs these new polytechnics would want to and did become universities in 1992 [25, p 658]. Once again it was assumed that higher education was a “common good” that should be available to all who were qualified and there was little philosophical debate about its purposes, or indeed the purposes of a university. These changes effectively killed off any chance of an alternative curriculum.

13 The alternative syllabus issue

13.1. Given the history of the CATs the question arises as to whether there could have been an alternative curriculum to the engineering science model that dominated thinking at the time (e.g. acoustics, electro-magnetic theory, mechanics, thermodynamics etc) with some attention to engineering drawing as was the case for example, at Imperial College [44]. Clearly the answer was that some distinguished engineers thought there were other ways, as for example the senior industrialist G. S. Bosworth [35]. When the University of Lancaster sought permission to develop engineering Sir Willis Jackson acting for the University Grants Committee made it clear to the university that proposals for departments in the traditional engineering subjects would not be accepted. The Vice-Chancellor sought the advice of a group of industrialists who developed some of Bosworth’s ideas into a general education programme based on problem and project based learning with subsequent specialisation [45]. It was so different from traditional programmes that it did not find favour with the Senate. Today the model would not seem unusual. So why did not the CATs seek to do something different? There seem to be three major reasons for this lack of interest. First, apart from some industrialists there was no call from the legislators for them to produce an alternative curriculum. Second the pressures within them supported their counter-cultural inclination to follow the practices of university programmes. Curriculum drift was in the direction of perceived higher status (see below 13.4). Third in order to develop new schemes ideas not only have to float around the system but they have to be discussed in some depth. There has
to be some philosophical *raison d’être* for change, and this has to accompanied by some foundation in new knowledge. Such a framework did not exist but by 1964 when the Lancaster group undertook its study it had access to a wide range of educational thinking in the area of the curriculum as the 1966 report shows. The same is true of industrial training in a culture that put great value on experience. The investigations of its value had to rely on the evaluation of the experiences of students, good experiences, and many were reported, were taken to indicate good training. Conversely a poor experience constituted poor training for the students involved. Considerable efforts were made by both the colleges and industry to ensure that training provided a good experience [46]. There was even evidence of an “integration” of theory and practice of which much was made, but there was no adequate theory of integration on which to build an integrated curriculum of education and training. A naïve theory did not emerge until the late nineteen sixties but it was not published [25, p 575 ff].

13.2. The Bosworth Committee made a similar point in its 1966 report. They referred to the Schools Council for Curriculum and Examinations which was a *quango* that had responsibility for the elementary and high school curriculum and undertook major curriculum projects. The committee noted “the absence of any body which might serve as a focal point for discussion of curricula in higher education in the way that that the Schools Council does for curricula.” [36]. It is of interest to note that at the present time there have been no developments in the UK and Europe to correspond with those in the United States where initiatives have been taken to develop departments and centres for Engineering Education.

It cannot, however, be argued that knowledge was not available that would have led to an alternative curriculum because there was a great deal of thinking going on in the electrical engineering industry that merited discussion. The problem was that those who were doing the thinking were not heard or did not know how to make their voices heard.

13.3. Furthermore policy was made without an understanding of the sub-system and the internal motivations generated as a result of its position in the system of higher education. A major reason for the lack of response to criticism is that the CATs were a relatively open sub-system of higher education in competition with a relatively closed system (the universities) on one side, and the relatively open system of the regional colleges on the other side for able students from the school system. The internal systems in some CATs were so open that they ran dip.tech courses in parallel with degree courses. While the CATs came from a similar culture the university culture had developed independently. It was exclusive whereas the other institutions were more inclusive. Similarly the historical culture of the CATs and regional colleges was of “earning-while-learning whereas that of the universities was of full-time education often with residence and a more leisurely approach to learning. It had its own hierarchy of status with Oxford and Cambridge at the apex. In a society that was (and is) very conscious of social class the CATs carried with them the stigma of being of lower middle and working class origins. It was from this culture that the CATs were trying to escape and for good reason. Surveys of school teachers showed the CATs were ranked in the minds of schoolteachers between universities and technical colleges [25, p 455 ff]. They thought you could not make universities out of existing technical institutions. They felt that industry
influenced the colleges too much and this contributed to their view that the courses were illiberal. Teachers were concerned to do their best for their students. Thus social values were as important as abilities. The fact that society brought about a structure in which there was a close relation between the two was a problem for society, not for the school. Hence it became a problem for the CAT’s and by extension sandwich courses. If they were to encourage able students to apply for their courses they would have to veer to the “pure” away from the “practical” and this inevitably meant the adoption of university type courses with which they were familiar: courses that emphasised the application of science.

14 Implications for the present

14.1. Last year the inventor of the bagless vacuum cleaner, Sir James Dyson explained in an article in The Times (26:02:2013) why his firm was investing £150 million ($225 million) in an electric motor manufacturing facility in Singapore rather than the UK. While he thought Britain was moving in the right direction it did not offer the tax incentives that Singapore did. “The country supports and values inventiveness and backs it up with an education system that encourages ingenuity [...] Singapore realises that human resources and ideas are its trump cards.” In the letters column of The Times on the following day no comments were to be found in the letters page on Dyson’s article but in the centre part of the page, always reserved for bold type was a long letter from a number of distinguished historians including the Harvard based Niall Ferguson backing the Secretary of State’s proposals for the history curriculum. They followed previous letters on this subject and were followed by more in bold type. Moreover, the issue had been raised many months previously and Dyson had found himself writing an article at the same time pleading for more school students to become interested in engineering. When the same Secretary of State had proposed a new curriculum for those taking examinations at the age of sixteen he had had little or nothing to say about technology which is reminiscent of the decision process prior to the 1944 Act (para 3).

14.2. Three of the themes that run through the narrative that has been presented, account for this lack of interest in engineering and technology among policy makers. They explain the legacy of the industrial revolution and are culture, status and social class. The narrative shows that whilst there was teaching in the applications of science in private schools in the eighteenth century it declined in the nineteenth century and institutions set up to provide useful knowledge for those in mechanical trades became places of literary study for the middle classes. It also shows that education for the poorer classes was focussed on teaching children to read the bible (para 1.4). Even so science had low status within the education system and by the middle of the nineteenth century a classical education divorced from science was a source of social privilege and science became identified with useful knowledge to be studied as a vocational subject rather than as part of liberal education (para 2.2). The directors of industrial organizations who came from this privileged class did not see the value of giving their managers scientific training when history showed that many intelligent artisans had caused the inventions that had contributed to the success of the industrial revolution (para 2.5). Nevertheless by the end of the century a technical college system had
developed that enabled workers to study at night and work by day (‘learning while earning’, as it was called). They could pursue courses for the qualifications offered by the professional institutions, or in the London Polytechnics pursue degrees of the University of London (para 1.5 and 1.6).

14.3. The study of pure science became valued for its own sake (para 2.6) and so a divide, sometimes expressed as pure-versus-applied, at other times as the academic-versus-the practical, or the academic- versus- the-vocational became part of the values and belief system of the policy makers who themselves came from privileged backgrounds. It is still a fact that there are very few legislators with engineering and science qualifications and this applies as much to the senior echelons of the civil service. The Percy Committee, the principal subject of this narrative, was established to stall criticisms that the government had failed to do much about technical education. In 1945 the classical curriculum offered by grammar schools was affirmed. The practical (technical/technological) continued to have less status than the ‘pure’ (para 3). Thus at the apex of status grammar schools were to be for the few who were academically able, technical schools were to be for those who were practically inclined, and modern schools were to be for the majority who apparently were of neither disposition. It was a false psychology that effectively divided children by social class. Alternative structures of schooling have not resolved this problem. However, it was the division between the arts and the sciences that led C. P. Snow to attack the two cultures that had developed out of this value system. There is no evidence that these divisions have gone away and this is at the heart of Dyson’s difficulties.

14.4. The recommendations and deliberations of the Percy Committee cannot be understood without reference to the culture of the education system in which they were made. They were faced with a dual system in which the number of graduate and graduate-equivalents being produced by the technical colleges was as great as the number of graduates coming from the universities (para 1.8). Furthermore the projected increase in the annual output of engineers would have to be provided by both the universities and technical colleges and maintained for ten years (para. 4.2). The committee, holding that every technology is both an art and science, considered that in the past the universities had emphasised the science aspect whereas the technical colleges had emphasised the art aspect. They believed that the different styles of training in the universities and technical colleges would lead to engineers with different qualities (para 5.1). However, at the same time they believed that the academic content of the technical college courses was inadequate. Therefore they recommended substantially more full-time academic study interwoven with works practice. While they responded to the demand from technical colleges to design their own curricular they did not allow them to offer their own award. Rather the award would be made by an independent council that would approve the courses submitted (para 7, para 9). While these courses would be of degree standard they would be awarded a diploma (para 5.6). Further the universities would concentrate on producing graduates able to do research and development while the technical colleges would produce engineer manager for design, manufacture, operation and sales (para 4.1, para 5.5). Thus the division between the academic and the practical, the pure and the
applied was made and the middle class versus lower middle/working class division in technological education continued.

14.5. When, ten years later policy makers adapted the proposals to respond to a perceived shortage of technologists (para 8.1, 8.3, 8.4) industrialists were delighted because they thought a qualification suitable to the needs of industry would be produced. They were to be disappointed and this was inevitable. The policy makers were largely concerned with meeting the perceived demand for qualified manpower while at the same time raising standards. They did not take into account the structure of the internal cultures within the nine colleges whose status they raised neither did they consider how it functioned as a sub-system. In the first place they did not make the diploma institutionally unique (para 9.1). Colleges were allowed to continue to run their degree level courses alongside of diploma courses. Second, other colleges were allowed to do the diploma. The diploma had to compete within colleges with other courses as well as within industry which now had another course from which to choose personnel. A uniform sandwich (cooperative) structure was not put in place. Apart from the failure to make the diploma institutionally unique the policy makers failed to realise the importance of status. The colleges were in competition with the universities and their teaching staff believed that if they were teaching courses of university standard they should be allowed to award their own degrees. Moreover they realised that teachers and pupils in the grammar schools from where they wanted to draw their students saw them as second class institutions. Industrialists watched the curricular in the colleges “drift” to mirror that offered by the universities and away from what industrialists thought was required while some allowed some diplomates to do R & D (paras 9.3; 9.4; 10.2 & 11). While this is probably the major reason for the failure to develop a radically different alternative there is evidence that while there was a philosophy for such an alternative, the educational knowledge and theory that would have enabled such a development was missing (para 13). The lessons for policy makers are simple. If curriculum change is wanted then persuade institutions that have high status to develop and sustain new models, and ensure they have an acceptable philosophy and knowledge to be able to develop them. Unfortunately the pressures in any system are toward the status quo. Change depends on the development of acceptable ideas. Newcomers have to adapt to the system and give it their total commitment. Major change has been sustained at Milwaukee’s Alverno College because it had a profound and well thought out philosophy of curriculum to which its faculty were enabled to give total commitment.

14.6. Substantial change in educational policy is only possible when the change agents (policy makers) understand the origins of and act on the social values that drive the system, and that requires a philosophical underpinning of the change that is sought, for many of the stakeholders will be required to change their attitudes. Such change depends on the development of ideas so that key concepts become something more than shallow ideas. The need for high status product champions who can sell those ideas at policy making and operational levels is paramount. At the same time policy makers need to be able to think in terms of systems and the effects their policies have on the exchanges they cause between the sub-systems that make up the system. It is a safe argument given the sociological knowledge that was available at the time, the demise of this sub-system of higher education was
predictable. It is contended that these findings are relevant to any one or any organisation interested in changing the structure and culture of engineering education.

Acknowledgements

I am grateful to Dr Alan Cheville for his constructive advice and criticism as well as to the unknown reviewers for their comments.

Notes and References


[6] *ibid*


[16] Lord Percy in a note in the report said he saw no reason why a B.Tech should not be awarded. However, since he wanted to avoid the disturbance that this would cause, he suggested that these specially selected technical colleges should be called “Royal Colleges of Technology” and that subject to moderation by a National Council of Technology they should be allowed to award an Associateship of the Royal College of Technology. He envisaged that some of these colleges would eventually become universities.


[23] In 1964 the American Engineers Council for Professional Development approved a new definition of an engineering technician.*While this was not adopted in the UK there was some interest in making a distinction between high and low level technician work.+ 


[34] Heywood, J (19740 Trends in the supply and demand for qualified manpower in the sixties and seventies. The Vocational Aspect of Education, 26, (64), 65 - 72.


Professor S. P. Hutton wrote to the author to say that some universities were prepared to take National certificate students and that his department found that they performed better than those coming straight from school with A levels. However, he found HNC students were taught badly often by drill methods [25, p 59].


Cited in ref 25, p 272. See also accompanying commentary.


