ORGANIZATIONAL BASES OF PROFESSIONAL STATUS:

A COMPARATIVE STUDY OF THE ENGINEERING PROFESSION

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Abstract

British engineers have a lower status than practitioners of other British professions, engineers in other industrialized and developing societies, and than the Victorian Civil engineer. Explanations of this problem in terms of variables specific to British society and culture are found inadequate, and an explanation is advanced that stresses the role played by the occupational group in determining its own status.

Professions are more or less effectively organized for the collective pursuit and legitimation of status. The historical development of the engineering profession in its British peculiarity resulted in a fragmented structure of organization by means of which speciality groups attempted to usurp the status of established practitioners, leading to mutual denigration and non-recognition, which eventually undermined the basis and questioned the legitimacy of engineering professionalism. While the British profession differs from some school-based ones such as the French and German in its relationship to the educational system, it is not peculiar in that respect, and the control exerted by the British profession over education and entry by means of pupilage and apprenticeship, would normally have enhanced the profession's exclusiveness. Fragmentation has precluded effective measures for raising the status of engineers, measures taken by other engineering professions, and left no recourse but an attempt to found professional status on speciality standing, an effort that has resulted in the present century in a decline of the engineer in positions of industrial leadership. Accountancy is the profession most like engineering in the structure of its organization and collective action, but there are significant differences that explain the differences in status.

Engineers have been attempting to raise their occupation's status by changing the structure of its organization and relationship with education and industry. The development to date will not bring about the ends of collective action, and further changes are likely.

Main Abbreviations

AAE	American Association of Engineers
ACAL	Institute of Company Accountants Limited
ACCA	Association of Certified and Corporate Accountants
Acct	*The Accountant*
AEC	American Engineering Council
AIEE	American Institute of Electrical Engineers
APEA	Association of Professional Engineers of Australia
ASCE	American Association of Civil Engineers
ASEE	American Society for Engineering Education
ASEE	Association of Supervisory Electrical Engineers
ASME	American Society of Mechanical Engineers
ASPEE	American Association for the Promotion of Engineering Education
BAGM	British Association of Gas Managers
BESA	British Engineering Standards Association
Big Four	ICE, IME, IEE, and INA
Big Three	ICE, IME, and IEE.
BIM	British Institute of Management
BMA	British Medical Association
BSI	British Standards Institution
CAAL	Central Association of Accountants Limited
CAL	Corporation of Accountants Limited
CEI	Council of Engineering Institutions
CIBS	Chartered Institution of Building Services
CNIF	Conseil National des Ingenieurs Français
CNAA	Council for National Academic Awards
EC	Engineering Council (U.S.A.)
ECPD	Engineers Council for Professional Development
EG	Engineers Guild
EIJC	Engineering Institutions Joint Council
EJC	Engineering Joint Council(U.K.)
EJC	Engineers Joint Council(U.S.A.)
Electricals, "Minutes"	Institution of Electrical Engineers,"Minutes of Council Meetings"
Eng	*Engineer*
Engrg	*Engineering*
EPRC	Engineering Public Relations Committee
ERB	Engineers Registration Board
EUSEC	The Conference of Engineering Societies of Western Europe and the United States of America
FAES	Federation of American Engineering Societies
FAL	Faculty of Accountants Limited
FASFID	Federation of French Associations and Socities of Diploma Engineers
FEANI	*Fédération Européenne d'Associations Nationales d' Ingénieurs*
HNC	Higher National Certificate
HND	Higher National Diploma
HVE	*Heating and Ventilating Engineer*
IAE	Institution of Engineers Australia
ICAEW	Institute of Chartered Accountants in England and Wales
ICAI	Institute of Chartered Accountants Ireland
ICAS	Institute of Chartered Accountants Scotland
ICE	Institution of Chartered Engineers
IChemicalE	Institution of Chemical Engineers

ICPAL	Institute of Certified Public Accountants Limited
ICWA	Institute of Cost and Works Accountants
IEA	Institution of Engineers Australia
IEE	Institution of Electrical Engineers
IERE	Instution of Electronic and Radio Engineers
IGS	Institution of Gas Engineers
IHVE	Institution of Heating and Ventilating Engineers
ILO	Institution of Locomotive Engineers
IM	Institute of Metallurgists
IMarE	Institution of Marine Engineers
IME	Institution of Marine Engineers
IMTA	Institute of Municipal Treasurers and Accountants
INA	Institution of Naval Architects
IPE	Institution of Production Engineers
IPLAL	Institute of Poor Law Accountants Limited
IRSE	Institution of Railway Signal Engineers
ISE	Institution of Structural Engineers
ISignalE	Institution of Railway Signal Engineers
Journ.IEA	Journal of the Institution of Engineers Australia
JIEE	Journal of the Institution of Electrical Engineers
JISE	Journal of the Institution of Structural Engineers
JRAS	Journal of the Royal Aeronautical Society
LAAL	London Association of Accountants Limited
Marine,"Minutes"	"Minutes of the Council Meetings of the Institution of Marine Engineers"
MICE	Member of the Institution of Civil Engineers
MIMechE,AMIMechE,etc.	Member of the Institution of Mechanical Engineers, Associate Member of the Institution of Mechanical Engineers, ditto the other Institutions
Min.Proc.ICE	Minutes of the Proceedings of the Institution of Civil Engineers
Min.Proc.IME	Minutes of the Proceedings of the Institution of Mechanical Engineers
NACEIC	National Advisory Council on Education for Industry and Commerce
NCEI	New Council of Engineering Institutions
NCTA	National Council for Technological Awards
NSPE	National Society for Professional Engineers
PAAL	Professional Accountants Alliance Limited
PE	Professional Engineer
PEAL	Professional Engineers Association Limited
Proc.ICE	Proceedings of the Institution of Civil Engineers
Proc.IME	Proceedings of the Institution of Mechanical Engineers
Production,"Minutes"	Institution of Production Engineers,"Minutes of Council Meetings"
RAS	Royal Aeronautical Society
RE	Royal Engineers
RIBA	Royal Institute of British Architects
RIC	Royal Institute of Chemists
RINA	Royal Institution of Naval Architects
SIAA	Society of Incorporated Accountants and Auditors
SSAL	Society of Statisticians and Accountants Limited
STE	Society of Technical Engineers
Structurals,"Verbatim Reports"	Institution of Structural Engineers, "Verbatim Report of Discussions and Proceedings and the Meetings of the Council"
Trans.ASCE	Transactions of the American Society of Civil Engineers
Trans.ICE	Transactions of the Institution of Civil Engineers

Trans.IGE	Transactions of the Institution of Gas Engineers
Trans.INA	Transactions of the Institution of Naval Architects
Trans.Newcn.Soc.	Transactions of the Newcomen Society for the Study of the History of Engineering and Technology
Trans.Soc.Eng.	Society of Engineers, Transactions.
UKAPE	United Kingdom Association of Professional Engineers
VDI	Verein Deutscher Ingenieure
WFEO	World Federation of Engineering Organizations

Chapter 1.

The Professional Status of Engineering Occupations

Introduction

The status of engineers in a wide range of industrial and developing societies has come to be a source of interest to both the state and the profession. Attention has been drawn by problems with the supply of scientific and technical manpower necessary for economic growth. The shortage of qualified manpower in the late fifties and early sixties, after the Russian success with the first Sputnik, created an awareness of the hiatus between the status of the "pure scientist" and the applied scientist, or scientists and engineers, which is not found to the same extent, if at all, in other European countries, or elsewhere in the English-speaking world. The further supposition that not only was the status of the profession low, but also its performance, was easily made, adding stimulus to the concern when the engineering industry was accounting for about 18% of output of goods and 45% of U.K. exports.

An ancillary consequence was the production of much comparative data bearing on the status and position of engineers and related occupations. Some of this material can be used to measure the prestige status of British professional engineers, which is the object of this chapter; following chapters will explain the findings. Specifically this chapter aims to measure the prestige status of British professional engineers in relation to a) other established British professions, b) the engineering profession in selected other societies, and c) British engineers in the nineteenth century. Ideally, measurement would produce a rank for the British professions in relation to the professions of other societies and historical trends in shifts of rank. The analysis will necessarily fall short of this ideal, systematic materials are not available.

The Engineer in the Occupational Prestige Survey

The rating and status afforded to the professional engineer in the occupational prestige survey is lower in Britain than in any other major industrial society.(1) The main survey, including engineers and conducted in Britain, is that of Gerstl and Hutton.(2) The findings are presented in Table 1, which shows the relatively low ranking of professional engineers. The "professional engineer" is

Table 1

Rankings of Occupations by National Sample

Occupation	Median Rank
1. Doctor	2.21
2. Solicitor	4.25
3. Univ. Lecturer	4.36
4. Research Physicist	4.62
5. Company Director	4.65
6. Dentist	5.96
7. Chartered Accountant	6.45
8. Professional Engineer	7.07
9. Primary School Teacher	7.67
10. Works Manager	8.27

N. = 1063

Source: Gerstl and Hutton (1966).

not included in that block of occupations for which the median rankings are similar; it is placed next to the semi-profession of primary school teacher, and only otherwise above works manager.

A comparison of the position of the professional, or civil engineer, in occupational prestige surveys carried out in the United States, beginning with Counts' pioneering study,(3) since reproduced,(4) shows that the prestige status of civil engineers in the United States is relatively higher than in Britian. There is not the difference between the civil engineer and other established professions; he is more likely to be placed among them, rather than at the bottom with the semi-professions. The NORC survey of 1947 found that the civil engineer ranked below lawyer and member of the board of a large corporation, and above the psychologist, minister, owner of a factory that employes about 100 people, captain in the regular army. In the 1963 NORC survey the civil engineer again ranked just below the member of the board of directors of a large corporation, but now also above architect, lawyer, and banker. In both these surveys the civil engineer ranks well above the accountant for a large business. The civil engineer does not differ significantl in his prestige from scientists. There is little difference in the ratings afforded to the two occupations in the American surveys.(5)

The Australian engineer, along with other Commonwealth engineers, has a higher status than the engineer in Britain. The occupation has been found to rank above university lecturer, manager of a large financial or industrial enterprise, school principal, owner of a business valued at between $30,000 and $100,000 (Australian), and well above the registered public accountant.(6) The status of the engineer in Canada is higher than in the United States and hence considerably higher than in England.(7) The Scandinavian countries have high status engineering professions. Svalastoga found that "civilingeniør" ranked approximately equal to attorney, teacher in a secondary school, and above army captain, and architect.(8) The occupation again ranked considerably above the accountant, which ranked below the semi-professions of elementary school teacher and librarian. It is a commonplace observation that the prestige status of engineering occupations is extremely high in the Soviet Union. The survey findings of Inkeles and Rossi,(9) V.V. Vodzinskaya and other Russian social scientists(10) confirm that the engineer is ranked near the top of the professional complex with university and other higher educational staffs, and scientists, and above such professions as medicine, law, and considerably above accountancy. The engineer is similarly high placed in other East European societies.(11) In developing societies the prestige status of engineers is usually very high in the cities, despite cultural differences as between e.g. Chile, Indonesia, Taiwan and India.(12) It is not uncommon to find the civil engineer placed above lawyers, university professors, managers of industrial companies and company directors, higher civil servants, dentists and other high-ranking occupations and positions. But, it is not uniformly high across developing societies.

These conclusions are supported by Hutchings' study of the attitudes of sixth form boys towards technology.(13) British students ranked a number of professions on the three dimensions of pay, intelligence and prestige and corresponding evaluations were made by German and French students. The civil engineer does not even appear on any of the three dimensions of ratings by British students; he ranks well below the doctor, solicitor, university lecturer, architect, school-master and nuclear physicist. Hutchings' study suggests that the status of engineers is higher in France than in Germany, both of which have a higher status profession than in Britain. Engineering occupations other than a "civil engineer" appear as being of doubtful professional standing at all. Indeed, students believed that the technologists received their education in the technical education system rather than universities, the preserve of scientists.(14)

It can be concluded that engineers in the United States have a relatively low status though higher than in Britain. There is not the gap between engineers and scientists found in the British surveys nor between engineers and other established professions. Engineers in Canada, Australia and New Zealand rank that much higher than they do in Britain. Much the same applies to the Russian engineers, but to an even greater extent. Engineers in developing countries are firmly and consistently placed towards the apex of the professional complex. For European societies, engineers rank very highly in France and Scandinavia, less highly in Germany. These professions also rank above the American profession, and quite clearly above the British engineers, a fact often commented upon. One American observer states: "The engineer, as a professional man, does not have the same social and professional status in the United Kingdom as does the clearly identifiable and highly respected university graduate engineer in Scandianavia, Switzerland, the Netherlands and Germany".(15) Nowhere does the prestige status of engineers appear to be as low as it is in Britain. Further notable features of the survey findings are the high status of accountants in England compared to the other societies, and the relative uniformity in the status of doctors and lawyers across Western industrial societies.

Further Indicators of the Relative Prestige Status of Engineers

The low status of British engineers, technologists and applied scientists, is a recurrent theme in the many reports on technical education and manpower requirements. From the "Percy Report" to the Annual Report of the Advisory Committee on Scientific Policy for 1963-64,[16] concern over the position of engineers and technologists in British society was voiced, remedial action called for, and schemes proposed. The difference in status between pure scientists and engineers has drawn particular attention: "The first of their ((the Advisory Committee on Scientific Policy)) propositions, on the superior prestige attached in this country to pure science as compared with technology, we recognise without reservation. This is not simply a matter of academic prestige; there also seems to be a widely held public attitude that a career in industry is socially unattractive. This attitude affects the status of technology, which is more closely related to industry than pure science....In the United States, for example, contacts between the two are much closer, and they are not considered as distinct kinds of professional people ((i.e. scientists and technologists))".[17] Evidence before the Robbins Committee had shown that those taking a first degree in technology as a percentage of first degrees in science and technology in various countries was, in 1959: Britain 36%, Canada 65%, France 54%, Switzerland 59% and the U.S.A. 49%.[18] The correlation found between the ratio of technology to science graduates and the rate of economic growth has added seriousness. Naturally these manpower problems have drawn attention to the evaluations implicit in the pattern of career choice at the university and higher education levels.[19] Unfilled places in university and technical college departments of engineering and applied science at the beginning of the 60's caused some disquiet.[20] One of Hutchings' primary findings was the overwhelming choice of pure against applied science careers among British sixth form students. Research was preferred to design or development: from a total of 1,523 sampled, 493 made research their first choice, 285 their second choice, and 153 their third.[21] French and German students were more likely than the British to choose the primary engineering function of design.[22] Entry standards are lower, those with the highest formal A level results, "the high-flyers", choose science rather than technology. Hutchings summed up the situation: "Although in some European countries (notably Holland and West Germany) there is a tendency for an intellectual elite to prefer pure science, as in England, this is a smaller elite, and there are other countries (Sweden and possibly France) where the position is reversed; nowhere does technology fail to attract the best brains _to anything approaching the same degree_ as in this country"(Italics in original).[23] This pattern of career choice is well-documented.[24]

In Sweden students who fail to gain admission to one of the technological universities enter the science faculties of the older universities as a second choice: some of the best students from these universities seek to transfer to the establishments of engineering education.[25] Svalastoga and Carlsson report on a study conducted by the Danish Gallup Poll; in the metropolitan area surveyed, the two occupations of engineer and physician far outranked all others in popularity for a son of sufficient ability. In Copenhagen engineering was preferred to medicine.[26] The French _grandes écoles_, especially the _École Polytechnique_ and the _École des Mines_, are very popular. The _École Polytechnique_ "is France's leading school, and enjoys an undisputed prestige."[27] With an intake of approximately 250 a year, Morel claims: "Thus, the 250th admitted to the _École Polytechnique_ is the 250th among the 30,000 French science students of his age group",[28] that is in terms of ability.

In the Soviet Union the studies of Subkin and others into occupational choice preferences among Soviet Secondary school students found that for both boys and girls the science subjects associated with engineering are preferred to medicine, biology, the social sciences and humanities.[29] "Thus we see that the greatest prestige among youth is enjoyed by occupations requiring knowledge of mathematics, physics and engineering."[30] The relatively that much higher prestige status of scientists and engineers, compared with professions such as medicine, law and dentistry, has frequently been commented on. For the legal professsion "the fact seems to be that the lawyer ranks considerably lower in social status in the

Soviet Union than he does in any other modern nation."[31] The status of the Russian doctor is estimated by an American physician as on a level with the semi-professions in the United States, similar to elementary and high-school teachers.[32] On the other hand, the high status of engineers is frequently pointed to.[33] Sarapata and Wesolowski report on a study in which the engineer received the largest percentage response in terms of desirability of the career for sons, far above doctor, university professor, and lawyer.[34] For girls the rank order was doctor, teacher, actress, musician or sculptor, engineer, lawyer(attorney). In this case doctors far outranked the other professional occupations in terms of the proportion of response, 41.2% as against 9.3% for teacher.[35] In the Soviet Union and Poland, medicine, like the "semi-professions" of Western societies, recruits largely among women, in itself at present an indicator of the status of the occupation.

Income has also been used as a measure of the status and position of engineers in European societies. Fores has reviewed some methodologically sophisticated studies, comparing differentials existing within individual countries.[36] A Swedish study found that in Sweden, Germany, and Denmark, engineers earn more than professors, in France slightly less, in the Netherlands and the U.S.A. 20% less, and in the U.K. the engineer's salary is 35% less than that of the same profession.[37] In a 1970 study made by Management Centre Europe of Brussels, engineers and persons with financial qualifications, accountants,etc., in industrial management were found to rank near each other in all societies except Britain. In France, Switzerland and Belgium the engineer earns more than the financial man by a few percent, in the U.K. the engineer earns 10% less. Fores concludes: " It is argued here...that because the UK professional engineer is found peculiarly low in the pay structure, we have a reasonable proof the U.K. engineer's status is also peculiarly low compared with engineers in Western Europe."[38]

Social scientists and other authoritative observers have frequently commented on the low status of UK engineers,[39] and the explanations of the phenomenon in chapter 2 constitute further evidence.

Engineers also believe that their status is low. A typical sentiment was expressed by one as a reason for joining the Engineer's Guild: " In the early days engineers were looked up to. Between the wars this declined. I thought the Guild would improve the situation."[43] The Engineers' Guild primarily aims to raise the status of the occupation, and its journal provides an outlet for communal discussion. Some systematic evidence on this self-evaluation is provided by a survey on Mechanical engineers.[44] Less than one third of the Mechanical engineers were satisfied with the status afforded them in Britain today. Over one half voiced specific frustrations and dissatisfactions. Older successful graduate engineers in general management were the most satisfied ; though generally honours graduates are less satisfied than non-graduates --- a point of significance in relation to the recruitment, mobility and socialization patterns of the Mechanicals.[45] The authors concluded that the "majority" of engineers are dissatisfied with the status of their profession.[46] Indeed a member of the Institution of Civil Engineers (M.Inst.C.E.) states: "discontent is widely felt nowadays on this indefinable question of status. It was in the air when I first entered Parliament in 1963, and I illustrated it in my first speech there when I said: 'engineers never become Lords, not as engineers. They sometimes do so because they are business men, but as engineers they are never enobled. Engineers are never selected to be the heads of Royal Commissions. These are matters of status which the government can attempt to put right.'"[47] The absence of the engineer in political life of contemporary Britain relates to this problem and is raised in the following terms: "This has not always been so. The great Victorian engineers were men of substance in the Britain of their day, and some of them were active in public life. Robert Stephenson for example, was a Member of Parliament for a time".[48] British engineering as well as British engineers has also declined in status: "Whereas in my young days British engineering had a universally good reputation, I believe that it now commands respect only in certain fields and that it has lost the broadly-based reputation that was worth so much to us."[49] There is also much to suggest that the prestige status of engineers was not always as low as it is today.

The Professional Status of the Victorian Engineers

The "great" Victorian engineers were highly esteemed indeed. The names of Watt, Telford, Macadam, Brindley and Smeaton among their precursors are well known even today, and later engineers such as Stephenson, Faraday, Rennie and Brunel equally so. Picture the latter, Isambard Kingdom Brunel, the younger (his father Sir Marc Brunel, knighted in the spring of 1841 by Queen Victoria just after his grandson, Isambard 111, became the first person to pass under the Thames through a completed driftway in the Thames Tunnel project, completed by his father I.K.) entertaining his friends to a banquet under the river to celebrate the completion of the Tunnel's first stages, "a company of fifty sat down to dine to the strains of the uniformed band of the Coldstream Guards "[(50)], or examining the progress of the Great Western Railway in his famous black britzska, "irreverently nicknamed the 'Flying Hearse'" designed to quarter his engineering instruments, plans, and "an ample stock of cigars",[(51a)] or again presiding at the launching of his, what were then "immense" ships, Great Britain, Great Western, Great Eastern, (the Leviathan), before the vast crowds that flocked to watch on such occasions. The Brunels, Stephensons and other greats were in large part held personally responsible to their promoters, investors, and companies, and likewise held so by the public for the invention and completion of these spectacular projects and commanded a kind of fame and celebrity status rarely bestowed on modern engineers, an aura that set the tone for the profession as a whole. These figures, part of the folklore of the industrial revolution, gained spectacular reputatations on the Continent, in North America, Russia, the Scandinavian societies and the Empire.

The high status afforded to these engineers had its origins in the late 18th century, at a time when mechanism was a hobby of gentlemen, and most of the business of the engineer involved him in constant dealings with aristocratic and noble patrons.[(51)] In the major period of canal and railway building, the last quarter of the 18th and the first quarter of the 19th century, before the Companies Act, incorporation meant petitioning Parliament, a process in which the expert testimony of the engineers became of considerable importance, and a high social status was essential. Consultants aside, even those engineers confined to particular projects found their status instrumental in maintaining control over subordinates.[52] Considerable scope also existed for private enterprise, and many of the early engineers, practically all of those now famous, made large sums of money, in some cases fortunes, developing entrepreneurial interests. Fortunes were also lost by engineers pursuing their inventive passion.[53] The early manufacturing and mechanical engineers, practicing in the machine shops, were not excluded from this status; a prominent firm like Boulton's had frequent requests to take in as apprentices boys of wealthy and noble families. Watt himself was offered a baronetcy "which he politely declined".[54] It was against this backdrop of a high and rising status in the eighteenth century[55] that the great Victorian engineers arose.

From its origins throughout the nineteenth century, with the exception of important short term fluctuations, the demand for Civil engineers was exceedingly high, a situation guaranteed by the relative absence of a supply of university or college trained recruits for the profession to satisfy a growing economy. Such demand meant vast opportunities for managerial authority, consultancy practices, entrepreneurship, and high incomes for the few who could claim qualification as Civil engineers. It is this elite, not the growing army of assistants, that captured high status and the public eye. By mid-century they numbered about 700 and (including assistants and all others aspiring to the profession) by 1861 such "civil engineers" in the census totalled 3,329, increasing to around 7,000 at the turn of the century. Other professions in 1861 numbered: civil service 6,996, accountancy 6,272, apothecaries 12,030, architects 3,843, attorneys and solicitors 11,386, barristers, advocates, special pleaders, conveyancers 3,071, physicians 2,385, medical students and assistants 3,587.[56] The exclusiveness of the group, as well as the kinds of opportunities open and the demand for their talents, is suggested by a contrast with the numbers in France, where in the period 1794-1851, two of the leading engineering schools alone (and there were others though less productive), produced 11,194 professional engineers to meet and stimulate the countries' industrial demands.(57) In England at the very most, 851 practiced in 1841, 3,009 in 1851, 3,329 in 1861, while qualified Civil engineers, numbered 525 in 1841, 716 in 1851 and 945 in 1861. In other words at mid-century in France there were nearly three times as many professional engineers as in England taking the broad definition, and sixteen to seventeen times the number in France if only qualified Civil engineers are included. (The estimated number of doctors in practice, all types, in France in 1866 totalled 16,822,(58) England, 1861, 18,688, the latter includes 3,587 students and assistants many of whom would have graduated by 1866.) But in 1868-9 the U.K. had completed 14,247 miles of railway as against France's 10,302; 160,000 miles of road, against France's 100,000; 3,000 canals, against France's slight lead at 3,154; all projects involving a concentration of civil engineers (the population of France stood at 38,192,064, the U.K. at 30,621,481).(59)

In England in the mid-thirties, the extreme shortage of engineers led to pupils, if any were to spare, being lent or even let out to other parties.(60) The Council of the Institution of Civil Engineers, the qualifying organization, in their report for 1846 commented that due to the extraordinary amount of employment among engineers, it had not been possible to get an engraving or lithography done for the Proceedings, nor had it been possible to assemble sufficient members to constitute a General Meeting.(61) In 1859 the demand for Civil engineers was so high that "a few men who divided the details of their design and execution among a large number of subordinates"(62) arose. This was during another surge in railway development when "there was generally no want of money, and the engineer--who conferred a favour in accepting an engagement--had carte blanche".(63) This particular growth in opportunity was fired by the Joint Stock Companies Act of 1856, which unleashed a period of high demand for engineers. These pioneers were also in high demand abroad, needed to take commanding positions, a factor that added romance to the occupation, while subordinates in home enterprises were very often the highly qualified Continental, German and French engineers, who came over to England to fill junior positions subordinate to

English engineers on the leading projects in the world. The German engineers in particular were willing to take less money than the English.(64) The lack of indigenously trained engineers meant that those with recognized professional status were in short supply for the most responsible executive positions; it was this situation that provided the opportunity for the development of the high-status consultancy roles that were pursued by many of the most famous names in nineteenth century engineering. It is the legacy of the nineteenth century system of professional organization that the consultancy role remains far more developed in Britain than on the Continent; whereas the elite of the profession in Britain has always aspired to such work, in France for example, the most prestigious positions are those in the state corps of engineers. This was even more the case at mid-century; whereas the status of the French and German engineer was bound up with his "official rank", his position in the state service, rather than his "moderate pay", the position of the English engineer had much to do with the fact that the profession was a "profitable one", more so than the Continental, partly because over there "they divide the work among a greater number of individuals".(65) It was these few consultants along with the senior resident engineers who gave the high professional tone to the occupation at mid-century; it was such careers that were so fashionable and in demand. As the <u>Engineer</u> commented in 1865: "An engineer, in these times, commands an amount of confidence hardly less than that accorded to a first-class general of old. If he need one million of money or ten, he gets it....we may say, and none will contradict us, that the engineer of established reputation rules now-a-days with a mighty influence. There are those who would buy him at any price, and bid to him to his face, if they dared."(66)

Incomes were certainly high. In 1864 an established practitioner, a reputable consulting engineer but not in the class of a Stephenson, Mr. Fothergill "required ten guineas for each professional day of six hours" and this was not the top rate for the work, more eminent engineers charged more.(67) One reason for the high incomes was that these engineers were frequently paid by a commission-- a fixed proportion of the money value of the work undertaken-- which engineers favoured as a protection against the abuse of the trust on which their professional reputation was founded.(68) In 1857 men entering mid-career, between the ages of 28 and 35, who were not consultants, but worked in a full-time capacity either in a railway company, engineering firm, or in some other type of work, typically commanded 500 to 800 pounds per year,(69) while 400 pounds a year was standard for a young civil engineer on the railways.(70) As the qualifications of most engineers at mid-century were proved talent and experience, or reputation, it meant that there were extremes in the differentials between the well-known older men and the younger who had not been able to establish themselves.(71)

The social class composition of the occupation is a useful indicator of status in the nineteenth century. An analysis of the backgrounds of 250 engineers listed in the Dictionary of National Biography indicates that of those engineers born between 1810 and 1829 approximately 82% came from the middle and upper social strata.(72) For the period 1830-1849 the figure is 87%. For the earlier period between 1780 and 1809, 73%. For all those born between 1810 and 1879, approximately 38% came from the upper stratum.(73) Comparison with Kaye's DNB sample of architects shows that engineers were generally recruited from higher social strata than architects. Taking the entrants to architecture between 1850 and 1890 (when their known social origins were highest) and entrants to engineering between 1860 and 1900, only 16% of the architects were drawn from the upper stratum, when fully 41% of the engineers had upper stratum fathers.(74) These data accord with other authoritative observations on the status of architects. Kaye records that in the first three decades of the century "their prestige with the public was negligible"(75) and little better in the forties and fifties,(76) a marked change from today.(77) During the railway boom of the thirties, architects even began to call themselves engineers, broadening out from the contruction of stations, which had been their preserve, a move deprecated by Civil engineers.(78)

The relatively more exclusive social class composition of the profession is reflected in the widening of the recruitment basis over the course of the present century. Table 1 shows the broadening of the recruitment base of both university graduate and non-graduate engineers in the Mechanical branch of the profession (the proportion of graduates taking up Mechanical engineering has itself been declining)[79]; Table 2 presents comparable data for Civil, Electrical and Mechanical engineers. The composition of the Civil and Electrical branches of engineering by age-cohort is unavailable, but Table 2 probably suggests a less exclusive social class composition for the Civils before World War 1 than was actually the case. Table 3 shows the Civils to be the most exclusive branch in the late ninteen-fifties. The recruitment patterns reflect differences in the relationship of the respective specialities to the educational system; changes in recruitment flow from changes in these relationships, described in chapter 4. It is to be expected that the Civils' composition before WW1 was that much more exclusive than the other two branches, and almost wholly made up from the upper and middle strata, even though of all those born before 1903, irrespective of speciality, only 8% were drawn from manual strata. The pattern of recruitment from the public schools (defined by inclusion at the Headmasters' Conference) supports these findings. About 37% of the Civils, 25% of the Electricals, and 18% of the Mechanicals are recruited from these schools.[80] For the three groups together, there has been a decline in the proportion: of those born before 1903, 39% attended public schools, the figure drops to 16% for those born between 1923-1932.[81] Again the early figures for the three specialities will understate the proportion of public school boys entering Civil engineering at the turn of the century, which was very high. Bishop's study of Winchester shows the steady increase in the flow into engineering throughout the century for Wykehamists born between 1820 and 1922.[82] As a percentage of the total for the period 1920-1922 the number entering engineering compares favourably with the numbers entering other professions. Between 1900 and 1904, of the 200 students who entered the Royal Indian Engineering College, just under half "came from 27 of the major Public Schools".[83] Most students, however, entered through the office of an established practitioner, and social ties became particularly important. Mr. Armstrong of the Great Western Railway said of those students

Table 1

SOCIAL CLASS COMPOSITION OF THE MECHANICALS BY AGE-COHORT AND GRADUATE, NON-GRADUATE STATUS

Father's Occupation	Born before 1918 Grad. %	Non.-Grad. %	Born 1928 & after Grad. %	Non-Grad. %
Professional and Executive	52	27	28	17
Middle White-Collar	25	41	42	26
Manual Worker	23	32	30	57
Totals	100	100	100	100

Source: Gerstl and Hutton, op.cit., pp.26-27.

Table 2

SOCIAL CLASS COMPOSITION OF THE BIG THREE BY AGE-COHORT

Father's Occupation	Born before 1903 %	Born 1923-1932 %
1 & 2	59	41
3 & 4	27	39
5,6,& 7	8	19
No information	6	
Totals	100	99(sic)

Source: McFarlane, op.cit., pp.174-185, the status categories are based on the "Standard Classification", see D.V.Glass ed., Social Mobility in Britain, London, Routledge & Kegan Paul 1954

Table 3

SOCIAL CLASS COMPOSITION OF THE MECHANICALS, CIVILS, ELECTRICALS

Father's Occupation	Civils %	Electricals %	Mechanicals %	tot. pop. %
1 & 2	52	52	40	7.4
3 & 4	37	27	41	22.5
5,6 & 7	5	21	19	70.1
No information	6			
Totals	100	100	100	100

Source: McFarlane, op.cit., p.178, Table 24.

entering his office at the turn of the century, who had not been to a university: "They have been to one of the public schools, Eton or Harrow or Winchester or Haileybury".(84) Other railways also recruited directly from those public schools with which they had ties.(85) In 1885 Escott recorded: "The headmaster of a large public school recently observed to the present writer that three out of every four of his pupils would, if polled, declare for engineering."(86)

In an Anglo-American comparison, Perrucci and Gerstl found changes in the recruitment patterns that suggested increasing rigidity in social class terms in the United States, compared with a greater fluidity in Britain.(87) But this is a special case: the finding is not representative of the U.K. professions as a whole. Unfortunately the studies of social class composition of other British professions, which break down the data by age-cohort, are not comparable with the studies of engineers tothe point where conclusions of the necessary precision can be reached on this question of relative changes in recruitment. This is because different social class scales are used. However, inferences may be drawn on the basis of educational make-up. The recruitment base of accountancy may well have become more exclusive over the course of the century;(88) the more so when compared to engineering. The reasons for this lie in the changing relationship between the occupations and the educational system, against the backdrop of the collective mobility of the entire occupational group.

Despite the evidence to the contrary, there is a myth that the professional engineers, who ushered in the industrial revolution, were primarily self-made men, rising from the ranks of mechanics and skilled craftsmen, and having their early origins in the millwrights and other lowly occupations. This myth has survived due to the changes in the relationship between segments of the profession and the educational system during the interwar years, especially the changing recruitment pattern of the Mechanicals that provided a basis for support for the image of engineering very largely the creation of Samual Smiles.(89) A typical example of his work is a chapter heading from Industrial Biography, less well known but written in the same vein as the massive Lives of the Engineers: "The great

Inventor is one who has walked forth upon the Industrial world not from universities, but from hovels; not as clad in silks and decked with honours, but as clad in fustian and grimed with soot and oil."[90] Smiles used his biographies as a vehicle for political and social reform, an objective stimulated by the tremendous success of his authorized biography of George Stephenson (who unlike his son, was not in fact a Civil engineer, but a much resented pretender) to be followed by Self Help and others in a similar vein. His extensive works, in many respects inaccurate and unreliable, provided a source for numerous biographies and histories, and they have had more impact on the image of nineteenth century enginering than any other literature.

Otherwise the image of the engineer in the literature of the 19th century is not unfavourable to the status of the profession.[91] While the image of a profession in fiction may depart from the social reality,[92] there are, nevertheless, in certain works clear portrayals of the occupational prestige hierarchy from the standpoint of a given character; and , in particular, a passage from Trollope has been frequently cited in connection with the status of engineers. It reads: "She (Mrs. Marrable) had an idea that the son of a gentleman, if he intended to maintain his rank as a gentleman, should earn his income as a clergyman or a barrister or as a soldier or as a sailor. Those were the professions intended for gentlemen. She would not absolutely say that a physician was not a gentleman or even a surgeon; but she would never allow to physic the same absolute privilege which, in her eyes, belong to the law and the Church. There might also be some doubt about the Civil Service and Civil Engineering, but she had no doubt whatsoever that when a man touched trade or commerce in any way he was doing that which was not the work of a gentleman. He might be very respectable and it might be very necessary that he do it; but brewers, bankers and merchants were not gentlemen, and the world according to Mrs. Marrable's theory, was going astray, because people were forgetting their landmarks".[93] Mrs. Marrable's opinion was floated in 1870 and on the surface may seem to discredit Civil engineering. But the view of what constitutes a profession is exceedingly narrow for the time; the context suggests that Mrs. Marable's views are old-fashioned.

The passage is as significant in what it does not say, as it is in what it does. There is no mention here of accountants, architects, chemists, scientists, surveyors, dentists, artists, musicians, actuaries, teachers, university professors and lecturers, veterinary surgeons, apothecaries, or even the lower branches within medicine and law. From the standpoint of a person who reserves even slight doubts about physicians and surgeons in the 1870's, even the mere mention of Civil engineers must be taken as an indication of high status. It may be, of course, that Trollope himself had a particularly high estimation of Civil engineers. In his autobiography he does not see fit to differentiate between engineers and other professions: "A barrister, a clergyman, a doctor, an engineer, and even actors and architects may without disgrace follow the heart of human nature, and endeavour" (i.e., the pursuit of material interests).(94) Elsewhere he refers to engineering as a recognized and established profession suitable for propertyless sons.(95) His novels distinguish between the various kinds of lawyers and doctors in such a manner as to imply that the professional status of those at the lower end of the respective occupations is questionable.

In the early part of the century, London was the acknowledged engineering capital of the world.(96) British Civil engineers were internationally esteemed. As late as 1857, Thomson could observe(in the context of career advice and employment opportunities): "The English engineer has a great prestige (sic) in foreign countries, and no small number of the great works of the Continent have been constructed by them. This arises from a want of native talent to meet the demands of general progress; but such a system cannot be expected to continue indefinitely".(97) This warning was a timely one. By the last third of the century some British engineers became concerned about engineering education and performance due to the rise of French and German engineering,(98) but this concern was of such a low level that the profession did not fully sanction the principle of formal examinations for entry until 1897. In the first two thirds of the century, the superiority of the British Civil engineer, in all respects, was an unquestioned assumption of the average professional man and as late as 1924, the professional bodies of British engineers were still internationally known as the "great engineering institutions".[99]

From the 18th century the French civil engineer had also commanded a high status, higher than his German or American counterpart,[100] although he too looked toward England for leadership. The status of the engineering profession in Russia, partly modelled on France, was also high.[101] German engineers did not receive full recognition of their professional status until the end of the century; engineers, and industrial careers generally, were lookod down upon. England is not alone among European nations in having a culture in which the upper classes have traditionally rejected trade. Indeed the situation in Prussia was more extreme than in Britain. Trade, industry and even the professions were forbidden to the nobility as a status disqualification both in law and custom. Not until the law of October 19, 1807, were the nobility specifically permitted access to the professions without loss of noble status, thus opening careers apart from the army, royal civil service, and estate management. Naturally the attitudes and preference for the civil and military service were maintained through the 19th century.[102]

The American profession was in some respects similar to the British, but not so exclusive. Mechanical engineering at first provided gentlemanly careers for the old business upper class in ungentlemanly industry.[103] Yet the American profession, as a whole, looked towards the British Civil engineer as a model for emulation. An American engineer of considerable standing within the profession could still claim in 1911 that "the English engineer of today ranks in his own country second to no other professional man. Again, the Institution of Civil Engineers of Great Britain is certainly the greatest and most influential engineering society in the world; and some of America's most eminent engineers are proud to be able to write M.I.C.E. after their names."[104] Curiously though by the mid-twenties, this position was being reversed, and an English Electrical engineer could quote from an American journal: "It is difficult to appreciate the cycle through which engineering has passed in the last two decades. Twenty years ago it was a profession more or less mysterious to the general public....To-day the men of this calling present as a whole the most definite profession in public life. They are recognized as the men in whose hands the material advancement of the race rests. They have gained a leading, if not the leading, place in the list of professions."(105) While no doubt reflecting aspiration as well as judgement, such an observation could not be made in even a weakened form in England after the WW1, as the status of the profession was declining and engineers were aware of it.

Some of the confusion in present-day conceptions of the status of the professions in the 19th century stems from differences in the meaning and definition of the groups and occupational segments used as the units of comparison.(106) Occupations such as medicine and law, dentistry, accountancy, science, are all relatively modern in origin, i.e., in the definition of the group, not in the service. If engineers are compared with physicians, surgeons and barristers, and certain army regiments, or the "ancient" professions, organized into such bodies as the Inns of Court, and the Royal Colleges, then their status may be said to be, in the last half of the 19th century, "relatively low". But then so was the status of doctors and solicitors; even today their status is low compared to the "higher" branches. Stevens comments on the 19th century: "With the exception of physicians and leading surgeons, doctors were held in relatively low social repute."(107) The Civil engineer has been compared to these elite, internal status groups: the historian of the movement for professionalization of scientific chemists, which led to the establishment of the Royal Institute of Chemistry during the latter part of the century, states that Professor Edward Frankland, the then President of the Chemical Society, in the course of his speech in honour of the Faraday Lecturer, drew attention to the "increasing importance of chemistry in relation to the wants of communities, and pointed out how great would be the usefulness of an Institute which would be to chemists what the (Royal) Colleges of Physicians and Surgeons were to the medical profession, the Institution of Civil Engineers to Civil Engineers, and the Inns of Court to the legal profession."(108) For a while, mainly during the last quarter of the past century, up to, and to a decreasing extent beyond, World War 1, some Civil engineers thought of themselves as comparable to "barristers" or members of the Royal

Colleges, but their relationship with the rest of the profession was never really equivalent to that of the higher branches of medicine and law to their respective lower orders.

If the Civil engineer is compared to other occupations of more recent origin, the "modern" professions including the lower branches of medicine and law, their prestige status was clearly high throughout the century. At mid-century many of these occupations, scientist, accountant, surveyor, dentist, doctor and solicitor, were only beginning to be defined, and the groups trailed off into the ranks of traders, craftsmen and artisans. They were not the homogeneous groups that they are today. Their struggles for a higher standing were, in most cases, just starting in earnest. The movement among scientific chemists, who desired full professional status like that of the Civil engineer, who was clearly defined, was stimulated by the fact that "chemistry did not constitute a definite vocation which a young man of the professional classes might choose with the same confidence as medicine or law."[109] Others wished to boost the acceptance of science by somehow attaching it to engineering, and participating in its aura.[110] Dentists did not begin to achieve truly professional status until the end of the century; as recently as 1878, the British Medical Journal could charge, "Medicine is a profession, dentistry is largely a business."[111] Accountants arrived no earlier. In 1875 Justice Quain commented on the effect of the Bankruptcy Act, "the whole affairs in bankruptcy had been handed over to the ignorant set of men called accountants, which was one of the greatest abuses introduced into law."[112] Accountants agree that the profession in England only emerged late in the century (not for lack of practice, 4,416 accountants contrasted with 853 civil engineers returned themselves in the 1841 census), before this it was not considered a professional area, it was disreputable, a parvenue occupational group at best.[113] Evidently the "title of accountant had been adopted by some who in Lord Brougham's phrase could give no account of themselves."[114] The metamorphosis of accountancy into a profession was largely the achievement of the interwar years.

By the early sixties engineers were placing their occupation ahead of these emerging groups. The Engineer editorialized in 1863 by way of response to an editorial in The Times on the death of R. Stephenson, which claimed that engineers were not yet one of the "three" professions: "But we are of the four professions, and we are willing to leave it with our barrister, our 'medical man', and our vicar (of course it will be said 'what an inversion of rank!') to decide what is the relative status of the engineer. (sic) We have no fear even of their verdict. We are not jealous, although there are those of other professions who are jealous of the engineers."(115) The situation was well summed-up by a late-century historian: "At the head of all the new professions must be placed that of the civil engineer."(166)

The status of the Victorian Civil engineer was higher than that of his 20th century equivalent; the pattern of professional development of engineering in Britain has not been a unilinear one. The "gap" between scientists and engineers is largely an interwar and postwar phenomenon, as is the relatively higher status of accountants. The Victorian Civil engineer was a clearly identifiable professional man of high social standing, since usurped by other, collectively mobile professional groups.

Conclusion

The evidence on the three dimensions will be evaluated in conclusion. While it is necessary to be cautious when generalizing about the measurement of a subjective phenomenon such as occupational status, it is reasonable to conclude on the inter-societial and the intra-societal evidence that the status of the engineer relative to other professional men, is lower in Britain than in any other industrial society known to this study. This finding is strongly supported by the prestige survey data, occupational choice patterns, authoritative observations, and relative incomes. On the third dimension, the historical and especially within that on the inter-societal plane, the evidence is, perhaps necessarily, less clear-cut. What it does suggest is this: throughout the 19th century the Civil engineer role was on the verge of being established at the apex of the professional complex, at a time when most of the modern professions outside the older branches of medicine and law and the clergy were emerging, but that subsequently, and especially after WW1, the potential was never realized and a decline in status occured, while the status of engineering professions in other societies, particularly Germany and the U.S., was being consolidated. It is clear that a small segmont of Civil engineers, never numbering over 5,000 throughout the century, commanded exceptionally high status and esteem, but this was not carried over into the major periods of expansion of the profession towards the end of the century and into the present. This situation is best inferred from the impressionistic materials, substituted for contemporary prestige survey findings, and authoritative observations, but it is also congruent with the data on the social class composition of the profession and on incomes, which while being indicators of professional status and strongly correlated with it, may also be influenced by factors wholly independent of occupational status and its determinants. In the literature either of or on the profession available today, observations and comments on the high status of the profession, like those in the 19th century literature, are not to be found and vice versa, which in the absence of the systematized evaluations of the modern prestige survey, is the best measure available. Further data relevant to this conclusion are contained in chapters 3, 4, and 5, below.

Footnotes to Chapter 1

1. The conclusions in this section are based on the findings of Appendix A, where further details and complete references will be found.

2. J.E.Gerstl and S.P.Hutton, Engineers: The Anatomy of a Profession, London, Tavistock Publications, 1966 , pp.144-6.

3. Counts (1925).

4. Hartman (1935), Nietz (1935), Deeg and Paterson (1947), Tuckman (1947).

5. See Appendix A, Table 2.

6. Congalton (1969).

7. Pineo and Porter (1967).

8. Svalastoga (1959).

9. Rossi and Inkeles (1957)

10. See Matthews (1972).

11. Sarapata and Wesolowski (1960-61).

12. Carter and Sepulveda (1964), Thomas (1962), Tiryakian (1958), Marsh (1970).

13. D. Hutchings, Technology and the Sixth Form Boy, Oxford University, Department of Education, 1963.

14. Ibid., Table 18, and p.33.

15. Edward McCrensky, Scientific Manpower in Europe, A Comparative Study of Manpower in the Public Service of Great Britain and Selected European Countries, New York, Pergamon Press, 1958, p.96.

16. Higher Technological Education, London, HMSO, 1945, (Percy Committee Report); and, Annual Report of the Advisory Committee on Scientific Policy, 1963-64, London, HMSO, Cmnd. 2538, (1964). See also chapter 7.

17. Ibid., p.18 of the Report, para. 55.

18. (Robbins Report), Report of the Committee on Higher Education, London, HMSO, 1963, Appendix 5, "Higher Education in Other Countries", Cmnd. 2154 (Vol.13, 1962-63) paras. 377 and 378.

19. Cf. Olive Banks, Parity and Prestige in English Secondary Education, Routledge and Kegan Paul, 1955, p.196, where it is concluded in the context of the relationship between the grammar school and occupational choice that the determinants must be sought in the social and economic rather than educational fields.

20. Cf. Robbins Report, op.cit., "Evidence of the Joint Advisory Committee on Engineering Education of the ICE, IME and IEE"; and Advisory Committee on Scientific Policy, op.cit., Appendix B, p.29 for discussion of figures in relation to social prestige.

21. Hutchings, op.cit., Table 25. For British students the pattern of career choice parallels the status of occupations in other surveys where there are duplicate

occupations, ibid., p.38. Cf. Professional Engineer, Vol. 8 (November, December 1963) No. 6, pp.187-9, for an American comparison.

22. Ibid., Table 25.

23. Hutchings, 1963, op.cit., pp.1-2.

24. On the assumption that career choices reflect occupational prestige in this area see S. Cotgrove, Technical Education and Social Change, London, Allen and Unwin Ltd., 1958, chs. 13, 8, 9; cf., ftn. # 21 above. For a bibliography of the relevant literature see: R.A.Butler, "A Review of the Literature with Special Reference to Science and Technology", Science Policy Studies No.2, Department of Education and Science, HMSO, 1968. On the pattern of preferences for pure science rather than engineering at both entry and exit to and from higher education see: Committee on Manpower Resources for Science and Technology, The Flow into Employment of Scientists, Engineers and Technologists, Report of the Working Group in Manpower for Economic Growth, London, HMSO, Cmnd.3760, 1968, (Swann Report); cf. E.Rudd and S.Hatch, Graduate Study and After, London, Weidenfeld and Nicolson, 1968. A study of a younger age group, 31 children between ten and twelve, showed part of the problem to be a total lack of comprehension of what an engineer was. None of the children were able to describe the occupation, the majority who answered at all thought of engineers as practical repair mechanics. See Jeannette E. Meredith, "A Child's eye view of the 'Engineer'", PE., Vol. 18, No.2 (April 1973) p.37.

25. Hutchings, op.cit., p.17.

26. K. Svalastoga and C. Carlsson, "Scandinavia", in M. Scotford Archer and S. Giner, Contemporary Europe; Class, Status and Power, London,Weidenfeld & Nicolson, 1971

27. Pierre Morel, "Engineering Schools in France", French Bibliographical Digest, No. 78, Series 11, November 1959, p.21.

28. Ibid., p.21.

29. V.N.Shubkin, "Youth Starts Out in Life", Soviet Sociology, Vol. 1V (Winter 1965-66) No.3, pp.3-15, see Table 5, p.13.

30. V.N.Shubkin, V.I.Artemov, N.P.Moskalenko, N.V.Buzukora, and V.A.Kalmyk, "Quantitative Methods in Sociological Studies of Problems of Job Placements and Choice of Occupation", Soviet Sociology, Vol. V11, (Summer 1968) No. 1, pp.3-24,15.

31. Frederich Wyle, "The Soviet Lawyer; An Occupational Profile", in A. Inkeles and K.Geiger, eds., Soviet Soviety, London, 1960, p.210.

32. Forward to Mark G. Field, Doctor and Patient in Soviet Russia, Cambridge, Mass., Harvard University Press, 1957, pp.viii-ix, by Paul Dudley White, M.D.

33. Cf. Eric Ashby, Scientist in Russia, London, Pelican Books, 1947, and D. Granick, The Red Executive, London, Macmillan & Co., 1960; McCrensky, op.cit., pp.98-9; W.G.H.Armytage, The Rise of the Technocrats, London, Routledge and Kegan Paul Ltd., 1965, p.263.

34. A. Sarapata and B. Wesolowski, "The Evaluations of Occupations by Warsaw Inhabitants", American Journal of Sociology, Vol. 66 (1960-61) pp.581-591, 589-590.

35. Ibid.

36. M. Fores, "The Professional Engineer in Western Europe", PE., Nov. 1971, pp.81-83; the low status of engineers in relation to the performance of the

engineering industry is discussed with reference to other income data in M. Fores, "Engineering and the British Economic Problem", PE., (July 1973) pp.50-51.

37. Ibid., 1971, p.82.

38. Ibid., 1971, p.83. Another study of French, German and British engineers found that among all engineers (unadjusted for the age structures of the professions and cost of living) the average earnings of British engineers was 23,000 D.M., for French engineers 33,000 D.M., and for German engineers 22,000 D.M. The cost of living at the time of the study, 1963-64, was about 10% higher in France and 7% higher in Germany. "The Earnings of Engineers", PE.,Vol. 10 (April 1965) No.2, pp.39-40, reporting on a German study.

39. Cf. Daniel Bell, The Coming of Post-Industrial Society, London, Heinemann Educational Books Ltd., 1974, p.153

40. Lord Hives, Nature, Vol. CLXXI (June 20, 1953).

41. Cf. PE., Vol. 10 (August 1965) No. 3, p.63, and see the April 1959 issue for a survey of "clocking in" in British industry.

42. Cf. PE., Vol. 6 (Jan. 1959) No. 1, pp.33-34, "Professional Engineers and the "Clock"", letter from C.G.Strange;and PE., Vol.6 (Jan.1960) No.5, p.192, "A Rose by any other name" from P.E.Davidson, on the problem of title and confusion with the "Mechanic"; and, "The Status of the Engineer", PE., Vol. 8 (March 1963) No. 2, pp.70-71, from J.R. Harding on confusion of the skilled workman and engineer and the problem of title.

43. Cited by K.Prandy, Professional Employees, A Study of Scientists and Engineer London, Faver and Faber Ltd., 1965, p.111.

44. Gerstl and Hutton, op.cit., pp.112-114.

45. See below, chapters 3,4,5, and 7.

46. Gerstl and Hutton, op.cit., p.112.

47. American Association of Civl Engineers and Institution of Civil Engineers, Joint Conference: The Engineer in the Community, (Bermuda, 1970), London, The Institution of Civil Engineers, 1970-71, pp.29-30.

48. Ibid.

49. Lord Hinton of Bankside, Engineers and Engineering, Science and Engineering, Policy Series, Oxford University Press, 1970, p.60; cf. A. Sampson, Anatomy of Britain London, Hodder and Stoughton, 1962, pp.516-518.

50. L.T.C. Rolt, Isambard Kingdom Brunel, London, 1957, p.57.

51a. Ibid., p.105.

51. W.H.G.Armytage, A Social History of Engineering, London, Faber and Faber, 1961, pp.131-132.

52. Cf. D.H.Calhoun, The American Civil Engineer, Origins and Conflict,Cambridge, Massachusetts, The Technology Press, MIT, 1960, pp.14-15.

53. CF. E.M.S.P. (anon.), The Two James's and the Two Stephensons, London, David

and Charles Ltd., 1961, first published in 1861.

54. T.H.Marshall, James Watt (1736-1819), London, Leonard Parsons, 1925, p.172.

55. On this high 18th century status, see Sydney Pollard, The Genesis of Modern Management, A Study of the Industrial Revolution in Great Britain, London, Edward Arnold (publishers) Ltd., 1965, pp.136-156 and passim; E. Robinson, "Matthew Boulton, Patron of the Arts", Annals of Science, Vol. IX (1953), p. 195. See chp. 3.

56. The census category of civil engineer was not an exclusive one, it included all practicing engineers returning themselves at the time, not just members of the Institution of Civil Engineers.

57. F.B.Artz, The Development of Technical Education in France, 1500-1850, Cambridge, Massachusetts, The Society for the History of Technology, and the MIT Press, 1966, pp.232-31, 251-2.

58. Theodore Zeldin, France 1845-1945, Vol. 1, Oxford at the Clarendon Press, 1973, pp.36-7.

59. C. B. Vignolles, Presidential Address", Minutes of the Proceedings of the Institution of Civil Engineers, Vol. XXIX, (1869-70) Pt. 1, pp.272-318.

60. "By a Civil Engineer", Personal Recollections of English Engineers and of the Introduction of the Railway System into the United Kingdom, London, Hodder and Stoughton, 1868, pp.45-48. The anonymous civil engineer is Francis R. Conder.

61. Institution of Civil Engineers, "Report of the Council", Min.Proc.ICE., Vol. 5, (1846).

62. The Engineer, Vol.8 (Oct. 21, 1859) p.299.

63. Eng., Vol. 9 (Jan. 13, 1860) p.26.

64. "Engineering as a Profession", Letter to editor, Eng., Vol. XXIII (March 15, 1867) pp.232-3.

65. "Professional Fees" Eng., Vol. 17 (March 4, 1864) p. 145.

66. "Engineers and their Clients", Eng., Vol. 19 (March 24, 1865) p.185.

67. "Professional Fees", op.cit., p.145

68. Eng.,Vol. 19 (March 24, 1865).p.185.

69. Eng.,Vol. 4 (Oct.2, 1857) p.261.

70. Eng. Vol. 15 (Feb. 13, 1863) p.94.

71. "Professional Fees", op.cit.,p.145.

72. B. A. McFarlane, "The Chartered Engineer; a study of the recruitment, qualifications, conditions of employment and professional associations of chartered civil, electrical and mechanical engineers in Great Britain", London, Ph.D. thesis, unpublished, 1961, pp.55-61, the sample of "engineers" represents all those so defined in the DNB and especially for the earlier time periods is likely to include many who were not civil engineers or members of the ICE. The occupational classification is that used by B.Kaye, The Development of the Architectural Professio

in Great Britain, 1800-1945, London, Allen and Unwin, 1960, appendix to Chapter 4, p.53, which utilizes titles found in the DNB to form three strata.

73. McFarlane, op.cit., pp.55-61.

74. Ibid., and Kaye, op.cit., p.47.

75. Kaye, op.cit., p.125.

76. Ibid., p.72 et.seq.

77. Architects have an appreciably higher status than civil engineers in modern Britain.

78. "By a Civil Engineer"(anon.), op.cit., p.47.

79. Gerstl and Hutton, op.cit., p.42, at present the percentage of graduates is 22%, non-graduates 78%; of those 55 and over the figures are 27% and 73% respectively for the youngest group, those under 35, the percentages are 18% and 82%.

80. McFarlane, op.cit., Table 27, p. 185.

81. ibid., Tables 25-27, pp.180-185.

82. T.J.H.Bishop in collaboration with Rupert Wilkinson, Winchester and the Public School Elite, London, Faber and Faber, 1967, pp.64-69 and pp.104-108.

83. J.G.P.Cameron, A Short History of the Royal India Engineering College, Coopers Hill, Coopers Hill Society, 1960, p.11.

84. The Institution of Civil Engineers, "Special Committee on Practical Training, Report of the Committee, 6 April, 1914," London, ICE, 1914, Evidence of Mr. Armstron p.11.

85. Ibid., p.17, Evidence of Mr. Fowler, Chief Mechanical Engineer of the Midland Railway.

86. T.H.S.Escott, England: Its People, Policy and Pursuits, London, Cassell & Co. 1885, Vol.2, pp.451-2. Many of the great Victorian engineers came from long-standin engineering families. For example the Rennies, John the elder (1761-1821) and Sir John the younger, the Stephensons, George and Robert, the James', the Brunels, both three generations and the Hopkinsons, (cf. Greig, James, John Hopkinson, Electrical Engineer, London, A Science Museum Booklet, HMSO, 1970), the Mylnes, the Donkins, the Barnaby's and many many others.

87. J. Gerstl and R. Perrucci, "Educational Channels and Elite Mobility; A Comparative Analysis", Sociology of Education, Vol. 38 (1965) No. 3, pp.224-232.

88. Nicholas A.H.Stacey, English Accountancy, A Study in Social and Economic History, London, Gee and Company (Publishers) Limited, 1954, pp.180-181.

89. There are a number of works. Of importance is the first, Samuel Smiles, The Life of George Stephenson, Railway Engineer, London, John Murray, 1857, and S. Smiles, Lives of the Engineers, London, 1861-62, 3 Vols. and reprinted with a new introduction by L.T.C.Rolt, Newton Abbot, David and Charles, 1968.

90. S. Smiles, Industrial Biography, New ed., London, Murray, 1889, p.183.

91. G.D.H.Cole, Studies in Class Structure, London, Routledge and Kegan

Paul, 1955, p.62, refers to Mrs. Oliphants' The Railway Man and His Children, 1891, which concerns the social dilemmas of a lady who is contemplating marriage with a civil engineer associated with the railways (she marries him in the end), as an example of Victorian snobbery, but the same doubts were also expressed about the lower branches of law and medicine, about attorneys and doctors, see Trollope's Dr. Thorne, the correspondence between Lady Amelia de Courcy and Miss Augusta Gresham, on the question of the latters marriage to Mr. Mortimer Gazabee, an extremely respectable London attorney. Gazabee later marries Lady Amelia. J.H.L. Waddell in J.H.L.Waddell and John L. Harrington, eds., Addresses to Engineering Students, Kansas City, Missouri, Waddell and Harrington,1911, pp.422-23 states: "It is not many years ago that the English novelists sneered at the engineer, terming him a "greasy mechanic" and placing him outside the pale of polite society. At that time American novelists either simply ignored the engineer by leaving him out of their dramatis personae,or, when he did come incidentally into the plot, considered him about on a par with a boss carpenter. To-day all this is changed, many of the prominent modern novels have civil engineers for their heroes; and in all of them the members of the engineering profession are invariably treated with the greatest consideration." The engineer made his appearance in fiction after the eighteen thirties, "By a Civil Engineer" (Anon.) op.cit., p.55. The adventures of John Buchan have (in a number of them) a hero, Richard Hanney, who is a mining engineer and extremely honourable and of high social standing. See for example, The Thirty-Nine Steps and The Island of Sheep (the first and last adventure with this character as the hero). These were published in the early part of the century, the first in 1915 and the second in 1936. The first was written in a period when the professional status of mining engineers was becoming more widely recognised, though the speciality has a long history, see below.

92. The relationship between the image of a profession in literature and its social standing is potentially so complex that for the purpose of this study it has been largely outruled as a potential indicator of occupatinnal status, except in the outstanding examples cited. On aspects of the complexity from the standpoint of measuring the status of professions, see R.B.Scott, "The Doctor in Contemporary Literature", The Lancet, Aug. 13, 1955, pp.341-343; and W. Hirsch, "The Image of the Scientist in Science Fiction; a Content Analysis", American Journal of Sociology, Vol. 63 (March 1958) No.5, pp.506-512.

93. A. Trollope, Vicar of Bullhampton, 1870.

94. A. Trollope, An Autobiography, London, Longman, Brown, Green, Longmans and Roberts, 1883, p.76 (cf. Stratford upon Avon edition, Shakespeare Head edition). Trollope was for a long time a surveyor, later a "hunting-surveyor" and would have knowledge of the engineering profession from this connection.

95. In Dr. Thorne for example.

96. C.R.Fay, Round About Industrial Britain 1830-1860: The Toronto Lectures, Toronto, University of Toronto Press, 1952, Chapter 3.

97. H. Byerley Thomson, B.A. of the Inner Temple, The Choice of a Profession A Concise Account and Comparative Review of the English Professions, London, Chapman and Hall, 1857, pp.302. .

98. Cf. ICE, The Education and Status of Civil Engineers in the United Kingdom and in Foreign Countries, London, The ICE, 1870, pp. IX, 192. See Chapter 4.

99. International Labour Office, Studies and Reports, Series L, No.1, "Engineers and Chemists: status and employment in industry", Geneva, 1924, p.29.

100. Cf. ICE, Education and Status, op.cit., p.x, and see chapter 4. F. Klemm,

A History of Western Technology, London, Allen and Unwin, 1959, p.335.

101. Stephen P. Timoshenko, Engineering Education in Russia, New York, McGraw-Hill, 1959, p.6.

102. See A. Goodwin, "Prussia", in A. Goodwin, ed., The European Nobility in the Eighteenth Century, London, A. and C. Black, 1953, pp.93-101.

103. M.A.Calvert, The Mechanical Engineer in America 1830-1910, Baltimore, The Johns Hopkins Press, 1967, pp.12-13; many of the original engineers (American Mechanical) were engineer-entrepreneurs; cf. Raymond Merritt, Engineering in American Society, 1850-1875, Kentucky, University of Kentucky Press, 1969, pp.118-9, and see Chapter 5 (below).

104. J.H.L.Waddell, "Address to the Members of the Graduating Class in the Engineering Department of the Rose Polytechnic Institute", in J.H.L.Waddell and J.L.Harrington, eds., Addresses to Engineering Students, Kansas City, Missouri, Waddell and Harrington, 1911, p.423. Cf. Calvert, op.cit., p.154 for a report on an American engineer meeting his upper class European counterparts.

105. A.M.Paton, "The Professional Status of the Engineer", Tees-side Sub-Centre: Chairman"s Address, Journal of the Institution of Electrical Engineers, Vol. 63 (1925) pp.128-132,129.

106. W.J.Reader, Professional Men, London, Weidenfeld and Nicolson, 1966, p.70, atypically concludes, on the basis of the erroneous assumption (following Smiles) that the social origins of engineers were low, that their social standing was "not very high". Reader's reference groups are the higher branches of the older professions, medicine, law, clergy and military, not for example the general medical practitioner after the effect of the 1858 Act was felt, or any other new profession.

107. Rosemary Stevens, Medical Practice in Modern England: The Impact of Specialisation and State Medicine, Yale University Press, 1966, p.23.

108. Richard G. Pilcher, History of the Institute: 1877-1914, London, Royal Institute of Chemistry, 1914, p.24.

109. Pilcher, op.cit., p.34; and, Nature, June 8th, 1876, "On the Organisation of the Profession of Chemistry".

110. D.S.L.Cardwell, The Organisation of Science in England, London, Heinemann, 1972 (rev. ed.) pp. 123, 144.

111. British Medical Journal, 1878, p.307, cited by A.M.Carr-Saunders and P.A. Wilson, The Professions, Oxford Univeristy Press, 1933, p.107.

112. Beresford Worthington, Professional Accountants, An Historical Sketch, London, Gee, 1895, p.73. It is stated that only time will put the accountant on a status comparable to divinity, medicine, or law.

113. Stacey, op.cit., p.50.

114. Richard Brown, A History of Accounting and Accountants, Edinburgh, T.C.& E.C. Jack, 1905, p.234.

115. Eng., Vol. 16 (Dec. 18, 1863) p.359.

116. Escott, op.cit., Vol.2, pp.451-2.

Chapter 2

Explanations and Hypotheses

Introduction

This chapter looks at the explanations advanced to account for the relatively low status of British engineers compared to other professional occupations in Britain. Following this, some of the general factors in the determination of the status of engineers in any society will be reviewed, and hypotheses advanced to account for the peculiarity of the British case within terms of this more general scheme.

Existing Explanations of the Problem

Existing explanations of the low status of engineers and technologists focus on British culture, values and tradition, the nature of the class system, or the structure and development of higher education. Most commonly it is argued that the low status of engineers, technologists and "applied scientists", is due to the high value put on "pure science", while this high valuation may in turn be caused by a number of factors, for example the tradition of amateurism stemming from the original "cultivators of science" (who pursued science as a gentlemanly hobby) and the association of amateurism with the gentlemanly ideal. In this vein gentlemen, those who adhere to the values and norms traditionally associated with British upper class culture, pursue science because it is worthless, non-utilitarian, while the working and mobile middle classes carry on applied science, technology, and engineering. It has further been argued that the incorporation of technology into the universities, here identified with upper and upper middle class culture, perpetuated the division; or that the lack of universal secondary education in the 19th century (in Britain) left entrepreneurs and industrialists ignorant of the value of science, pure or applied; that amateurism is characteristic of the ethos and culture of the public schools, which have influenced the outlook of the upper and professional and business classes towards engineering and applied science, making their acceptance difficult. Some explanations may be reviewed in more detail before proceeding to a critical examination.

One variable not so far suggested is religion. Cotgrove points to the interrelations of religious, educational and class variables as a fundamental cause of the phenomenon: "Throughout the 19th century, educational provision and policy were closely related to the class structure. In this, religious traditions played a part. Protestant countries were pioneers in the introduction of universal compulsory education at both the primary and secondary levels, motivated in the first place to make the Bible accessible to an illiterate people. By contrast, predominantly Catholic countries with their more hierarchial and authoritative values, have concentrated on the education of an elite, through whom the allegiance of the masses could be ensured. The Anglican tradition in the 19th century tended to approximate to the Catholic, in its suspicion of the education of the poorer classes."(1) This religious factor operates through its influence on the attitudes of management: "The lack of support for technical and scientific instruction by industrialists and businessmen goes far to explain the relatively slow progress in technical instruction compared to Germany."(2) Cotgrove, then, concurs with other analysts that the lack of secondary education is a crucial variable: "The long period of industrial pre-eminence in the 19th century in primarily non-scientific industries has established industrial traditions which did not include the application of science and research to production. 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."(3) Th explanation can be summarized as follows: religious traditions in their articulation with the class structure, led to the absence of universal secondary education in the 19th century that in turn gave rise to negative attitudes among managers and industrialists of the worth and value of science in its relevance to the productive process, which have survived to the present time, and account for the hypothesized absence of qualified scientists and engineers on the directorate, higher management, and positions of industrial leadership generally. Haines has also stressed the role of the religious variable when comparing English and German provision of education for science in the nineteenth century.(4) Cardwell emphasizes the role of secondary education as the crucial variable,(5) its absence was stressed by those active in the Society of Arts and other reform movements in the last three decades of the century.(Higher technological education could not be provided, it was argued, if students were not adequately prepared for it at the secondary level, and a unifority of standards could not be achieved at the tertiary level if uniformity did not exist at the secondary.) Religious traditions aside, Prandy has argued that the high status of pure scientists has contributed to the low status of applied scientists in this manner: "Science is now accepted, but only science of the pure sort. This very term used, with its high value loading, is indicative of the attitude. Pure, basic science, so the idea runs, is eminently useless and must therefore be decent--- a fit occupation for a gentleman. If this is a caricature of influential opinion, the scientists themselves are partly to blame for it. They have emphasized the importance of basic research--- science for its own sake--- partly in order to maintain control over their own subjects, since clearly only they are competent to judge the value of research. Once they attempt to be practical, however, they surrender judgment and therefore also direction into the hands of laymen."(6) Prandy further observes that engineering is even less prestigious than applied science and technology. This is, it is held, indicated by the social background of the practitioners, the reason for the difference being the differential historical development of the disciplines: "Whereas science was strongly associated with the activities of gentlemanly amateurs, engineering has always been a practical matter, only recently becoming an academic discipline (or rather cluster of disciplines). Traditionally, the training of engineers has been largely "on the job". Nevertheless, although the differences existed they did not prevent a great deal of interest in practical problems by scientists. With the rise of professional scientists and a greater theoretical emphasis in science, associated to some extent with its pursuit within the universities, this practical interest diminished, and applied science, technology and engineering, assumed a definitely inferior position, looked down upon as much by the new pure scientific culture as by the old literary one. Having been largely rejected by the universities technologists have had to be content almost until the present day with second-class educational institutions. Even now...((engineers are)) only about one-half graduate....There can be little doubt that in Britain those differences of social background are a determinant of the relative social prestige of scientists and engineers."(7) The status implications of the relationship between technology and academic values within the university setting have also been stressed by Ashby.(8) Universities have been hesitant to accept, first science, and now technology: "There is no great divergence between the attitude of the physicist toward the concept of entropy and the attitude of the philosopher toward the concept of virtue. But teaching and research in technology are unashamedly tendentious, and their tendentiousness has not been mellowed (as it has for medicine and law) by centuries of tradition. Technology is of the earth, earthy; it is susceptible to pressure from industry and government departments....And so the crude engineer, the mere technologist (the very adjectives are symtoms of the attitude) are tolerated in universities because the State and industry are willing to finance them."(9) The problem lies with the belief of academics that technologists have nothing to contribute to the universities intellectually.(10) Rudd and Hatch also put forward an explanation that rests on academic and pure science values: academic careers are preferred to those in industry, technology and engineering because, "In part this is a continuation of the gentlemanly amateurish tradition in British society. It has also a more modern, idealistic component---a rejection of business morals as symbolised by advertising and the profit motive; and a belief that the modern corporation does not offer the responsibility, the freedom and the intellectual challenge that the graduate wants."(1 Other factors involved are the failure of industry to attract scientists, and the values internalised in graduate school that stress the pursuit of knowledge for its own sake. Universities inculcate a high value for pure science careers.

Such explanations, incorporating education and training are frequent: "In Britain their ((technologists, i.e., in effect engineers)) influence and status are lower than those of their Continental couterparts owing to the legacy from the past of cultural prejudices persisting in schools, colleges, universities, boards of directors and Civil Service departments."(12)

The hypothesis that the status of engineers varies with the degree of industrialization, supported by a Spearman rank correlation co-efficient of -.73 (significant at the .05 level) is also advanced; the correlation being of prestige status (as measured by a number of surveys) and GNP per capita, as an index of industrialization. It is suggested that as the numbers of engineers increase, relative to other occupations in the labour force, competition for rewards leads to a declining status for engineers, and industrialization leads to the increase.(13)

This empirical observation and inference is informed by the functionalist theory of social stratification, which is peculiarly relevant to the situation of technical occupations. Technical occupations such as engineering provide the simplest case of rewards being distributed so as to draw talent and motivate training.(14) These occupations do not receive the highest rewards because their importance is never so great as those positions involved with the integration of societal goals (positions religious, economic, or political in character) as they are concerned only with means. Debasement of the prestige of technical positions results from unemployment or an excess of personnel seeking positions over the available openings.

Most of these explanations are contradicted by the facts, historical facts that have not been researched before, facts presented in the chapters that follow. All the same a few preliminary criticisms are in order.

Cultural variables, prominent among the explanations, cannot account adequately for the problem as defined and measured on the three comparative dimensions. The observation that English culture places high value on theory, should not necessarily lead to the conlusion that low value is put on practice.

The gentlemanly amateur ethic with its supposed emphasis on theory, principles, generality, rather than practice and specialization, has not influenced the largely upper and middle class recruits to medicine, surgery, law, or dentistry, which could hardly be more practical (in 1955-56 between 28 and 30 per cent of all students entering universities came from families of manual workers, in medicine the proportion was 16-20 per cent, only the proportion in dentistry, 15-16 per cent was lower).(15) Moreover specialists within such professions often have higher status, more education and training, than general practitioners. As the practicality of the occupation, the fact that it is an area of applied knowledge not pure scientific research, is an important part of the definition of a profession, it remains unexplained why the gentlemanly amateur ethic peculiar to British culture discriminates against engineering alone. A possibility here is that industry as a whole, when compared to the United States, France, and Germany, is held in low regard because of the nature of the class system and the British cultural tradition. Common though this belief is, it conflicts with the findings of prestige surveys on the relative position of such key jobs as company director and accountant on an Anglo-American comparison. While industry may have low social standing in certain professional circles, particular professions and occupations within industry, trade, finance and commerce, need not. Nor of course need such anti-industry attitudes, associated with British upper class culture, be evenly distributed across the population, which would explain the findings of the prestige surveys, but not the peculiarity in the status of the engineer. In either case, such anti-industry attitudes, where directed at engineering, assuming their origins in a pre-industrial order and continuity through the articulation of the interests of the landed and professional strata in modern Britain, are very difficult to explain in the context of the higher status of Civil engineers in the 19th century. The prejudice of the Prussian upper class towards industry (incorporating legal prohibitions as it did) was greater than in Britain, but that did not stop the German engineering profession from rising in status over the course of the century. Indeed the entire idea of "pure" science was itself of German origin.(16)

It is still well entrenched today, despite the relatively higher status engineering profession, emphasizing once more that a high value for pure science does not necessarily lead to a low value on the applied and practical. Consistent with the high status of Civil engineers in the 19th century, chapter 4 below indicates that engineering and technology were in fact eagerly incorporated into London and the new redbrick universities at their foundations in the eighteen thirties and forties (even an ancient university such as Cambridge fostered the growth of engineering from Newton through the 19th century to the point of becoming a leading, if not the leading, British engineering department by the turn of the century) and during their expansion in the closing decades of the century. In fact, many developed out of technical institutions almost exclusively concerned with these subjects, while other higher status professions such as accountancy, did not get a foothold in the universities until after WWII.

The long history of the "ancient" professions, those that today still retain remnants of a collective organization dating back before the mid-eighteenth century, shows them to have varied widely in status and position not only in broad historical civilizations, those of Greece, Rome, Egypt, China and pre-industrial Europe, but also during their development during the 19th century. It is not clear how the high status of the medical man in ancient Rome or low status in ancient Greece contributes to contemporary evaluations. If such practitioners were "doctors" by modern definition and usage, then engineers may claim, as they do, as equally long history, as designers of the first pyramids or as the first technologists, the first to invent tools. In fact most professions in their modern organization do not date back past the mid-nineteenth century, <u>later</u> than engineering, e.g., dentistry, accountancy, the "solicitors" and "doctors" as distinct from barristers, physicians and surgeons. Civil engineers in Britain are among the oldest of the modern professions. While tradition serves to add further legitimacy to occupational status, and under special circumstances be all important, it is not, from the factual evidence of changes in the relative status of professions in industrial societies, the primary basis of such status, or the factor that distinguishes engineering from other modern professions.

Another cluster of variables, education, social class, and income, associated with status cannot give an adequate account of the problem either. Divergencies between the social status of occupations measured in ways other than through social class composition and that composition itself are common, and engineering is no exception. As far as the data are available, engineers (taken together and by speciality) are favourably placed in a rank order based on social class.(17) Wide differences in the social background of practitioners in various branches of engineering exist. The top speciality within the internal hierarchy of the profession in terms of status (though not necessarily the top in terms of social class, there is no information for some potentially more exclusive specialities), Civil engineers (18) have a higher social class composition than university teachers, 5% and 24% of the members of the two professions respectively are recruited from the homes of manual workers,(19) but civil engineers are ranked well below university teachers on prestige.(20) Moreover university engineering students are more likely to be products of public schools from middle and upper class homes, than are the more able, science students.(21) Engineering was still the most popular choice of career among Marlborough boys in the early 1960s, pursued by 11% of its graduates, when 9% went into medicine and dentistry, 8% the services, 6% the law, 6% agriculture, and 5% accountancy.(22) Of course this influx of public school leavers (more pronounced in the late 1950s and 1960s than in the interwar years or the 1940s) may not reflect positively, or contribute to, the status of the occupation; it has been well known through the period to which this survey data relates among school advisory and career officers and headmasters that engineering is one of the easiest subjects to enter into at the universities, the brighter working class boys are attracted to science, which in turn may contribute to the determination of the relative prestige of the occupations. While engineering students at the universities are recruited from the public schools, it is nevertheless true that an image of the profession as the stronghold of the mobile skilled manual worker has a factual basis in the recruitment pattern of the Mechanicals, the largest speciality,(23) which opened up part-time routes to membership in the inter- and postwar years that did permit of access to professional status for craft apprentices and the sons of skilled manual workmen familiar with the opportunities and costs. Even so the Mechanicals have a smaller portion of sons of manual workers (19%) than does univeristy teaching(24%).(25) Although the social class composition of the engineering profession has declined over the course of this century, it is not now sufficiently low in comparison to other professions to be able to explain the decline in status during the same period; a discrepancy now exists between that composition and standing. While the social class composition of a profession is closely related to its status, the former is not only a correlate and indicator of the latter, but also an effect (an effect that may lag well behind changes in status and be influenced by the nature of the institutions, not least the British educational system in its historical complexity, through which it is transmitted). Much the same may be said of income: both within and between engineering and other occupations differences exist between income and status measured in other ways.(26) ---again the association is a very close one. Peculiarities in the social class composition or income of engineers proceeding from exogenous causes that could explain the peculiarity in the status of engineers are not evident in the available data, which taking into account the trends suggest that to the extent these factors are independent causes (mainly reflecting peculiarities in the relationship of the profession to the educational system and market forces associated with a shortage of engineers), engineers do not receive the status from them that they "ought" to. Their income and social background are now higher than would be expected if predictions were to be based on contemporary status alone. Nevertheless, because of the intimate association between the variables, any explanation of the status of British engineers should have the capability of explaining changes in social class and income, and especially, be able to elucidate the mechanisms of such change, a capability not evident in the theories and explanations reviewed above.

The functionalist theory of social stratification advances a societal equivalent to the determination of income by market forces for status. But on the assumption that the two propositions concnerning the determinants of positional rank are valid (i.e., the functional importance of the occupation and the extent to which the position requires the greatest training or talent), the theory cannot explain the British case. There is no evidence that the goals to which the occupational acts of the engineering profession are symbolically related are any less valued in Britain than they are in other advanced industrial societies, not that the occupation is any less relevant to the realization of these goals (if that were the case a similar debasement of the prestige of other scientific and industrial occupations, such as accountants, scientific chemists, physicists, company directors, might be expected). Of more importance is the scarcity of personnel. There is evidence of a relative shortage of engineers in Britain contrasted with Germany, France, the United States, and the Soviet Union (the British is one of the most exclusive engineering professions in terms of the ratio of engineers to scientists, technicians, and population), but there has been no corresponding rise in status, as predicted by the functionalist theory of stratification.

Peculiarities in the development of the British educational system, either in relation to the class structure or religious order, cannot explain the phenomenon, as measured on the three comparative dimensions. Again the idiosyncrasies that do exist could be expected to offect other professions in s similar way. Whilè (at the primary date of comparison, 1960) only about half of all engineers (differences exist between specialities e.g., three-quarters of the Civils, one-quarter of the Mechanicals are graduates) were also universsity graduates, this does not explain their low status when the non-university routes for solicitors, accountants, architects and other British professions are even more important. Accountancy in particular has a far smaller proportion of graduates than engineering, but a higher status. University-level education has not been as important for entry into the British professions as for the German, French, American, but Britain is not unique, the Australian engineering profession, with its higher status, has an educational make-up very similar to the British. The fact is that the British engineering profession does not differ significantly from other British professions in its relationship to the educational system.(27) Nor did the lack of secondary education in the 19th century, although an important influence on other institutional developments, have the effect on the status of engineering and technology that has been attibuted to it. Neither Canada nor Australia, both with high status engineers, had any more comprehensive provision of education in any sphere, including secondary, at comparable dates to Britain in the 19th century. School-based professions, e.g., France and Germany, have built up their status at different lengths--the former within years of establishment, the latter over the course of a century, which all emphasizes the absence of a fixed ti[me] limit on the establishment of a high place for new educational institutions within the social order, though tradition helps to legitimate it. The absence of secondary education may have contributed to the sceptical attitudes of a generation of businessmen towards science, scientific education, and the employment of the university graduate in industry, but by the same token they welcomed engineering as a proved field of application. Finally, religion probably did not have the effect imputed t[o] to it: technical education was provided for the working class on an ample scale in the last decades of the century, while the Anglican tradition failed to produce education for an elite. The state mainly left professions and professional education to develop autonomously, or to be incorporated piecemeal into universities. I[t] was France, Russia and Germany that pioneered engineering education for an elite.

An explanation frequently put forward by engineers themselves is that the public does not "know" what an engineer is: if the public did know, he would have a higher status, so a change in status could easily be brought about through an adoption of a more readily identifiable occupational title. While it is true that in Britain there is confusion over the meaning of the title "engineer" alike applicable to the mechanic and the professional man, this is also to a greater or lesser extent the case in other societies, especially English-speaking societies. Ambiguity of title parallels confusion over relative status levels: the knowledge of a subjective phenomenon such as an occupation's status cannot be separated from the phenomenon itself. The confusion over the meaning of the word engineer as it relates to professionalism is no less a confusion over the engineer's status. A simple change in title would not lessen such "confusion" leading to a higher status;(28) in Britain the professional engineer does have his own peculiar title, e.g., chartered civil engineer, chartered mechanical engineer, etc. On the other hand should the "public" recognize and adopt a title referring to a high-status identifiable group to be used in relation to engineers, as was the case of the 19th century usage of Civil engineer, C.E., or just engineer, but understood as referring to the C.E., the profession would of course have that higher status. This view is corroborated by the findings of recent research into the meaning of the response to prestige surveys: respondents generally seem to afford the occupations the status that they do because of their "knowledge" of that status, not because of the reasons supposed to lie behind such an evaluation, e.g., functional importance, responsibility, worth, moral standing, etc.(29) Thus any explanation of the status of engineers should have the potential to explain how such "knowledge" of the profession becomes a part of social reality and how it changes.

These explanations all involve, however, institutions, attitudes, values, that are in some way connected with the phenomenon of the British engineer's low status, but essential elements and relationships have been overlooked. They do not provide an explanation of the problem that is both causal and meaningful, within terms that are at once both peculiar to British engineers but also applicable to all professions.

Professionalization and Professional Status

A factor not so far considered is the potential role played by the occupational group in the determination of its own status. Every profession is organized to a greater or lesser extent for the collective pursuit and legitimation of status for its occupation and membership, and there can be more or less success in the historical actions that are the legacy of the workings of such occupational organization. Each profession seeks legitimacy for its claim to a unique role and responsibility within the division of labour, and for a special position within the social order. The British engineering profession, it is hypothesized, has fallen short of the ideal in professional organization, action, and ideology, where these have a bearing on the status of the occupation, and it will be the burden of this study to examine precisely what role engineers have had in the determination of the own status, exclusiveness and position through the collective pursuit of status. But before looking at this aspect in historical detail, some reasons for the similarities in low status of engineers throughout a range of societies will be advanc before turning to the differences between engineering professions.

Barriers to Professionalization and Closure of Engineering

In the Western democracies engineers generally rank below other established professions, especially medicine, university teaching and law, in their sta us. The reason for this similarity in position across societies of a given politi al and industrial type, is that nowhere have they been able to develop the kind of collective action that characterizes the "free professions", nor as a consequence achieved the same degree of control over education and practice, or state-sanction and legitimacy for their claims.

The traditionally free professions, such as medicine, the law, clergy, ministry, higher civil service, and university teaching, all have an advantage over engineers by being practiced in organizations that themselves give a professional service, hospitals, churches, the armed forces, universities, and other educationa and research establishments. These occupational groups have come to occupy those positions within their organizations that confer the highest status and claim reponsibility for the service of the organization as a whole.[30] Apart from a limited number of research organizations, a small proportion (3% in 1966 and 5% in 1971) of independent consultants, and a variety of other institutions offering professional services (about 4% of engineers in 1971 were in research associations, 7.8% in a consulting firm),[31] which account for only a fraction of the profession, engineers are an appendage to organizations that have a variety of non-professional goals, typically the business or industrial firm. In this case engineers offer a service within the organization in their capacity as "staff" along with a number of other functional groups, which are to a greater or lesser extent professionalized such as chartered company secretaries, managers, personnel officers, scientists and other staff occupations. This fact of practice within a non-professional organization does itself tend to reduce the status of engineering compared to other professions. The occupational group is not identified with the goals of the organization as a whole, but rather functions within the organization. The engineers' claim to be giving a service to the public is mediated by the interests of the industrial organization and ideologies stressing the capitalist profit motive and other ends that conflict with the values implicit in the professional service ideal. The antagonism between capital and labour imposes further limitations on the development of the service ethic.[32] Scientists are in a logically similar situation, and the few attempts to professionalize on the model of the established free professions among scientists in Britain, have led to the dilemmas characteristic of such movements among engineers in other societies, and the limited expression of such idealism in Britain.

This ideological dilemma is manifest in the absence of truly enforceable ethical codes among engineers. Ethical codes can become a substitute for formal rules, and in such a case usually signify both the autonomy of the profession from outside control, and a monopoly of function, needed for effective enforcement, which is why they have been taken as the one best indicator of professional status.

The ideological dilemma that would arise if professional status was to be sought in earnest has not been problematic because the organized client and early bureaucratization of the profession has lessened the threat of unqualified practice to the status and livelihood of engineers. In 1960 the proportion of principals in private practice in accountancy was 33%, among architects 25%, solicitors 62%, surveyors 27% and engineers only 2%.[33] The impetus to collective action provided by fee-taking and a personal fiduciary, client-practitioner relationship have been absent, as has the belief of practitioners in the benefit that would result to the public from the suppression of unqualified practitioners. There has never been a period in the development of the British profession in which unqualified practice became a major problem. The internal divisions within engineering stemming from the historical embeddedness of the profession in large-scale organizations, has further dampened the interest of practioners in securing a monopoly of function. Professional engineers have naturally identified with their employers in a way in which free practitioners do not with a diverse group of clients, and were originally defined in terms of this relationship, which included a strong element of patronage. The absence of a client-practitioner relationship both contributed to its initial professionalization and to its subsequent lethargy.

A consequence of such bureaucratization and internal differentiation emphasized by Rothstein,[34] and Perrucci and Gerstl,[35] is that the engineering profession lacks community of the quality found in some other established professions. This lack of community in both the American and British professions has its expression partly in the fragmentation process and stems from those characteristics of the occupation that enhance loyalty toward the organization within which it is carried out rather than the wider professional community. Such organizational orientation, "localism" rather than "cosmopolitanism", has contributed much to the lack of demand for closure and community formation among engineers.[36] "Success" for the engineer frequently involves movement up a non-technical managerial ladder,[37] a career pattern accompanied by growing organizational rather than professional loyalties. Successful engineers are also those in the most powerful positions within the profession itself, in Britain in the Councils and other high offices of the professional bodies. For engineers to have, or surpass the status of doctors, it would be necessary for the occupation itself to become identified with the functions of the industrial organization, for these other occupations (i.e. secretaries, accountants, managers of various types, scientists and other staffs) to "service" the professional engineers, and for all top purely administrative positions which, if necessarily carrying a superior authority, to recruit from among the engineering staff of the organization. A thorough bureaucratization of industry and a professionalization of the resulting positions on the basis of the qualifications controlled by an autonomous organization of practitioners, are the ideal conditions for the development of full professional status; such an ideal situation could be defined through recognition of a unified system of professional organization. Only in a full-blown "technocracy" would engineers be able to rank above all other professions and then not necessarily; such a situation would be one in which the industrial system was run for the benefit of society as a whole, by technical experts or engineers. Those modern post-industrial societies that are most frequently termed technocracies, Russia, France and to a lesser extent the United States, have high status engineering professions; in England by contrast, the term technocracy is used comparatively rarely to describe the political or industrial system and technocratic themes have been less applicable, a phenomenon paralleled by the status of the engineering profession as well, as is illustrated in chapter 5, the movement of engineers into positions of industrial leadership and general administrative authority.

Footnotes to Chapter 2

1. Stephen F. Cotgrove, Technical Education and Social Change, London, George Allan & Unwin Ltd., 1958, p.17.

2. Ibid., p.28.

3. Ibid., p.187.

4. George Haines, German Influence Upon English Education and Science 1800-1866 London, Connecticut College, 1857, pp.3-7.

5. D.S.L.Cardwell, The Organisation of Science in England, London, Heinemann, 1972 edition, first published in 1957, pp.194 et.seq.

6. Kenneth Prandy, Professional Employees, A Study of Scientists and Engineers London, Faber and Faber Ltd., pp.18-19. On the idea that gentlemen as amateurs, do not put high value on practical occupations, cf. R. Wilkinson, The Prefects, British Leadership and the Public School Tradition, London, Oxford University Press, 1964.

7. Prandy, op.cit., pp.19-20.

8. Sir Eric Ashby, Technology and the Academics, An Essay on Universities and t Scientific Revolution, London, 1958.

9. Ibid., pp.65-6.

10. Ibid.

11. E. Rudd and S. Hatch, Graduate Study and After, London, Weidenfeld & Nicolsc 1968, pp.184-186.

12. Arthur E. Mills, and John P. Edwards, Management for Technologists, London, Business Books Limited, 1968, pp.19, 20-34.

13. William M. Evan, "The Engineering Profession: A Cross-Cultural Analysis", in R. Perrucci and J.E.Gerstl, The Engineers and The Social System, New York, John Wiley and Sons Inc., pp.126-128; cf. Carter and Sepulveda (Appendix A), for a similar hypothesis.

14. K.Davis and W.E.Moore, "Some Principles of Social Stratification", American Sociological Review, Vol.10 (1945) No.2, pp.242-249.

15. Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom, Report of an Inquiry into Applications for Admission to Universitie by R.K.Kelsall, London, Association of Universities of the British Commonwealth, 1957, Table 14.

16. See Abraham Flexner, Universities: American English and German, New York, 1930; cf. Haines, op.cit.; see Chapter 4 below.

17. The conclusion is based on a thorough examination of the available literatur on the social class composition and recruitment patterns of professions.

18. Members of the ICE.

19. McFarlane, op.cit., (Ch.1) Table 24, p.178; H. Perkins, Key Profession, London, 1969, appendix 111, Table 11. Differences in the scales used preclude further comparisons.

20. See Chapter 1.

21. Donald Hutchings, The Science Undergraduate, A Study of Science Students at Five English Universities, University of Oxford, Department of Education, 1967, Table 10 and 11; see also Chapter 7 below.

22. Marlborough, an open examination written by the boys, London, Kenneth Mason, 1963, p.74. Another public school with a heavy emphasis on engineering is Oundle. Cf. Ian Weinberg, "The Occupational Aspirations of British Public Schoolboys", The School Review, Vol. 74 (Autumn 1966) No.3, pp.265-282. 37% of the Civils, 25% of the Electricals, and 18% of the Mechanicals had attended public schools, McFarlane, op.cit., Table 27, p. 185.

23. The dangers of generalizing on the basis of J.E.Gerstl and S.P.Hutton, Engineers: The Anatomy of a Profession, London, Tavistock Publications, 1966, can hardly be overemphasized. The survey is based on a sample of Mechanical engineers, who have a highly distinctive tradition in recruitment. See Chapters 3 and 4.

25. Cf. Perkins, op.cit., and Table 3,Chapter 1.

26. Engineers in the late 50s and early 60s had higher incomes than some professions with a higher status; cf. D.S.Lees, The Economic Consequences of the Professions, London, Institute of Economic Affairs, 1966, for a review of some findings; Report of the Royal Commission on Doctors' and Dentists' Remuneration,196[illegible] London, H.M.S.O., Cmnd, 939, Table 9, p.40. Engineers were not found to be among the leaders, but on a par with architects and university teachers. Within engineer[illegible] the highest status speciality, civil engineering, receives less income than the next two rivals, mechanical and electrical. The divergence of income and status within the professional complex is evident from a comparison of socioeconomic indices, which include income and occupational prestige ratings within one measure, with purely prestige survey findings. (See Appendix A).

27. Robbins Report, op.cit., "Professional Education", Part V of appendix 2/B.

28. See Chapter 7.

29. L. Kriesberg, "The Bases of Occupational Prestige: The Case of Dentists", American Sociological Review, Vol. 27 (April 1962) pp.238-244.

30. F.C.Mosher, Democracy and the Public Service, New York, Oxford Univerity Press, 1968, see especially chapter 4, "The Professional State".

31. See Council of Engineering Institutions, The 1971 Survey of Professional Engineers, London, CEI, 1971; cf. The Survey of Professional Engineers, 1966, London Ministry of Technology and CEI, HMSO, 1966; The Survey of Professional Engineers,196[illegible] London, Ministry of Technology and Council of Engineering Institutions, HMSO, 1968. The figures are for the 15 leading specialities.

32. In the United States, engineers have looked upon themselves as mediators between capital and labour, an idea diffused early in the century through Taylorism in its articulation with engineering professionalism and ethics; on this role-conception, see Robert K. Merton, Social Theory and Social Structure, New York, The Free Press, 1968, Enlarged Edition, Chapter XIX, pp.616-627, "The Machine, the worker and the Engineer".

33. Report of the Royal Commission on Doctors' and Dentists' Remuneration, op.cit Table 14, p.48.

34. W.G.Rothstein, "Engineers and the functionalist model of the Professions", in R. Perrucci and J.E.Gerstl, op.cit.

35. Robert Perrucci and Joel E. Gerstl, Profession without Community, Engineers in American Society, New York, Random House, 1969.

36. On the relationship of the engineering profession to host organizations, see especially, W. Korhhauser, Scientists in Industry, University of California Press, 1962; S. Marcson, The Scientist in American Industry: Some Organizational Determinants in Manpower Utilization, Princton, Industrial Relations Section, Princeton University, 1960; cf. Prandy, op.cit.

37. See, F.H.Goldner and R.R.Ritti, "Professionalisation as Career Immobility", American Journal of Sociology, (March 1967) p. 141, for a systematization of an old observation. For U.K. data on career aspirations, see Gerstl and Hutton, op.cit., McFarlane, op.cit., and Prandy, op.cit.

Chapter 3

The Professional Organization of Engineering Occupations

Introduction

In this chapter the historical development of the professional organization of British engineers is described and the present structure compared to that of engineering professions in other societies. The structure of organization in Britain differs crucially from that in other societies in the extent and nature of fragmentation, where in other societies the organization of the profession is more unified and cohesive. Fragmentation in Britain has led to rivalry, mutual denigration, internal conflict in the historical actions of the profession, which together have undermined the legitimacy of the claim for professional status for engineers over the course of the development of the profession in this century. By comparison, other professions with unified organization have cooperated in the collective pursuit of status, gaining state-sanction for their claims (if the profession was not the result of state action), and have effectively defended their interests against other non-engineering occupational groups. The implications and nature of the fragmentation process in Britain cannot be fully drawn without an analysis of the relationship of the profession to education and entry and its control over conditions of practice. These relations are documented in the two following chapters.

Origins and Early Development of Professional Organization in Britain

The occupation of "engineer" can be traced to antiquity, and the "modern" civil engineer to the Renaissance, in particular to Leonardo de Vinci the first "engineer",(1) but such beginnings have little direct bearing on the modern profession or its status except as part of the mythology of the occupation. The profession in England dates from the formation of the Society of Civil Engineers in 1771, later known as the Smeatonian Society of Civil Engineers or simply "Smeatonians", the first engineering society of its kind to be formed in the world. The Royal Society, the Society for the Encouragement of Arts, Manufacture and Commerce (later the Royal

Society of Arts), numerous provincial scientific societies, most notably the Lunar Society of Birmingham, including Boulton, Watt, and Priestly among its members who were also members of the Society of Civil Engineers, and other regional scientific societies (e.g., the Royal Society of Dublin found under the title of the "Dublin Society for Improving Husbandry, Manufactures and other useful Arts" in 1731 and the Welsh Society of Cymmrodorion founded in 1751) provided a forum for the development and communication of engineering science (the preoccupation with pure science by bodies such as the Royal Society is comparatively modern), but did not confine themselves exclusively to engineering or attempt to professionalize the occupation in any way, except indirectly.(2)

By the 1770s civil engineers had grown conscious of themselves as a distinct occupational group; the works carried out after 1760 "gave rise to a new profession and order of men called Civil Engineers. In all the polished nations of Europe, this was and is a profession of itself",(3) although in England, where there was no provision for study, "the formation of such artists had been left to chance." These civil engineers, who drew up the plans deposited with canal bills, "often met accidentally...in the Houses of Parliament and the Courts of Justice, each maintaining the propriety of his own designs without knowing much of each other."(4) Such occasional contacts eventually produced the Society on March 19th 1771 to consolidate the status and professional authority of practicing civil engineers: "It was proposed by one gentleman to Mr. Smeaton that such a state of the profession, then crude and in its infancy, was improper: and that it would be well, if some sort of occasional meeting, in a friendly way was to be held; where they might shake hands together, and be personally known to one another:- That thus the sharp edges of their minds might be rubbed off, as it were, by a closer communication of ideas no ways naturally hostile; might promote the true end of the public business upon which they should happen to meet in the course of their employment without jostling one another with rudeness too common in the unworthy part of the advocates of the law, whose interest it might be to push them on too far."(emphasis in original).(5) Many of the original members knew each other before the formation of the association(6) but they now looked forward to a closer acquaintance over their parliamentary, legal and engineering work. The Minutes of the Society indicate that they met regularly during the session of Parliament, but little detailed record of what took place remains for the years before 1792, although a Minute of April 3,1778 contains the suggestive comment, "This eveing after being spent Hydraulically, Mathematicall Philosophically, Mechanically, Naturally and Sociably was adjourned."(7) Later, in 1782, Smeaton read a paper on "An Experimental Enquiry concerning the Natural Powers of Water and Wind", producing a discussion afterwards, which is the first recorded meeting of its kind. Attendance and membership of the Society before 1790,fluctuated, reaching a low in 1774, as it had been resolved: "...that it be submitted to the future consideration of this very respectable Society;--that in their Meetings hitherto for want of a sufficient number of Members have been unduly and irregularly attended -- Circular Letters be issued inviting all the reputable and ingenious Mechanics that can be found in this Metropolis or elsewhere to join a Society which if properly supported might become one(sic) of the most RESPECTABLE in the Kingdom." (8) Even worse, on 24th April 1778 only two members participated, but the Society survived and overall membership grew to over 65 in th period prior to reconstitution though "only about 15 were real engineers" including Yeoman, Smeaton, Grundy, Milner, Nichalls, Jessop, Goldborne, Whitworth, Edwards, Joseph Priestly, Major Watson, Boulton, Whitehurst, Rennie and Watt. "The other members were either amateurs or ingenious workmen and artificers connected with and employed in works of engineering."(9)

In 1792 the Society was reconstituted in a more "respectable form",(10) following "some untoward circumstances in the behaviour of one of the gentlemen towards Mr. Smeaton."(11) It seems that Joseph Nichalls, President of the Smeatonians in 1784, 1786 and 1791, but previously a resident engineer under Smeaton, had challenged Smeaton's professional authority; prior to this Smeaton, acting as a consultant, had condemned Nichalls' plans for a harbour at Bristol, leaving a certain animosity between the men. The reconstituted Society met on Fridays again "during the session of Parliament"(12) in the evenings for dinner wit the object of communicating knowledge.(13) It was stratified into three classes.

The first for the purely professional engineers, "real engineers", included William Jessop, Robert Whitworth, John Rennie, F.R.S., James Watt, F.R.S., James Goldborne, Sir Thomas H. Page, Kt., F.R.S., John Duncombe, Captain Joseph Huddart, F.R.S., William Chapman, M.R.I.A., and James Cockshutt. The second class of Honorary Members were not professional engineers but "men of science and gentlemen of rank" in some way connected with engineering works or interested in engineering such as, Sir Joseph Banks, Sir George A. Shuckburg Evelyn, Doctor Charles Hutton, F.R.S., The Right Hon. The Earl of Morton, F.R.S., John Lloydd, F.R.S., and the Right Hon. Charles Greville, F.R.S., General Bentham, Joseph Priestly and Henry Oxendon. The third class of Honorary Members, essentially similar to the second class, consisted of persons of lower social status: William Faden, Geographer; Jesse Ramsden, F.R.S., Instrument-maker; John Troughton, Instrument-maker; John Foulds, Millwright; Samuel Phillips, Engine-maker; Samuel Brooke, Printer; John Foulds, Millwright; Samuel Phillips, Engine-maker; Samuel Brooke, Printer; and John Watt, Land Surveyor.(14) This differentiation reflected the growing self-consciousness of civil engineers as a profession with relatively defined boundaries, excluding mechanics, millwrights, surveyors and architects, employers or craftsmen and artisans. Smeaton, the first to style himself "civil engineer" and a charismatic figure for the early engineers, agreed to become a member of the reconstituted Society, but died in 1792 before the first meeting in April of 1793. The members would pay a "pious tribute" to his memory, as both an honour to him and to the Society. In 1830, at the suggestion of Sir John Rennie, the younger, the Society became known as the "Smeatonian" (also referred to as the "Engineers" or "Engineers' Society"), and Smeaton himself as the "Father of English Engineering",(15) though he is not the only engineer to be so called, and his role was down-played by the members of later engineering societies.

Another engineering association, the Society for the Improvement of Naval Architecture established in 1791, was of little consequence for the development of the profession, despite the fact that it numbered far more than the Society of Civil Engineers, having some 300 members in 1792. It was a quasi-study association and pressure group modelled on the Society of Arts, publishing technical proceedings and pressuring, successfully, for the establishment of a British School of Naval Architecture, which opened at Portsmouth in 1910. Like other engineering associations with technical activities in military fields, it was heavily patronized by the aristocracy and in this area the admiralty, but the professional naval architects in the employment of the state, who actually designed the warships, the colleagues of professional members of the Smeatonians, "kept aloof...probably considering that its formation was a direct slight to their own abilities and productions."(16) As a consequence it was a failure, dissolving in 1799 without developing into a professional orgánization. In its character the Society of Civil Engineers was more like the late-eighteenth century associations of surveyors and architects, the first known purely professional associations in these fields. The functions of the engineer, surveyor and architect were not completely distinct, many practioners styled themselves as a combination of two of these three. These early associations were initial attempts at a definition of the occupations. The Surveyors' Club (1792) emerged partly as a reaction to the Architects' Club (1791), which excluded certain of the City Company Surveyors.(17) The limited documentary evidence suggests that both the Surveyors' Club and the Architects' Club(18) began as professional organizations carrying out some study funtions, which then developed into dining clubs with an exclusive character---a pattern repeated by the Society of Civil Engineers.

Initially a rival rather than a "parent-body" to the Institution of Civil Engineers, the Society functioned to define and service the elite of the profession (where it still recruits today). Its growing exclusiveness in the face of rising numbers of young resident, assistant, and workshop mechanical engineers provided room for the development of the ICE. For some time before the second half of the 19th century, the activities consisted primarily of six dinners a year and an Annual General Meeting held at the Institution of Civil Engineers.(19) Since 1913 recruitment has been limited to 48 full members and 12 honorary members, many of whom are the sons of eminent engineers. Indeed between 1771 and 1936 of the six Treasurers the principal offider, three were Mylnes' and three Rennies'. The Treasurer for the period 1949-1971 was Sir John Wrightson, Bt., whose father, Sir Guy, was President in 1939 and whose grandfather was a member.(20) Yet despite the eminence of its members the Society had little impact on the subsequent growth of the profession.

The Establishment of the Institution of Civil Engineers

The Institution of Civil Engineers, established in 1818, and perhaps the oldest modern engineering organization in the world, was established intitially for the communication of knowledge and the development of research published in the Minutes of the Proceedings of the Institution of Civil Engineers.(21) The objects of the founders emphasized this function as the overt purpose of association "for facilitating the acquirement of professional knowledge and for the promoting of mechanical philosophy",(22) but its success was to wait upon the pursuit of non-technical professional goals.

The original impetus for association came from some younger engineers, by no means established in their careers. William Maudslay, Joshua Field, James Ashwell, Charles Collinge, James Jones, and probably also Thomas Maudslay and John Thomas Lethbridge, met at the King's Head tavern at Cheapside on the 2nd January 1818 and decided, under the leadership of H.R.Palmer, Telford's 23 year old assistant, to form the Institution.(23) Field's role in its foundation has also been emphasized.(24) Over the course of the next two years only four were added to the original eight, and by 1820 the young engineers were looking towards Telford, eminent civil engineer, consultant, and Smeatonian, as a patron to help raise the prestige of the young Institution, and ensure its survival.(25) A letter of the 3rd February 1820 to Telford described the objects of the Institution as reasons for Telford's patronage: "To facilitate the acquirement of knowledge in engineering; to establish in it the respectability which it merits, and to increase the indispensable public confidence, are the objects of the Institution, the members of which now have the honour of addressing you."(26) Further on it is stated that there is an emphasis on rules "to perserve selectness in its members"(emphasis in original). Telford, invited to be President because he was at the "summit of his profession", accepted these objects, and underscored the problems of respectability and securing recognition of its importance. The policy of exclusiveness pursued by Telford, and propounded in his Inaugural Address of 1821 launched the Institution on its development into a professional organization rather than a study association: "In foreign countries similar establishments are instituted by government, and their numbers and proceedings are under its control; but here, a different course has been adopted, it becomes incumbent on each individual member to feel that the very existence and prosperity of the institution depend in no small degree on his personal conduct and exertions; and that merely mentioning the circumstances will, I am convinced, be sufficient to command the best efforts of the present and future members, always keeping in mind that talents and respectability are preferable to numbers, and that from too easy and promiscuous admission, unavoidable, and not infrequently incurable, inconveniences perplex most societies."[28] Telford went on to stress that the Institution existed for the advancement of "engineering" and not engineers, and would not become either a debating society or a trade union.[29] In this he had hit on a formula for association, the germ of which was contained in the Smeatonians, that was to become in later years the peculiarity and dominant characteristic of the British profession.

From its foundation, members had been restricted to those qualified. By 1836 the regulations provided for four classes: Members, Corresponding Members, Associates, and Honorary Members. Members were practicing Civil engineers. Associates "shall be those, whose pursuits constitute branches of Engineering, but who are not Engineers by Profession".[30] Corresponding Members were full members but "who reside without the limits of the three-penny post."[31] Honorary Members were not Civil engineers, but eminent persons in related occupations and limited to forty in number. Election to all three classes was through a ballot at the Ordinary Meeting of the Institution at which three-quarters of the ballot was needed for election. The application had to be "subscribed by at least three Members of the Institution who shall certify their personal knowledge of such candidate",[32] who also had to be over 21 years of age. Provisions were made for expulsion.

Under Telford's guidance over matters of membership(33) (he also left a collection of books, providing the basis of the Library, and a legacy of £2,000 to the Institution)(34) the "Civils", as they became known, quickly moved to a position of strength --- it is widely held in the Civil engineering community among historians, biographers and officials that if Telford had not accepted the presidency in 1820 this particular effort would have foundered and indeed he was largely responsible for ensuring that it took on the form of a professional organization. In 1822 there were about 50 members. In 1823 The Morning Chronicle reported the First Anniversary Dinner of the Institution: "The guests chiefly consisted of Engineers and men of science of the first respectability. Among the Company we observed Sir Henry Parnell, Bart., M.P., Sir George Alderson, Sir Edward Banks, the celebrated Edward Troughton, F.R.S., M. Brunel, F.R.S., Henry Maudslay, Bryan Donkin, Esq., etc., etc.,; indeed a company containing so much scientific talent and mechanical skill has seldom been witnessed."(35) One toast was "To the Memory of the following Eminent Engineers, whose loss we have had to deplore, who have formed a valuable school, which survives them, and left work which form the subject of our admiration and instruction, viz.: Smeaton, Milne, Jessop, Bramah, Watt and Rennie."(36) These were Smeatonians. In 1824 there was a further report that "The Civil Engineer Institute is going very prosperously".(37) Telford was admitted a Fellow of the Royal Society in 1827, and in the following year the Institution of Civil Engineers was granted its Royal Charter, the first modern usage of its kind, "which signified the national recognition of civil engineering as a profession of honour and repute."(38) From this date onwards membership has increased steadily, and "Within a few years of Telford's death it had become essential for every engineer of any ambition to be a member of the Institution."(39) Telford's role in the development of the Institution of Civil Engineers has led to the epithet, "Father of Civil Engineering", an interpretation that downplays the professional nature of the Society of Civil Engineers, the growing exclusiveness of which, during a period of rapidly increasing employment opportunities, contributed to the initial expansion of the new Institution. A report of 1836 by the ICE describes the Smeatonians as still meeting monthly during the session of Parliament at the Freemasons' Tavern: "and includes, as it has done from its foundation, some of the most eminent men in the profession, with associates from the ranks of general science. But though this society had so far answered to good an end, its constitution was of too exclusive a nature to meet the wants of so large and mixed a body as soon became engaged in engineering, and a feeling began to be generally entertained that in addition to it, an institution on a larger scale, having for its object the furtherance of professional knowledge, might be made eminently useful, and was indeed due to the profession for those engaged in it. This opinion was held by the late Thomas Telford ((himself a Smeatonian)) among others and an opportunity ere long occurred of giving it practical effect."(40) In the early years, some leading civil engineers, particularly the Rennies and other influential members of the Society of Civil Engineers, who disapproved of Telford having accepted the position of President, boycotted the Civils. But as the Institution grew in membership and stature, such opposition diminished, and John Rennie, the younger, eventually became President himself.

By 1836 the membership totalled 238, this expanded to 525 by 1841, and 797 by 1856. In 1841, 853 persons returned themselves as civil engineers in the census of that year, which suggests that the Institution, while perhaps not fully meeting its claim that all engineers fell within its province, was highly inclusive. "Civil engineers" were not precisely defined in the census and the category included many persons ineligible for membership of the Insitution.(41) Compared to other professional bodies, the rate of recruitment was exceptionally high. The Royal Institute of British Architects only included 153 of the 1,675 architects in the 1841 census ---or 9% of the total --- the rate for the RIBA remained under 20% throughout the century.(42) By the forties the ICE was established and recognized as the professional organization of engineers.

Origins of Fragmentation

In 1847 the Institution of Mechanical Engineers formed. This initial fragmentation of the profession, of some consequence for the future development of occupational organization, set a precedent for a pattern of collective action that has repeated itself for over a century. This event was not fortuitous.

The formation of the IME took place in circumstances that have since become the object of myth-making in the engineering community. The most prominent and widely believed attributes the formation of the Mechanicals to the refusal of the Council of the Institution of Civil Engineers to admit George Stephenson (certainly one of the most famous engineers that have lived) to the membership. The myth owes much to a passage in Smiles' official biography, omitted in later editions, (but also to be found in Lives of the Engineers). It consists of Stephenson's reply to a question put at the beginning of 1847 concerning the "ornamental intials" attaching to his name, and is contained in a letter to Mr. J.W.Bell a month after the inaugural of the Institution: " I have to state that I have no flourishes to my name, either before or after; and I think it will be as well if you merely say "George Stephenson". It is true that I am a Belgian Knight, but I do not wish to have any use made of it. I have had the offer of a knighthood of my own country made to me several times, but would not have it. I have been invited to become a Fellow of the Royal Society, and also of the Civil Engineers' Society, but objected to the empty additions to my name. I am a member of the Geological Society; and I have consented to become president of, I believe, a highly respectable Mechanic's Institution of Birmingham."(43) Further on Smiles has this to say on the event: "As the founder of the school of modern engineers, it might have been expected that Mr. Stephenson would have been invited to join the Civil Engineers' Institute; and, indeed, he himself desired to do so. But there were two obstacles to his being admitted to membership. The first was, that Mr. Stephenson had served no regular apprenticeship to the profession; and the second was the composition of a probationary essay in proof of his capacity as an engineer. Mr. Stephenson could not comply with the first condition, and would not comply with the second. The council of the institute were willing to waive the former, but not the latter point, but Mr. Stephenson said, if he went in at all, he would go in upright, not stooping one inch; and he did think it was too much to ask him, that he should undergo the probationary test required from comparatively unknown juniors, and write an essay in proof of his knowledge of engineering, for the approval or criticism of a society, many of whose members had been his own pupils or assistants. He therefore turned his back, though reluctantly, on the Institute of Civil Engineers, and accepted the office of President of the Institution of Mechanical Engineers at Birmingham, which he held until his death."[44] Parsons, in the official history of the IME, repeats Smiles' account, adding that a group of engineers, forced by the rain to take shelter in a hut by a railway, in the course of discussing this insult, decided to establish the Institution.[45] Solid documentary evidence to substantiate Smiles' original account does not exist; the ICE has on a number of occasions stressed the absence of such materials in their archives, but such facts are less important than the symbolic functions of the myths surrounding the event.

Stephenson, a Methodist, rose from "humble origins"[46] to a position of eminence and financial success through a unique combination of mechanical ingenuity, business acumen and managerial ability.[47] He was involved in a number of priority disputes with eminent engineers of the day: most notably with Sir Humphrey Davy over the safety lamp,[48] with Brunel over gauges,[49] and with William James over the title "Father of the Railways",[50] in which his friends and biographers like Smiles claimed that his social status blocked recognition of his achievements. The last dispute is of particular significance, symbolizing the conflict between the ICE and IME. Whereas James' claim to the title of "Father of the Railways" rest on his original projections for railway development (including the Liverpool and Manchester Railway, the first public railway to handle both goods and passenger traffic on the main line by steam locomotives)[51] at a "theoretical" level, Stephenson's rests on his having executed and made "practical" innovations on these same projects; he and Robert Stephenson were patronized by James and worked under him.[52] If Stephenson had been admitted to the ICE he would also have had to forgo direct claim to the title of "Father of the Railways". In the same year as the ICE formed a testimonial to William James was drawn up, signed first by "Old George's" son Robert Stephenson, an ICE Council member, who "despised the very class" from which he sprang,(53) certifying that James, the Civil engineer, had a prior claim to the title.(54) It was also signed by ICE President Rennie, and Council members Vignolles and Brunel.

Furthermore, Stephenson argued and disagreed with all the Presidents of the ICE who held office during his lifetime. Telford was never reconciled to the development of the railways and the use of locomotive power. He had been offered the appointment of engineer to the Liverpool and Manchester before Stephenson, but refused it partly out of loyalty to the canal companies. He later opposed its development. H.R.Palmer spoke on behalf of the canal interests and against Stephenson before the Committee of the House of Commons examining the Liverpool and Manchester Bill. Stephenson at this time could not find a single leading engineer to support him in his evidence before the House --- he alone among engineers had prophetic visions of railway development. On the second try at getting the Bill through, the line employed Messrs. George and John Rennie, and Charles Vignolles, which attracted the capital of the canal owners. After the Bill was passed Stephenson was reappointed but he could not work with Vignolles who resigned. Walker was never really favourable to moving engines and John Rennie (knighted in 1831 on the completion of London Bridge, based on his father's design), appointed President in 1845, and who shared a London consulting practice with his brother George, was an old adversary of Stephenson, refusing to recognize him as a colleague or work with him.(55)

The source of the conflict between the "colliery engine-wright" and the Civils lay partly in his priority disputes with members of the Institution, especially with James. These in turn symbolized the claims to professional status made by assistant engineers, especially those achieving a certain esteem on the northern railway undertakings. "Old George" championed the cause of the "manufacturing", "mechanical", and subordinate assistant engineers, against the Civil engineer; and they in turn supported his priority claims.(56) Stephenson's role was in many ways comparable with Smeaton's and Telford's. Just as Smeaton had led the first wave of professional engineers; Telford the second after the Smeatonians' growing exclusiveness; now Stephenson led a rising tide of would-be professional assistants and underlings on the growing railway, manufacturing, and iron and steel industries. The Institution of Mechanical Engineers emerged just after the "great mania of 1845", which had been brought to an end on 16th October, when the Bank of England raised the rate of interest. This was the third, the most intense of the railway booms; the first after Stockton and Darlington in 1825, and the great "Railway Mania" of 1836 --- each more pronounced. The Manchester and Liverpool was a result of the first of 1825, after which nearly 1,000 miles of railway were constructed by 1840.(57)

The Civils had little intention of admitting these newcomers to their now rapidly becoming exclusive circle. There had already been a tightening-up of the bye-laws in 1838 for the full Membership and a new class of "graduates" introduced for "pupils or assistants to Engineers", who with the backing of ten Members might in time themselves reach that exhalted station.(58) But in 1846 the Graduate class was disbanded after it became swamped with practicing engineers, who could not get into the higher grades at any time. Earlier in 1841 between the two railway booms, President James Walker of the Civils expressed his concern that the profession might become overcrowded: " Is then the demand for professional gentlemen likely to <u>increase</u>? Is it not likely rather to <u>decrease</u>?"(59) Under such apprehension, unfounded in the event, there seemed little point in letting in the "motley crew", who after 1835 imitated the style of Stephenson and proclaimed themselves railway engineers, sometimes even coming in as consultants.(60) The booms provided opportunities, unprecedented since the great era of canal building threw up the Brindleys, for social mobility, further encouraged by the system of subcontracting, under which "the careful 'navigator' became first an underguager and then a guager; the guager changed into a contractor; and at this time there are many men who, twenty years since, delved and dug and gained their bread by the sweat of their brow, are men in possession of most valuable estates".(61) The top-flight Civil engineers of the day did not see the industrial development of the economy as an unending line of progress and economic growth calling for ever increasing numbers of engineers, and they saw no reason to establish as Civil engineers the "motley crew" of upstarts who had gained the first rung during the booms.

The initial ideology of the IME emphasized the affinity with these "mechanics" and its "practical" nature,(62) and there was some effort to see that recruitment gave preference to mechanics, especially, those achieving the position of "Managing Heads of Establishments", either producing or using engines and machinery.(63) This flourish in favour of mechanics caused some bewilderment among those on the fringe of the engineering community. The Mechanics' Magazine (started in 1823 in the early years of the Mechanics Institutes movement) welcomed the Mechanicals' objective of making scientific knowledge available to working mechanics but its editors could not see why it was called the Institution of Mechanical Engineers. All engineers, i.e., Civil engineers, were "mechanical" to some degree, this title did not distinguish the new Institution, of what would be better termed it suggested, "working engineers", or "manufacturing engineers", from the Civils! "if our Birmingham friends but assumed the style of the Institution of Manufacturing Engineers, they would have cleared away all doubt about their status, and objects, and multiplied their chance of success tenfold."(64) Stephenson (the first President) actively supported the Mechanics' Institutes movement, founding an Institute at Chesterfield for the benefit of his own employees, and dubbed the IME that "highly respectable Mechanic's Institution of Birmingham",(65) causing some of the original confusion. He appears to have regarded the IME as a kind of "higher" Mechanic's Institute.(66) But such views were not unanimously shared by the largely middle class original officers and founder members, few of whom were "mechanics".(67) Six founder-officers were in fact Civils. These men wished to establish Mechanical engineering as a separate speciality branch with a status and Institution comparable to the Civils, for professional Mechanical engineers, doing so at a time when the mechancial engineer was not known as a distinct kind of professional engineer, though some Civils were specializing in the "mechanical" work. Decades passed before this ideal was realized. The IME progressed slowly; in 1850 attempts at introducing a class of graduates aborted because the prestige of the Institution was not sufficient to attract would-be Mechanicals to anything bar the senior grade.(68) Not until 1877 did the Institution develop the stature to move its offices to London,(69) but it managed to survive.

The Extent and Nature of Fragmentation

The process of fragmentation, started by the formation of the IME, continued through the development of the profession up until the mid-1960s. Whereas the IME originated as a professional organization, other Institutions started as trade associations, study associations, in particular industries and in government, only later developing into professional organizations, functioning to define and qualify for practice.

The Institution of Electrical Engineers, along with the Mechanicals and Civils, is one of the "Big Three" engineering Institutions.(70) According to his son Lord Cranford, it arose in the laboratory of Lord Lindsay, a centre for those interested in electrical engineering;(71) another account by Major-General Webber has it that the idea was taken up after the attendance of one of the founder members at a meeting of the Association of Gas Engineers and Managers.(72) The Institution was eventually established as the Society of Telegraph Engineers in 1871 "having for its object the general advancement of Electrical and Telegraphic Science, and more particularly for facilitating the exchange of information and ideas among its members."(73) An earlier study association in the field was the Electrical Society of London (1837), established for the "experimental investigation of electrical science in all its various branches, and its advancement, not only pursuing original paths but by testing the experiments of other engineers",(74) but it went under in 1843 due to debts incurred over the cost of the journal. The Society of Telegraph Engineers was not simply a pure scientific study association, though certainly international in outlook compared to the Mechanicals, but included a "trade" element reflected in the large number of Associate Members, as well as those seeking a professional speciality status. In 1880 it became the Society of Telegraph Engineers and Electricians, adopting the style Institution of Electrical Engineers in 1888,[75] a change that represented the growing strength of the professional members.

An Institution with even purer study origins, the Royal Aeronautical Society, the oldest aeronautical organization in the world, stems from a meeting held at Argyll Lodge, Campden Hill in 1866 with His Grace The Duke of Argyll presiding, where it was resolved to form a society to increase experimental knowledge of aeronautics, aiming from the start at heavier-than-air flight. With a small and fluctuating membership, down from 100 to 40 odd in 1897, it carried out technical-study proceedings till after the War in 1922, when the plans formulate in 1912 by the professional segment within its membership, for entrance to the Associate Fellowship grade of the RAS by examination, were actualized.[76] This move was partly stimulated by the formation of the Institution of Aeronautical Engineers in 1919, representing professional engineers, and paralleled by a decline in the membership of the RAS between 1919 and 1923 from 1,000 to 800. But both the break-away group and the RAS continued to have membership problems and the financial pinch prompted an accommodating amalgamation in 1927 when the new RAS was established on a more professional footing, membership again passing the 1919 mark. Up until WW1 the RAS had few characteristics of the more professional Institutions, and its professionalization occurred in the interwar years, not until after it had been in existence for over 60 years.[77]

At another extreme, the near-union end, was the Institution of Marine Engineers. The Marine Engineers' Union was established to improve the status of marine engineers in relation to brother deck-officers. Some of the original founder-members, mainly chief engineers of steamers in the Port of London, broke away to found the Institution. They felt a need for a specialist study association for marine-going engineers, and also some way of consolidating their corporate status. The objects of the original circular listed, firstly, "the social elevation of the members generally",[78] secondly, the improvement of the knowledge-base, thirdly, encouragement of practical applications, fourthly, again the maintenance and raising of status, and fifthly the provision of facilities for the above. Again other associations developed not out of study groups or near-unions, but out of management and commercial trade associations, Prominent for its extremity in representing this element, to be found to a greater or lesser extent, in all the bodies, was the Institution of Gas Engineers, the early years of which are described in chapter 5.

Table 1 presents the main major and minor Institutions by date of initial formation (irrespective of original title and character). All bodies are professional or would-be professional organizations offering qualifications in a particular branch of engineering. Not all are of equal professional status.

Table 1

MAJOR AND MINOR ENGINEERING INSTITUTIONS BY DATE OF FORMATION

Date	Title
1818	Institution of Civil Engineers
1847	Institution of Mechanical Engineers
1860	Institution of Naval Architects
1863	Institution of Gas Engineers
1866	Royal Aeronautical Society
1871	Institution of Electrical Engineers
1873	Institution of Municipal Engineers
1889	Institution of Mining Engineers
1889	Institution of Marine Engineers
1892	Institution of Mining and Metallurgy
1895	Institution of Sanitary Engineers
1895	Institution of Engineers-in-Charge
1895	Institution of Public Health Engineers
1896	Institution of Water Engineers
1897	Institution of Heating and Ventilating Engineers
1906	Institution of Automobile Engineers
1908	Institution of Structural Engineers
1918	Institution of Locomotive Engineers
1912	Institution of Railway Signal Engineers
1911	Institution of Fire Engineers
1919	Institution of Engineering Inspection
1920	Institution of Aeronautical Engineers
1921	Institution of Production Engineers
1922	Institution of Chemical Engineers
1925	Institution of Electronic and Radio Engineers
1930	Institution of Highway Engineers
1930	Institution of Agricultural Engineers
1945	Institute of Road Transport Engineers
1945	Institute of Engineering Designers
1946	Institution of Plant Engineers

Defined as "learned societies" similar to the Institution of Civil Engineers and based around technical proceedings, the stated objects of each are mostly concerned with the development of the speciality, its status and knowledge-base, wit a tendency to stress the technical proceeding functions. But such objects are not the best guide to understanding the Institutions, there is much window-dressing: indeed stated objects are sometimes reformulations after officials have taken Counsel's Opinion in order to bring them into line with Section 37 of the Income Tax Act of 1918, which grants exemption from income tax for certain public service bodies. E.G: at the IPE1933, Counsel deleted all paragraphs bearing directly on the "interests" of engineers, so that the document showed objects to be restricted to the promotion of the science and practice of production engineering, advancing status should be strictly subordinate to such primary concerns.(79) Along with the bodies listed in Table 1 (which it should be emphasized is not an exhaustive list, outside estimates put the number of Institutions at 150), there are also regional and local associations cutting across the national specialities. The Institution of Civil Engineers in Ireland, the Belfast Association of Engineers(1892) in Northern Ireland, the Institution of Engineers and Shipbuilders in Scotland (1857 the South Wales Institute of Engineers (1857), represent engineers in Ireland, Scotland and Wales. Prominent among the regional associations are the North-East Coast Institution of Engineers and Shipbuilders, and the West of Scotland Iron and Steel Institute (1892). Local societies in chief manufactuing cities, for example, the Manchester Association of Engineers (1856) and the Liverpool Engineering Society (1875) are also noteworthy, though they are not professional orgnaizations as are the national Institutions. There are a number of peculiarities. The Institution of Mining Engineers, which deals with coal while the Institution of Mining and Metallurgy caters for all other types of mining, is a federation of a number of local associations, each of which retains its own name, publishing its papers in the <u>Transactions</u> of the parent-body. It has no members apart from those of its constituents. Included among these is the North of England

Institute of Mining and Mechanical Engineers (1852) and the South Wales Institute of Engineers, also a regional association but originally projected as the South Wales Institute of Mining Engineers, becoming federated with the Institute of Mining Engineers in 1952. Its membership was never over 600 in this century. The Royal Artillery Institution was formed in 1838 for the communication of technical knowledge. Membership is confined to artillery officers in the service or retired. The Royal Engineers Institute (1875) is a similar body, recruiting among the Corps of Royal Engineers.

Although the origins of engineering Institutions, as with other social institutions do not necessarily provide any special insight into their subsequent character, the diversity in the reasons for fragmentation and the foundation of new Institutions does point to one of their central features: they are multi-functional, carrying out a range of activities, that, as is illustrated below, have in other engineering professions been carried out by separate organizations. The wide range of functions relate to two main sets of activities, the essential dual functions of the Institutions, concerning the achievement and legitimation of professional status for their discipline and membership, and the furtherance of the technical, speciality knowledge-base. This duality lends to the Institutions their peculiarly British standing as "learned societies", the designation used by the officials and members of the Institutions to describe their character and purpose. Unlike the pure study association, for example, the British Association, the Society for the Chemical Industry, the Chemical Society, the Geological Society, the engineering Institutions carry out both study functions and professional qualifying activities at the same time. The internal organization of the Institutions is designed to cater for this duality; some grades of membership are for the non-professional engineers, interested in the technical proceedings, while other grades of membership, the corporate grades, are confined to those with the appropriate qualifications, whether this be through an examination, university degree, pupilage, apprenticeship, or the incumbency of a position of responsibility within the speciality. It is not just that the grades require a certain level of qualification, they have come to be qualifications in their own right, a functional alternative to the registration authorities of established professions such as medicine and architecture. The professional nature of the organizations, the professional status-raising side of their activities, can be seen in a description of the structure of this organization in terms of the actions taken by the Institutions on professional questions in their historical development. Such actions are a better indicator of the nature of the organizations than the official descriptions of their aims and actions; the ideology of the learned society. Vested interests in the established organizations, resistant to change, depict the multi-functionality under the term "learned society", which covers the unique blend of functions and roles of the Institutions, and is used variously to give the Institution activities an air of dignity, rather than to recant the actual nature of the operation. As part of this ideology, Institution officials and historians, and some sociological observers,(80) have stressed that the source of fragmentation in the engineering profession lies in the nature of the knowledge-base, the need for technical specialization, which produces divergent interests, dampening community and cohesion. The reason for this official stance is simple; it serves to legitimate the claim to professional status being advanced by the collectivity, while at the same time describing an important set of Institution activities. But there is no such connection between the nature of engineering science and a particular type of social formation; the organization of engineers differs widely in different societies, while the extent and nature of the knowledge-base are less variable. The duality in functions carried out by the British Institutions permits the redefinition of actions in one sphere into the terms of the other, and naturally Institution officials and members have sought to maximize the benefits for their speciality from this source by describing "interest" pursuing objects in terms of a mystique stressing overtly public service objects. This division between ideology and action arises because specialist fission stemming from the nature of the knowledge-base need not have any relation to fragmentation in the system of professional organization (inclusive of all those social institutions that together determine the distinction between the qualified and the unqualified for professional status and practice, e.g., a combination of educational establishments, professional associations acting as pressure groups, registration machinery, and other statutory provisions). Unity in professional organization, the establishment of a minimum level of qualification with a corresponding monopoly of professional practice for the qualified, can coexist with numerous study associations in the same profession as it does in France, Germany, the United States, Australia, and other cases described below, following a review of the fragmented structure of professional organization in Britain where this has become manifest in the historical actions of the profession.

The Structure of the Organization of the British Engineering Profession

The Institutions vary widely in their status within the engineering community. Differences also exist between the Institutions in age and social class composition, geographical location, employment and deployment pattern, income, educational levels and entry routes, and size of membership, differences that are in some cases as marked within engineering as between other occupations and professions. But despite this there are a number of superimposed status divisions, cutting across the Institutions, and manifest in conflict and cooperation in the collective pursuit of status. These divisions are far more meaningful to engineers than they are to the public; a major part of the status problem of the profession is that action to further the status of engineers has been taken in relation to the internal hierarchy, whereas the public and employers, less knowledgeable or mindful of the many, even minute differences, have confused the status of the most lowly with the most high. These status divisions are dilineated and become most apparent in movements for professionalization. The divisions resulting from the fragmentation process are as follows: a) between the Institution of Civil Engineers and all other Institutions, b) between the Big Three and all other Institutions, i.e., the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, c) between the Big Four and the rest, the Big Three plus the Institution of Naval Architects, d) between the Big Four and a small and changing number of other chartered Institutions and the rest, e) and some minor cleavages appearing under special circumstances. The most important divisions are between the Institution of Civil Engineers and all others, the Big Three and the others, and the chartered and others. Each has been superimposed on the preceding during the history of the fragmentation process. Moreover at the bottom end of the hierarchy, there is no clear break between the most junior of the Institutions and skilled manual workers, semi-technicians, and tradesmen, who along with members of the AUEW have tried to usurp the status of the engineer, claiming for themselves the responsibility for industrial advance.(81)

The primary division between the Civils and the other Institutions was, of course, deepest during the 19th century, reaching a watershed in 1921, and continuing after that with lessening intensity up to 1961. After the formation of the Mechanicals in 1847, Civils continued to claim to be the only group of truly professional engineers, while acting to resist attempts to halt fragmentation, and extending only limited recognition to the legitimacy of the claims of new groups to professional status for their work. Up to a point fragmentation served the interest of the Civils by preventing the dilution of their own membership, and so it was encouraged. As the Mechanicals, few of whom were also Civils, had proved to be little, if any, challenge to their status, intitially adding to it, the Civils went on to sponsor the Naval Architects and Electricals through the provisions of excellent facilities for meetings,(82) a factor dampening the enthusiasm of these new societies for the occupancy of a common cooperative building in 1877. (83) Such patronage worked to maintain and further the status of the elite in relation to the new groups forming in the engineering community. Yet continually mindful of the maintenance of their position, when in 1867 the Society of Engineers petitioned for a royal charter of incorporation, the Civils immediately countered with their own petition, arguing that no royal charter should be granted to any body purporting to be a "society of engineers", regardless of the actual wording of this designation, as it would lead to confusion and undermine the prestige conferred by their designatory letters, "MICE". The Board of Trade, in its statement to the Commons, accepted this argument and refused the grant of charter to the Society of Engineers.(84) This action, at a time when there were some twelve new engineering societies, was symptomatic of the ambiguity in the attitude of the Civils to the other bodies; while on the one hand they were sponsored and partially recognized, on the other they were denied professional status, or access to the instruments through which this would be realized. The Civil engineer was <u>the</u> professional engineer.. As late as 1886 the Council of the Civils asserted most emphatically that the term "Civil engineer" meant only a civilian as distinguished from a military engineer--it in no way denotes a speciality grouping. "The term 'Civil Engineer' means, therefore, an engineer who is a civilian, as distinguished from a military engineer. This Corporation is intended to include all classes of engineers who do not belong to the military service."(85) In fact though the growth of new Institutions meant the growth of new specialities, first among which was the Mechanicals, as the Civils remained concentrated in their traditional works. An 1889 official addition to the 1885-6 statement equivocates about the position of these "mechanical engineers". While "nothing can be more incorrect or in worst taste" than for the Civil building engineers to adopt an attitude of superiority towards their "mechanical brethren", to their work and to mechanical science, this holds only so long as such mechanical engineers are a specialist type of Civil engineer, in turn being all non-military engineers, or members of the ICE, rather than of the IME.(86) Pole, the author, went on to explain: "In the first place, it is earnestly desired that all bona fide professional civil engineers, whatever their rank or standing, should belong to the Institution. The Institution gladly recognizes other Societies representing separate branches of the Profession, such as -- The Institution of Mechanical Engineers, The Iron and Steel Institute ((a study and trade association)), The Institute of Naval Architects, The Society of

Telegraph Engineers and Electricians, The Gas Institute, The Society of Municipal Engineers and local Societies under various names "(87); and continues "But it must be again pointed out that all these branches are comprehended in the general designation of 'Civil Engineering', and that the parent Institution, which represents the general professions, is open freely to Engineers in all branches."(88) This statement has provided the formula for the Civils' policy in subsequent decades, and in some segments to the present day. Specialist engineers in areas outside the speciality of civil engineering are professional if members of the ICE, meeting its standards, which in such cases are very high, while specialists outside its pale, the vast majority of the members of other societies, are not professional engineers. The claim to catholicity (in actual fact, as is shown in more detail in chapter 5, the bread-and-butter of the Institution has always, since the growth of specialities, come from its specialist-serving functions as its members specialized into "civil engineering" in the narrow usage) provided the ideological backdrop to its opposition to the growth of new professional specialitie

The Civils were only willing to act jointly with minor Institutions over measures that threatened their own dominant position. A brief cooperative venture took place when the Institution of Civil Engineers, the Royal Institute of British Architects, the Royal Institution of Chartered Surveyors, and the Institutions of Electrical and Mechanical Engineers acted together to ensure that the Architects' Registration Bills (also titled, Architects' and Civil Engineers' Registration Bill, the Architects' and Engineers' Bill) of 1886 and 1888 were not passed into law. Engineers came within some of the provisions of the various Bills, not because of any indigenous demand, but because the members of the Society of Architec who practiced on the fringe of the architectural profession, where its boundaries blur with surveying and engineering, mistakenly hoped to gain support for an Act based on the Medical Acts from these other occupations to counter the opposition that they knew would be forthcoming from the R.I.B.A., which had just tightened up its entry requirements (stimulating the formation of the Society of Architects in 1884). The unqualified practicing architects who urged the Bill onwards, failed to gain the support of any organization within the engineering community, and the measure was shot down in Parliament.[89] In an official statement, the Institution of Civil Engineers maintained that the public would not suffer by the lack of registration because, while it did not have examinations like the R.I.B.A., and the Surveyor's Institution, "the qualfications of their Members were submitted to rigorous inquiry and consideration before election, and might, therefore, be relied on."[90] It went on, "as it stands, therefore, the Institution guarantees the competency for practice, of all those who belong to its corporate body."[91] (This clear acknowledgement of the quasi-registration functions of the Institution stands in sharp contrast with later arguments against registration and related measures on the grounds that as purely learned societies the Institutions could not participate in actions directly serving the interests of engineers.) The ICE further pointed out that the public could know of its quasi-registration function through the designations, M.Inst.C.E., or A.M.Inst.C.E. The use of C.E. by itself, though still common, was to be discouraged as it might lead to confusion. A few students and outcast engineers supported the move to no avail, while establishment engineers (e.g., the Society of Engineers and The Engineer) supported registration in principle, but not this particular movement. In later years promoters of Bills designed to secure registration of architects excluded, wisely, engineers from the main provisions.

The ICE continued to show little disquiet at official levels over the fragmentation process in its actions up until the first decade of the present century. Official publications maintain the dignified aloofness of a learned society ostensibly unconcerned with the practicalities of professional status. But in the report of the Council for 1908-9, the Institution announced the decision, "to leave to the public the recognition of the professional status of members of the Institution, rather than seek to impose legal restrictions upon other persons, provided the latter do not assume wrongfully the title of its membership."[92] Although now worried about the rapid proliferation and growth of specialist bodies, the Civils were still formally differentiated from the lesser organizations by the possession of their royal charter, which symbolized a uniquely professional status. But between 1889 and 1908, at least 10 new Institutions, most of them substantial minor bodies, were formed. Moreover, in 1910 a petition presented by the Institution of Naval Architects for a royal charter was successful.[93] The Civils began for the first time to show major signs of concern over the extent of recognition and the validity of their claim to sole full professional status, by taking action other than simply aiding fragmentation and its learned society activities, which, in the absence of such action save that referred to above, meant that this course was expedient for "obtaining for the Profession a high and honourable standing in the eyes of the public."[94]

In 1912-13 the ICE applied to the College of Arms for a grant of Amorial Bearings, and a coat of arms.[95] However, 1915 saw the grant of royal charters to the Institution of Mining Engineers and the Institution of Mining and Metallurgy. These grants symbolized the growing stature of the Institutions at a time of rapid educational expansion and sharp increases in membership. The Civils continued their attempts to gain monopoly privileges;[96] a unilateral attempt at registration followed. The report of the Council for 1919-20 states that action had been taken on the question of registration; a survey of the membership revealed some 87% of Civils to be in favour of the establishment of a legal register, with the restriction of the title "Civil engineer" to the registered, and other legal restrictions on practice.[97] Preparations went ahead to gain Parliamentary authority through a private bill. The register was to include: a) all corporate members of the Institution, and the Institution of Engineers, Ireland; b) persons who within three years of the Act satisfied the Tribunal that for 5 years before that date they had been practicing as civil engineers; c) some persons who had been engaged for a minimum period as assistants to Civil engineers, and d) other persons accepted by the Council of the Institution of Civil Engineers as qualified to practice civil engineering, defined as <u>all</u> profesional engineering. The Tribunal would deal with applications under "b" and "c" and would be composed of one representative nominated by the Board of Trade, one by the Ministry of Health, six members of the Council of the Institution of Civil Engineers and one member of the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institution of Electrical Engineers, the Big Four. Under the proposals only the Civil Engineer could give a certificate, as from an engineer, and non-registered engineers would be disqualified from recovery of any charges in a Court of Law for professional services rendered as a civil engineer.

The matter proceeded no further because of the problem of accommodating the other Institutions, over the question of the composition of the Council, which in effect gave control to the Civils (for example, the President of the Electricals stated "unless some satisfactory definition is laid down of the terms 'Civil Engineer' and 'Civil Engineering', the Institution of Electrical Engineers would be compelled to oppose the Bill".(98) This movement aroused considerable opposition among some of the other established engineering Institutions.(99) Fears of rivalry within the profession, this and other rumoured registration moves, issuing from government as well as private sources (the 1920s saw registration attempts in many professions), were intensified by anxieties over trade unionism and the threat of Bolsheviks in the engineering industry. The professional engineer might lose in struggles with the unions that had grown in influence and organization within the industry during the War.(100) The Institution of Electrical Engineers responded with a petition for a royal charter in 1921, an earlier petition had been unsuccessful. It had been planned before the War,(102) but the Civils' move precipitated it.(103) Partly to appease the other Institutions for the affront caused by the registration attempt of 1920-21, the Civils sponsored a conference in 1922-23 at which the Big Four formed the Engineering Joint Council.(104) This body was purely advisory, little more than an agency for communication between the Four, having no executive powers, nor powers of initiative. Matters bearing on the status of the Big Four in relation to other Institutions were referred to it by the member Institutions, each of which was represented on the Council by two members.(105) Limited successes were scored in countering petitions from minor engineering Institutions outside the EJC membership before the Privy Council and Board of Trade, especially the former, on the grounds that goals specified in the objects of the new association were adequately pursued already and that their membership was not of professional standard. The Big Four, in the absence of registration, sought to act together to stop the process of fragmentation and also attempt to block the issue of further royal charters. Naturally, the formation of the EJC met with the hostility and ambivalence of the minor Institutions. The Council of the Institution of Marine Engineers failed to understand it: "in view of the acknowledged importance of marine engineering alongside the branches of the profession represented by those four Institutions." (106) They relentlessly badgered the EJC group for four years, fearful that some attempt at closure was in the offing. (107) In the end the Marines came in as a "Constituent Institution", as distinct from a "Founder Institution". A collective response to the EJC took place in 1922, when the Society of Engineers arranged a conference at the Engineers' Club to consider a proposal to form an Association of British Engineering Societies. (108) Twenty societies were invited to the meeting, which eventually appointed a Committee of 7 to draft objects and a constitution. But the primary subsequent activity of the Committee, which met at the Society of Engineers, was to attempt to gain representation on the Joint Council. The proposed Association of British Engineering Societies never got any further, "after some unpleasant happenings."(109) Symptomatic of the problem was the attitude of the Marines, who though invited to the conference refused to identify "itself in anyway" with the new association in case banding together with the outcasts jeopardized their chances of getting into the EJC. It was not possible to unify the profession without the sanction of the Big Four.

These stirrings among those on the fringe of the engineering community peaked in 1926-27 in the Engineers' Bill for registration, the obstruction of which was a major achievement of the EJC. The major and important minor Institutions united in opposition to the Bill behind the leadership of the Civils, who solicited the support of the other Institutions. The Structurals reported receiving a letter from the Civils "begging us to obtain as much Parliamentary opposition to the Bill as we possibly could."(111) In March 1927, nine of the Institutions agreed at a joint-conference that the Bill was neither in the interest of the profession nor the public, a copy of the resolution was sent to the Home Secretary. The Secretary of the Society of Technical Engineers, a recently formed non-speciality pressure group(112) promoting the Bill, stressed that the Bill had been withdrawn because he did not want to clash with the Institutions, which had so vigorously expressed their opposition.(113)

The Engineers' Bill provided for a General Council with 48 representative of most Institutions and other organizations with an interest in the profession, including nearly all the existing Institutions(114) as well as colleges and universities.(115) The title of "engineer" was to be monopolized along with certain practices.(116) All practicing engineers who could possibly lay claim to the status were catered for in the first instance; no limit in terms of a defined group of Institutions was imposed as the working of the clause in the Bill was open-ended, providing for Institutions not specifically mentioned. The Secretary of the Society of Technical Engineers estimated that 100,000 engineers practicing throughout the country, only a third of whom were members of the Big Three, were eligible.(117) The Bill was presented by Mr. Herbert Williams and supported by Sir Martin Conway, Rear Admiral Sueter, Mr. Clarry, Colonel Crookshank and Mr. Pielou. After its failure the Society of Technical Engineers intended to act as a lever on the Institutions, to get them to pursue a Bill of their own, but it collapsed and shortly went out of existence.

The reasons given for opposition by the Institutions varied. Prominent was the simple point that the provisions were not needed, a view with which Brig. (-Gen.), Magnus Mowat, Secretary of the IME, "fully agreed".(118) The Marines' Council unanimously condemned the proposals as "unnecessary".(119) At the back of this view lay the fact that the established Institutions themselves functioned as so many speciality registration authorities, much like the Royal Colleges in medicine. They feared that should the profession as a whole be registered their role, depending as it did on a pool of formally "unqualified" engineers, emphasizing the difference between their members and the common herd, would be undermined. The threat to the well-being and growth of the Institutions posed by registration on examinations alone had been mitigated by a concession to the Institutions introduced into the Bill by the Society of Technical Engineers, stipulating that all engineers wishing to be registered would first have to join an Institution. But the number of Institutions to be included was too great for the Big Three, who had far more applications for membership than were admitted so the concession would strengthen the minor bodies, involved an unacceptable "dilution" of the profession, with the result of what they expected to be an immediate decline in status. For these reasons there was little to no support for the Bill within the major Institutions, though some of the minor Institutions, e.g., the Institution of Production Engineers, flirted with the idea. In principle they favoured it, in practice they waited on the attitude of the Civils, not wishing to anger the most powerful voice in the profession.(120) Sir Alexander Gibb, President of the Chemicals, another young body, looked forward in 1929 to a General Medical Council style "General Engineering Council"(121) These young Institutions had the support of The Engineer, which in 1927, looked toward some scheme of "unification-with-autonomy" for the profession.(122) The question of closing the profession arose at the Annual General Meeting of the Mechanicals in 1926, during the opposition to the Bill, and received no support from the grassroots,(123) Again in 1927 the Institution of Municipal and County Engineers asked the EJC to consider registration and perhaps draft a Bill, but the EJC concluded that registration was not in the best interest of engineers, going so far as to send a memorandum stating its views to the constituent Institutions.(124) Behind all the opposition was the Institution of Civil Engineers: President Sir Clement Hindley summed the matter up, "No surer means would be found of jeopardizing the social and economic status which has been achieved by the Institutions...than to acquiesce in the handing over of their standard-making functions to a statutory body."(125)

Subsequently the Engineers Joint Council, which lacked the executive power to initiate new policy, was not in any way a particularly important or influential body,(126) its activities focusing on the debate of professional questions.(127) After its formation and the strictly limited activity and cooperation in the period after World War 1 (one ICE official in the context of contemporary relations considered that the Civils and Mechanicals were "hardly on speaking terms" during the interwar years), the structure of the profession remained much the same as it had done before the War, except that now the division between the Big Three and a select and changing group of other Institutions had been superimposed on the earlier cleavage between the Civils and the rest. Little change took place until 1961, except that now, whereas fragmentation at first benefited the Civils then other established Institutions, it was now beginning to have the reverse effect. The recognition of the Mechanicals, Electricals, Naval Architects, Aeronauticals (who joined the EJC as a constituent in 1934), signified the gain of a certain legitimacy for their claims to professional status, which blurred the 19th century divide between the professional ICE member and the rest, the essential basis of their high status at that time. The major Institutions therefore acted between 1930 and 1961, to block the rise of minor specialities, mainly through opposing grants of royal charter.

Such opposition gradually had the effect of transferring the royal charter into a major instrument for the state-sanction of professional status in the engineering profession. The Privy Council has gradually evolved a procedure and criteria to ensure that certain standards are met prior to the grant of the privilege and powers of the charter; a high standard of ethical conduct and of education became necessary for the grant of a charter to an engineering Institution. Usually the petition for a charter contains a list of the objects of the Institution and then a statement as follows: "That your Petitioners believe that the incorporation of the Institution by your Majesty's Royal Charter and the recognition thereby of its status as a body representative of the profession of gas engineering, will be the means of enabling the Institution more fully than hitherto to achieve the objects which it has in view and will tend towards the great development of gas science and the maintenance of a high standard of professional conduct among its members and that it will thus serve the bests interests of the community."(128) The petitions and charters of nearly all the Institutions are closely modelled on each other, and contain a similar clause conferring status as a means to community service. The charter is not simply an empty status symbol coveted only by officials of the Institutions: it is, in the absence of other modes of conferring legitimacy and state-sanction, truly a means to the achievement and maintenance of status, and its grant is considered to be a significant event in the history of an Institution, often awaited at a mass meeting of engineers. As the charter has come to signify excellence and the highest possible standing in the field, members of the chartered bodies have had a <u>prima facie</u> case for employment within the public service, over the claims of members of rival non-chartered Institutions. The chartered Institutions thus have a customary monopoly of practice in the state service. Table 2 shows the date of formation and the date of grant of royal charter for the chartered engineering Institutions. The IME did not achieve its charter till 1930:(129) a fact that signifies the changing function of the charter, which only became mandatory for the would-be truly professional Institution during the interwar years. The Civils' original charter had, in fact, nothing to do with state-sanction of its professional status; it was the only suitable means of incorporation before the Companies Acts. Though itself medieval, the current usage of the royal charter is very modern. Crucial for the changing role of the charter was the increasing rejection of petitions by the Privy Council. Interested parties are able to object to the grants of royal charter, and the Privy Council often consults existing public service organizations before making a new grant. Petitions have been opposed and rejected on a number of grounds. For example the 1925 petition of the Institution of Municipal and County Engineers', mainly challenged by the Civils, was objected to by the Electricals because a "charter should be granted only to those (Institutions) which grant diplomas based soley on technical qualifications and not on the holding of a particular type of appointment."(130) The successful resistance by the Big Three to the Structurals'

Table 2

ENGINEERING INSTITUTIONS: DATE OF FORMATION AND GRANT OF ROYAL CHARTER

Date	Royal Charter	Institution
1818	1828	Institution of Civil Engineers
1847	1930	Institution of Mechanical Engineers
1860	1910	Institution of Naval Architects*
1863	1929	Institution of Gas Engineers
1866	1949	Royal Aeronautical Society
1871	1921	Institution of Electrical Engineers
1873	1948	Institution of Municipal Engineers
1889	1915	Institution of Mining Engineers
1889	1933	Institution of Marine Engineers
1892	1915	Institution of Mining and Metallurgy
1908	1934	Institution of Structural Engineers
1921	1964	Institution of Production Engineers
1922	1957	Institution of Chemical Engineers
1925	1961	Institution of Electronic and Radio Engineers

Note: * the style "royal" was granted through the Supplemental Charter of 27th January 1960.

petition the following year was primarily on the argument that the Civils already provided qualifications and a professional service in the area. Later in 1932 the Privy Council, while being favourable to the idea of granting a charter to the Marines, again after opposition, wanted to see the bye-laws limit the Institutions' Membership to qualified marine engineers.(131) It is in the counter-petitions to charters that the derogation of engineer by fellow- or would-be fellow engineer receives its most formalized expression. Typically the ICE or other opposing Institutions will seek to show that the aspirant Institutions' objects are already catered for and that its membership, where not also in the Civils, are not of professional standing, but traders, manufacturers, mechanics, artisans, or whatever the case may be. Informally members of minor bodies , or those seeking a charter, are known by such epithets, e.g., in the case of the Institution of Heating and Ventilating Engineers as mostly "plumbers" by the Mechanicals and other more established specialities, not just "mere technologist". Practically all the minor bodies have had to battle for their charters, some with a longer struggle than others. Over the period the criteria have become more rigorous, along with the kind of evidence demanded as proof of claims and counter claims made about the composition of the membership. The Big Three opposed Chemical engineering after WW 1 on the point that it was neither chemistry nor engineering and therefore not of professional status, as other bodies carried out the separate tasks at a professional level and any genuinely professional chemical engineer would have a standard of qualifications permitting him to the membership of those bodies. The largest struggle of all, some twenty years or so in preparation, was had by the Institution of Electronic and Radio Engineers whose Secretary, G.D.Clifford, was determined that the Institution should gain a charter, writing the Institution's history in support of the petition. The counterpetition of the Big Three, put forward in 1960, outlines as part of the argument the changing functions and meaning of the charter, it had now, they urged, "by the discrimination which the Crown, acting on the advice of the Privy Council, had displayed in the granting of Charters of Incorporation within the field of engineering,"(132) become a distinguishing feature of the truly professional body of engineers. They submitted that the prime consideration in deciding whether to grant a new charter would concern whether: "the branch of the science of engineering in question is inadequately advanced under the aegis of an existing Charter."(133) They went on to claim that the objects of the IERE lay "wholly within the scope" of the IEE, and were carried on by a specialist division (with a larger corporate membership than the IERE) having considerable autonomy, the Electronics and Communications Section, once styled the Radio Section. But a technicians' Institution in this field would, according to the IEE, meet national manpower needs, "and the Petitioners' Institution presents a great obstacle to what is so clearly required."(134) The IERE was in fact more suited to being a technicians' organization. The Electronic and Radio Engineers successfully countered that a specialist body and a specialist Chartered Radio and Electronic Engineer would aid in the development of the science-base and be in the public benefit, an argument based essentially on the need for a specialist body for the area, a body paying it sole attention.

Apart from the opposition to new charters, one further cooperative association in the interwar years was the Engineering Public Relations Committee formed in 1937 be the Big Four, and Gas, Municipal and County, Iron and Steel Institute, Marine, Water, Heating and Ventilating, Automobile, Structural, Consulting, and Chemical engineers, not all chartered bodies. The Committee, formed "for the purpose of presenting to the public in a suitable form information concerning the science and practice of engineering and its services to the public," (135) originated at a 1936 conference sponsored by the Civils in response to the Architects Registration Act, 1938 and the movement that led up to it. The Engineering Joint Council was all but moribund by 1937, and a new common voice might again be necessary. Its activities are only worth recording to illustrate their essential insignificance. In 1938 it issued a booklet, similar to the large numbers produced by the individual Institutions, publicizing engineering and its services to mankind. (136) A representative Committee was appointed to study registration, eventually producing the report "The Engineer and the General Public", which was completely ignored by the Big Three. But some state-santion was secured: at the suggestion of the EPRC the Chief Passport Officer recognized, for example, Chartered Gas Engineers as persons authorized to sign declarations of applicants for British passports. (137) "Activity" ceased with the outbreak of the War.

A number of suggestions for cooperation were aired during and after the War. A new body was felt to be needed to discuss subjects of mutual interest, not just reconstruction and postwar planning and rehabilitation, but also education and training and examinations. The Institution of Structural Engineers, the Engineering Industries Association and the Society of Engineers were particularly vocal. In 1943 the Society of Engineers proposed an Association of Engineering Institutions, a sort of "Council of Engineering Institutions", to consider such subjects as registration of engineers, the apprenticeship system, education of engineers and research. The need for such an association was graphically represented "If a doctor asks a tailor to make a utility suit, he gets four waistcoat pockets. If an engineer asks for a suit, he only gets two."(138) These proposals again fell through because the Big Three were not interested in cooperation for unity.(139) On the other hand the state was known not to have objections, even wishing to see it. A Committee appointed by the Minister of Works to study the United States' building industry recommended the registration of British engineers for the public good in its report of 1943. The Minister of Works requested that the recommondations be considered in 1944 by the Advisory Council of the Building and Civil Engineering Industries, which included representatives of the Institution of Civil Engineers, the Federation of Civil Engineering Contractors, and the Civil Engineering Construction Conciliation Board. It reported that any demand for registration "can only come by pressure of public opinion", implying that it was not needed. The Minister accepted these proposals and emphasized in a statement to the Engineers' Guild that any promotion of such proposals would have to come from the organizations directly involved,(144) viz., in this case the Institution of Civil Engineers. After the War and the 1950 Conference of British Commonwealth Engineering Societies, the Big Three made a statement on their registration policy, which said that the public and profession were best protected from "unqualified persons" by maintaining a high standard of admission into the Institutions rather than by registration. Their policy remained unchanged during the fifties, and was accompanied by efforts to block the grant of royal charters and some limited amalgamation proposals, through which the Big Three hoped to cannibalize minor Institutions in the style of the Mechanicals, who incorporated the Institution of Automobile Engineers as an Automobile Division in 1945,(141) an arrangement oiled by the wholesale transfer of the Automobile membership to the corresponding grade in the Mechanicals, despite their lower qualification, and by an expansion of the IME officialdom, who along with their opposites at the Automobiles had designed the amalgamation with little reference to the rank-and-file.

To conclude: this brief historical survey of the actions of the Institutions in the sphere of inter-Institutional relations where these bear on the structure of the professional organization, the frontiers of the profession, and the instruments, registration, the royal charter, incorporation, used to secure these boundaries, points to a gradual lessening of the distance between the once wholly dominant Civils and the rising tide of specialist bodies, only the main claimants among whom have been mentioned in this review. Gradually cooperative ventures have been undertaken to maintain the position of the established organizations at the expense of the newcomer, and the latecomer. Yet even by the post WW II period little had been done to restructure the profession, and it is fragmentation into the structure defined that is the chief characteristic of the system of professional organization in Britain.

The status of any profession depends first of all on the claim advanced by its practitioners, then on the public recognition of it, recognition that, if it does not have its origins there, is usually backed by state-sanction of the legitimacy of the claim. In engineering the claims of the Civils, at one time recognized, then of the Big Three, have been undermined by the rival claims of minor speciality groupings of would-be professional engineers who have tried to usurp the status of the established elite, throwing it into question. In the more or less total absence of agreement on the boundaries of professional community, the public cannot be expected to confer status on groups the legitimacy of the claims of which have been denied by those who should be most aware of their validity. The Civils, nearly to this day, have maintained the fiction of inclusiveness, while in actuality a specialist organization with only a token representation in the other specialities. Fragmentation also precluded effective status raising actions, measures taken by other professions, an aspect described in chapter 5.

<u>The Professional Organization of Engineering Occupations in Other Societies</u>

The organization of engineers in the other societies described differs from that in Britain on a point that they have in common with each other: the extent of unity and cohesion in organization and collective action. There are three broad types of professional organization among engineers: a) a system of professional schools, b) a registration or licensing system, or c) an autonomous qualifying body. Most professions are a mixture of each, a complex balance of interests, representation, power and control between practitioners, educators and the state. Of those professions discussed, the British, an example of the third, is the most autonomous from the engineering schools and the state; the French and German are largely school-based professions; the American profession contains elements of both as well as of the second type.

Engineers in the United States have organized on lines similar to the British, but there are important differences. On the surface the three hundred odd professional associations (142) appear to parallel the British Institutions, but unlike the latter, the American "Societies" are not the sole or chief element in the system of professional organization. These largely study associations, have cooperated (an alliance symbolized in the common New York headquarters, the United Engineering Center building housing 19 associations) in the formation of unity organizations, registration laws, accreditation programs, and other provisions designed to secure a distinction between the qualified and unqualified for practice that does not depend on membership in a specialist organization , in the Societies themselves. While the distinction in the American case is not a pure one, the duality of function characteristic of the British Institutions is not found in the same mix in the American Societies, which are less concerned with professional qualifying functions than they are with study and pressure group activities. The fact that they do not perform the quasi-registration functions of the British Institutions has contributed to their search for other means to regulate entry and practice.

The late-nineteenth century relations between the American engineering Societies did contain elements of the non-recognition and rivalry so characteristic of the Institutions, but the status divisions and speciality identification were not at a depth or strength sufficient, as in Britain, to dampen calls for unity, so that by 1916 the American Society of Civil Engineers, like in England the premier body, had joined the others in the Engineering Societies Building and in the cooperative ventures planned there. The first main step towards unity came from outside the established Societies with the formation of the Chicago-based American Association of Engineers in 1915 among younger civil engineers (not ASCE members), demanding registration, unity and a higher status.(143) Stimulated by the intitiative of the AAE, the four "Founder Societies" (Civil, Mining, Mechanical and Electrical) set up, following several years discussions in joint affairs' committees, the Engineering Council in 1917 as a department of the United Engineering Society "for united action upon questions of common concern to engineers." (144) A broad range of professional activities, important among which were demands for registration of engineers, were pursued, but the bye-laws of the Council did not permit of the kind and level of action being demanded by engineers after the War, and the Engineering Council became the agency for the birth of more active societies, at first the Federation of American Engineering Societies, founded in 1920 under the EC umbrella.(145) Unlike the British Engineering Joint Council (1923) it did not originate in inter-organizational squabbles over levels of professional status, nor later function to define the "truly" professional organizations, but actively pursued the interests of engineers as engineers, not specialists, in relation to non-engineering agencies (something the Engineering Joint Council never did). Practically its first action was to draw up a list of some 26 Societies and associations whose aid was then solicited, with only the proviso that it might not be desirable to admit "any society not closely related to engineering." (146) In fact the EC, short-lived as it was, did more on professional questions than the British joint councils have done in their entire existence, a fact reflecting the very different functions of the respective bodies within the overall system of professional organization.(147) The FAES was likewise short-lived (see chapter 5 for the reasons) and it eventually reformed as the American Engineering Council, more representative of the views of Council members of the major Societies; in 1934 it too was reorganized, but it survived until 1945, when its successor, the Engineers Joint Council was formed by the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgy, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers, eventually including the 26 Societies listed in Table 3 . As a federated "unity" organization, it acts as a common spokesman for the constituent Societies. Another organization, established also by the five Engineering Joint Council founder Societies but in conjunction with the State Engineering Boards (for registration), the Engineering Institute of Canada, and the National Society for the Promotion of Engineering Education, and styled the Engineers Council for Professional Development, focuses on questions internal to the profession, education, training and licensing (though there is some overlap with the EJC). The American Association of Engineers developed into the National Society of Professional Engineers, formed in 1934, as a national association to represent the interests of the state societies of professional registered engineers,(148) recruiting largely from the civils in the state service.

Along with these unity organizations taking care of the common non-technical interests of the Societies, the American profession is further distinguished by the existence of a system of licensing laws, state registration, providing a basic minimum standard of qualification for the "P.E." and restriction of certain employments to the qualified. These laws originated in pressure from the organized profession, especially at the local level, in sharp contrast with the British Institutions' uncompromising resistance to all such measures (for further details of the American laws see chapter 5 where the actions taken by the profession to control practice are described).

Table 3

ENGINEERS JOINT COUNCIL: CONSTITUENT SOCIETIES, DATE OF FOUNDATION AND MEMBERSHIP

Title	Date	Membership
American Society of Civil Engineers	1867	46,000
American Institute of Mining, Metallurgical and Petroleum Engineers	1871	34,700
American Society of Mechanical Engineers	1880	45,800
American Water Works Association	1881	13,300
American Institute of Electrical Engineers	1884	54,473
American Society of Engineering Education	1893	10,000
American Society of Heating, Refrigerating and Air-Conditioning Engineers	1894	18,000
American Society of Agricultural Engineers	1907	5,910
American Society of Chemical Engineers	1908	20,000
The Society of American Military Engineers	1919	26,900
American Institute of Plant Engineers	1948	10,000
Nationanl Associated Societies		
American Institute of Consulting Engineers	1910	300
Americant Institute of Plant Engineers	1954	1,800

Notes: membership figures and the societies listed are those for 1960/61, the primary date of comparison. Also included are a number of Regional Associate Societies and two Affiliated Societies (the American Society for Testing Materials and the Chinese Institute of Engineers).

The difference between the role of the American Societies and the British Institutions is pointed up in the findings of a series of American surveys indicating that: a) educators are more likely to be members than first, government and then industrial practitioners (with engineering degrees); b) of the approximately 55% of industrial engineers who are members of Societies, the science-based rather than the practice-based specialities are above the average, while the Civils for example are below (i.e., the scientific-minded and the successful engineer are more likely to participate in Societies); c) the membership of Societies, e.g., the AIEE, favour the pursuit of study rather than professional and status raising functions.(149) At a comparable date, the corresponding facts for the British profession are: a) industrial practitioners,&government engineers dominate Institution membership, educators are a minority with very little difference over policy; b) the major British Institutions represented some 80- 100% of all practitioners at a professional level (depending on Institution and employment area), c) members of the British Institutions, insofar as there are survey data, play down the study functions as reasons for joining, citing qualification and related functions instead.(151) All these differences relate to the relative absence in the American Societies of the quasi-registration and professional function carried out by the British Institutions.

The important differences, then, between the British and American professions lie in the unity organizations and their historical actions, the system of state registration of engineers with which they are involved, and the role of the university engineering school. This diversification has resulted in a separation of the dual functions of the Institutions into distinct agencies that have then become more effective on both fronts: the Societies emphasize study functions, also undertaking a range of professional pressure group type activities, the unity organizations, registration machinery, and engineering schools carry out the main professional qualifying functions. With regard to the latter, the profession is relatively unified, there is a common basic minimum standard of entry, and a more or less sure distinction between the professional and non-professional engineer, a definition not depending on membership of engineering Societies, but on educational qualifications and registration. While the separation of the study and professional qualifying activities into these respective spheres is not pure, by comparison with the British Institutions, it is marked. Membership in an American Society has carried some weight as a qualification for practice, but a degree or registration as a P.E. have been more important and the normal mode of reaching professional status; in England of course, professional status was largely conferred by virtue of Institution membership. Chapter 5 describes how the separation of functions and achievement of unity have permitted more effective collective action in pursuit of status for the engineer by the Societies, which have mostly through the unity organizations developed a range of activities not envisaged by the British Institutions.

Commonwealth engineering professions exhibit some features in common with the British profession. Major professional bodies include the Institution of Engineers, Australia, the New Zealand Institution of Engineers, the Engineering Institute of Canada, and the Institution of Engineers, India,(152) which perform different functions within their respective professions, but all cut across specialities. Rival specialist organizations are not characteristic of the Commonwealth engineering professions. There was more fragmentation in the past, partly a reflection of the British Institutions' presence. During the early part of the century some British engineers looked upon the profession as based on departmental Institutions (specialities but broadly based) international in scope and standing above a system of local or geographical inter-departmental associations ----a vision that compensated for fragmentation in Britain.(153) But all of the older Commonwealth professions have undergone changes in their structure, in the direction of unification; the bodies cited are all authoritative spokesmen for their respective specialities.

Comparison with the Commonwealth professions points up the important fact that the British Institutions are not peculiar in their role as autonomous professional organizations. The Institution of Engineers Australia, established in 1919 and granted a royal charter in 1938, following an unsuccessful movement for registration, is a qualifying body holding its own examinations: "As it is the only national Engineering Institution in Australia, qualifications acceptable to it are commonly adopted as the qualifications required of an engineer."(154) A high percentage of all practicing engineers (as in the U.K.) are members of the IEA, some 80-90,(155) reflecting the quasi-registration functions it performs in common with the Institutions and by contrast to the American Societies. The Association of Professional Engineers of Australia, a British Medical Association style pressure group, works in conjunction with the Institution, as the latter mainly carries out the functions of a learned society, (156) which by virtue of the royal charter of incorporation precluded wage bargaining. The Institution of Engineers, Australia, is not the only Australian association of engineers: others include, the Institution of Gas Engineers (Australia) f.1920,m.200(for 1970,approx.) the Institute of Industrial Engineers, f.1959, m. 1,000; the Australian Institute of Marine and Power Engineers, f.1881, m.3,500; the Institution of Radio and Electronic Engineers, Australia, f.1924, m.2,300; the Agricultural Engineering Society, f.1953, m.400; the Society of Licensed Aircraft Engineers (Australia), f.1958, m.100. The Institution of Gas Engineers (Australia) caters mainly for qualified gas engineers in local government. The Institute of Industrial Engineers admits engineers with 15 years industrial experience, as well as those with educational qualifications, to its membership, and accomodates technicians and others excluded from the Institution of Engineers, Australia. The Australian Institute of Marine and Power Engineers services seaborne engineers.(157) The emergence of these minor organizations testifies to the similarity in functions of the IAE and the British Institutions: the difference lies in the complete hegemony of the IAE--its membership is threefold that of the combined strength of the minor bodies, whose finances make it necessary for them to take in technicians.

The Canadian profession provides some further interesting contrasts as it has some features similar to the American profession, the Commonwealth profession, the French profession, and the British profession. (158) The Engineering Institute of Canada represents professional engineers in all specialities throughout Canada. The presence of the British Institutions and the American Societies has detracted from the Canadian Institute's strength. It has affiliated with the ASME, and U.K. ICE, IME, IEE, RAS. The objects of the Institute included: "to develop and maintain high standards in the engineering profession, and to facilitate the acquirement and the interchange of professional knowledge among its members".(159) Registration is carried out at the provincial level. The Corporation of Engineers of Quebec, and Montreal, the Association of Professional Engineers of Nova Scotia, New Brunswick, Saskatchewan, and Alberta, are the principal agencies. The profession has perhaps a greater degree of control over the registration authorities than in the United States.(160) Membership in one of these bodies constititutes the right to practice. There are provincial variations in the legal restrictions on practice. The Dominion Council of Professional Engineers was established in 1936 to coordinate the provincial bodies. Other associations of professional engineers carry out study functions.(161)

Registration has been less important for the status of European professions than elite engineering schools, but there are registration provisions, for instance in Italy. The typical configuration is a two-tier structure of professional schools, a professional association undertaking pressure group activities and a number of study associations that parallel the American Societies and British Institutions. In Germany, the _Technische Hochschulen_ graduate the professional engineers. Below these schools are other higher technical schools, the _Fachschulen_ or _Ingenieurschulen_ that produce lower status engineers. The main association is the _Verein Deutscher Ingenieure_, open to all engineers irrespective of speciality.

It is divided into approximately thirty specialist divisions, covering many of the areas covered by the British Institutions, which overlap in their membership with other purely scientific study associations in all the major fields. In France the professional schools are dominated by the prestigious grandes écoles. These schools produce the professional engineers and are the backbone of the organization of the profession. The Société de Ingénieurs Civils de France, the main association, caters to a broader speciality grouping than the ICE, but its activities, as in Germany, are supplemented by the work of the numerous speciality bodies, Société Française des Électriciens and so on. In the purely professional field, rather than study, the Federation of the French Associations and Societies of Diploma Engineers (FASFID) unites the school-based associations on a range of professional questions, representing the interests of qualified engineers regardless of speciality.(162) The organization of the French and German professions is described more fully in chapters 4 and 5.

Conclusion

The British engineering profession, by comparison to the American, German, French, Australian, and Canadian (as well as with others not reported here), is fragmented, lacking cohesion in the structure of its professional organization, where those others are unified with a basic minimum standard of entry and qualification. The fragmented structure of organization in Britain has undermined the legitimacy of the claim to a truly professional status; would-be specialist groups have sought to usurp the status of the old respected segments, throwing the basis of engineering professionalism into question, by casting doubt on the claim to exclusiveness. Collective "public" knowledge of the engineer's status has not kept up with the internal restructuration of the engineering community: status divisions within the profession are not meaningful to the non-engineering public and client, nor recognized. In other societies there are ways to distinguish between the professional and non-professional engineer and action has been taken to secure public and state recognition of the legitimacy of that status, actions precluded by the fragmentation (the non-recognition of engineer by engineer) existing in Britain. Before going on to describe those actions, the relations of the various professinns to educational institutions will be analysed.

Footnotes to Chapter 3

1. Cf. J.K.Finch, Engineering and Civilisation, New York, McGraw-Hill Book Company Inc., 1951, pp.12-17 on the Egyptian, Greek and Roman engineers and p.17 et.seq., for Leonardo da Vinci (1452-1519) and other Renaissance "engineers".

2. Sir H. Hartley, "The Debt of Engineering to the Fellows of the Royal Society", Notice and Records of the Royal Society of London, Vol.16 (April 1961) No. 1. Cf. Derek Hudson and K.W.Lockhurst, The Royal Society of Arts, 1754-1954, London, John Murray, 1954, pp.5 et.seq.

3. Rovert Mylne, Preface to The Reports of the Late Mr. John Smeaton, F.R.S., London, S. Brooke, 1797, Vol.1., pp.iv-v (and reprinted in 1812 for the Society of Civil Engineers).

4. Smeaton's Reports, op.cit., p.vi.

5. Ibid., p.vi. Society of Civil Engineers, "Facsimile Copy of the Minutes", Library of the Institution of Civil Engineers, Minute of 3rd May 1782. See below. Figures from Reports, op.cit., pp.vi-vii.

6. E.C.Wright, pp.64-5 in the discussion following S.B.Donkin, "The Society of Civil Engineers (Smeatonians)", Transactions of the Newcomen Society, Vol. XVll (1936-7) pp.51-71, points to a long-standing association between particular members. Cf. K.R.Gilbert, "Machine Tools", chapter 4 in C. Singer, et.al. eds., A History of Technology, Oxford, The Clarendon Press, 5 vols., 1954-1958, vol. lV, p.418 for an outline of the close ties between engineer-inventors between 1750-1850.

7. Society of Civil Engineers, "Minutes", op.cit., April 3, 1778.

8. Ibid., min. of May 27th 1774.

9. Smeaton's Reports,op.cit., pp.vi-vii.

10. Ibid.,

11. Ibid.

12. Ibid., p.vii.

13. Ibid.

14. Ibid., pp.vii-ix. In March 1792 the "Minutes", op.cit., Min. of Friday, March 18th 1892, record a decision to have only one honorary class.

15. Donkin, op.cit., p.52.

16. A.W.Johns, "An Account of the Society for the Improvement of Naval Architecture", Transactions of the Institution of Naval Architects. Vol. 52 (1910) pp.28-40,28,33.

17. F.M.L.Thompson, Chartered Surveyors, London, Routledge and Kogan Paul, 1968, pp.71-2.

18. B. Kaye, The Development of the Architectural Profession in Britain, London, George Allen and Unwin Ltd., 1960; cf. F. Jenkins, Architect and Patron, Oxford, 196

19. Donkin, op.cit.,pp51-71; cf. A.W.Skempton, The Smeatonians Duo Centenary Notes on the Society of Civil Engineers, 1771-1971, London, The Society of Civil Engineers, 1971.

20. Smeaton, op.cit. p.7 et.seq.

21. Minutes of the Proceedings of the Institution of Civil Engineers, described as the Journal between 1935-6 and 1951 and then just Proceedings, from 1952, were not published regularly until Vol.1 of 1837-41. Abstracts of the proceedings for earlier years are in the Athenaeum. A selection of papers and addresses prior to 1842 were published in 3 volumes of Transactions of the Institution of Civil Engineers, by Weale in 1836, 1838, 1842.

22. "Regulations", Trans.ICE., Vol.1 (1836) p. xxxii, Section 1, 'Of its Objects', p.xv; cf. H.R.Palmer, Address of 1818 in Min.Proc.ICE., Vol. 1 (1837-41) p.3, for a partial reprint of the 1818 address as a restatement of aims.

23. The number of founder members is disputed. Official historians and biographs of the Institution usually put the number at the eight listed (a fact corroborated by a statement in the memoir of Palmer in Vol.4 of the Min.Proc.ICE.), but, the Trans.ICE., Vol.1 (1836) p.xxi list only six, Lethbridge and Thomas Maudslay are missing, and in his Presidential Address of 1848 Joshua Field refers to the origins of the Institution in the association of six young engineers in 1818.

24. Field and two other men are said to have started the Institution as the "Engineers'Society" in 1816. Field was the first chairman in January 1818; cf. John W. Hall, "Joshua Field's Diary of a Tour in 1821 through the Midlands, with Introduction and Notes", Trans. Newcn.Soc., Vol.VI (1925-26), pp.1-41 and pp.39-41 for a discussion of the "Diary".

25. Trans.ICE.,Vol.1 (1836) p.xxi, a resolution requesting Telford's patronage is reprinted. Telford had not heard of the ICE before this communication, ibid., p.xxii.

26. Letter dated 3rd Febuary 1820 to Thomas Telford and signed by members. Telford's reply, London, 16th March 1828. Library of the ICE.

27. Ibid.

28. Thomas Telford, Inaugural Address, 21st March 1821, Trans.ICE.,Vol.1 (1836) pp.xxii-xxiii, p.xxiii.

29. Ibid.

30. "Regulations",Trans.ICE.,Vol. 1 (1836) pp.xv-xxxii, p.xvi.

31. Ibid. p.xv.

32. Ibid. p.xvii.

33. Telford introduced the grade of Honorary Member by inviting influential non-engineers to participate in order to build up its prestige.

34. John Rickman, ed., Life of Thomas Telford, Civil Engineer, written by himself Containing a Descriptive Narrative of his Professional Labours, with a folio Atlas of Copper Plates, London, James & Luke G. Hansard and Sons, 1838, pp.661-2.

35. "Institution of Civil Engineers", The Morning Chronicle, Tuesday, Febuary,

36. Ibid.

37. Sir Alexander Gibb, The Story of Telford, The Rise of Civil Engineering, London, Alexander Maclehose & Co., 1935, p.196.

38. L.T.C.Rolt, Thomas Telford, London, Longmans, Green and Co., 1958, p.191.

39. Ibid.191.

40. "Introduction", Trans.ICE., Vol.1 (1836) p.xx.

41. See Appendix B.

42. Barrington Kaye, op.cit., Table 111, p.175.

43. S. Smiles, The Life of George Stephenson, Railway Engineer, London, John Murray, 1857. Smiles has been called "inaccurate and untrustworthy" by C. Wright in Donkin, op.cit., p.66; and indeed there are many points at which his work differs from other biographers and historians of the profession.

44. Smiles, op.cit., (1857) pp.472-3.

45. The nature and location of the original meeting are disputed, see: R.H. Parsons, A History of the Institution of Mechanical Engineers, 1847-1947, London, Institution of Mechanical Engineers, 1947, pp.10-15; L.T.C.Rolt, The Mechanicals: Progress of a Profession, London, Heinemann (published on behalf of the IME), 1967, pp.14-20 for an account of formation; W.H.G.Armytage, A Social History of Engineering, London, Faber and Faber, 1961, pp.130-131; The Institution of Mechanical Engineers, A Brief History of the Institution of Mechanical Engineers, 1847-1899: A Commemorative Booklet issued on the opening of the New Building, London, IME, 1899, pp.5-6; Institution of Civil Engineers, "A Study of an Alleged Slight", London, the Institution of Civil Engineers, unpublished typescript document, 1956.

46. S. Smiles, op.cit., p.2 et.seq. His father was a fireman for a pit engine.

47. On Stephenson's managerial ability and technique, see Smiles, op.cit., (1857) p.194,386-7,419 et.seq.

48. Smiles, op.cit., pp.110,116, many others also claimed to have invented the safety lamp, known in the North as the "Geordie Lamp".

49. L.T.C.Rolt, Isambard Kingdom Brunel, London, Longmans Green, 1957, and Pelican Books, 1970, pp.146,155.

50. James' claim to the title "Father of Railways" is put forward in E.M.S.P.anon (Mrs. Paine), The Two James' and the Two Stephensons, first published in 1861 and reprinted, London, David & Charles, 1961.

51. The origins of railway transport itself of course being at least mediaeval, see C. Hamilton, A.R.Hall and Trevor I. Williams, eds., A History of Technology, Oxford, The Clarendon Press, 1958, Vol.V., pp.322-349,322,323.

52. E.M.S.P., op.cit., chapter 3.

53. Richard S. Lambert, The Railway King, 1800-1871, A Study of George Hudson and the business morals of his time, London, George Allen & Unwin Ltd., 1934, p.67.

54. E.M.S.P., op.cit., chapter 4.

55. Rolt, op.cit. (Mechanicals), p.15.

56. *Min.Proc.IME.*, Vol.1 (1847-49) pp.3-10, "Notice of the Life and Character of the Late George Stephenson", By the direction of the Council, prepared by J. Scott Russell (a Member of the Council), and cf. pp.10-11, speech of Mr. Geach, who pointed out that Stephenson was proud of his early life and never lost an opportunity of expressing it.

57. H.G.Lewin, *Early British Railway: A Short History of their origin and Development, 1801-1844*, London, Locomotive Publishing Co. Ltd., 1925, p.186; cf. idem., *The Railway Mania and its Aftermath, 1845-1852*, London, 1936.

58. "Annual Report", for 1838, *Min.Proc.ICE.*, Vol.1 (1837-41), pp.1-4, pp.2-3.

59. James Walker, "Address of the President to the General Meeting, Febuary 2, 1871", *Min.Proc.ICE.*, Vol. 1 (1837-41), pp.23-27; cf. William Cubitt, "Address of the President", *Min.Proc.ICE.*, Vol. IX (1849-50) pp.133-142, refers again to the relatively low demand for engineers: "during the past year there has not been so great a demand for the talents or the energies of engineers,....".

60. "By a Civil Engineer" (Anon.), *Personal Recollections of English Engineers and the Introduction of the Railway System into the United Kingdom*, London, Hodder and Stoughton, 1868, pp.45-48 and chapter 4.

61. John Francis, *History of English Railways, Its Social Relations and Revelations, 1820-1845*, London, 1851, Vol. 2, pp.70-7, Sir Richard Scatchard in A. Trollope's *Dr. Thorne* is one such particularly successful railway contractor, but a "railway" rather than "Civil engineer", if an engineer at all.

62. Cf. "First Circular of the Institution of Mechanical Engineers convening a Meeting on 7th October, 1846, Before the Foundation of the Institution", London, Library of the Institution of Mechanical Engineers, and signed by J.E.McConnell, Charles Frederick Beyer, Archibald Slate and Edward Humphreys; & "Report of the Council on 24th January, 1849", *Min.Proc.IME.*, Vol. 1 (1847-1849) pp.3,10.

63. R.H.Parsons, op.cit., p.15.

64. *Mechanics Magazine*, Vol. 50 (Jan.6th-June 30th, 1849) pp.491-2; *Mechanics Magazine*, Vol. XLVI (Jan.2nd-June26th, 1849), p.520.

65. Smiles, op.cit., (1857) p.392, in the passages already quoted, cf. Parsons, op.cit., p.8.

66. W.O.Skeat, *George Stephenson, The Engineer and His Letters*, London, IME, 1973, p.247.

67. Cf. Parsons, op.cit., pp.12-15, for biographical details of the founder members and original officers.

68. "Report of the Council", *Min.Proc.IME.*, Vol.3 (1852) p.7; see Appendix B, Table 2.

69. "Annual Report of the Council", *Min.Proc.IME.*, Vol. 29 (1878) p.20.

70. For a brief historical, quasi-official, sketch of the Big Three, see: L.St.L.Pendred, *British Engineering Societies*, London, Published for the British Council by Longmans, Green and Co., 1947.

71. Rollo Appleyard, *The History of the Institution of Electrical Engineers, 1871-1931*, London, IEE, 1939, pp.11-12.

72. A trade association with a professional membership, see Chapter 5.

73. Institution of Electrical Engineers, "Minutes of Council Meetings", first recorded minute. 17th May, 1871.

74. Appleyard, op.cit., p.20.

75. Cf. Edward Graves, "Address of the President", Journal of the Society of Telegraph-Engineers and Electricians, Vol. XVII (1888) No.70, pp.4-31, 30.

76. In 1926 one candidate (only) succeeded in both papers that he submitted, Journal of the Royal Aeronautical Society, Vol.30 (1926) p.626.

77. Royal Aeronautical Society, A Short History, London, The Royal Aeronautical Society, 1967 (not paginated); and "Annual Reports" of the Royal Society of Aeronautical Engineers.

78. Bernard C. Curling, History of the Institution of Marine Engineers, London, Institution of Marine Engineers, 1961, p.3.

79. Institution of Production Engineers, "Copy of Counsel's Opinion", in "Council Papers", 1933, p.101.

80. See, A.M.Carr-Saunders and P.A.Wilson, The Professions, Oxford, The Clarendon Press, 1933. pp.156,320; William Kornhauser, Scientists in Industry, University of California Press, 1962, chapter on professional associations; Harvey L.Smith "Contingencies of Professional Differentiation", American Journal of Sociology, Vol.LXIII (January 1958) pp.410-14; R.Lewis and A. Maude, Professional People, London, Phoenix House Ltd., 1952, p.24.

81. Cf. a reprint of an original AUEW circular in S.& B.Webb, The History of Trade Unionism, London, Longmans, Green and Co., 1970 edition, pp.199-200.

82. The societies included the Society of Telegraph Engineers, on occasion the IME, the Meteorological Society, the British Association of Gas Managers (f.1863) and the Iron and Steel Institute (1869) and others.

83. Appleyard, op.cit.,p.48.

84. "The Society of Engineers",Eng., Vol.XXIV (Aug. 9, 1867) p.113; "Professional Monopoly", Eng., Vol.XXIV (July 26,1867) p.75.

85. "Report of the Council, Session 1885-86", Min.Proc.ICE.,Vol.LXXXVI (1886) pp.153-183,166-7.

86. "On the Status and Training of Civil Engineers, with data as to the means available for promoting the Education of engineering students. Prepared at the request of the Council of the Institution of Civil Engineers", by William Pole, (being a set of partially corrected proofs), London, Library of the Institution of Civil Engineers, 1889, pp.27-8.

87. Ibid., p.26.

88. Ibid.

89. On the Bills see: Appleyard, op.cit., p.107; Thompson, op.cit., pp.316-317; Kaye, op.cit.,pp.135-141; Parsons, op.cit.,p.34; Min.Proc.IME., Vol.39 (1888) pp.160-165; and "Annual Report", Min.Proc.IME.,Vol. 40 (1889) p. 6; Statement of President, Petition, Circular, and Statement of the Council of the Institution of Mechanical

Engineers against the second reading of the Architects' Registration Bill" in Min.Proc.ICE., Vol.39 (1888) pp.160-165; see Eng., Vol.65 (Feb. 10,1888) p.119, (March 23, 1888) p.242, (April 13,1888) p.294, (April 21, 1888) p.320; Engineering, Vol.45 (March 16, 1888) pp.266-267, (April 13th, 1888), p.369, (April 20, 1888), p.396.

90. "On the Status and Training of Civil Engineers", op.cit., pp.27-8.

91. Ibid.

92. "Report of the Council", Min.Proc.ICE., Vol.CLXIX (1908-9) Part IV, pp.137-8

93. Earl Cawdor, as the President of the Institution was the Chief Petitioner. The Charter of Incorporation is reprinted in the Trans.INA., Vol.53 (1911).

94. "Status and Training of Civil Engineers", 1889, op.cit., p.2.

95. "Report of the Council", 1912-13, Min.Proc.ICE., Vol. CXCIV (1912-13) Pt. IV, p.338.

96. J.H.T.Tudsbery, Min.Proc.ICE., Vol.CCV (1917-18) Pt.1, pp.21-223.

97. "Report of the Council for 1919-20", Min.Proc.ICE., Vol.CCX (1919-20) pp.299-300.

98. IEE.,"Minutes", Min. 114, 12th Febuary 1920.

99. IEE., "Minutes", Min. 88, 8th January 1920; Min. 101,22nd January 1920; Min. 114, 12th Febuary 1920; Min. 191, 15th April 1920.

100. IEE., "The Admission of Associate Members to Council 1922, How it Started", London, IEE, 1948, typescript document, headed "Confidential and Personal to Col. H. Randall Steward, 1935-6-7".

102. Appleyard, op.cit., p.245.

103. IEE., "Minutes", Min. 244, 13th January 1921; Min. 75 and Min. 246, 10th Febuary 1921; Min. 103; Min 133 7th April 1921.

104. See, "Report of the Council, 1921-1922", Min.Proc.ICE., Vol. CCXIV (1922) pp.196-212,202 and "Supplemental Charter of the ICE,"reprinted pp.213-217. IEE.,"Mintutes", Min. 84, 15th Dec. 1921; Min. 118, 2nd Febuary 1922; Min.238, 23 June 1922.

105. Engineering Joint Council, Bye-Laws, reprinted as Appendix C to "Report of the Council for 1923-1924", JIEE.,Vol. 62 (December 1923) No.324, pp.533-534. Cf. Dr. Alexander Russell, "Inaugural Address", JIEE.,Vol. 62 (December 1923) No. 324, p.1.

106. Curling, op.cit., p.44.

107. Institution of Marine Engineers, "Minutes of Council Meetings", 21st July 1924, and passim 1922-26.

108. F.J.S.Lamport, "Proposed Association of Engineering Institutions", The Socie of Engineers, Transactions for 1943, pp.61-65, and discussion pp.65-83.

109. A.S.E.Akerman, (Society of Engineers), in discussion following "Proposed Association of Engineering Institutions", 1943, op.cit. p.734.

110. Marine, "Minutes", Min. 14th Aug. 1922, p.4.

111. Institution of Structural Engineers, "Verbatim Reports of Council Meetings", March 10, 1927, pp.8-9.

112. Richard Hazleton, (Sec.Society of Technical Engineers), "The Registration of Engineers", Trans.Soc.Eng., 1928, pp.26-36. Membership of the STE was between 200-300, it was registered as a trade union. "Apparently it has got into hot water already with the TUC., and I do not think the Bill will have a chance, because the Labour Members have been instructed to block it as a body". Structurals,"Verbatim Reports", March 10, 1927, p.9. The Bill was at first postponed becuase it was scheduled to be read during the General Strike. When it came up for a second time after haveing been resubmitted, its promotors did not urge it forward as by that time the Institutions' opposition had become clear, it had no hope, and there was no debate.

113. Hazleton, op.cit., pp.26-36, 36-55.

114. Engineers: A Bill to provide for the registration of and to regulate the qualifications of engineers, 29th April 1926, Bill 101, 16 Geo. 5., C. 1-2, London, HMSO, 1926. See also Parliamentary Debates, Commons, Vol. 194, 19th April 1926, 2208; introduced again 22nd Febuary 1927, Vol. 202, 1590, "Engineers Bill", no second reading given.

115. Ibid.

116. Ibid., Clause 6.

117. Hazleton, op.cit., pp.26-36,29.

118. See letter dated 22nd July 1926 to Mr. Williamson from Magnus Mowat, headed "Registration of Engineers' Bill", in reply to receipt of a cutting from The Journal of Commerce (Liverpool), July 8, 1926 on registration, London, Library IME.

119. Marine, "Minutes", Min. May 17th, 1926, pp.88.

120 Production, "Minutes", May 4th, 1929, pp.1-2.

121. Sir Alexander Gibb, The Co-ordination of Engineering Institutions and Societies, Presidential Address, Institution of Chemical Engineers, March 20th, 1929

122. "The Federation of Engineering Societies", Eng., Vol. 144 (December 16, 1927 p.687.

123. Min.Proc.IME.,Vol. 107 (1926) p.275; cf. Parsons, op.cit., p.63.

124. Engineers employed in the state service in various categories have more readily gained a monopoly of function and favoured registration to formalise their advantage. In 1919 the Municipal and County and Waterworks joined with the Society of Engineers to discuss a code of professional practice that they wished to see established in branches of the profession.

125. Cited by Hazleton, op.cit., p.8.

126. Its main activity of import was the opposition of petitions for royal charters, see below; and see IEE,"Minutes", Min.17, 1929; Min.106, 1930; Min 108, 1931; Min. 96, 1932; Min. 111, 1933; Min.129, 1934; Min.115, 1935.

127. On the activities of the EJC see Marine, "Minutes", Min.December 5th 1932, p.27; 1933, various dates, pp.49,60,64,68,91; July 2nd 1934, p.122; some of the smaller Institutions, like the Marines, did look towards a more active EJC. In 1932 twelve societies in favour of federtion began discussions on the subject at the Civils; in 1933 a proposal for the reorganization of the EJC giving it more executive power, was tabled and went no further, again because of the problem of inter-Institutional relations, particularly whether power would be exercised on the basis of seniority or numbers, or on a one-to-one basis. Naturally the smaller and more numerous associations could gang up to demand the latter, producing a stalemate

128. W.T.K.Braunholtz, The Institution of Gas Engineers: The First Hundred Years, 1863-1963, London, Institution of Gas Engineers, 1963, p.111, Petition for Charter of 1929.

129. The Charter of the IME had been contemplate for some years to further differentiate it from the mino Institutions, especially the Institution of Automobil Engineers, that were encroaching on its territory. Engrg., Vol.CXXVll (May 17, 1929) p.618; Engrg., Vol. CXXVll (May 17, 1929) pp.615-6; Engrg., Vol.CXXVll (May 31, 1929 p.673; Engrg.,Vol. CXXVll (June 13, 1929) pp.769-70. Later the IME opposed the grant of a charter to the IHVE on similar grounds. Interestingly, the clause cited above reads in the case of the IME, "Such incorporation would constitute a recogniti of the postion and status which the (IME)....has attained through the representative character and varied activities of its members over a long period of years, and would enable the Institution to enter upon a further period of increased usefulness to the engineering profession and to the community at large." Petition for a Royal Charter, IME., July 1929, Clause No. 8.

130. Electrical,"Minutes", Min.71, 17th December 1925; and Min.63, 3rd Dec. 1925.

131. Marine, "Minutes", Nove 7th 1932, p.23.

132. Memorandum submitted by the Councils of the ICE,IME,and IEE, "In the Matter of a Petition by the British Institution of Radio Engineers" para.4.

133. Ibid. para. 6.

134. Ibid. para. 20.

135. Electricals, "Minutes", Min. 76, 21 January 1937, and see, Min. 111(6), 25 Febuary 1937; Min. 171, 11th May 1939; Min. 186, 4th July 1939; Min. 135(a), 8th April 1937.

136. Engineering; What it is and does, London, The EPRC., January 1938.

137. Braunholtz,op.cit., p.129.

138. Lamport, Trans.Soc.Eng., op.cit., pp61-5,65-33. Cf. H. Jackson, "The Place of the Engineer in Post-war planning and reconstruction, The Structural Engineer, October 1942.

139. Ibid. The yer before in 1942, the IME had declined to assist in a proposal for the national registration of Structural Engineers, Electricals, "Minutes", Min. 18, 1942.

140. Reply of Minister of Works, 1944, reprinted in Engineers' Guild Ltd., "Report of the Committee on Statutory Registration of Engineers", London, The Engineers' Guild Ltd., typescript document, 1951. The reply is to an enquiry from the Guild.

141. See, "Proposed Amalgation of the Institution of Automobile Engineers with the Institution of Mechanical Engineers", London, IME, 1945, printed document marked "confidential".

142. Engineers Joint Council, Directory of Engineering Societies, New York, EJC, 1968.

143. Edwin T. Layton, The Revolt of the Engineers, Cleveland, The Press of Case Western Reserve University, 1971, p.122-4; cf. Monte A. Calvert, The Mechanical Engineer in America 1830-1910, Professional Cultures in Conflict, Baltimore, The Johns Hopkins Press, 1967, p.133.

144., Engineering Council, " A Brief History", New York, Engineering Societies Building, Library, 1921, p.3.

145. Ibid., pp.13-14; Federated American Engineering Societies, Engineers Unite, (Highlights of the 1920 Conference), New York, McGraw-Hill Inc., n.d.circa 1920

146. "Engineering Council Minutes" Feb. 21, 1918, p.10, Engineering Societies Library New York.

147. Ibid. for a record of EC activities. There is no corresponding record of UK joint council activities apart from the reports of invidual Institutions, all pointing to a total absence of positive action.

148. In 1959/60 the NSPE reported 52,000 out of about 225,000 eligible for membership (i.e. registered engineers). It has, throughout its existence, avoided technical matters, concentrating directly on engineering professionalism. See The National Society of Professional Engineers History Committee, "Early History of the National Society of Professional Engineers", typescript document, Engineering Societies Library, New York, See also Chapter 5.

149. Kornhauser, op.cit., pp.94-102.

151. On the first two points see Chapter 4 and 7; on the last there is the data presented by Prandy, cited in detail in chapter 7.

152. For brief descriptions of the Commonwealth Institutions see, The Conference of Engineering Institutions of the British Commonwealth, " A Note on its Nature, Aims and Activities, with Salient Details of the Participating Institutions as at 31st October, 1951", London 1952, cited as CEC (1952);and, The Conference of Engineering Institutions of the British Commonwealth, " A Note on its Nature, Aims and Activities, with Salient Details of the Participating Institutions as at 30th November, 1959", London, 1960, rev.ed. cited as CEC (1960). The latter is more inclusive and gives details for Ceylon and Pakistan; and, The Conference of Engineering Institutions of the British Commonwealth, "A Note on its Nature, Aims and Activities, with Salient Details of the Participating Institutions as at 31st December 1954", London, 1955, cited as CEC (1955). See also Sir James Currie, ed., Professional Organisations in the Commonwealth, published for the Commonwealth Foundation by Hutchinson of London, 1970, for a survey of all Commonwealth associations known at the time of the intitial survey in 1966.

153. See Chapter 5.

154. Cf. CEC 1960, op.cit., p.8, and A.H.Corbett, The Institution of Engineers Australia, A History of the First Fifty Years 1919-1969, Sydney, The Institution of Engineers Australis, 1973, pp.35-40, pp.241-242, for internal organization and speciality groupings within the IEA.

155. See Footnote 156 below.

156. B.E.Lloyd and W.J.Wilkin, The Education of Professional Engineers in Australia, The Association of Professional Engineers, Australia, 2nd ed., 1962, pp.33-34.

157. Currie, op.cit., pp.214-217. Date of membership figure is not given precisely, but after 1966 and before 1970, probably near latter.

158. See CEC, 1960, op.cit., pp.9-12; cf. Report on Organisation in Industry and Commerce and the Professions in Canada, "Engineering", Canada, Department of Labour, 1947-67, p.145.

159. Report, op.cit., p.145.

160 A Report by the Institution of Engineers Australia, "Registration of Engineers", PE., Vol. 9 (March/April 1964) No.2, pp.44-52.

161. Report, op.cit., pp.145-6.

162. On the organization of the European professions including Germany and France, see The Conference of Engineering Societies of Western Europe and the United States of America, (EUSEC), Report on Education and Training of Professional Engineers, London, 1961, Vol.1, "Introduction and Description of the system of Engineering Education in EUSEC and OEEC Countries"; Vol.11., "AComparative Study of Engineering Education and Training in EUSEC and OEEC Countries", Proceedings of the Third EUSEC Conference on Engineering Education, London, 1958; idem, 1953; EUSEC, "Aims of Some Engineering Societies of Western Europe and the U.S.A.", London, 1956; and other EUSEC publications and unpublished documents in the libraries of the sponsoring Institutions, the ICE, IME, IEE, see also the references in Chapters 4 &5.

Chapter 4

Professional Organization and Education

Introduction

Educational institutions are an important ingredient in professional organization, and the collective pursuit of status often takes place through them; practitioners attempt to regulate entry, standards and exclusiveness by controlling education. But the relationship of profession to education can and does differ widely between, as well as within, societies. In Britain the profession has autonomy from higher engineering education, and exerts a control over it, more than in the United States and Australia. Normally such autonomy and control would result in a high status, but the fragmentation process undermined the conditions needed for this outcome. In those societies where the state has been most active, the profession is practically coterminous with the system of engineering education; yet, such education-based professions do not necessarily guarantee a high status to practitioners. In this chapter the relation of the profession and education will be analysed on a comparative basis, and it will be argued that the peculiarities in the relationship of the British profession to education do not in themselves account for its low status.

Early Engineering Education and the Role of the ICE.

In England, unlike in France and to a lesser extent Germany, no system of high status engineering education developed early on during the industrial revolution with the consequence that the practicing profession developed autonomously.

Before the formation of the Institution of Civil Engineers, engineers, members of the Society of Engineers, received their training in a diverse range of occupational careers. Smeaton originally trained as a lawyer, Telford wished to have been an architect. (1) Although "self-taught" as engineers,(2) in their general education many had benefited from the excellent schools that were the legacy of the 18th century growth in education,(3) and in some cases a university, or a craft apprenticeship.(4) The establishment of the ICE provided an agency through which education and training could be regularized; association led to mutual recognition of the right to the new status of Civil engineer, and lent legitimacy to the claim of superior qualification. At first the Institution, which did not number over 250 till after the mid-thirties, recruited from among engineers already in practice. For the younger would-be engineer, established practitioners, not least Telford,(5) favoured "practical" training through pupilage and apprenticeship and gradually the hierarchical organization of engineering works, such as Henry Maudslay's(London), Boulton and Watt's "Soho Foundry" and the canal and railway civil engineering projects, became fused with a system of practical training and recruitment.(6)

The little "theoretical" engineering education was largely provided by the universities. Cambridge University had a long tradition of engineering, dating from Newton. In 1707 public lectures on hydrostates and pneumatics outlined mechanical aspects of the pressure and equilibrium of liquids and the mechanical properties of air, gases, and other elastic fluids. An advance came with the establishment of the Jacksonian Professorship of Natural Experimental Philosophy in 1782.(7) Isaac Milner, the first incumbent, carried out chemical, electrical and mechanical experiments and introduced studies of mechanisms and engines into his lectures. The study of construction and machines began on a large scale with William Farish, the first professor of chemistry (1794-1813), and Jacksonian Professor (1813-1836). His highly practical course pertained to the engineering of the day.(8) Engineering also interested Airy, the Lucasian Professor of Mathematics (1826-1828), and the Plumian Professor of Astronomy(1828-1834). Consulted by Stephenson, Brunel and other eminent engineers, he was elected a Member of the ICE, and awarded the Telford medal in 1867 for a paper on bridges. These early initiatives reflected the residue of the 18th century gentlemanly interest in mechanism and engineering as a hobby and pastime of landed gentry, interested in exploiting mineral and other deposits on their estates. In 1837 Robert Willis succeeded to the Jacksonian Professorship of Applied Mechanics, and built up a course of lectures for a degree examination in applied science "On statics, Dynamics and Mechanism, with their practical applications to Manufacturing processes, to Engineering and Architecture."(9) By 1838 he had been elected an Honorary Member of the Civils, and in 1853 Willis accepted the post of lecturer in applied mechanics at the Kensington School of Mines. He died in 1875. Engineering education at Oxford came later; the Final Honours School in Science started in 1850.

The thirties saw the introduction of engineering education in some of the new foundations. In 1839, a landmark of sorts, schools opened at Durham and at King's College, London.(10) University College, London, founded three chairs; the first, in civil engineering, went to C.B.Vignoles, who after practicing in Russia and America, was known for his suspension bridge over the Dnieper at Kiev, the largest in the world at the time. Although it had been intended to establish a chair of engineering at its opening in 1827, the new College could not afford an eminent engineer and Vignoles did not take up the appointment until 1841.(11) In 1846 a chair for mechanical engineering was filled by Eaton Hodgkinson, and another for machinery was occupied in the same year by Bennett Woodcroft. Later in 1859, William Pole took up an appointment to the civil engineering chair at University College. Edinburgh had a chair of civil engineering in 1865. At Glasgow, where engineering was recognized during the thirties and forties like Cambridge, "It is perhaps a fine point to claim for Glasgow University the first British University chair of engineering for although this was founded in 1840 and engineering classes offered, there was no degree awarded in science or engineering _per se_ until the BSc degree was established in 1872."(12) Ewing, the Cambridge professor, identified the foundations of university training of engineers as having been laid with Rankine's appointment to the chair of Civil Engineering and Mechanics in Glasgow in 1856.(13) The chair itself had been set up in 1840.(14) Engineering was also established during this period at the three Queen's Colleges of Ireland, Belfast, Cork and Galway.(15) And along with this provision existed the military schools.

Practicing Civil engineers sought to promote these developments in engineering education, which added legitimacy to their new professional and now learned status. At King's College the department of civil engineering and mining was the result of actions by the Institution.(16) Again at King's College, Durham a local group of engineers succeeded in cooperating with the university in establishing a school of engineering.(17) It also took an interest in others.(18) By 1839 the ICE President observed triumphantly: "Classes, with Professorships, for the education of the Civil Engineer, are established at our Colleges; and there is now upon the table a prospectus for the establishment, on a large scale, of a College for Civil Engineering."(19) The College of Civil Engineers was launched at Gordon House, "about the year 1839, by a body of Noblemen and Gentlemen who intended it as a system of education for youths in lieu of the system of pupilage to Engineers then the only method of bringing up a youth to the profession."(20) Originally run by Colonel Hutchinson, the staff included Samuel Clegg, before he became Professor of Engineering at Chatham in 1849, Edward Frankland, and Lyon Playfair, the professor of chemistry.

Suprisingly these centres did not flourish. Durham collapsed soon after it opened. In 1840 the School of Civil Engineers had 26 students, but by 1863 it had ceased to exist; a school of physical science, started in 1865, also failed.(21) Engineering education lay dormant at Cambridge for some years, despite the early interest and lack of resistance to its inception. Its acceptance and expansion as a modern academic subject is sometimes put at 1875 with James Stuarts' appointment as the first Cambridge Professor of Mechanism, though this, like the earlier assignment, is arbitrary.(22) In 1852 Putney College underwent a financial collapse due to the burden of free and lower-payment students.(23) The fees ranged between L160 and L180 per annum. Part of the problem, and a fact that helps to explain the subsequent relationship of technology to the universities, was that engineering was being too eagerly embraced. One school alone, the School of Civil Engineers, produced approximately 500 graduates in the thirteen years ot its existence, or about half as many persons as declared themselves engineers in the census. Although desiring connection with the higher learning, the Institutions took fright at the numbers: "Now certainly the number of Engineers or Students for Engineering is increasing. If we look at the number of students in the classes for Civil Engineering at the different Universities and Academies; the Universities of Edinburgh and Durham, King's College, University College, and the College for Civil Engineers in London: we are led to ask, will this country find employment for all these? I freely confess that I doubt it."(24)

The Institution and its members became increasingly conscious of their growing interest in pupilage and apprenticeship, as preferred routes of entry. Even when most active over questions of engineering education, the Institution did not lose sight of this interest: "Much has at times been said respecting the establishment of a School of Engineers, and many comparisons have been drawn betwixt the advantages possessed by this and other countries in this respect; but not for an instant to enter on the great question of the nature of a complete establishment under that name, it may with confidence be asserted that this Institution is in itself a School of Engineers; a school, not in the term wher knowledge is forced upon the unwitting student but one where the attentive student possesses remarkable opportunities to self-improvement by study and mutual intercourse."(25) Once practitioners of the "school" showed favour to the practica engineering pupil, their own "graduates", there was little point in those training for the profession spending funds on a university or other engineering education, if this did not also ensure the desired object of all professional education, security in practice and employment. Parents avoided entering into such excess. Indeed, so great had become the insistence of the profession on pupilage that one school, the Crystal Palace School of Practical Engineering, was actually establishe in 1842 "to prepare students, by systematic practical instruction, for professional articles, so that on entering an Engineers' office or works, the pupil may at once be useful to his principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession."(26) The university and other schools foundered due to a lack of students willing to pay fees and then on top of that a premium. At first some schools, such as University College, urged the adoption of engineering in the expectation that it would undercut the high cost of pupilage, in 1832 between £500 and £1,000 for five years to a leading practitioner, but recruitment to the profession was almost wholly determined by the recommendations of existing Civils of high repute (necessarily so in the absence of an established system of engineering education), and they strongly objected to degrees becoming a substitute for the kind of practical training that they had undergone. At mid-century, the premium payable to these practitioners varied between £200 and £1,000.(27) A frequent complaint was that office fees and the period of pupilage were not reduced for those with a formal or theoretical engineering education: in its absence why should intending engineers go to the additional expense? especially when the bulk of the established practitioners themselves denigrated such education.(28) There was no resistance to social change peculiar to engineering in Britain; rather engineering education was losing its major advocate.(29)

At mid-century the educationalists in the profession exercised little influence. Of the first ten Presidents of the ICE only three had university training and these were Scottish,(30) but there was also some non-university technical educators. McFarlane's DNB sample showed that of those who were in the 40-70 age group, at the most influential points in their careers, 17% entered through a craft apprenticeship, 23% were engineering pupils, 10% entered via apprenticeships in other fields, for example architecture, 8% had military experience, 16% worked in related fields, and a further 19% in other professions, 3% in other occupations and only 8% entered directly from university.(31) The important change in the educational experience of this group compared to those born before 1780 was the increase in the relative numbers entering via apprenticeship and especially pupilage for the profession. Moreover, of those young engineers entering between 1830 and 1850 practically half (46%) were engineering pupils, while a further 13% were graduates pursuing some further practical training.(32) In other words the expansion of the profession between 1830 and 1860 took place largely through pupilage. These engineers, and their pupils in turn who were equally numerous (a fact that is substantiated by surveys carried out by the profession at the turn of the new century), largely controlled the development of the profession during the second half of the 19th century.

The Victorian Civil engineer considered "theoretical" (i.e., school-based rather than practice-based) engineering education or "scientific" training to be largely irrelevant, in some cases harmful, to the everyday business of the profession. Advances within the engineering industry were made by men raised in the practical tradition; such engineers, not least Stephenson, the semi-literate "colliery engine-wright" from Killingsworth, who, among other similar accomplishments, sold Germany its first steam engine, were high in demand on the Continent, despite the large number of engineers graduating from their schools and their "theoretical" excellence. Civils equated "theoretical" with "hypothetical", as opposed to "practical" men of affairs like the surgeon, doctor, lawyer. What counted was the number and size of bridges built, ships launched, tracks laid, or experience on such projects, not "theoretical" engineering education.

Early Developments in Engineering Education in France, Germany, the United States and Russia.

In France and Germany the state intervened in the establishment of engineering education before the formation of an independent engineering profession. Consequently the profession became an outgrowth of the system of engineering education--in many cases in Europe into actual state corps of engineers both educated and supported by the government and with a monopoly in the public service, and usually(in contrast with Britain), an effective pressure group for the theoretical school-based engineering education.

The origins of French engineering education predate the revolution. The École des ponts et chaussées was formed under the guidance of Perronnet, the French "Father of Civil Engineering", in 1747, in order to service the Corps des ponts et chaussées. The Corps itself dates back to the 13th century, but it was expanded by Louis XV in order to build roads. The Écoles des mines opened in 1778 (Louis XV named it in 1788). The revolutionary governments reorganized these state-supported schools and created new ones, especially the Écoles polytechnique, 1795 (sometimes hailed as the greatest achievement of the French revolution in the field, it was supported by Napoleon, and has since produced numerous distinguished graduates). State recognition and authority greatly enhanced the status of the schools, and by the end of the mid-twenties, many regarded the French system as the most advanced in the world, and it was widely imitated as a consequence.(33) But before 1815, the schools' fortunes fluctuated, and financing was eratic. Artz comments: "The whole system never functioned well until after 1825."(34) The system that developed consisted primarily of the École polytechnique providing a generalist engineering education with a heavy emphasis on mathematics and other basic theoretical subjects, and a number of Écoles des application, into which graduates of the former school, along with some non-polytechniciens, passed. From there the engineers entered into various branches of the state service for which the speciality schools prepared them. The École d'application included the École des pont et chaussées, École des mines, École d'artillerie, École des ingénieurs géographes, École des ingénieurs de vaisseaux, and the École du génie militaire.

In addition, the École centrale des arts et manufactures, emerged in 1829 during the Bourbon Restoration, as a private venture college, with the object of training engineers for industry in order to raise the productivity of French manufacturing industry and to facilitate competition with England. Wickenden, in his 1929 study, stresses the influence of the English model on the French developments: "The granting of a royal charter to the Institution of Civil Engineers in London in 1828 emphasized the contrast between the strong position of civilian engineers in Great Britain and their weak position in France. These influences led a group of French scientists, Dumas, Ollivier, and Peclet, and an engineer Benoit, to join with a public spirited capitalist Lavallee in creating a private school at Paris in 1829 for the purpose of training civil and mechanical engineers, heads of manufacturing establishments and teachers for technical schools.(35)

Unlike the École polytechnique and the Écoles d'application (and particularly, from the point of view of civil engineering, the Écoles des ponts et chaussées, and École des mines), the École centrale des arts et manufactures did not become a state-supported school until 1857.(36) By all accounts at mid-century the schools had excellent facilities, faculties and exclusive competitive entrance examinations, by the standards of the day. Something of the scope of the French system may be gauged from the number of graduates. From 1794 to 1815 the École polytechnique alone annually graduated about 120 engineers. The average intake for the period 1796-1831 was 134; for 1831-1850, 301. The École centrale des arts et manufactures had 140 students on opening in 1829, and 4,560, admissions by January 1864, including some 600 foreigners.(37) The schools influenced engineering education outside France, particularly in Russia after the Napoleonic wars, but also elsewhere on the Continent and in the United States.

Theoretical and scientific excellence in engineering education replaced pupilage and apprenticeship: "There is nothing in France resembling the pupilage of English Engineers."(38) After school young men received practical experience by being attached to an important industrial enterprise as "supernumeraries, draughtsmen, or sub-engineers"; in the last two positions they were paid, as volunteers they were not, but under no circumstances was any kind of apprenticeship or pupilage fee demanded from them.(39) The "very few" engineers trained in offices or works "seldom inspire the same confidence as the others",(40) a situation precisely the reverse in England.

Unlike in Britain, the rigid German status system contributed to the rejection of engineering as a subject suitable for incorporation into the university.(41) The Technische Hochschulen developed separately from the universities, originating in technical schools and colleges, some dating back to the 18th century. These eventually grew into polytechnics (Polytechnikum) differentiated from the universities by lack of state-sanction of status and degree awarding powers, and later in the century these in turn emerged as Hochschule.

By mid-century, institutions that were later to develop into Technische Hochschulen had been established in Dresden (1828), Berlin (1866), Karlsuhe (1829), Stuttgart (1828), Darmstadt (1936), Brunswick (1845), Munich (1927), Hanover (1831). In 1765 a royal Bergakademie was established at Freiberg by Prince Xavier of Saxony for the teaching of mining and metallurgy. J.A.Eytalwein contributed to its organization and became director and Professor of Engineering Mechanics. Although small in size until the middle of the century when it was largely the preserve of foreigners, its influence was great, not least through the spread of the principle of Lehr und Lern-Freiheit to the universities via Von Humboldt, an ex-student. The Bergakademie was set up for training state officials, civil engineers, surveyors and architects.(42) In 1799 a royal Bergakademie at Berlin was opened by Frederick William111 of Prussia. The states of the old Austrian empire also developed technical education in the early 19th century, which later became engineering centres. Other trade schools were also founded in this period between 1799 and 1835, and many went on to become polytechnics in the years between 1835-1875, after which these institutions began to achieve university status.(43) Karlsruhe, the first polytechnic of it kind in Germany, originated in 1825 with the amalgamation of two older schools, after the efforts of Nebenius, liberal economist and statesman, who sought to establish in Baden a school modelled on those in Paris. The Fachschule/Hochschule distinction (based on the scientific generality of the teaching) was introduced by Nebenius at an early time with Karlsruhe becoming a Hochschule in 1833, and professionally orientated (the Hochschule designation was not adopted until 1885, but it was from 1833 organized on this basis). Charlottenburg grew out of the Bergakademie at Berlin (1799). By 1850 it had become an institution giving a four year professional training. Other polytechnics that later were to develop into Hochschulen progressed in a similar manner: a gradual raising of standards and change of functions; for example, Darmstadt polytechnic was so designated in 1864, previously being a Realschule at its establishment in 1822, then a higher industrial school in 1836 and finally Hochschule status in 1877.(44) German engineering education has been historically more practical than the French, e.g., in Prussia practical training between periods of formal education was demanded of engineering students intending to enter the state service, but although industrial training was viewed as an integral part of engineering education, it was not as in England the main or in most cases the sole element nor were fees demanded of pupils (schools were state financed and fees ridiculously low by British standards).(45)

In both France and Germany the most active associations on questions of engineering professionalism originated among the graduates of particular schools. The Société des ingénieurs civils des France (SICF) formed in 1848 around a nucleus of the graduates of the École centrale des arts et manufacture, and a number of other French associations also arose in this way, e.g. the Société des anciens élèves des écoles nationales d'arts et metiers, along with other specialist study and student associations. In Germany, the VDI began as a student association at the gewerbe-akademie (46) and developed into a national organization of graduates of engineering schools in 1856. Engineering educators were active among the membership from its inception; in particular, the first director, S.Grasof, was professor of applied mechanics in the Karlsruhe Polytechnical Institute, one of the earliest Technische Hochschulen,(47) which also provided other early supporters. School-based societies have also grown out of the engineering schools and departments in Britain. The Society of Engineers was set up by former students of the College of Civil Engineers in 1854; at first it was known as the "Putney Club",(48) but on comparison with the German and French associations its role in the profession has been wholly insignificant, as has been that of the associations of university enginering students in Britain.

Engineering schools in the United States emerged in the 1820s, most noticeably with the Rensselaer Polytechnic Institute at Troy in 1823 by Stephen Van Rensselaer, "(it) developed in the course of twelve years into a professional school of civil engineering, the first in the English speaking world."(49) Predated in its applied science teaching by the Military Academy at West Point, it first adopted the title "civil engineering" for some of its studies in 1828. The name Polytechnic Institute was adopted in 1849, at which time it became a truly professional engineering school, partly modelled on the Ecole centrale des art et manufactures.(50) Various colleges and universities began to adopt engineering studies in the forties and fifties, including Harvard and Yale, though Harvard did not develop its program until the 1890s, well after the other Cambridge, a factor in the emergence of the Massachusetts Institute of Technology in 1860.(51) A chair of mathematics and civil engineering was set up at Yale in 1852. By the fifties at least six engineering schools existed. Nevertheless, not until the expansion of engineering education after the sixties did such formal education become a primary route of entry. Before this apprenticeship and pupilage were common, if not the normal mode of study and they survived afterwards to a limited extent in segments of the profession.(52) Attempts to found a national association of engineers go back to the thirties: "In 1834, the American Railroad Journal wished for a national organization in the United States like the Institution of Civil Engineers. The editor anticipated that a society might give its members such prestige that companies would single them out for jobs...."(53) The Boston Society of Civil Engineers, founded in 1848, was active to 1860; the New York American Society of Civil Engineers, founded in 1852, was moribund by 1855, after only a local appeal; the American Society of Civil Engineers did not operate on a permanent footing until 1867, fully thirty-seven years after the Institution of Civil Engineers and nearly a century after the Society of Civil Engineers.

To conclude, France was the undisputed leader in theoretical and scientific engineering education during the first half of the 19th century. Aspects of the organization of its professional schools spread to Germany in the polytechnics, to Russia and to the United States. Germany also developed a system of schools but they had to struggle against the universities for full professional status through the century, a problem that did not emerge in France both because of the circumstances of the creation of the engineering schools and because the universities were largely moribund until the 1890s. In both cases the establishments were state-supported and their graduates looked towards the state services for employment.

British theoretical and scientific engineering education in the 1830s and 1840s did not compare favourably in either the extent of provisions or the numbers trained.

The Development of the British Profession 1860-1890: Relations with Technical Education

The sixties saw heightened concern over the lack of professional schools in British engineering comparable to those in France and those being developed in Germany. This alleged deficiency became linked with the issue of foreign competition, highlighted by the Paris Exhibition of 1867, organized by Le Play the sociologist, then Commissioner-General for the Universal Exhibitions of 1855 and 1867. In the Great Exhibition of 1851 Britain practically carried away all the honours; in the 1868 Paris Exhibition, Britain won only 10 out of 100 departments. The situation was a serious one, there were signs that foreign competitors could take the lead in engineering, and the general anguish and demand for progress eventually contributed to the belated development of the British system of scientific, technical and engineering education outside the universities. But amid this, what was to become through the rest of the century, growing outcry over the slow pace of British response to Continental initiatives in social technology, the voice of the Institution of Civil Engineers and the organized profession was not to be heard. While other engineering professions fought for improvements in education, as did British pure scientists, British engineers (with some special exceptions) resisted the growth of theoretical and scientific engineering education.

The problem of British education did not go entirely unnoticed however, within the ICE, but the educationalists were a small force to contend with the rank and-file with their interest in maintaining the existing system of pupilage and apprenticeship. In 1866 Sir John Fowler in his Presidential Address went so far as to suggest that theoretical engineering education in England "is not considered to be quite equal to that of France or Germany", quickly adding "in practical branch we are admittedly superior".(55) After strenuously asserting that no advance in the theoretical "ought to be obtained by any sacrifice whatever of our undoubtedly great practical knowledge", he urged that steps be taken to bring England to a position of equality with France and Germany.(56) While the spirit of the address was applauded by the progressive engineering press, which urged the collection of funds for a British École polytechnique,(57) Fowler's, it was observed, was an isolated voice and there was no organized support within the ICE. President Fowler himself and his few supporters among the educationalists were able to establish a class of students in 1867 consisting of pupils to Members who sought Membership themselves and were, somehow, gaining a general or theoretica education, proof of which they were supposed to produce before Council before their election.(58) The following year it was proposed to introduce "readerships" for students to enable them to gain theoretical and scientific knowledge, but this, like so many other similar proposals, was never carried out.(59) In fact the major outcome of Fowler's demands was a thorough comparative study of the status and education of engineers,(60) which implied, by the selection of materials for publication rather than direct statement, that Britain lagged behind the Continent in the number of centres and in provision for these, a reason being that "it is not the custom in England to consider theoretical knowledge as absolutely essential".(61)

The report recognized a series of centres as providing instruction "bearing on the profession of engineering" ((emphasis mine))(none, of course, had the full sanction of the Council, as providing a complete engineering education): King's College, London, University College, London, The Royal School of Mines, London, The Royal School of Naval Architecture, London, the University of Edinburgh, University of Glasgow, Trinity College, Dublin, Royal College of Science Dublin, Queen's College, Cork, and Owen's College, Manchester.(62) The Royal Agricultural College, Cirencester, also gave some instruction relevant to the "constructive operations of agriculture" coming within the engineering field.

Despite the evidence of Continental excellence, it was still maintained that any deficiency in theoretical and scientific attainments was outweighed by the proficiency in practical work, which has given such a high standing to the profession in this country."(63) Neither was the Student class a success: C.B. Vignoles, in his 1870 Presidential Address, again referring to the theoretical superiority of the French engineers so evident to him from the study,(64) observed that the scheme for the formation of a Student class with a "view to affording their theoretical education",(65) did not show signs of being efficacious. In the absence of hard and fast criteria of the theoretical , practice orientated Councils, as most were, simply continued admitting on traditional lines. After Vignoles' term ended the entire matter was quietly dropped by the Institution even at the level of mild debate. Students were actually warned against too much theory for the practical engineer.(66) Theoretical education was considered here and by a large segment of the Membership as a disadvantage, and indeed many were the instances when employers would choose unqualified over graduate engineers, taking the view that the latter had the hard additional task of unlearning what had been taught to them. In the sixties and seventies, engineers employed by the railways complained that after employers reluctantly let them leave their companies for a university engineering education, they could not regain their positions even at their old level. The more liberal view among engineer-employers (the majority of ICE Presidents and Council during the 19th century) was that the intending engineer would not regret a university education followed by pupilage or apprenticeship.(67) In 1878 the question of the ICE exerting any pressure was finally dismissed: action was not taken because the Council felt that the Civils "could not become a scholastic institution".(68) President John Frederic Bateman went on in his Address to assert that the fact that British engineers were not better trained than the French on the theoretical and scientific side was not due to the lack of facilities, but because parents did not encourage sons to use them.(69) Bateman dwelt on the extent of provision in England, itemizing those centres where "special instruction is given bearing on the profession of engineering", which had been recognized by the Council, and adding the College at Durham, the Whitworth

Scholarships, the Examinations for the Engineering Service for India, the Royal India Engineering College, as well as private establishments.(70) At the most, all that is needed in British engineering are a few minor improvements to the theoretical side to back up the practical system.(71) But, the present system, to the extent that it is purely theoretical, is also open to criticism: "I cannot, therefore, help expressing myself upon this Institution ((i.e., the Royal India Engineering College)) as I have upon Trinity College, Dublin, and Queen's College, Cork, that the idea, which is evidently entertained, that a young gentleman will be thoroughly educated in both theory and practice, and fitted at once to act as an engineer, is a mistake, and has a mischievous effect in inducing him to think that he is master of a profession of which he has but a partial knowledge."(72) Bateman took exception to the fact that the Royal India Engineering College, Cooper's Hill, permitted direct access to the state service to a proportion of its graduates on the French model.(73) A preferable arrangement was provided by the Crystal Palace School of Practical Engineering, which actually managed to train students for pupilage: "This seems to be a laudable arrangement, and, if successful and well supported, may be expected to be attended with beneficial results."(74)

Although further action by the Institution of Civil Engineers was not to be taken until the nineties, the themes voiced by Vignoles, Fowler and other engineering educationalists, found an outlet in the technical press, which was far more outspoken in its demands. The journal Engineering, in particular, from the time of its foundation in 1866 under the editorship of Zerah Colburn throughout the period of Dr.W.H.Maw's editorship from 1870 to 1924, pressured constantly, through flood of criticism in editorial and feature articles, for reform in engineering education and the technical education system, reaching a height of ten editorials in 1897. By contrast, the Engineer was not so ardent a supporter of the Continental schools. In 1883 it ran a leader in favour of maintenance of the apprenticeship system and against Professor Huxley's wish to replace it with technical education. The leader claimed that apprenticeship and pupilage were alive and well as the methods of entry into professional Institutions, and not a dying route as Professor Huxley claimed.(79) The editorials and articles in Engineering frequently depicted pupilage and apprenticeship as the "curse" of British engineering: a system designed to keep out the talented and recruit only those with private means. The educational value of the institutions was minimal: pupils learnt little, and were exploited as cheap labour by principals.(76) Alternatively, attendance at the engineering schools could easily be secured by the action of the profession: "Let it be given out, as distinctly as the leading engineers, and especially the younger but rising engineers, care to commit themselves, that they should give a preference, in the selection of their pupils and assistants, to those who had passed satisfactory examinations at the Engineer's School (or College, if the term be preferred), and an attendance of pupils would be at once secured which would render such a school self-supporting."(77) Along with Haw, Vignoles at University College, Wheatstone at King's, Huxley and Playfair at the School of Mines, Rankine at Glasgow, and Fleming Jenkyn at Edinburgh, all advocated the creation of a few colleges of the highest rank.

There were many reasons for the reluctance of individual practitioners to abandon practical training. Engineers hesitated to engage graduates of engineering schools and universities because it upset the office by the introduction of persons who had mastered a substantial part of the profession with too little difficulty.(78) Such education threatened the mystery and mystique of the profession, qualities enriched through apprenticeship and pupilage. There was also the financial aspect, certainly important. Pupilage can supply both inexpensive labour and a premium, and is easily subject to abuse. In architecture(79) and in surveying (80) and the land professions, interest in pupilage was a reason for opposition to both formal examinations and registration.

Professionalization and Engineering Education.

Criticism of the passivity of the ICE was accompanied by the repetition of the Civils' pattern of the thirties, of intial support for theoretical and scientific engineering education from the younger Institutions now emerging. These organizations, all in the early stages of professionalization and each eager to establish the legitimacy of its own speciality, made tentative moves for incorporation into professional schools and universities.

The Institution of Naval Architects helped set up the Royal School of Naval Architecture at South Kensington in 1864. In a well received paper "On the Education of Naval Architects in England and France", before the Institution in 1863,(81) J. Scott Russell, a founder member, stressed the important influence within the INA exerted by pupils of the former School of Naval Architecture as well as the alleged superiority of the French naval architect and his education. The paper led to action by the INA President, Sir J.S.Pakington and a committee of leading naval architects and Admiralty patrons who overrided the objections within the Institution, many to the effect that "my son will return to me from Eton, as well fitted to be a naval architect by the practical education he will afterwards receive, as if he were educated in a school of naval architecture",(82) and went on to launch the school in conjunction with the Science and Art Department. For its part the Department courted the INA "to render the School acceptable as possible to the shipbuilding interests of this country....,"(83) and appointed Dr. Woolley, one of Her Majesty's Inspectors of Schools and INA Secretary (1875-78) to take charge along with Captain Donnelly R.E.(84) Similarly, Members of the IME were active in the foundation and early growth of Owen's College, Manchester, in 1851 (made possible by Ŀ100,000 left in the will of John Owens, a Manchester Merchant), among whom were C.F.Bayer, one of the original IME Members, Sir Joseph Whitworth, and Sir William Fairbairn,(85) all involved with leading engineering firms in the district. Osborne Reynolds was the first professor. This intial activity on the part of the Mechanicals was not characteristic of the policy of the Institution in subsequent years,till the turn of the century.(86)

The Institution of Electrical Engineers took an interest in the further development of education in its speciality during the early years of professionalization. In

1889 Faraday House Engineering College, London, was founded by the profession. It came to award an Associateship of Faraday House (A.F.H.) after a three year course in mechanical and electrical engineering.(87) Some of the smaller Institutions were also keen to legitimate their status through links with centres of engineering education. The study of engineering at Durham was revised in 1871 at Armstrong College in Newcastle under the guidance of the University and the North of England Institute for Mining and Metallurgy.(88) James Kitson, the locomotive engineer, was among the original proposers of the Yorkshire College of Science, afterwards part of Leeds University.(89) Later the Association of Civil and Mechanical engineers donated £9,000 out of the £10,000 needed to build new engineering buildings in 1886. During the same year, the North East Coast Institution of Engineers and Shipbuilders helped to establish a chair of engineering and naval architecture at Newcastle and it continued to maintain close contact with the department.(92) The Institution of Gas Engineers has close connections with the University of Leeds; in 1909 it aided the endorsement of the Livesey Chair of coal, gas and fuel studies.(92) Other Institutions also developed early relations,(93) but the context in which this quest for legitimacy by the younger Institutions took place was changing; engineering education rapidly expanded irrespective of the wishes of the profession, and again the problem of too much provision of theoretical and scientific engineering education was to arise.

The Expansion of Engineering Education in England between 1880-1918

The initiative for the expansion of engineering education in the last quarter of the 19th century came from outside the profession itself, which (with the exceptions mentioned) preferred to remain aloof. It was during this period that the groundwork of the English system was laid by such bodies as the Science and Art Department, the Royal Institution, the Society of Arts, the National Association for the Promotion of Technical Instruction (established in 1887 as a result of the activity surrounding the 1881-4 Royal Commission on Technical Education and later disbanded), and other pressure groups representing both the public and private interest. The expansion took place against a backdrop of more generalized educational provision following the Education Act of 1870, which was the beginning of the introduction of universal elementary education, levied on the rates, and state modes of finance for expansion of education at all levels.

The newer "redbrick" universities received their charters late in the century. Many grew from earlier colleges that provided facilities for engineering education and continued to be receptive to the inclusion of engineering in their period of formative development.(94) Sanderson emphasizes that industry and the universities maintained close connections in Britain especially during this period of critical initial expansion, and that the acceptance of engineering was one "of the firmest links binding the universities and industry."(95) The first of these modern universities was Victoria University (previously Owens College, Manchester) chartered in 1880; in 1881 the Royal Commission on Technical Instruction reported that the new science buildings were comparable to anything in Germany. Others, many substantial foundations and equally embracing engineering followed: Hartley Institute (University College in 1902), Southampton University in 1952; Newcastle College of Physical Science 1871, became an independent university in 1963; Yorkshire College of Science 1874, into Leeds University in 1904; the College of Science for the West of England 1876, into Bristol in 1909; Firth College 1880, into Sheffield 1905; Mason Science College 1880, into Birmingham 1900; University College 1881 into Nottingham University 1948; University College (Liverpool) 1882, to Liverpool 1903; University Extension College 1892, to Reading 1926; and Exeter Technical College and University Extension College 1895, to Exeter 1955. Both in their early years as scientific and technical colleges and in their maturity as universities, these centres taught engineering as a major part of their program. Some indeed were too eager to train engineers. Imperial College, the product of the amalgamation of the Royal School of Mines, the Royal College of Science and the City and Guilds Technical College at South Kensington under its charter of 1907 when there were 600 full-time students, was greeted at the time of its establishment as the basis of a "British Charlottenberg"; a designation that the engineering profession resisted in its full implication. ICE President White had stressed that the model of Charlottenberg should not be "slavishly copied".(96) Other colleges compared favourably to the Continenal schools in the eyes of foreign observers. An American engineering educator in Europe reported in 1898, after a prolonged investigation and extended tour of both works and schools, that "The Durham College of Science in Newcastle-upon-Tyne is one of the most progressive, earnest, practical schools in Europe."(97) Imperial College did not expand as rapidly as Cambridge, which quickly became a leading centre, at first under the guidance of Sir Alfred Ewing, who established a laboratory in 1890. By 1913 the enrollment was 250 and this practically doubled within the next two decades, making it the largest university school of engineering and technical science. At Oxford the chair of engineering science was established in 1909, and a laboratory in 1913. The enrollment for the next two decades was about 30. Despite this expansion, however, overall there were in 1900 only 345 third year and 52 fourth year students of engineering in the country, many entering with inadequate secondary education.

Non-university engineering education also made great advances. The Glasgow and West of Scotland Technical College, designated the Royal Technical College in 1912, was one of the oldest colleges of applied science in the English speaking world, dating back to 1796, and was remoulded out of Andersons' college and two other institutions in 1886. In 1895 it was re-housed in a new building, a "magnificent plant", and later affiliated with the University of Glasgow. The Robert Gordon College; the Heriot-Watt College (that became affiliated with the universities of Aberdeen and Edinburgh as faculties of technology respectively); the Municipal College of Technology (Manchester), with origins in the Mechanics Institute of 1824 and expanded under the Acts of the eighties, and linked with the Victoria University in 1905 as a faculty of technology, also emerged as leading centres during this period. By 1929 the latter boasted one of the most extensive educational plants in Great Britain. Finance for the developments came from the Act of 1889 and the Education Act of 1908, which gave the local authorities powers of control and administration over technical education. The Local Taxation (Customs and Excise) Act 1890, provided "whisky money" for the development of new establishments and the expansion of those in existence. Between 1890-1902 nearly £900,000 was spent; resulting in twelve polytechnics or technical institutions in London, and a further 100 science schools. The City of London Parochial Charities Act of 1883 yielded funds for the London Polytechnics By 1830 there were over 200 technical colleges in England and Wales, and a further 21 in Scotland.

Of crucial importance for an understanding of these developments and the significance of the engineering Institutions to the development of engineering education in this country is that no nationally recognized system of accreditation was established apart from the designation of a limited number of establishments as universities, which themselves were not without problems of recognition. These new and expanding centres had to gain recognition for the degrees and diplomas offered in engineering as they had "hardly the same practical value as those in Arts or Medicine."(98) One engineering professor in Wales, as late as 1917, gave evidence that his degree had "hardly any professional value outside the college."(99) London County Council found that the city was "overstocking the market with 'half-baked' engineers."(100) The City and Guilds provided a national standard but at a level below that of the professional engineer, mainly for technicians and craftsmen.(102) These establishments could not easily define their status in relation to requirements that dovetailed with the system of secondary education, because it also was highly diversified. This meant that unlike on the Continent where the engineering schools tend to be defined in relation to secondary education, there was a need for agencies outside establishments themselves to regulate standards. It also meant that whenever possible centres of higher engineering education sought status through incorporation into the university system rather than independantly as in Germany. It is this diversity of standards, establishments, provision, which is the outstanding feature of the British system when viewed on a comparative basis. This fact is of crucial importance to an understanding of the actions taken by the profession in subsequent decades. The provision was adequate. What was absent was any means for the employer, state or public of recognizing the meaning and value of a given diploma --- hence the famed "localism" of British technical education. In such circumstances the Institutions as the representatives and arbiters of the established and recognized profession were able to take the lead in providing some overriding national standards, an outcome supported by industry and state, while pressure for a high-status system of technical education autonomous from the profession was mitigated within the educational field itself by the pattern of selective upgrading of the cream of the technical colleges into universities. Before examining some of the consequences, the response of the profession to expansion will be examined in more detail.

Developments in Engineering Education in France, Germany, Canada, Australia and the United States

In France little expansion in engineering education took place between 1860 and 1890, but from the 1890s a number of new centres took shape: the École d'ingénieurs in Marseilles (1891); the École speciale des travaux publics, du bâtiment, et de l'industrie, originally trained subalterns in the state administration of public works; the various specialist schools, most important here, École supérieure d'électricité at Paris (1894) set up by the Société Française des électriciens; and, the university institutes, the institutes techniques, emerged as specialist schools after the reforms of 1896.(103) By the 1920s the foundations of the present structure had been laid: the École d'arts et métiers are at the bottom, with the university institutes and certain private schools occupying an intermediate place, and the École polytechnic, Écoles d'application, École centrale, and the various schools of specialization in Paris forming the elite of the profession,(104) a hierarchy partly reflecting the relative prestige of routes from the secondary educational system, and partly the exclusiveness of the typical employments of graduates.(105) The schools continued to maintain high standards. Speaking of the Écoles de ponts et chaussées, an American observer of the European engineering scene could say that "it would be difficult to find in any country any civil engineering school that surpasses, possibly equals it, in scope, extent, thoroughness and completeness."(106)

In Germany, the Technische Hochschulen, founded at Dresden (1851); Berlin (1866), Karlsruhe (1865), Stuttgart (1862), Darmstadt (1868), Hacken (Aix-la-Chapelle) (1870), Brunswick (1877), Munich (1877), and Hanover (1879) progressed toward full university status at the turn of the century. The rejection of engineering as an academic discipline and the low status of the practitioners within German society, provided the stimulus for progressive and reformist drives in the actions of the profession. From the establishment of the intitial polytechnics until full recognition as Technische Hochschulen, the profession acted as a pressure group for the expansion of engineering education. The successive rises in status were partly the outcome of the activities of the VDI and the willingness of the state to respond to the pressure, by provision of facilities, finance and legal degree-conferring rights. In 1899, the centenary of the Bergakademie, the Technische Hochschulen at Charlottenberg (perhaps the most outstanding of the nine schools) was formally recognized by the state when Emperor William 11 granted the right to award the degrees of Diplom-Ingenieur, Dokter-Ingenieur, and Doctor Honoris Causa.(107) By 1898 these engineering schools "could not, in their special methods be further improved".(108)

The policy of the VDI had been formulated in 1864 by the adoption of the recommendations of the Grashof Report. In essence this advocated the elaboration of a distinction between the polytechnics, which should evolve into technical universities, and lesser schools for the training of technicians. The distinction could be drawn by the regulation of entry requirements from the system of secondary education. The policy also called for the widening of the careers of the polytechnics' graduates to incorporate non-engineering functions. These aims were vigorously pursued, and nearly all the major recommendations of the Grashof report were adopted, greatly facilitating the rise in the status for the profession.(109)

In Australia, the primary expansion in engineering education, both in the universities and in the technical colleges, came late in the century, starting in the seventies, with major foundations in the eighties. Some Australian Technical Colleges originated in Mechanics Institutes and Schools of Art, the earliest in the 1860s. In 1895 and 1897 the first diplomas in engineering were awarded in New South Wales and Victoria.(110) Canadian education progressed along similar lines.(112) Although in both cases expansion in education followed British example and leadership, the pattern of association differed. Whereas the ICE was formed in 1818, the first Australian societies grew up at the time of educational expansion, the earliest, the Engineering Society of New South Wales, was founded in 1870 and incorporated in 1884. The Institution of Engineers, Australia, founded in 1919, incorporated in 1926 and granted a royal charter in 1938, resulted from centralization of some ten existing societies, the majority of which did not cater for specialities, but were colonial associations or in some cases recruiting from a particular kind of practice or educational institution.(113) These bodies did perform some qualifying and other professional functions (the IAE took these over in its examinations) but were not of course established on anything like a comparable basis to the British Institutions, which were extremely influential within the Australian profession for some years after the foundation of the, at first rival, IEA.(127) There were some exceptions: the Australian Institute of Mining and Metallurgy and two regional societies did not participate.(115)

The development of the Canadian profession is similar to that of the Australian in these respects; as in Australia and Britain the origins of engineering education lie in the first half of the century, but expansion did not take place until the last quarter.(116) The first society of import, the Canadian Society of Civil Engineers, incorporated in 1877, gained state recognition in the late nineties as the qualifying body for civil engineers within the provinces of Manitoba and Quebec where legal restrictions on practice were intitiated. It is out of this body that the Institution of Engineers in Canada developed. After the movement during 1910-1920, registration and similar functions were delegated to the provincial corporations and the IEC has since acted as a central spokesman for the profession, and learned society. Again unity was achieved through the lack of indigenous organizations with an established status; the British Institutions functioned as qualifying bodies, as in Australia.

The relationship of the American profession to the educational system, at the stage of early expansion, shows some similarity with the Australian and Canadian professions: yet as with these two, there are also numerous differences that are less relevant here (from the standpoint of the broad differences with the British profession).

The Morrill Land Grant Act of 1862 provided the primary stimulus to expansion. Between 1862 and 1872 the number of engineering schools jumped from about 6 to 70 as a result of the funding and land made available by the Act, itself the outcome of a popular movement among farmers and mechanics: "Within a period of twenty years the federal government made grants from the public domain which considerably exceeded the area of Great Britain to aid the States in establishing colleges of agriculture and mechanic arts."(117) A leading college and model for others during 1870 and 1900 was Cornell.(118) It was, however, later after the 70s that the schools developed formal engineering program ---from 17 in 1870 to 110 in 1890. As a consequence the number of persons styling themselves "civil engineer" in the census returns rose from 512 in 1850 to 4,703 in 1870, and 8,261 in 1880; and between 1880-1920 the engineering profession increased almost 2,000% from 7,000 to 136,000 members.(119)

Two characteristics stand out in their bearing on the present status of the American profession. The engineering schools are more autonomous from profession and state than they are in any of the other cases considered;(120) the Societies have had little control over their standards. Secondly, great differences in standards exist between engineering schools. Most of the American professional organizations developed along with the expansion in education and as a result of it. The American Society of Mechanical Engineers, founded in 1880 almost as a gentleman's club, represented the interests of established engineers practicing before and during educational expansion.(121) The American Institute of Electrical Engineers was formed in 1884; soon afterwards in the same year the American Society for the Promotion of Engineering Education, a body significantly without a British counterpart, was set up to further the interests of numerous educationalists within the profession. At first it was composed of men teaching civil, mechanical, mining and electrical engineering (engineering educators not practitioners) and became in subsequent years a powerful organization, gaining control over curricula and admission standards. The ASCE at first claimed to represent all engineers, but it never achieved the level of recognition commanded by the Institution of Civil Engineers. An indication of the relative lack of establishment of the American Societies compared to the Institutions was their easy admissions policy, a characteristic of trade and study associations. The early constitutional history of the Founder Societies records numerous internal disputes over the nature of the association on the trade/profession axis, similar to the Institution of Gas Engineers.(122) The American Societies never provided a national qualification fully equivalent to the Membership of the Institution of Civil Engineers, or other major Institutions.

Practical Education and the Process of Fragmentation: The Response 1890-1917

The expansion of theoretical and scientific engineering education in Britain represented a potential threat to the basis of the status of practitioners. Should the new universities and technical foundations produce fully qualified graduates on the much vaunted Continental model, control over education and employment would eventually pass from practicing engineers to higher educational and state agencies both of which showed signs of seeking autonomy from the profession.(123) At the elite trend-setting Cambridge engineering school in 1882, for example, Professor J. Stuart certified that "the Cambridge School of Engineering could supply a complete preparatory training to the engineering profession."(124) Should lesser establishments also aspire to such autonomy the Institutions would gradually lose their qualifying role and be replaced by a Continental style system. These changes called forth action within the profession.

Action was again prefaced by research and study urged on by such leading ICE Members as Sir John Wolfe Barry, Sir William White, Sir Guilford Molesworth, Dr. Kennedy, Professor Unwin, and Mr. Siemens. The first major investigation into the relation of professionalism, the Institution, education and training, appearing in unpublished form in 1889,(125) declared that along with a necessary "natural aptitude" for the occupation, the engineer needed a "fair and suitable theoretical education", and a "thorough practical training".(126 But the expansion of technical education on the Continental model was an over-reaction at the expense of the practical: "Institutions((of higher engineering education)) were formed which professed to teach engineering entirely within their own walls, and to send their pupils out full-blown Engineers, capable of undertaking anything the public chose to entrust to them. It is hardly necessary to say what deplorable failures resulted from this course."(127) The main outcome of the report, part of which was later published in abbreviated form,(128) was the establishment of the projected Student class of 1870 on a firmer footing. After June 1889 Students would need a certificate of proficiency in subjects of general education to be specified by the Council (generally at a level equivalent to, e.g., matriculation in the University of London or the Engineering Department of King's College). Descriptions of facilities for engineering education along with a list of "examinations recognised by the Council"(129) were published as a guide for the intending student. But these changes fell short of the introductio of examinations for entry into the Institution. The profession lagged behind the Inns of Court, the Incorporated Law Society, The Royal College of Surgeons of England, Royal College of Physicians of London, Royal Institute of British Architects, Institute of Chartered Accountants, Institute of Actuaries and the Surveyors' Institution, which had all adopted, albeit reluctantly in most cases, qualifying entrance examinations earlier in the century. The lack of formal examinations reflected the opinion of the engineering establishment that practical training through pupilage and apprenticeship sufficed for full professional status, and the Institution's fear that if it introduced examinations for the Associate

Member career grade, entry via practical training would decline as a consequence.(130) But the 1889 inquiry had left no doubt in the minds of ICE officials that theoretical engineering education had come to stay, and the engineering examination was finally adopted for entry into the Associate Member grade in 1897. The Institution of Municipal Engineers already had examinations and the other major Institutions quickly followed the Civils as Table 4 shows. The introduction of examinations by the Civils had an immediate impact on higher engineering education with many establishments, especially the young and foreign, adopting curricula and standards in line with the ICE requirements for recognition of courses and exempting from their own A.M. examinations.(131) But the control that could be exerted through formal

Table 1

ESTABLISHED ENGINEERING INSTITUTIONS: DATE OF FORMATION AND DATE OF INTRODUCTION OF EXAMINATIONS

Date	Exams	Institution
1818	1897	Institution of Civil Engineers
1847	1913	Institution of Mechanical Engineers
1854	1912	Society of Engineers
1863	1926	Institution of Gas Engineers
1866	1922	Royal Aeronautical Society
1871	1913	Institution of Electrical Engineers
1873	1886	Institution of Municipal Engineers
1889	1935	Institution of Marine Engineers
1889	1947	Institution of Mining Engineers
1892	1950	Institution of Mining and Metallurgy
1897	1920	Institution of Heating and Ventilating Engineers
1908	1920	Institution of Structural Engineers
1921	1932	Institution of Production Engineers
1922	1925	Institution of Chemical Engineers
1945	1965	Institution of Road Transport Engineers

examinations was not sufficient to guarantee the future prosperity of the Institutions, so at the same time the ICE and others acted to ensure the survival, continuation and strengthening of the practical tradition that many predicted was now coming to an end.

The Institutions' program for adaptation to expansion in theoretical and scientific engineering education emerged through two decades of debate in a series of reports and conferences that produced the peculiarly British formula for engineering education, the combined theoretical and scientific education with practical training and experience. This formula was almost exclusively the product of Institution thinking and reflects the dominance of practitioners over educators in their Councils. The first conference, staged in 1903, had been urged by educationalists among the Mechanicals who desired to see improvement of British engineering education on the Continental model, (132) but their enthusiasm was tempered by the representatives of the Civils, Electricals, Naval Architects, Mining, Gas, Scottish and North East Coast Institutions of Engineers and Shipbuilders. A Committee of the conference produced the White Report in 1906,(133) acceptable to the profession because it reiterated practitioners' views on the necessity for practical training both before and after a period spent in scientific and theoretical engineering education.(134) This was hardly suprising as the report reflected response to a questionnaire sent overwhelmingly to practicing engineers rather than educators, (135) although not all educators favoured the purely theoretical, for example, Professor John Dewar Cormick thought the theoretical to have been overemphasized when "technical education fever was at its height", and called for a standardization of practical training. (136) Not less than 72% of those responding felt that intending engineers should spend one year in an "introductory workshop course" before undergoing engineering education at a college or university; and a further 21% felt that one year was too short, with only 4% not agreeing (3% gave no answer). Most thought that this year should either be before going to college or after the first unspecialized year, but not at the end of college education.(137) On one question 31% were found to favour no college at all after the workshop period, which was to follow on general education relevant to engineering up to the age of 17. Some 63% supported alternation between college and practical training, 42% of which wanted six month periods. The one question on which the response strayed from this pattern, is significantly on the point of whether or not practical training ought to be introduced into colleges, which a majority were against. Such support for practical education and for the accommodation of the theoretical with the practical through the newly arrived at sandwich system, reflected the fact revealed in a later survey that in 75% of the works covered "regular arrangements" existed for pupilage (over half the remainder were in engineering departments of municipal authorities) and this excluded private practice because there was no doubt at all that pupilage continued to flourish there.(138)

Another Conference on Education and Training of Engineers held at the ICE in June 1911 dealt largely with the relationship between the practical and theoretical, debate focusing on whether the practical training should come before, during or after the major portion of engineering education.(139) By now the question of the expansion and improvement of theoretical and scientific engineering education, which had stimulated the 1870 and 1889 investigations at the Civils and the 1903 conference, had almost completely given way in Institution circles to discussion of how to adapt and accommodate practical training to changes in education. The 1911 Conference led to a 1914 report wholly concerned with the practical: the ICE Council instructed a committee to determine whether the conditions of practical training could be more clearly defined in the bye-laws and whether coordination between engineering colleges and engineers and other employers over practical education could be improved.(140) Another survey of 234 engineers and firms(141) found that 75% or 175 took in either indentured or unindentured pupils or apprentices, (75% of whom paid premiums), 59 did not take them. Most of those not having formal schemes with certificates being issued at the end and an agreed upon course of study expressed willingness to adopt such a program under Institution supervision.(142) These findings strengthened the resolve of the Civils to further institutionalize the "routine" of pupilage, to standardize the courses of practical training, and ensure that passage through such a scheme continued to be part of the requirements for practice. Specifically three conclusions were reached: the provisions of the bye-laws for practical training were adequate as to the minimum period of practical training, b) practical training should involve some sort of prior agreement on the course of study, c) such agreements should be accompanied by statements, useful to the Institution, pupil and engineer, on the scope and progress of the training (especially if there were no articles). These conclusions lay behind subsequent Institution policy, also informed by the belief that "the status of engineers depends very much on the conditions of entrance to the profession."(143)

The opinions and attitudes expressed by leading practitioners in the conferences, debates and surveys during these years of professional adaptation to educational change is largely coterminous with that of "industry" and "industrialists" as expressed in the pattern of support for scientific, technical and engineeing education. The well-known reluctance of British industry contrasted with American, German or French to employ graduates or products of purely theoretical or scientific engineering education is to be largely explained by the influence and interests of the organized engineering profession. The higher walks of Institution membership have been fused with the highest levels of management, administration and ownership of industry.(144) The policy of Institutions is formulated by such engineers and by the leading practitioners, an elite within Institutions that has from a purely professional standpoint had little interest in expanding a kind of education through which they themselves did not pass. While the negative attitudes of business towards scientific instruction (145) also partly reflect the conservatism of persons not themselves so trained, in the case of professional engineering a strong interest in practical training combined with such traditionalism to produce a genuine hostility towards these "swollen headed" youths "intolerable alike to the employer and workman".(146) These graduates would "be of no greater value---possibly even less--- than apprentices without college training."(147) Engineers blamed the failure of small engineering businesses on their management by university bred idealists, out of touch with the practicalities of manufacturing.(148) Civil engineers put the widespread complaints of the public that industry rejected graduates to the "popular belief that a university degree in engineering completes an engineer's training."(149)

In short, the resistance to formal engineering education as a complete professional qualification in industry, and especially to university graduates, came firstly from the engineering profession, the members of which collectively sought to ensure that the purely theoretical never supplanted the practical routes of entry. The reason was a simple one: the mainstay of Institution support historically derived from the absence of alternative modes of qualification; the establishment of Continental style engineering education would have dealt a death blow to the Institutions by undermining their main function. Consequently, they acted at first to resist expansion of purely theoretical engineering education, to strengthen practical routes, and finally to promote and support the diversity in the English technical education system on which they thrived.

The Development of National Certificate Schemes: 1921-1961

In the interwar years a number of schemes developed by means of which the Institutions came to exert control over the content of theoretical engineering education: foremost were the national certificate schemes.

The first of the National Certificate and Diploma schemes started in 1921 after the Board of Education approached the Institution of Mechanical Engineers, "the leading professional body concerned in this field of educational work", with a proposal for "a joint endorsement of the Local Certificates by the Board and the Institution."(150) Its authors intended the scheme to develop the "Science and Art" examinations by further coordination in the courses and subjects, but the Education Committee of the Council of the Institution of Mechanical Engineers, under the chairmanship of Dr. Hele-Shaw, recommended a considerable extension of the original proposal, in the form of a national scheme with certificates regulated jointly by the Board of Education and the Institution (The Scottish Education Department and Ministry of Education, Northern Ireland also adopted the scheme). Hailed as "one of the most remarkable steps forward that our Institution has ever taken towards the control of education of mechanical engineers",(151) the Mechanical vigorously encouraged the scheme, providing prizes and medals for exceptional achievements, and more important, permitting holders of the certificate exemption from parts of the Institution's own examinations, the major factor in the success of the scheme.

The Institution of Electrical Engineers joined the plan in 1923(152); like the Mechnicals, the qualifications led to partial exemption from the IEE's own examinations. Others followed: Table 2 shows the date of introduction of schemes

Table 2

DATE OF INTRODUCTION OF NATIONAL CERTIFICATE AND DIPLOMA SCHEMES FOR SELECTED INSTITUTIONS

Date	Subject and Institution
1921	Mechanical Engineering
1923	Electrical Engineering
1926	Naval Architecture
1941	Production Engineering
1943	Civil Engineering
1951	Chemical Engineering
1952	Mining and Mine Surveying
1957	Mining
1958	Aeronautical Engineering

for minor and major Institutions.

The certificates created a non-university route via formal education to professional status. The basic feature of all the schemes is a Joint Committee of the Ministry of Education and the appropriate Institution that supervise the questions and marking of the examinations in the approved technical schools and colleges. The examinations have to be submitted to the Institutions' assessors (by the college) as do the marked scripts, so that they may be altered in accord with national standards. The external assessors may substitute up to 40% of the questions and make up to 40% of them compulsory. Possession of an HNC exempts the aspirant from part of the Institution's examinations; further examinations are "endorsements" on the certificate and this permits of further exemptions. Reaching this level takes 4-9 years of concentration on the speciality usually in evening classes, and formally qualifies the aspirant, in the first instance, for graduate membership of the Institution, e.g., G.M.I.Mech.E. A number of years practice and attainment of a position of sufficient responsibility enable the aspirant to apply for Associate Membership, e.g., A.M.I.Mech.E. After many more years of practice and the achievement of high responsibility in the profession, the HNC may be elected to "full membership", e.g., M.I.Mech.E., with a right to also designate himself as a Chartered Mechanical Engineer. By comparison with the HNC part-time route, the full-time HND has never been popular: it did not provide an inexpensive avenue for the ambitious craftsman into the ranks of professional engineers as did the HNC, which permitted the financial burden to be spread over years of night class attendance. A consequence has been that the Institutions with heavy intake from the part-time routes also have a wider social class composition. The IEE and IME expanded their membership by recruiting through the HNC in the interwar years. At the Mechanicals, 1,253 students from over 50 schools sat the first examinations in 1922; by 1937 3,327 students participated in the scheme in 139 schools; and by 1946 the numbers sitting for the final examinations reached nearly 12,000. At the Electricals 600 candidates came forward in 1926, and 2,500 by 1938. On the other hand the interwar period was not one of expansion in the provision of engineering education within the universities. The number of students in technology (engineering and applied chemistry, mining, metallurgy and architecture) decreased from 3,882 in 1922-1923, to 2,959 in 1927-1928, to 3,498 in 1933-1934 with an increase to 4,217 in 1938-1939. Pure science fared a little better. But the percentage of students reading science and technology both together and separately decreased between 1922-1923 and 1938-1939, from 19.3% to 16.2% in science and 12.5% to 11.3% in technology.(153) What expansion occured was largely through the new routes opened up from the technical education system, and especially the HNC, which had been as popular with industry as it was with the Institutions and students.(154) By 1957 (just before the Institutions' policy over part-time education changed(155)) a third of all engineers were being recruited through HNCs, (see Table 3).

The national certificate schemes are numerically the most important of the various relationships that have been built up between the Institutions and the technical education sector. As well as recognizing examinations as exempting from part of their own examinations (e.g., HNC and HND), the Institutions may exert control by inspecting a college and accrediting the department as recognized to teach for its own examinations, or at an extreme prescribe syllabuses at a level granting exemptions from their exams. The Civils, who shunned HNCs save for a brief period of experimentation after WW11 (it proved too popular and was dropped), had developed the latter relationships to a greater exent than the other Institutions, and as can be seen from Table 3, differ from other Institutions, who differ among themselves, in the high proportion (two-thirds) of graduates and persons taking their examinations directly (usually in a college with a joint Institution scheme). Whatever the relative source of intake, the end claim of Institutions remains the same: that all their members have a professional qualification above and beyond that of any given examination, by virtue of practical training and experience, while their examinations are set at university level.

Education and the Stucture of Engineering Professions

The structure of the French system of professional organization today remains similar to that which emerged in the 19th century; a number of changes however, have led to a consolidation in the system.(156)

At the apex are the prestigious Grandes écoles, which still supply the specialist schools with recruits for the state-service. The Grandes écoles now comprise the following major centres: the École centrale des arts et manufactures; the École nationales supérieures des Mines; École nationale supérieure de l'aéronautique; École nationale supérieure du genie maritime; École nationale supérieure des télécommunications; École nationale supérieure des ponts et chaussées; Institute national agronomique; and the École supérieure d'électricité.(157) Most of the schools(whose alumni are known as "anciens élèves") have an intake of about 50 students a year except for the École centrale and École supérieure d'

Table 3.

QUALIFICATIONS FOR EXEMPTIONS OFFERED BY NEW ASSOCIATE MEMBERS OF PROFESSIONAL INSTITUTIONS (1957) AND MEMBERSHIP FOR 1957

Institutions	Total	Full or partial exemptions on account of Univ. degree	Associate-ship	HNC	other	no exemp.	Grads.	Assoc. Mech.	Memb or Fells.	Total*
Aeronautical	346	145	8	62	125	--	1,261	4,304	504	6,059
Chemical	129	105	1	7	6	8	859	1,409	608	2,876
Civil	807	602	8	65	--	131	3,690	12,293	2,762	18,745
Electrical+	937	443	22	393	79	--	13,246	18,624	4,066	35,936
Gas	69	10	--	31	27	1	--	1,539	1,160	2,699
Marine	411	21	--	--	390	--	746	2,139	5,143	8,023
Mechanical	1,614	290	10	1,129	185	--	15,495	21,745	4,787	42,027
Metallurgists	179	91	4	--	33	51	942	1,920	860	3,722
Mining and Metal	72	42	25	--	5	--	--	1,291	692	1,983
Municipal	128	31	2	5	14	76	--	3,366	1,807	5,173
Naval Arch.	130	29	31	35	62	--	--	1,608	1,304	2,912
Production.	406	21	--	303	82	--	2,259	5,192	1,720	9,171
Structural	322	70	12	25	28	187	2,077	3,679	1,120	6,876
Total Eng.	5,544	1,900	95	2,057	1,038	454	40,565	79,109	26,533	146,207
Percent.	100	38	2	34	18	8				

Notes. Source: Office of the Lord President of the Council, data supplied for G.L. Payne, Britain's Scientific and Technological Manpower, London, 1960; and adapted from Table 6.9 and Table 6.10, pp. 215-217.

+ The distribution of electrical engineers by type of exemption is partly estimated.

* Students and honorary members are excluded. Some of the HNC totals include a few HND holders.

Associateship column: these awarded by Manchester College of Technology, the Royal Technical College, Glasgow, the Heriot-Watt college, Edinburgh, the Camborne School of Mines. Other awards include: diplomas of Imperial College of Science and Technology, Loughborough College of Aeronautics (one of the eight national colleges); associateships of the City and Guilds of London Institute and of several distinguished technical colleges, alumni of the service training schools (Royal Naval College, Royal naval Engineering School, Royal Air Force Technical College and Royal Military College of Science). In the case of marine engineers - holders of certificates of proficiency awarded by the Ministry of Transport. The same data for 1961 is presented in Robbins Report, op.cit., Table B8.2. App.B2, p.536.

électricité, which admit about 300. A basic homogeneity is maintained by highly standardized entrance requirements, and, of course, physical proximity in Paris.

The Écoles nationales supérieure d'ingénieurs are also part of the high level establishments. These predominantly provincial centres developed out of the university institutes; the state consolidated the status of the university institutes in 1947 by standardizing entrance requirements and organization. Admissions reach as many as 150 per year, but the average intake is 40. Most notable among the schools are: E.N.S. des industries chimiques de Nancy; E.N.S. de chimie de Strasbourg, École de physique et chimie industrielles de Paris; E.N.S. d'électrotechnique d'hydraulique et de radioélectricité de Grenoble, E.N.S. de le Metallurgie et de l'industrie des mines de Nancy, E.N.S. de géologie appliquee et de protection miniere, École centrale de Lyonnaise, E.N.S. d'électricité et de méchanique de Nancy, École supérieure de travaux publics. There are 18 altogether. These schools share with the Grandes écoles an admission requirement of a two-year preparatory course, with an emphasis on mathematics, following completion of the Baccalauréat. The standing of these schools, along with that of others (private and municipal) of roughly the same standard, is maintained by state certification. The courses generally last for three years (after the two following the Baccalauréat for admission), ending in an examination and the right to adopt the title Ingénieur. In the case of the Grandes écoles preparatory courses may last three years after the Baccalauréat, or even longer. The next level is the Écoles d'ingénieurs d'arts et metiers, entry to which is possible after one years preparation on top of the Baccalauréat. The structure reflects the length and status of the preparatory courses necessary before a student may sit the competitive entrance examinations or concours d'entrée. Admission to the Grande école d'ingénieurs is, thus, usually at about 21, the Baccalauréat level is achieved at 18.(158) The output of the schools in 1974 gave a composition to the French profession as follows: 23,000 graduates from the arts et metiers; 12,000 from the polytechnique; 12,000 the Écoles centrale des arts et manufactures; 10,000 École supérieure d'électricité;

a further 1,5000 came from another 20 schools, and the remainder, less than 1,500 from the rest of the schools.(159)

The designation of the establishments is regulated by the state Commission de titre d'ingénieur established in 1934 in the Ministère de l' éducation nationale, which accredits schools by giving them the right to use the title ingénieur-diplôme.(160) Schools both in the public and private sector are granted this right under the law of 1934. In 1958 about 125 schools were accredited by the Ministry, graduating some 3,000 engineers a year. The Ministry is able to exercise control over standards through this instrument.(161) In 1974 there were about 141 schools, each granting the title Ingénieur followed by the name of the school. The Écoles d'arts et metiers grant the degree of Ingénieur d'arts et metiers; the École centrale the degree of Ingénieur des arts et manufactures, and the abbreviation I.E.C. (Ingénieur diplôme de l'école centrale). The titles are protected in law.

Close connections exist between the schools and industry as well as the state. The Schools' Councils included representatives of industry and commerce, as does the teaching staff, while the School Principal is a government appointee. Firms cooperate with the schools in providing practical courses in the schools' workshops and laboratories, to prepare students for industry, while undue specialization is avoided by a balance between the theoretical and practical in the curricula along with the inclusion of subjects in science, technology, languages, law and economics.(162) These ties between the schools and industry serve as equivalents to the British apprenticeship and practical training schemes within industry.

Although the borderline between the various schools is often ill-defined in terms of relative status, this hardly constitutes a fragmentation comparable in scope to that of the British profession. The difference between the schools is not great; a basic minimum standard of qualification flows from state regulation of designations. This minimum level for entry and qualification, enclosing some 170,000 engineers in 1974, or half the total claimed number of engineers in the census for Britain in 1971 (or just over the number of chartered engineers at the same date). One prominent French engineer and society official concluded his discussion of the status and education of French engineers with the observation: "French engineers are conscious of belonging to a 'social body', concerned with the general public and national interest. They have achieved unity of action and devote their efforts to maintain and develop higher educational establishments to train higher grade personnel for the industrial and commercial world by selection and multi-disciplinary training, which are characteristics of the French system of 'Grandes Écoles'".(163) This sense of community and common interest is nurtured by the Federation of the French Associations and Societies of Diploma Engineers (FASRID) active on questions of the recruitment to and training in the schools, the retraining of engineers, the role and participation of engineers in the organizational work-setting, the position of engineers in official and other bodies, as well as environmental and other issues. It is associated with the scientific and industrial societies, e.g., the Society of Electricians, the Society of Automobile Engineers, both study associations, in contrast with the British Institutions. It is also active in the Conseil National des Ingénieurs Français (CNIF), a coordinating organization linking principals of the schools and heads of large industrial enterprises.(164)

German engineers qualify upon graduation from a Technische Hochschule marked by attainment of the Diploma ingenieur, which is legally restricted to successful candidates at the final diploma examination, Diplom-Hauptprüfung. Beneath the Technische Hochschule are some 82 Ingenieurschulen (known previously as Fachschulen), 67 of which are state owned(whereas all of the Technische Hochschulen are) the others being mainly administrated by cities. They prepare students for a state examination and the right to the title Ingenieur.(166) The two levels differ in the course of instruction and requirements, the age of entry, entry requirements,and subsequently, like their French counterparts are partially defined in relation to standards in the secondary education system Below the professional level of technical education are establishments for technicians, the Technikerschule, graduating "state examined technicians", and below that the *Berufsschule* providing part-time vocational schooling for apprentices of trades and crafts, who left school at fifteen. The *Technische Hochschulen* recruit from the *Höhere Schüle* (*Gymnasium*), *Mittelschule* (*Realschule*) and the *Ingenieurschule*; the *Ingenieurschule*, as well as recruiting from these two, also take students from the *Berufsschule* and *Lehre* (*Gewerbliche Berufe*). The age of entry into the *Technische Hochschulen* being about 20, into the *Ingenieurschule*, about 18.(167) Further study at a *Technische Hochschule* can lead to the degree of *Doktor Ingenieur*. Only the academic titles of *Doktor Ingenieur* and *Diplome Ingenieur* are legally protected. While, as in the French profession, the relative prestige of the establishments in the secondary education system are important supportative and contributory factors to the structure of engineering education, more basic still is the type of employments and positions occupied by graduates.(168) The schools are furher differentiated by the extent and nature of the balance between practical and theoretical training, the level of generality, the non-professional levels concentrate on the practical. At the *Ingenieurschule* the five year course is divided into three theoretical and two practical, while at the *Technische Hochschulen* the five to six year courses have a variable but generally smaller practical component, replacing the post-graduate practical requirements of the British Institutions.

Consequently a main line of activity of the VDI in the educational sphere in recent years has concerned the distinction between the lower and higher elements.

Australian engineering education, like the British, is highly diversified, giving rise to a need for a uniform minimum standard (less important at first because of the presence of the British Institutions), permitting the development of an indigenous association of practicing engineers. The Institution of Engineers in Australia, by the recognition of colleges and courses, "effectively sets and controls the standard for admission to the profession of engineering, and the standard is maintained by keeping the courses and exceptions under constant review."(169) Control is by no means complete. All first-degree courses in engineering at the universities are recognized, although in the past some were not.(170) In the technical education sector the Institution can afford to be more restrictive; for example, in 1961 a number of courses at the Royal Melbourne Institute of Technology did not exempt the holders of the diplomas from the examinations for Associate Membership of the Institution.(171) The IEA does not have the autonomy of the major British Institutions. It recognizes courses leading to exemptions; it does not control the content of these to the same extent as the U.K. profession has been able to do. The IEA, like the British Institutions, has practical requirements as well as examinations---"a minimum of at least four years' experience for holders of certain degrees." (172) But, the resources of the IEA are not sufficient for it to exert the "degree of control over training schemes that is maintained by the United Kingdom Institutions."(173) The policy of the IEA visualizes a tighter grip on such schemes. The educational composition of the IEA is practically the same as in Britain for those entering in the period 1958-1960; 49.5% qualified with a university degree; 46% a technical college diploma; 1.2% certificates from Local Government Boards and 3% examinations of the Institution. 19.8% of those entering via the technical colleges did so part-time.(174)

In the United States the key feature of the educational scene remains the autonomy of the engineering schools from the organized profession. Nothing like the grip of the British Institutions on engineering education is exerted by any of the American Societies. Engineering is alone among the established professions in having the bachelors degree as the basic minimum qualification for entry; other professions, especially medicine and law have succeeded in using this degree largely for a pre-professional and liberal education.(175) Educators have been far more prominent in the leading positions of the engineering Societies than in Britain. Attempts to control standards through the Engineers Council on Professional Development and other organizations, have had some impact since the report of the Society for the Promotion of Engineering Education in the twenties, mainly leading to greater uniformity in standards throughout the country, but still in the early sixties at a level for the bachelors degree often said to be the equivalent of the British HNC.(176)

The relative exclusiveness of engineering professions may be gauged from comparative manpower statistics. Such figures say nothing about the quality of the education of the professional personnel in the various categories; many persons described as "technicians" in England may, for example, have the same quality of engineering education as professional engineers in the United States. Table 4 shows the ratio of technicians to engineers for France, Great Britain, the United States, the Soviet Union and Western Germany. Problems of comparability (177) do not alter the exceedingly high ratio of technicians in Britain. There are industry differences (in metal manufacture it reaches a high of 6.3 technicians for every engineer)(178), but it is quite clear that in Britain professional engineers (members of the major Institutions) are a highly exclusive group, even more than in France. Noramally this exclusiveness, also prominent on an Australian comparison, (179) should lead to a high status for the profession.

Table 4

RATIO OF ENGINEERING TECHNICIANS TO ENGINEERS IN FRANCE, GREAT BRITAIN, UNITED STATES, SOVIET UNION, AND W.GERMANY.

Country	Reference period	No. of Eng. in tot.lab. force	No. of Engrg. technicians in tot.lab.force	Ratio of Eng.Techs. to Engs.
France	1954	140,000	340,000	2.42
G.B.	1959	100,800	Not avail.	4.20
U.S.	1960	853,738	275,072	0.32
S.Union	1960	1,236,000	2,157,000	1.74
W.Germany	1956	74,741	189,676	2.53

Source: William M. Evan, "On the Margin--The Engineering Technician", in P. Berger, ed., The Human Shape of Work, New York, 1964, pp.83-112.

Conclusion

The British profession has been peculiarly successful in maintaining its autonomy from engineering education, and could expect a higher status as a result, but the fragmentation process has dampened the effect of its control, gradually leading to a situation in which the profession has become a barrier to the development of a high status system of engineering education. The relationship of the professions (included in comparisons) to engineering education differs considerably; but the really significant difference between the British profession and the others lies in the pattern of its historical development in relation to that educational system, a pattern which has affected the nature and extent of fragmentation. In Britain the profession became established before the large-scale expansion of engineering education, in other societies the profession either developed as a result of educational innovation, as in France and Germany, or coterminously as in Canada, Australia and the United States. The result has been differences in the structure of interests within the respective professions; in Britain a legacy that has proved to be its "curse". The Institutions reacted to the threat to their survival posed by educational expansion by insisting on practical training; but pupilage and apprenticeship reinforced fragmentation and socio-technical specialization. The outcome has been that while the Institutions maintain a grip on entry and technical education, an internal gradation was substituted for the barriers and divides on which exclusiveness is founded. In this context the collective pursuit of status has brought the profession into conflict with "theoretical" and scientific engineering schools that are in most societies an important, if not the main, element in professional organization and status.

Footnotes to Chapter 4

1. B.A.McFarlane, "The Chartered Engineers: a study of the recruitment, qualifications, conditions of employment and professional associations of chartered civil, electrical and mechanical engineers in Great Britain", London, unpublished Ph.D. thesis, 1961, p.57, Table 9, found that of the 55 engineers in his DNB sample who were born before 1780, 18 went through a craft apprenticeship, 9 worked in engineering or related fields, 4 were engineering pupils, 6 university educated, 8 recruited from other professions, 5 from commerce and/or business, one farmer, one "jack-of-all-trades", one home spinner (plus two for which there was insufficient information).

2. Cf. George Emmerson, Engineering Education, a Social History, Newton Abbot, David & Charles, 1973, p.247.

3. See N. Hans, New Trends in Education in the Eighteenth Century, London, Routledge and Kegan Paul, 1951, ch. VII; cf. S. Pollard, The Genesis of Modern Management: A Study of the Industrial Revolution in Great Britain, London, Edward Arnold (Publishers) Ltd., 1965, pp.104 et.seq.

4. McFarlane, op.cit., p.58, Table 10; in his DNB survey found that of the 55 engineers born before 1780, 27% had little or no education, 16% went to school to the age of 14, 11% went to a good school to that age (i.e. grammar, private or private tuition), 5% went to school beyond the age of 14, 9% went to university, 5% graduated(presumably the 9% went but did not graduate), 4% went to military and naval schools, 15% went through an apprenticeship of some unspecified kind, and for 7% there was no information.

5. John Rickman, ed., Life of Thomas Telford, Civil Engineer, written by Himself, containing a Descriptive Narrative of his Professional Labours: with a folio Atlas of Copper Plates, London, James and Luke G. Hansard and Sons, 1838, p.3.

6. Cf. D.H.Calhoun, The American Civil Engineer, Origins and Conflict, Cambridge, Massachusetts, The Technology Press, M.I.T., 1960, pp.47-50.

7. T.J.N.Hilken, Engineering at Cambridge University, Cambridge, 1967, p.36.

8. Emmerson, op.cit., p.323.

9. Emmerson, op.cit., p.115.

10. F.J.C.Hearnshaw, The Centenary History of King's College, London, G.G.Harrap & Co., p.147.

11. H.H.Bellot, University College London, 1826-1926, London, University of London Press, 1929, p.40. Millington, the Professor of Engineering and the Application of Mechanical Philosophy to the Arts, also a professor at the Royal Institution, resigned the chair in 1828 after the refusal of the Council to give a salary £400 a year. On Vignoles' appointment and career, see pp.260-7.

12. Emmerson, op.cit., p.119.

13. J.A.Ewing, The University Training of Engineers, an Introductory Lecture delivered January 20,1891, Cambridge, C.U.P., 1891.

14. Cf. J. Coutts, History of the University of Glasgow, Glasgow, James MacLehose & Sons, 1909, pp.171,338,390,409.

15. Herbert G. Taylor, The Education of Engineers, London, G. Bell and Sons Ltd., 1917, p.2.

16. Hearnshaw, op.cit., pp.190-191,120,146-150.

17. C.E.Whiting, The University of Durham, 1832-1932, London, Sheldon Press, 1932, pp.74,80-83,188-191.

18. Cf. Taylor, op.cit., pp.8-9.

19. "Address of the President"(January 15th 1839), Min.Proc.ICE., Vol. 1 (1837-1841).

20. From a letter to Mr.A.T.Walmislay (Past-President of the original or first Society of Engineers---not the Smeatonians---from M.H.P.Stephenson, one of the founders of the olds Society, dated 24th January 1888, reprinted in "Putney College for Civil Engineers", Trans.Soc.Eng., 1930, pp.107-109.

21. Whiteing, op;cit., pp.104-105.

22. Cf. Ewing, op.cit., p.4;cf. Eric Ashby, "Education for an Age of Technology", chapter 32 in Singer et.al., eds., A History of Technology, Oxford, The Clarendon Press, 1958, Vol. V, p.780, it is put at 1878. The Cambridge Natural Science Tripos was started in 1878, which provided opportunities for Mechanical Engineering education. John Hopkinson, for example, (1849-1898) took his degree in 1871, spending 1872 as a Fellow and then directly entering into practice. James Weig, John Hopkinson, Electrical Engineer, London, A Science Museum Booklet, HMSO, 1970. Cf. Wilkin, op.cit., pp.97-98.

23. Trans.Soc.Eng., op.cit., pp.107-109.

24. James Walker, "Address of the President to the General Meeting, Febuary 2, 1841", Min.Proc.ICE., Vol. 1 (1837-41) pp.23-27.

25. "School of Engineers", Report of 1838, Min.Proc.ICE., Vol. 1 (1837-1841) p.4.

26. Prospectus, cited in "On the Status and Training of Civil Engineers. With Data as to the Means Available for Promoting the Education of Engineering Students, prepared at the request of the Council of the Institution of Civil Engineers", a set of partially corrected proofs prepared by William Pole, London, Library of the Institution of Civil Engineers, 1889, pp.44-5.

27. Eng., Vol.8 (Nov. 11, 1859) p.351; cf. H.Byerley Thompson, The Choice of a Profession (A Concise Account and Comparative Review of the English Professions, London, Chapman and Hall, 1857, pp.287,300-301, estimates the premium for engineers as being between Ł200 and Ł500,for architects Ł100 and Ł500. Taking into account other expenses Thomson puts the cost of entry into civil engineering at not less than Ł1,000.

28. "The Education of Engineers", Eng., Vol. XXlll (Feb.,15, 1867) p.141.

29. A number of non-University professional schools in related fields were established without undue resistance, partly or in some cases mainly as a result of pressure group activities. Cf. D.S.L.Cardwell, The Organisation of Science in England, London, Heinemann, 1972 edition, for the pressure group acitivity, and below.

30. Obituaries of Past-Presidents, Library of the Institution of Civil Engineers.

31. McFarlane, op.cit., p.61, Table 13.

32. Ibid.

33. Frederick B. Artz, The Development of Technical Education in France, 1500-1850, Cambridge, Massachusetts, The Society for the History of Technology and the MIT Press, 1966, pp.151-166,230-253, for the status system in the period 1814-1848; see pp.81-86 for the intitial development of the Ecole des Mines, and École des Ponts et Chausées; cf. p. 230, "The Ecole Polytechnique ...widely recognised as the leading technical school of Europe". William E. Wickenden, A Comparative Study of Engineering Education in the United States and Europe, Bulletin No. 16, of the Investigation of Engineering Education, 1929, see Society for promotion of Engineering Education, Report of the Investigation of Engineering Education, 2 Vols., University of Pittsburgh, Pittsburgh, P.A., 1930, Vol.1, pp.748-1038, pp.9-15 for early and revolutionary period development and pp.21-23 for the status of these schools up to 1850 (on a comparative basis); at 1850 France was still the leader in engineering education. See also, H.C.Barnard, Education and the French Revolution, Cambridge at the University Press, 1969, chapter 10.

34. Artz, op.cit., p.166.

35. Wickenden, op.cit., pp.16-17; cf. Artz, op.cit., pp.247-253, for a description of its establishment and early progress.

36. Chapter 5 infra.

37. Wickenden, op.cit., pp.9-11; Artz, op.cit.,pp.81-85,195,233-252.

38. Evidence of M. Bruner, Inspector of the Imperial School of Mines, in Institution of Civil Engineers, The Education and Status of Civil Engineers in the United Kingdom and in Foreign Countries, London,ICE, 1870, compiled by Mr. Pole, p.30.

39. Ibid.

40. Evidence of General Morin, the director of the Conservatoire Imperiale des Arts et Métiers, Education and Status of Civil Engineers, 1870, op.cit., p.26.

41. On the rejection of engineering by the universities, see Wickenden, op.cit., pp.44-45,54-56; Cardwell, op.cit., pp.28-32; Abraham Flexner, Universities: American English,German, New York, Oxford University Press, 1930, pp.327-331, for discussion of separate development. See Joseph Ben-David and Abraham Zloczower, "Universities and Academic Systems in Modern Societies", European Journal of Sociology, Vol. 111 (1962) pp.45-84.

42. A.E.Twentyman, "Note on the earlier History of the Technical High Schools in Germany", Board of Education, Special Reports on Educational Subjects, Vol. IX (1902) pp.465-74,468-9.

43. Wickenden, op.cit., pp.47,45-6.

44. Wickenden, op.cit., pp.48-51' see also H.Hartmann, Education for Business Leadership: the role of the German Hochschulen, Paris, OECD, 1955.

45. Education and Status of Civil Engineers, 1870,op.cit., pp.97-8; and on fees, "The Official Report on Continental Education", Eng., Vol. 26 (August 7, 1868) p.104 wondered at the fee of 9s to £2 8s per annum for a single course of study at the Polytechnic School at Hanover.

46. Wickenden, op.cit., p.52.

47. S.P.Timoshenko, History of Strength of Materials, New York, McGraw-Hill

Publishing Company Ltd., 1953, pp. 133 et.seq.

48. "Putney College for Civil Engineers", Trans.Soc.Eng., 1930, pp.107-109.

49. Wickenden, op.cit., p.62.

50. Ibid. pp.63-4.

51. Ibid. p.66.

52. D.H.Calhoun, op.cit., pp. 47, 189-90; Monte A. Calvert, The Mechanical Engineer in America 1830-1910, Professional Cultures in Conflict, Baltimore, The Johns Hopkins Press, 1967, chapter 4 and p.77, Table 2, on the position of apprenticeship in 1896.

53. Calhoun, op.cit., pp.172-3.

54. Calhoun, op.cit., p.189; Calvert, op.cit.,p.109.

55. John Fowler, "Address of the President", Min.Proc.ICE., Vol.25 (1865-66) pp.203-228,220-221.

56. Ibid.

57. Engrg., Vol.1 (June 19,1866) p.42.

58. "On the Status and Training of Civil Engineers", op.cit., p.27.

59. "Report of the Council, Session 1885-86", Min.Proc.ICE., Vol. LXXXVI (1886) p.164.

60. Education and Status of Civil Engineers, 1870, op.cit.

61. Ibid., p.ix.

62. Ibid., p.3.

63. Ibid., p.ix.

64. C.B.Vignoles, "Address of the President", Min.Proc.ICE., Vol. XXIX (1869-70) Pt.1., pp.272-318.

65. Ibid., p.316.

66. T.Hawksley, "Address of the President",Min.Proc.ICE., Vol. XXXIII (1871-72) Pt.1., pp.333-351,350.

67. Thomas E. Harrison,"Address of the President", Min.Proc.ICE., Vol. XXXVII (1873-74) Pt.1., pp.225-243,227.

68. John Frederick Bateman, "Address of the President",Min.Proc.ICE., Vol. LII (1877-78) Pt.II., pp.2-35,7.

69. Ibid.

70. Ibid., pp.8-9.

71. Ibid., p.10.

72. Ibid., p.11.

73. The Royal India Engineering College, Coopers Hill, Calendar for 1879-80, London, W.H.Allen & Co., 1879, p.5.

74. Bateman, op.cit., pp.11-12. For details of the course of instruction, see Second Report of the Royal Commissioners on Technical Instruction, London, Eyre and Spottis Woode, 1884, Vol. 1, pp.417-8.

75. Eng., Vol. 65 (Febuary 10, 1888) p.116.

76. "Engineering Education", Engrg., Vol. 1 (Febuary 2, 1866) pp.78-9; cf. Engrg., Vol. 1 (Jan.,19,1866) p.42.

77. Engrg., Vol.1 (Febuary , 1866) pp.78-9.

78. Engrg., Vol.3 (May 24, 1867) pp.536-537.

79. Kaye, op.cit.,pp.105, 147.

80. Thompson, op.cit., p.209.

81. J.S.Russell, "On the Education of Naval Architects in England and France", Trans.INA., Vol. lV (1863) pp.163-88. Cf. J.Scott Russell, Systematic Technical Education for the English People, London, Bradbury Evans & Co., 1869, pp.7-8 and passim.

82. Trans.INA., 1863, op.cit., p.178.

83. Letter from Henry Cole at the Science and Art Department, reprinted in "Address of the President", Trans.INA., Vol. V (1864) pp.xxii-xxiv for letter.

84. Trans.INA., op.cit., 1864 and Woolleys paper "The Education of Naval Architects".

85. Joseph Thompson, The Owens' College:its Foundation and Growth, Manchester, 1886, pp.295-6,314,553-7, appendix lll,p.633.

86. For one of the few official references see, The Right Honorable the Marquis of Hartington, M.P., speech at Annual Dinner of IME, Min.Proc.IME., Vol. 39 (1888) pp.170-172, and the reply, Edward H.Carbutt, "Address by the President", Min.Proc.IME., Vol.39 (1888) pp.272-288,286-7. Hartington was President of the National Association for the Promotion of Technical Education. His proposals were received coolly.

87. Rollo Appleyard, The History of the Institution of Electrical Engineers, 1871-1931, London, IEE, 1939, pp.73-76, for an account of the IEE's desire to see technical education furthered in the 1880s and in relation to the City and Guilds of London Institute for the advancement of technical Education.

88. See Footnote 17.

89. A.N.Shimmin, The University of Leeds, The First Half Century, Cambridge University Press, 1954, p.13.

91. Michael Sanderson, The Universities and British Industry, 1850-1970, London, Routledge and Kegan Paul, 1972, p.91.

92. A.G.Higgins, "The Institution of Gas Engineers", PE., (July-August 1963) No. pp.129-30.

93. The IGS provided finances for the appointment of resident staff at the University of Leeds, Shimmin, op.cit., p.172.

94. For a brief review of the provision made for engineering and technology in those establishments during the period, see Michael Argles, South Kensington to Robbins, an account of English Technical and Scientific Education since 1851, London, Longmans, 1964, pp.49-54; see also Wickenden op.cit.

95. Sanderson, op.cit., p.14.

96. Proc.IME., April 1903, p.292.

97. Elmer L. Corthell, "Report upon Engineering Education, to Dr. W.R.Harper, LLD., President of the University of Chicago", 1898, typescript document in the Library of the Institution of Civil Engineers.

98. "On the Status and Training of Civil Engineers", 1889, p.22.

99. Cf. Sanderson, op.cit., p.140.

100. The problem seen by the Committee was one of "quality" not "quantity", compared to Zurich, the Federal Polytechnic School which Professor Unwin, from whom advice on the matter had been taken, described as one of, if not the best in Europe. London County Council, Report to the Special Committee on Technical Education, 1892, p.71, and see footnote 123 below. The conclusion was reached after taking advice from the profession.

102. See City and Guilds of London Institute, Memorandum on the Origin and Development of the Institute, London, December 1949.

103. Wickenden, op.cit., pp.18-23; cf. V.G.Couch, "A Sociological Interpretation of the Development of Technological Education in England, France and Germany during the 20th Century", London, University of London, unpublished Ph.D. thesis, 1953.

104. Wickenden, op.cit., pp.83-94.

105. See below and chapter 5.

106. Corthell, op.cit., p.19.

107. Wickenden, op.cit., p.50.

108. Corthell, op.cit., p.31.

109. Wickenden, op.cit., pp.52,53,54.

110. B.E.Lloyd and W.J.Wilkin, The Education of Professional Engineers in Australia, The Association of Professional Engineers, Australia, 2nd ed., 1962, pp.158-9.

112. Emmerson, op.cit., pp. 210-215.

113. Professor A.H.Corbett, "The First Hundred Years of Engineering Education, 1861-1961", Journal of the Institution of Engineers, Australia, (April/May 1961) pp.16-21, and IEA., "Development of the Engineering Profession", Seventh Commonwealth Engineering Conference, India, 1966.

114. Lloyd and Wilkin, op.cit., pp.33-34; cf. Corbett, Journ.IEA., op.cit., pp.16-

115. Ibid.

116. Royal Commission on Industrial Training and Technical Education, Report of the Commissioners Parts 1 and 11, Ottowa, 1913.

117. Wickenden, op.cit., p.68. See also, Society for the Promotion of Engineering Education, Report of the Investigation of Engineering Education, 1923-1929, 2 Vols., Pittsburgh, 1934; Wickenden's study is part of this investigation, much of which he directed, and which is unrivalled in its scope.

118. Charles Riborg Mann, A Study of Engineering Education, (prepared for the joint Committee on engineering education of the National Engineering Societies), Bulletin No.11, Carnegie Foundation for the Advancement of Teaching, New York,1918.

119. Raymond H.Merritt, Engineering in American Society, 1850-1875, Kentucky, University of Kentucky Press, 1969, p.10; and Edwin T. Layton, The Revolt of the Engineers, Cleveland, The Press of Case Western Reserve University, 1971,p.3.

120. Society for the Promotion of Engineering Education, Report of the Investigation of Engineering Education, 1923-1929, 2 Vols., University of Pittsburgh, Pittsburgh, P.A., 1930, Vol.1, pp.650-657, "The Influence of the National Engineering Societies in Engineering Education".

121. Calvert, op.cit., pp.114,109, et.seq. 122. Layton, op.cit. chapter 2.

123. London County Council desired to increase the number of engineers to a level unacceptable to the profession by excluding engineers from the category of a "close profession". Cf. London County Council, Report to the Special Committee on Technical Education, Being the result of an Inquiry into the needs of London with regard to technical Education, the existing provisions for such education, and the best means to be taken by the London County Council for improving that provision, under the Technical Instruction Acts, 1889 and 1891 and the Local Taxation (Customs and Excise) Act, 1890, by H. Llewellyn Smith, London County Council, 1892, p.71.

124. See Couch, op.cit., p.93.

125. Cf. on objectives, "Memorandum" by William Pole enclosed with materials in "On the Status and Training of Civil Engineers", 1889, op.cit.

126. "Status and Training of Civil Engineers", 1889, op.cit., p.15.

127. Ibid., p.17.

128. ICE, Engineering Education in the British Dominions, (compiled from official sources, with regulations of the Institution of Civil Engineers on the Admission of Students), London, ICE., 1891.

129. Ibid., pp.6-8, Schedule No.1, and appendix A for a list of the centres.

130. ICE, "Evidence given before the Committee on Examinations, Wednesday 6 January, 1897", London, ICE, 1897, p.12.

131. On the acceptance of ICE examination standards see, "Opening Address of the President", J.C.Hawkshaw, Min.Proc.ICE., Supplement to Vol. CLIV, "Engineering Conference, 1903", edited by J.H.T.Tudsbery, London, ICE., 1903, pp.10-15. The Associate Membership exams were taken by third year students at the Royal India Engineering College, see J.G.P.Cameron, A Short History of the Royal India Engineering College, Coopers Hill, Issued by the Coopers Hill Society,for private

circulation, 1960, p.11. The college itself shortly went out of existence because of the now adequate supply of suitably qualified engineers for the P.W.D., ibid., pp.28-33. On its closure cf. Eng., Vol. 102 (Nov. 2,1906) p.454 and the Royal Commission on Technical Instruction, Vol. 1, 2nd Report, Part 111.

132. W.H.Maw, "Address by the President", Proc.IME., Vol.60 (1901) pp.431-458; "The Education of Engineers in America, Germany and Switzerland", Proc.IME., Vol.64 (1903) pp.181-349; J.Hartley Wickstead, "Address of the President", Proc.IME., Vol. 64 (1903) pp.271-279,278.

133. ICE, Report of the Committee appointed on 24th November 1903, to consider and report to the Council upon the subject of the best methods of education and training for all classes of Engineers, London, William Clowes & Sons Ltd., for the ICE; and "Report of a Committee Appointed by the Council of the Institution of Civil Engineers on the 24th November, 1903", Min.Proc.ICE., Vol. CLXVl (1905-6) Pt. 1., pp.2-169.

134. "Report of the Council, 1905-1906", Min.Proc.ICE., Vol.CLXVl (1905-6) Pt.lV, pp.137-158. It is stated on pp.137-8 that the report was "especially satisfactory", because of the emphasis on practical training. Cf. Sir William H.White, "Presidential Address", Min.Proc.ICE., Vol. CLV (1903-4) Pt.1, pp.2-169.

135. Education and Training of Engineers, 1903, op.cit., appendix ll. The questionnaire was administered to 692 practicing engineers from various specialities and 44 persons who were professors or persons engaged in teaching, 237 and 30 being returned respectively.

136. Professor John Dewar Cormack, "Apprenticeship in Engineering Training", Min.Proc.ICE., Supplement to Vol. CLlV, "Engineering Conference, 1903", edited by J.H.T.Tudsbery, London, ICE., 1903, pp.92-98,93.

137. Education and Training of Engineers, 1903, op.cit.; on the statement that the workshop should be before the college or after the first year (i.e., that portion of college which is common to all engineering), 33% agreed, 47% before college, 10% after the common portion, and only 5% after completing college first, 3% alternating with college and 2% gave no answers.

138. ICE, Education and Training of Engineers, Report of the Conference held at the Institution of Civil Engineers, June 28 and 29, 1911, London, John Parkinson Bland, 1911, pp.20-21, and see The Times, July 5, 1911, for partial reprint.

139. Education and Training of Engineers, 1911, op.cit., especially Section ll and 111,(pp. 35-44,53-62)

140. ICE, "Special Committee on Practical Training, Report of the Committee, 6th April, 1914", London, ICE,1914, p.1, marked "confidential", (printed by William Clowes and Sons, Ltd.).

141. The sample included: a) engineers in private practice, 44(replies); b) railway engineers, railway mechanical engineers and dock engineers, 38, municipal, waterworks and gasworks engineers, 78, manufacturing engineering firms, 74; "Special Committee on Practical Training", 1914, op.cit., p.2.

142. Ibid., p.6, question 7.

143. Ibid., p.9.

144. See chapter 5 infra. for details.

145. S. Cotgrove, Technical Education and Social Change, London, George Allen and Unwin Ltd., 1958, pp.23-28, 76-81, 186-187.

146. "The Student and the Factory", Eng., Vol.134, (October 20, 1922) p.415.

147. Ibid.

148. "The Tragedy of the Small Engineer", Eng., Vol.134 (August 4, 1922) p.112, (letter).

149. C.L. Howard Humphreys and G. Howard Humphreys, The Training of a Civil Engineer, London, Edward Arnold & Co., 1932, pp.21-22.

150. R.H.Parsons, A History of the Institution of Mechanical Engineers, 1847-1947, London, IME, 1947, p.56.

151. H.S.Hele-Shaw, "Address of the President", Proc.IME., Vol. 103 (June-December, 1922) Pt. 11, pp.985-1011,990.

152. "Report of the Council for 1923-24", JIEE., Vol. 62(1924) p.531.

153. See Argyles, op.cit., pp.74-75.

154. J.D.Scott, Siemens Brothers, 1858-1958, An essay in the History of Industry, London, Weidenfeld and Nicolson, 1958, pp.258-259.

155. See chapter 7 infra.

156. See The Conference of Engineering Societies of Western Europe and the United States of America (EUSEC), Proceedings of the Third EUSEC Conference on Engineering Education, London, 1958, and other EUSEC publications. Most of the EUSEC materials are published by the British Engineering Institutions who also hold in their Libraries a considerable amount of related, unpublished, documents generated by EUSEC activity. Cf. Fédération Européenne d'Associations Nationales d'Ingénieurs (FEANI), The Training of Professional Engineers, London, ICE, 1972; cf. ASEE, "World Congress on Engineering Education", 1965, held at Illinois Institute of Technology June 21-25,1965, Library of the United Engineering Center, New York.

157. Pierre Morel, "Engineering Schools in France", French Bibliographical Digest, No. 28, Series 11, November 1959, for a description of the courses and other details of individual schools.

158. Cf. EUSEC, Report on Education and Training of Professional Engineers, London, Vol.11, "A Comparative Study of Engineering Education in EUSEC and OEEC Countries", 1961, pp.22-23,(cited as EUSEC, 1961,Vol.11); cf. EUSEC, op.cit., Vol. 1., "Introduction and description of the systems of Engineering Education in EUSEC and OEEC Countries", pp.27-31.

159. Rene Alquier, "Status and Education of Professional Engineers in France", PE.,Vol.17 (November 1972) No.4, pp.73-75.

160. EUSEC, 1961, op.cit., Vol. 1, p.27.

161. EUSEC, Proceedings of the Third EUSEC Conference on Engineering Education, London, IME., 1958, (Section VI) p.99.

162. Alquier, op.cit., p.73.

163. Ibid., p.75.

164. Ibid.

165. EUSEC, 1961, op.cit., Vol.11, pp.23-24.

166. Ibid., Vol. 1, pp.32-35.

167. Ibid.

168. For a study of the impact of social, economic and occupational factors on secondary education and the relative status of institutions, see Olive Banks, Parity and Prestige in English Secondary Education, London, Routledge and Kegan Paul, 1955; see also chapter 5 infra., on what the German profession has done to advance the position of practitioners in state and economy, which in combination with their activity on the educational front, has contributed much to the standing of the profession.

169. Lloyd and Wilkin, op.cit., p.3.

170. Ibid., p.207.

171. Ibid., pp.209-212 on unrecognised courses.

172. Ibid., p.3.

173. Corbett, Journ.IEA., op.cit., p.104.

174. Lloyd and Wilkin, op.cit., 1962, p.122 Table 6.1. and Appendix H., Table H.1, p.340, which shows that the university/technical college ratio has been steady since 1947, excepting yearly fluctuations (especially in the mid-fifties) with greater numbers coming from the technical colleges.

175. Cf. Robert Perrucci and Joel E. Gerstl, Profession without Community: Engineers in American Society, New York, Random House, 1969, pp.56-7.

176. On educational levels, see Merton J. Peck, "Science and Technology", in Richard E. Caves, ed., Britain's Economic Prospects, London, George Allen and Unwin Ltd., 1963, pp.448-84, 458; cf. Ministry of Education, Technical Education, 1956, Appendix A. Outside observers (the IEA) commented, "Registration has resulted in the adoption of a reasonably uniform standard of qualification throughout the country", in A Report by the IEA, "Registration of Engineers", PE., Vol. 9 (March/April 1964) No.2, pp.44-52, 45. Cf. K.S.Lynn ed., The Professions in America, Cambridge, Massachusetts, 1965, p.214; cf. C. Richard Soderberg, "The American Engineer", in Lynn, op.cit., for a brief account of the ECPD, EJC, and ASPEE; see C.E.Davies, "The Builders of the ECPD", 25th ECPD Annual Report, 1957; see Thorndyke Saville, "Achievements in Engineering Education", Trans.ASCE., 1953, CT, p.147; and see, H.L.Hagen, "The ECPD Accreditation Program", Journal of Engineering Education, Vol. 45 (October 1954) No.2, p.101.

177. The U.K. figures are from a Ministry of Labour Survey of Technicians that gives a ratio but not the number of technicians. Other surveys support the findings, see below and chapter 7 infra.

178. Council of Engineering Institutions, The 1971 Survey of Professional Engineers, London, CEI, 1971, found that the ratio of engineers to other technical personnel was 3.3 overall, being slightly higher in private industry. Engineers are here defined as corporate members of the chartered Institutions.

179. Lloyd and Wilkin, op.cit. p.131, table 6.3. Incidentally, the profession in Spain has been extremely exclusive in the past--also in Italy.

Chapter 5

Professional Organization and Practice

Introduction

Professionalism involves not only the control over entrance to an occupation, but also control over practice, through statutory and customary sanctions for a monopoly of function for the qualified. Fragmentation, the resistance to registration and other means to gain state sanction for the status of the professional engineer and legal restrictions on practice, left Institutions with little other course than to found professional status on speciality qualification, without countervailing actions to ensure the passage of engineers into positions of authority and power within industry, or to distinguish the professional engineer from the practical specialist. Related to this pattern is the absence of a generalist technocratic ideology in the British profession, a claim to greater areas of responsibility and autonomy, manifest in the relative absence of action on questions of ethics affecting the conditions of practice. By contrast, where engineering professions are more unified, in the United States and Germany for example, pressure has been aimed at both a wider role for the engineer in industrial leadership and the restriction of certain areas of practice to the qualified. In Britain the absence of agreement on the boundaries of the occupation necessarily precluded attempts to restrict practice to the qualified, except by individual Institutions who could only then argue for the case of the specialist. The result has been a decline in representation of engineers, who are regarded as narrow specialists unsuitable for filling industry's top posts, in positions of industrial leadership in Britain over the course of this century, while in the United States and Germany the pattern is reversed.

Early and Nineteenth Century Development of Civil Engineering Practice.

In the 18th century the role of the early civil engineers was at first embedded in the related occupations of surveyor,(1) architect, estate manager, mine manager, and various other types of managers peculiar to the industrial organization of the day, such as "undertaker", "contractor", and in the mining industry, "viewer";(2) but gradually the engineer role became differentiated on the basis of the engineer's position as the designer and director or executor or certain types of large-scale works, which were "public works, or private undertakings of a great magnitude",(3) such as canals, fen-drainage works, roads, docks and river navigations, dams, mines, and increasingly the engines and machinery used in these works. These projects were often under the direction of a "resident engineer", who if competent would be responsible for its execution, while the "principal engineers" or "consultants" would undertake the preliminary surveys, detailed technical plans for all aspects of the canal, locks,etc., and related works. The most important engineering project at this time was canal building, which peaked in the 1790s. These undertakings were often managed by the engineer, who was responsible for its execution and in some cases for over 1,000 men employed on them.(4) The members of the original Society of Civil Engineers were drawn mainly from these canal engineers. Many of these early Smeatonians practiced as consultants because of the restrited supply of qualified men capable of assuming responsibility for the projects; "resident" engineers and assistants worked under the authority of the eminent consultant, who had gained his position by virtue of his success in past projects.(5) These projects increasingly also involved mechanical work. John Rennie (the elder) used steam engines for the operation of pile drivers, water pumps, etc., in the building of London Docks.(6) This was not peculiar: particularly close ties developed between mechanical and civil engineering in England before the Institution of Civil Engineers was founded,(7) and the Smeatonians eagerly embraced the "mechanical" work available or emerging, thereby branching out from their staple, the construction of bridges, canals, roads, docks, harbours, drainage works. James Watt (1736-1819), sometimes styled "Father of Mechanical Engineering", was a member of the Society of Civil Engineers. It was among young engineers, subordinate to the Smeatonians, often in the capacity of assistant, and "for the most part engaged on what is now more specifically considered the mechanical side of engineering"(8) that the Institution of Civil Engineers arose.

The backgrounds of the original members notwithstanding, the ICE soon came to include engineers from all branches: it represented the Civil as opposed to the military engineer. By 1828 the charter stressed that Civils were engaged in the contruction of roads, bridges, aqueducts, canals, docks, ports, harbours, moles, in the drainage of cities and towns, and in the "construction and adaption of machinery".(9) By 1886 the Council had elaborated on Tredgold's definition, embodied in the Charter, and outlined ten "classes of works" that practitioners were involved in: a) works bearing on internal communications (e.g., roads, railways, canals, telegraphs, etc.,); b) works connected with the sea-coast harbours, piers, breakwaters, sea-walls, lighthouses, etc.; c) works for facilitating communications across the seas, including naval architecture, iron shipbuilding, construction and laying of submarine cables; d) works connected with reclamation, irrigation and drainage of land; e) works for cities and towns, e.g., sewerage, water supply, lighting, street improvements; f) any large buildings in their "mechanical and scientific arrangements"; g) mining and metallurgy "so far as they involve the application of mechanical science"; h) design and construction of the "mechanical prime-movers", e.g., steam-engines, water wheels, other hydraulic motors, windmills, electric and other engines; i) "the design, construction and adaption to practical use of machinery and mechanical appliances of all kinds"; j) design and manufacture of all large and important metallic structures, "including artillery and other large munitions of war."(10)

While this broad claim to include all non-military engineers was true in 1886 and also, though slightly less so, in 1900, the membership of the Civils was not evenly distributed across all these branches of engineering. In 1870-74 44% of new members were employed by railway companies usually either as chief or resident engineer in charge of the whole undertaking or as a first assistant, depending on the size of the works; a further 16% were in private practice as civil engineers embracing railways, roads, bridges, docks, canals, sewerage, drainage, and other connected works; 21% were employed on dock works, drainage, sewerage, irrigation, habour works etc.; 8% on similar projects in public works departments. The remaining 4% were in the construction of buildings, roads, and bridges, gas, shipbuilding and mining industries, and education.(11) These are the main areas of employment at the date of application for membership: in fact most had straddled all the major functions of the civil engineer, the construction of railways, etc., docks, etc., roads and bridges. The technical knowledge necessary for the execution of these diverse duties was sufficiently rudimentary, by todays standards, to be well within the limits of the intelligence of the average Civil engineer. Only a small percentage were engaged as specialists within mechanical engineering, gas engineering, naval architecture, electrical engineering, or mining, though in its membership it included persons in the engineering management for all these areas, even though they were yet in their infancy, e.g., as managing partner, iron and shipbuilding works, or engineer and managing director of a gas company. Thus although true that engineers in all branches of the profession were members of the ICE in 1870-1900, the bulk of the membership was, even then, and increasingly, becoming located in what was to become the speciality of civil engineering, which is also the main area served by the ICE's technical proceedings. In the period 1894-1907 out of a hundred odd subject areas dealt with by the Proceedings, bridges alone had 21 pages of proceedings-index devoted to them, some 7% of the total; railways, all aspects including bridges, had 10%; electricity, a misleading category inclusive of many cross-references to civil engineering work, 8%. In what may be a slightly arbitrary classification, only 8% of the total entries dealt with subjects not directly or indirectly (and again that is difficult to evaluate) connected with the speciality of civil engineering; these were aeronautics .1%, automobiles 1.3%, coal .6%, marine-engines .3%, mines and mining 4%, ships and shipbuilding 3%.

Specialization and Engineering Practice, 1847-1939

The process of specialist fission in the British profession has not simply meant the dividing up of ever more complex and differentiated segments of engineering science among practitioners: it has been a peculiarly, by comparison with other professions, social process, bound up with the conditions of practice and fragmentation. The tendency has been for specialist Institutions to form among, or draw support from, practitioners falling under the technical jurisdiction of an established Institution (first the Civils and then the Big Three), who are also in lower-status positions, positions of subordination, to members of the "parent" group, and who were unlikely to have a speciality related theoretical engineering education. These relatively unqualified practitioners then make a bid for parity of status by virtue of the speciality standing. The Institutions are not then equally specialized. The Big Three apply specialist techniques founded on fundamental branches of engineering science in a diverse range of industries and employments; others develop aspects of these techniques in a more limited range of employments. Related here are those forming to cater for all the techniques within a given industry or technology, e.g., Fuel, Welding, Automobile. Specialization in British engineering, in its broad historical development, has not typically involved the qualified engineer in a search for further, more advanced, specialist qualification; specialization became a substitute for qualification; it is, in its British form, intimately bound up with pupilage, apprenticeship, the practical tradition in opposition to the theoretical and scientific engineering education that is usually the breeding ground of post-graduate, high status specialization, of the kind found in medicine, science, and other engineering professions.

The Mechanicals were first drawn from the lower level echelons of the railway engineers, but soon expanded to cater for a diverse group of non-Civil engineering specialists, not all strictly engineers, but often interested persons within the engineering and manufacturing industries. Financial pressures on the new Institutions forced officials to pursue an open door policy on admissions in the early years, irrespective of stated intentions to qualify only professional engineers, and the Mechanicals were no exception. In 1860 the Engineer distinguished between the Institution of Mechanical Engineers and the Institution of Civil Engineers on the grounds that the former was more a "commercial" Institution, the latter a professional one. Throughout the century they incorporated a medley of engineering and engineering management talent, with not a few interested manufacturers and industrialists. Speaking of the definition of the Mechanical Engineer, E.B.Ellington in his 1911 Presidential Address concluded that it fell somewhere between the good artisan on the one hand and the commerical agent on the other. He urged a continuation of the policy of the day, the rejection of a "very large number of men", managers, draughtsmen, engineers-in-charge, foremen, and others seeking admission, in order to make this definition more rigorous.(13) More exactly, of the(largely northern) intake between 1858 and 1864 34% were engaged in the iron and steel industry; 17% in engine works and locomotive departments on the railways; 11% elsewhere on the railways; 5% on iron bridge works; 13% in miscellaneous manufacturing industries; 7% in the mining industry; 5% as consultants; 3% were "civil engineers"; 2% in shipbuilding; and 3% on the mechanical side of dock and river works. Compared with the Civil engineers of the same period, the Mechanicals were, when in similar employment areas, located in positions of lower status that would not qualify for admission into the Civils. For example, whereas the Civils on the railways were usually either resident or chief engineers, in some cases "district" engineers, for a company, all with responsibility directly to the promoters or directors, and in charge of all engineering works inclusive of the mechanical side, the Mechanicals worked in lower level positions within,e.g., the Locomotive Department of Midland Railway, or within the railway carriage works. Others still were "inspecting engineers" for a railway company, few of whom appeared in the Civils. Of the total intake of Mechanicals, most simply describing themselves as an engineer within some works, (the Mechanicals' membership form did not require the detail of the Civils'), only 5% were in positions of prime responsibility, as managers, manufacturers or chief engineers. Chief and resident engineers to railway companies rarely joined the Mechanicals. This contrasts sharply with the 52% of the Civils holding positions with the responsibility of chief or resident engineer, responsible for the engineering works as a whole to the managing director or owners (in the period 1870-74), at a time when a further 16% were in practice on their own account. Another aspect of the higher professionalism of the Civils was the 8% employed in departments of public works; only 1% of the sample of Mechanicals was so occupied.

The diversity of employment areas and the lower status of the positions occupied by the Mechanicals compared with the Civils remained throughout the century (and in a modified form because of the rise of other specialities to the present day). The intake at 1900 was composed of two main groups: managers and manufacturers with a limited responsibility for engineering but not closely involved in the technical work of the mechanical engineering industry, these made up 12% of the total; a further 14% were draughtsmen, assistants to other engineers, again in mechanical engineering and manufacturing industry. The intake was otherwise spread over a diverse range of work areas: civil engineering, mining, iron and steel, army, electrical industry, power industry, sewerage, machinery and machine tools, railway, automobile and other miscellaneous manufacturing industry with no one type of employment standing out from a range of 2-6% of the sample. Within these areas about 18% were in chief or resident engineer positions, 30% were assistant engineers of various levels, 6% works managers, 16% managers and manufacturers, (and interestingly a further 8% were heads of specialist departments within engineering enterprises, under another engineer responsible for the engineering as a whole to the board, e.g., as chief mechanical engineer or of machine tools, (the remaining 22% were graduates and students of the Institution). Some of the chief and resident engineers also may have been specialists on the mechanical side. Very few operated in the traditional areas of civil engineering, or in government. The 1900 intake of the Civils on the other hand showed an approximately equal concentration of full Members in four areas: railways, public works departments, canals, docks, sewerage, etc., and private practice; with about 20% of the profession in each; the remainder were 10% in the iron and steel industry, and the rest scattered over mines, gas works, bridges, (other than public works), electrical power, education and miscellaneous manufacturing industry. The railway engineers were invariably chief or resident engineers, as were those involved with canals, docks, harbours, etc. Only one engineer in the sample was head of a specialist department, in the iron and steel industry. There were only two assistant engineers, both in very large concerns. About 14% described themselves as "engineer or manager" or "engineer and managing director", these being deployed in a number of private industries. By contrast, nearly half of the Associate Members recruited at the same time were described as assistants to engineers in the positions occupied by full Members. Others were on works of smaller magnitude, and of lesser experience.

While the Civils claimed that, still at 1900, to be a non-specialist body, their membership was concentrated in a few types of speciality civil engineering work, in fact the kind of work undertaken by the Civils was more homogeneous than that of the membership of the Mechanicals, whose members operated in a far more diverse range of employments and positions. What lay behind the Civils' claim, despite the bread-and-butter of the Institutions' work in the civil engineering speciality, was the policy of intake of all professional engineers, irrespective of speciality, occupying the leading positions in the professional hierarchy (especially reputable consultants whatever the field). While relatively few of the leading "specialists" joined, they were sufficient for the claim that the Institution of Civil Engineers represented professional excellence in all areas of engineering to be maintained, despite the fact that the bulk of the membership were specialists, more so than the Mechanicals, which tended to operate as a catch-all for lower status engineers in manufacturing industry. More inclusive even than either the Mechanicals or the Civils are the Electricals, who have maintained the diversity of employments and positions pursued in the 19th century. Initially about half were drawn from government employments and the services, while the rest were in railway and foreign telegraph departments, or employed as scientists and researchers, or as manufacturers in the growing heavy electrical engineering industry, which remains a stronghold of the still about half of the Electricals in the private sector. As among the Mechanicals these employments were at a lower level of responsibility than those of Civil engineers within the same areas.

The meaning and consequences of further waves of specialization can be seen in the rise of two non-chartered minor Institutions after the First World War. The Institution of Railway Signal Engineers (formed in 1912) started as a splinter group within the broader confines of the jurisdiction of the Civil engineer. Whereas the Civil engineer as resident or chief engineer had in the mid-19th century carried out all the technical functions necessary for the successful construction and running of the railway enterprise, by the early 1900s recognized positions for the Mechanical engineer and the Electrical engineer (i.e. Institution members) had developed. Now also the Signal engineer wished to establish a speciality on the same foundations. By the mid-twenties the technical side of a railway company would be divided between three officers: the chief Mechanical engineer, charged with the construction and upkeep of the locomotives and rolling stock; the Civil engineer, responsible for the track, bridges and works; and the operating manager, who controlled the signalmen and sometimes the enginemen; and of less importance, the telegraph department under an Electrical engineer. Historically the signal engineer had been in the department of the chief engineer, usually a Civil engineer or person holding a number of qualifications (not difficult for an ICE member) responsible for the technical side of the concern. There he (the signal engineer) had responsibility for the layout of the signals and block--an increasingly complicated interlocking system, which determines, in effect, the speed of trains, and as a consequence could claim considerable responsibility for the safety of the operations and passengers. The immediate postwar (WW1) years saw a great expansion in the number of Signal engineers, from about 100 in 1918 to nearly 300 full Members in 1926. In that year it was proposed by the Signal engineers involved with the new Institution that the signal and telegraph departments should be combined under a signal and telegraph engineer. This would mean that the new "Signal engineer" would have the block instruments, telegraphs and telephones, track circuits, electric locks, etc., and as a consequence the telegraph and telephone wires under his charge. More than this (the Signal engineers urged) the Signal engineer, the head of the new department, should "hold an independent appointment, and be responsible direct to the general manager, instead of, as is almost the universal practice, to the chief engineer." (14) The reason advanced to justify this veritable leap in status was that the officer in question has dealings with many departments, with the chief engineer, operating manager, chief mechanical engineer, running superintendent, and the electrical engineer, "and therefore should be independent of them all".(15) The <u>Engineer</u>, on the side of the establishment, argued that the signal and telegraphs are essentially "works" and therefore in the province of the chief engineer (i.e.a Civil). Moreover, the Signal engineer would be more likely to be successful in the cause of his department, its needs and aims, if he was backed by "the more powerful pleading of a chief engineer, with the breadth of view, farseeing vision, and wide experience..." typical of men of that position by virtue of his qualifications and experience.(16) The reference here was to the origins, background and qualifications of the Signal engineers, graphically traced through two generations from the skilled artisanate, who first commanded this province, to the junior would-be professional engineer of the day. One "railway engineer" took exception to this: "in my humble opinion, and from what

I have seen of the modern signal engineer, he is quite capable of putting forth in a lucid and sufficiently forceable (sic) manner his requirements to the general manager or board of directors."(17) The ISignalE survived, though it has never had more than 300 full members (a fact that irrespective of the level of professionalism puts a brake on the range of activities that officials would like to undertake, not least petitioning for a royal charter, the cost of which varies directly with the opposition to it). But it was not for many years after this that the Signal engineer, with the aid of the British Railways Modernization Plan in the mid-fifties, became an"independent officer",(18) and even now, despite the separation of "technicians" from the professional "members" within the Institution, the signal engineers are hardly recognized as on a par with the Big Three or minor chartered Institutions such as the Chemicals, Aeronautical, Naval Architects, Structural, or Mining. A futher development along these lines, but this time in the jurisdiction of the Mechanicals, was the formation of the Institution of Locomotive Engineers in 1911: "It was true that the 'Mechanicals' and others dealt with locomotive work, but so far as he knew, there was no Institution in the country, except their own, which devoted itself exclusively to that very important subject."(19) The rise of the ILocomotiveE parallels the separation of the "mechanical and running departments". In order to sidetrack any negative consequences of this change on the London, Midland and Scottish railway, a scheme had been constructed through which young men serving their articles under the chief Mechanical engineer were allowed to gain experience "on the footplate, and of repair work in the sheds".(20) These men, and the members of the Institution of Locomotive Engineers generally, aspired to a distinct professional status as specialist "Locomotive engineers", but these wishes expressed in the heady atmosphere of the annual dinner, and fuel by the developments at the London, Midland and Scottish, were never realized, and subsequently the Locomotive engineers were extinguished by the Mechanicals in 1969, who took on only those Locomotive engineers with professional level qualifications other than membership of the Institution of Locomotive Engineers, which the Mechanicals never considered to be a professional qualifying body on a level with their own.

This process of specialist fission has repeated itself again and again in British engineering. In its combination with fragmentation in the professional organization of the Institutions, it has meant not the development of higher levels of qualification, and new areas of knowledge built on a professional base, but the usurpation of the status of the qualified man by the unqualified on the grounds of speciality knowledge ---knowledge that in engineering is always bound up with technique and technology, providing scope for the rise of skilled workmen and artisans to the world of professional and semi-professional engineering. Once emerged, such specialists fought for their own area, through the formation of an Institution, the development of an identifiable and easily recognizable role and corresponding positions and employments within industry. This usually took, where successful, many years, except in a few cases, such as chemical engineering, which came onto the scene with a bang because it fused two older established specialist areas of engineering (mechanical and civil) with chemistry, also a recognized professional field. In contrast to the Railway Signal engineers, the *Engineer* saluted the formation of the Institution of Chemical Engineers, while regretting in principle that another Institution had been added to the "over-long list".(21) Chemical engineering had received a major boost during WW1, soon after which the Institution formed. While many established engineers were wondering whether the Chemical engineer was a "chemist with engineering knowledge or an engineer with chemical knowledge" and thus a professional man at all, the IChemicalE was determined "to give to him a status equivalent to that of the mechanical engineer, or the civil or electrical engineer".(22) In terms of role there were at the time of the formation of the Institution of Chemical Engineers two main types of chemical engineer (though of course, there were wide differences even among Chemical engineers over the definition of the new profession, the scope of his duties and status within the factory): a) the engineer employed in the chemical works, and b) the engineer on the staff on the engineering works specializing in chemical plant. Small chemical firms had new plant installed by engineering firms specialized in such work and then had the upkeep and repairs carried out by their own engineer, with or without the help of the works chemist (usually members of the Royal Institute of Chemistry), but "In such cases there does not seem to be any scope for the fully trained chemical engineer, and we think the time is distant when it will be the recognized thing for a small chemical works to appoint both a technical chemist and a chemical engineer." (23) The new Chemical engineer was to take over functions previously carried out by the works manager, the chemist, and the engineer, and his training on the engineering side would have to be as a mechanical, electrical, and civil engineer.(24) Even though the Chemical engineer was still being looked down upon as a professional man after World War 11 by the Big Three, ostensibly for being neither fish nor fowl, the Institution of Chemical Engineers eventually gained after much opposition from the established Institutions, a royal charter, and now ranks among the most important. The Chemicals were peculiar in their specialization: they were the upshot of a combination of a number of areas of engineering into a new technique--a pattern that has met with more success than those Institutions forming as a speciality wholly within the territory of an established Institution, merely pushing its boundaries in a particular direction.

Yet a successful Institution of the latter type, comparable otherwise to the Institution of Locomotive Engineers or the Institution of Railway Signal Engineers, is the Institution of Structural Engineers, a striking example of the logic of situation imposed by the ideology of the Civils and of its negative consequences. The Structurals originated in the Concrete Institute, an association with a strong "trade" element,(25) along with an elite group of engineers who desired to professionalize the organization, prominent among whom stood Etchalls later Secretary to the Structurals, and a number of other members of the Institution of Civil Engineers.(26) Etchalls and his group, though among the few outspoken advocates of unity for the profession as a whole, were forced, as a logical outcome of the acceptance of the ideology of the Civils, to form a further, in fact, rival body. While many engineers took the view that civil engineering had no wider scope than structural engineering, the President and the Council of the Institution of Civil Engineers: "have on many occasions confirmed their adherence to their first aims as expressed in their first charter, where it speaks of 'the profession of a civil engineer being the art of directing the great sources of power in Nature for the use and convenience of man.'"(27) The Institution of Structural Engineers was formed with the help of a small band of Civil engineers who were members of both Institutions, to be a specialist association, specializing in part of the field (the ISE claimed it was the whole of the civil engineering speciality) in which the other Institutions alleged that the Institution of Civil Engineers specialized in, and in which field its members were concentrated. But again, in order to build up membership in its early years, recruits were drawn from lower-level positions, often working under Civil engineers, who themselves might be members of both Institutions. "Technical assistants", "draughtsmen" and "supervisors" in private companies in the contruction industry, designers and draughtsmen in companies making reinforced concrete, and in the offices of firms of Civil engineers and consultants, draughtsmen in public works departments, chief draughtsmen, "assitant designers" in the bridge and construction department of a private company, a "junior reinforced concrete designer" in a construction company, a "structural engineering assistant" in a County Architects Department, a "general engineering assistant" in a City Engineer's Department, as well as architects, surveyors, directors and general managers, quantity surveyors were among those admitted, searching for a firmer professional identification, during the interwar years. As well as providing further technical activities for some Civil engineers seeking a greater coverage of specialist aspects of the broader civil engineering speciality (just as others have split-off within the Mechanicals, e.g., Automobile engineers, Locomotive, etc., and the Electricals, e.g., Radio and Electronic), the Structurals began, in effect, registering persons in parts of civil engineering, mainly the concrete-based building industry, who did not have the qualifications demanded by the parent Institution. The formation of the Structurals, "after years of controversy, in which the opposing sides fought strenuously for a single purpose, namely how best to improve the power, prestige and status and influence of the Institution"(28), gradually led to a consolidation of the status of lower-level assistants in building, constructing and consultancy offices, but it was a status won at the expense of the Civils and the wider profession. Those involved in the movement imagined the engineering profession as being divided, firstly, into the military and civil branches, represented by the Institution of Royal Engineers and the Institution of Civil Engineers and then into three specialist Institutions grounded on specialist knowledge, the Structural engineers, the Mechanical engineers and the Electrical engineers.(29) In this spurious vision there is no mention of the Naval Architects, Gas, Aeronautical, Mining or Marine engineers, which in all respects except the affinity with the Civils were far more established and of much higher professional standing than the new Institution, which even the Civils labelled as a non-professional upstart. The Structurals, led by Etchalls their Secretary and the architect of the movement, were riding the band wagon of the Civils, challenging them at their own game. The ISE took advantage of the Civils' ideology to claim for themselves a position equal to the Mechanicals and Electricals, both far broader in scope not just than the ISE but also, quantitativel than the Civils. Predictably, the Structurals' petition for a royal charter in 1927 was vigorously opposed by the Institution of Civil Engineers on the grounds that the only professional engineers in the Institution of Structural Engineers were already members of the ICE, and that the remainder were not professional engineers at all, but a collection of would-be engineers drawn from diverse other occupations, traders, technicians, draughtsmen, office-assistants, builders and concrete-makers.(30)

Another important example of a successful attempt at duplication is the British Institution of Radio Engineers, founded in 1925. The Institution of Electrical Engineers was only 20 years old when Marconi was conducting his experiments, and had already expanded its scope in previous years to accommodate the telephone and electric lighting. As with the other minor Institutions members were at first located in lower-level positions within territory claimed by one of the Big Three, and have, again with the other minor (both chartered and non-chartered)Institutions, continued to be less established overall than the membership of the Civils, Mechanicals or Electricals (though there are exceptions).

At the other end of the Civil engineering hierarchy from the Structurals and Railway Signal engineers, the consulting engineers broke away to establish their independence in 1912, partly because existing Institutions did not provide for the "purity of conduct" on ethical questions expected of the consultant--an allegation repudiated by Engineering, which argued that a new association claiming moral superiority to all, could only reduce the status of the major organizations.(31) At the very first meeting an argument blew up over the scope of the membership; leading consultants wanted members restricted to corporate Members of the Civils, the few Electricals and Mechanicals present wanted to include their own Institutions to ensure that the new association was not dominated by persons "having offices within a few hundred yards of Great George Street".(32)(Opposite Westminster the location of the splendid headquaters of both the Civils and the Mechanicals and the most fashionable Victoria consultancy practices.) In this short-lived struggle the Civils triumphed, dealing another minor blow to the professional aspirations of the Electricals and Mechanicals.

Not every engineer favoured the specialization that by the early 1920s was becoming the distinguishing feature of the British profession, just as the consultant had been in the mid-nineteenth century. One letter to the Engineer complained of the immobility and inadaptability of specialists within engineering departments and specialist departments; he called for a return to the team work that had characterized the war-time economy and a halt to the move towards increased specialization, " it takes years of experience in one line to produce an expert capable of controlling a department. An employee, having reached this position by resisting all temptation to be drawn into some other branch, finds that his activities are limited to a small number of firms, often associated, from whom he cannot escape".(33) The "over-specialized inbred type", taken in by the firm when young and likely to make a career within the confines of the firm, was preferred by employers to the qualified graduate engineer.(34) Unlike professions such as medicine where specialization meant gaining post-graduate and additional qualifications, in engineering specialization accompanied an emphasis on practical experience in opposition to, and instead of, (in many cases) theoretical, scientific, or formal engineering education at a college or school. Institution-specialization was not the outcome of greater differentiation in the technical knowledge base of the graduate engineer, of theoretical and scientific specialization, in engineering education; specialization was fused with the practical; it permitted the otherwise unqualified man to rise, or attempt to rise, to a position equal to those with formal qualifications, those capable of "team-work" by virtue of their common knowledge of fundamentals. The complaint went out: "At present specialist knowledge sometimes gives a purely practical worker a preference both in regard to position and salary over a much more qualified man, owing to his environment having given him this special knowledge which, by its rarity and by the laws of supply and demand, commands it, although perhaps quite undeserved".(35) But these new specialists were not "professional men".(36)

Internal Stratification of the British Engineering Institutions

The internal politics of the Institutions and their major status securing activities concern the question of the definition and nature of membership, its professional-specialist status. The goal has been to establish a hierarchical gradation of technical specialists and to ensure a parallelism between "registration" in these grades and the position of the member in practice, to monopolize certain functions. There is of course no legislation to ensure that industrialists "recognize" these so "registered" (outside a formal registration act there is little possiblity of that), but informal monopolies have been built up as engineers have had (more so in the past before the growth of professionalized personnel management departments) a large say in the recruitment of colleagues, and the evaluation of qualification. But in the state service, royal chartered engineering Institutions have gradually been recognized as conferring qualifications appropriate to professional classifications, so that grants tend to ensure some customary monopoly privileges. Not only is the internal organization of the Institutions designed to cater for the differences in the purely professional hierarchy, but also the grades separate the engineers from the interested layman, industrialist, scientist, or other interested persons, e.g., extending to the corporate membership of firms and research associations. Both major axes of differentiation, the internal status hierarchy and the professional-non-professional division, arise out of the peculiarities of the fusion of the dominant study and professional functions within the Institutions: such complexities as exist in the internal organization of the Institutions stem from the diverse needs of members created by this duality in overall purpose. The activity and internal politics of the Institutions are directed towards the composition and nature of the membership in this sense, and the Membership Departments in the Institutions are typically one of the most important. In turn the composition of the membership, the political domination of segments over the affairs of the Institutions, has acted back on Institution policy in the area vital to the well-being of the profession.

A particularly interesting case is the Institution of Naval Architects, which is one of the Big Four engineering Institutions, not so much because of its size, as because of its internal composition and organization. The impulse for association came from prominent engineers, including J.Scott Russell, and 17 others, 11 of whom were in the Admiralty service. Full members were to be: "Such persons who are in your judgment worthy to be deemed 'naval architects'--- persons who may write after their names 'M.I.N.A.', without in any way discrediting the Institution."(37) The Associate class on the other hand, aimed at gathering all those who could help in the advancement of the profession, ship-builders, scientists, seamen, marine engineers, officers of the Royal and Mercantile Marines. (38

These original intentions became part of the bye-laws: members were to consist exclusively of naval architects, the candidate had to submit "a set of drawings of a ship designed by himself for some specific purpose, together with the calculations of her quantities",(39) be over 24 years old, and employed in shipbuilding for a minimum of 7 years. Associates were to be persons "who are qualified, either by profession or occupation, or by scientific or other attainments, to discuss with Naval Architects the qualities of a ship, or the construction, manufacture or arrangement of some part or parts of a ship or her equipment."(40) The professional members sought to build up their stature and that of naval architects through the contagion effect produced by association with high status laymen, which led to the Institutions' domination for many years by the Associate class. In 1861 Members numbered only 64, compared to the 390 Associates, mainly naval men; in 1864, when there were 75 full members and 409 Associates, approximately 141 of the latter held positions in the Navy, including not less than 50 Admirals.(41) The Members only began to exceed the Associates in the late 1870s. This was facilitated by the admission of "distinguished marine engineers" to the full membership grade in 1870, which itself was part of the effort of the professional naval architects to enhance their influence within the Institution.(42) In 1868 the INA was near collapse as a result of the domination of officials from the Controller's Department of the Navy,(43) some of whom wanted it to move in the direction of the British Association rather than the ICE, thus acting in 1868 to cut back the secretarial and other official services.(44) The struggle between the admiralty "study" group, "the short ironclad and broadside school", and the professional naval architects concerned not just the power and representation of different segments in the membership, but also the content of the technical proceedings and the adoption of new techniques, the admiralty officials control being cast on the side of tradition, throwing "cold water on every proposition". Others wanted to see the INA reflect the needs of the naval architect, shipowners and shipbuilders for which it was originally projected, and wished for a wider and more vigorous set of technical publications.(45) Others still wished to see the naval architects "rank with any engineer", urging an ICE type consitution to bring this about.(46) The inclusion of Marine engineers in 1870 represented the first of a number of changes pointing the INA in a more professional direction. In 1870 15 "distinguished Marine Engineers" were admitted, including Sir William Fairbairn, Bart., Joshua Field, George Banks Rennie, George Robert Stephenson, all leading members of the Institution of Civil Engineers.(47) In 1877 out of 26 Vice-Presidents 1 was a Royal Navy Captain, 13 Admirals, 2 Politicians, and 10 professional members.(48) In 1879 bye-laws were changed at the demand of professional members to ensure that the Council, previously self-perpetuating, was elected by the membership.(49) Another demand was for the exclusion of non-professional Vice-Presidents from voting. The relations between the Members and Associates were not happy; in 1872 Lord Hampton, the President, summed up a technical discussion after a paper, "On Tipod Masts and the Arrangement of Rigging connected with them", presented by Admiral Paris of the French Navy, as "a very spirited action...chiefly consisting of some very excellent broadsides".(50) This conflict was exacerbated by the fact that most of the Admirals, about a quarter of whom were also Vice-Presidents of the INA, had never led a fleet in action; no large-scale naval war was fought by the British Navy in the 100 years prior to 1914. But in the main the response of professional members to the denial of their professional authority (by those whose superior status, and recollections of the days of sailing ships when the highest posts in Her Majesty's Dockyards were held by untrained and untutored men, led them to believe that they were also more technically competent), was in the early years restrained and calculated, becoming more vigorous as membership grew. The Institution of Naval Architects, as an engineering speciality making its own way, needed the Associates to advance its status.(51)

The "trade" versus "profession" conflict existing to some degree in most Institutions, dominated the development of the internal organization of the Institution of Gas Engineers up until the grant of royal charter in 1929, when it was recognized as an established professional organization of engineers. Although the first "gas engineer" was appointed engineer at the age of 32 to the Chartered Gas and Light and Coke Co., London. in the 1820s, the Institution developed much later out of the British Association of Gas Managers in 1863, having as its object "the encouragement and advancement of all matters connected with gas engineering, manufacture, and finance---being established to facilitate the exchange of information and ideas among its members."(52) The first meeting of the BAGM was attended by "gentlemen, being engineers or managers of gas works",(53) the gas engineer of the 1860s, 70s, 80s, and 90s was often indistinguishable from the "manager", a typical title being "engineer or manager" of the gas works, a few such engineers were recruited through purely clerical and supervisory careers. The BAGM was internally stratified into three grades, two of which, the Extra-ordinary (with full voting powers) and the Honorary Members included owners and other interested persons and dignitaries, further differentiated only on the point of higher and lower social status (between the two grades), while the third grade of Ordinary Members, the full membership grade, included both professional engineers, and managers, secretaries, and other high level employees in the gas industry. At first growth took place in the Ordinary Membership grade (in 1872 there were 391 O.Ms. and only 27 "trading" E.Ms.), and professionally orientated engineers became concerned as to how to distinguish between engineers, managers, owners and company secretaries on the one hand, and assistant managers, superintendents, and pupils on the other. Complaints arose in 1877 with the election of "outdoor superintendents" and other lower-level non-technical personnel, while some gas engineers were allegedly being excluded. The first move came in 1881 with the change of title to the Gas Institute (1881-1890) and introduction of a new grade of Associates (without voting powers), "persons holding a responsible position in gas works, or pupils of gas engineers and persons whose pursuits constitute branches of gas engineering, or who are otherwise qualified to assist in promoting the objects of the Institute. Managers or secretaries shall also be eligible."(54) The other grades remained the same, opposition to the inclusion of secretaries and lower management personnel in the full membership grade continued, and now on top of this, dissatisfaction then arose over the new ill-defined Associate grade and there were proposals for a graduate class to accommodate the aspirations of professional members who saw the A.M. grade as a second tier of would-be professional engineers, by contast to the more traditional "associates" of engineering Institutions, the interested layman or non-professional. The graduate class was then transformed into a grade of "Associate Members", supposedly aspiring professionals. At root the trouble was with the full membership grade, inclusive still of engineers, managers, and secretaries. As long as its professional purity could not be maintained there was little hope of transforming subordinate grades into professional enclaves--managers and secretaries had assistants too. The introduction of the A.M. grade was accompanied by efforts to see that "associates" were associates in the traditional sense of non-professionals.

The professional engineers urging these changes did not object simply to the presence of managers, but to the "traders" and what they were doing, attending meetings not to listen to the proceedings, but to conduct business, turning papers into advertisements for products. The conflict between the "trading element" and the engineers came to a head in the "Bray affair", eventually leading to the break-up of the Gas Institute. George Bray, an Extra-ordinary member and an appliance manufacturer charged that certain members of the Gas Section Committee of the Crystal Palace International Electric and Gas Exhibition of 1882-83, who were also officials of the Institute, had engaged in fraudulent practices, promoting a company at the Exhibition in which they had interests. Bray relentlessly pursued this matter for three years, demanding an inquiry by the Institute into the conduct of the four member-officials. In return the Institute expelled him by a vote of 162 against 62; but the constitution required a two-thirds majority and Bray successfully obtained a High Court injunction, restraining the Institute from barring his participation in the proceedings.(55) The Council agreed to reinstate him and pay all costs, a decision promptly followed by the resignation of its leading members. This debacle was ushered in by a revolt among engineers aiming to purge the O.M. grade of all non-engineers,(56) taking up the Bray affair as a cause célèbre (Bray's company had been in legal dispute with its Council-represented rival, W. Sugg & Co., since 1880, two years before the inception of the Crystal Palace Exibition). They demanded rules to restrict Ordinary Membership to practicing engineers, allowing expulsion of engineers subsequently (to election as engineers) occupying non-technical positions. As one Gas engineer put it: "It cannot be too clearly understood that the rock upon which the Gas Institute split is the question of the exclusion or otherwise of the trading element."(57) The resigned Council members then spearheaded a movement to form the Incorporated Institute of Gas Engineers in 1890, "to promote the advancement of the gas industry in all or any of its branches." At the same time a breakaway group founded the Institution of Gas Engineers, for the advancement of "gas engineering". The internal termoil had taken its toll---between 1885 and 1890 its membership dropped from 913 to 604, most joined the Institution but a few fell by the way and it was to be 35 years before the combined membership of the Institute and the Institution totalled more than the 1885 figure. Both bodies tried to get their constitutions on a more professional footing, with the Institution remaining the purer, which paved the way towards an amalgamation in 1902, desperately needed by both. A compromise was reached on the trading element question. Some of the leading traders were permitted to stay on as Ordinary Members, others were transferred to the Associate and Honorary Member grades, still others resigned, as the amalgamation set the new body definitely on the path to becoming purely a professional organization.(58) A consequence of the intention to exclude non-engineers for the full membership grade of the new "Incorporated Institution of Gas Engineers" was the formation of the Society of British Gas Industies in

1905, taking some of the old trading functions. Later in 1915 the Coke Oven Managers' Association catered for yet others falling within the old trading element, and other study and trading associations formed subsequently.

The development of the new Institution of Gas Engineers is similar to that of other minor established Institutions: a progressive move towards the creation of ever more homogeneous membership in the separate grades. They sought at first to exclude persons not in the top technical positions of gas undertakings, and some attempts were made at removing those employed in the manufacture of gas plant and appliances. In fact when the charter was granted in 1929, not without a long struggle, those engaged in the supply side of the industry and as chemists were relegated to the Associate grade, rather than the professional grades, those alone permitting use of the title "Chartered Gas Engineer". But the definition of "the gas industry" remained fairly broad including in 1962 all branches of the industry, production, distribution, and utilization, as well as those in the manufacture of gas plant appliances, as well as some in the coke oven industry. With a membership of little over 3,000 in 1962, the Chartered Institution of Gas Engineers comprised Honorary Members, Honorary Life Members, Members, Associate Members (the latter two are corporate Chartered Gas Enginers), Associates, and Students. Full members elected in 1933-34 ranged from managing director , engineer and manager, works engineer, technical director, engineer, manager and secretary, to engineering assistant, and technical assistant in private gas companies, gas and coke companies, local corporations, companies of tar distillers, oven constructors, etc. Associate Members were junior technical assistants in the same areas, with the odd chemist (despite the charter), and the Associates included traders at all levels, e.g., chairman and governing director, outside superintendent, commercial manager, assistant and research chemists, with a residue of engineering and technical assistants not deemed qualified for the A.M. grade. The trend towards professionalization of the grades has continued.

The Naval Architects and Gas engineers illustrate tendencies present in nearly all the Institutions, actions to exclude non-professional engineers from corporate membership and control (two major bodies, the Institute of Fuel Technology and the Royal Aeronautical Society include persons other than professional engineers in their full membership grades, but these are special cases, partly reflected in the style of the titles--the Institution of Municipal Engineers and other Institutions with a membership confined to state employees do not of course have the same problem of distinguishing between profession and business). The core structure of most Institutions, overlooking variations, is a full membership grade, an associate grade, a further class of graduates, a class of students. The relative distribution in the Big Three for 1961 is shown in Table 1 (59) (abstracted from Appendix B); all the minor Institutions have similar distributions(60)(see Appendix B). Of the grades on the professional side, only the full membership is the truly professional grade in the view of the Institutions (sometimes stretched to Associate Members) incorporating about 10% of the membership. Such persons have successfully completed all exams and practical training, and on top of this have attained a position of high, professional responsibility in their area of practice. Associate Members have all other qualifications but are behind the Members in their level of responsibility and experience. Graduates are gaining practical experience, student studying for the various examinations. In addition to the professional grades, are non-corporate forms of membership, usually Honorary Members and Associates, and maybe others, Companions, Honorary Life Members, constructed to cater for different status levels. In addition to this core structure, there are various irregularities bound up with the historical development of the individual Institution. The aim of the Institutions' membership policy is to see that the internal stratification parallels the level of responsibility and qualification of the engineer in his employment, often quite complicated a task, politically central to the life of the Institutions. This stress on practical responsibility as a criterion of professional status operated in the early years of the century and interwar years to exclude some educators from the highest grade, especially

Table I

INTERNAL STRATIFICATION OF THE BIG THREE AND NUMBERS IN EACH GRADE (1961)

Institution of Civil Engineers Grades	Membership
Honorary Members	20
Members	2,988
Associate Members	13,679
Associates	41
Graduates	3,932
Students	4,546
Total	25,206

Institution of Mechanical Engineers Grades (Corporate)	Membership
Honorary Members	17
Members	4,909
Associate Members	26,646
Grades (Non-Corporate)	
Honorary Members	14
Companions	34
Associates	686
Graduates	17,187
Students	6,169
Total	55,660

Institution of Electrical Engineers Grades (Corporate)	Membership
Honorary Members	29
Members	4,288
Associate Members	20,191
Grades Non-Corporate	
Companions	76
Associates	2,587
Graduates	14,508
Students	4,824
Total	46,481

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those in the technical education sector. On the other hand no countervailing measures have been effectively enforced to ensure that Members do not seek, after election, positions that would debar them at the time of election, usually an employer or employer orientated rather than an employee or profession orientated status, or academic, etc. On many occasions professionally minded engineers have demanded the restriction of full Membership to the actual practicing engineers, but such attempts have usually faltered (e.g., at the Structurals in 1927), or as in the case of the Gas engineers have had extremely disruptive consequences. Professional members face a serious dilemma: the highest positions in the profession by virtue of its embeddedness in large-scale non-professional organizations, the top engineering positions, those with the highest responsibility, blur with the top leadership positions, the attainment of which often represents success in the career. As the Council and Presidents of the Institutions are usually drawn disproportionately from such successful engineers no longer in practice, often representing employee-interests, and this is often even more pronounced in the early years of many Institutions, any revolt from the rank-and-file within a particular speciality is unlikely to meet with much success. It would be politically impossible for Institutions' Members to purge these engineers-turned-administrators: the problem of definition alone is insurmountable in the absence of a standard uniform classification of "professional" engineering positions throughout industry with a corresponding uniform set of entry qualifications, or a system of licensing encompassing periodic re-qualification examinations. The tendency has been the reverse of that suggested by the ethos of professionalism: engineers have cultivated the patronage of such once-engineers in authority. Equally important is the election procedure for Council members, especially the nomination process, typically shrouded in the utmost secrecy and confidentiality, leaving the impression of rule by self-perpetuating oligarchies, often a source of complaint at the grassroots. This fact of success accompanied by diminution of profession al engineering responsibility and increasing administrative responsibility (although a matter of degree and subject to relative changes over the course of this century as is indicated below)plus disproportionate representation in Council and official office (Presidents of the Civils aged 65.4 years over the course of this century) for the successful, has added up to contribute to the conservatism, the major characteristic on any comparison, in the policy of the mature Institutions on questions bearing directly on engineering professionalism on the status of engineers, especially on legal restrictions, and even on study questions the Big Three have been dubbed the "cynicals" for their attitude towards embracing new developments in engineering, an attitude dominated by "no" rather than "yes".(61) Virtually no action has been taken on salaries,(62) save of course the fundamental policy of status through exclusiveness, which has often been depicted in terms of its effect on salaries. But it would be misleading to suggest that the consitution and internal politics of the Institutions fundamentally misrepresents the views of the bulk of the membership, rather than just reflecting the more conservative element, as on the all important questions of inter-and intra-Institutional relations, those bearing on unity and fragmentation, it is the average engineer who jealously guards the uniqueness of his specialist standing, separating him as it does from a mass of would-be professional engineers.(For survey details see chapter 7.)

The main actions taken by the Institutions to secure a monopoly of practice have been through informal contacts, not through legislation, with employers, state servants and government ministers, stressing that Institution members in the relevant grade are qualified for practice in the speciality field. Such a mechanism has naturally dampened enthusiasm for restriction of overall Institution Membership to practicing engineers rather than administrators, such demand could only be workable on a non-speciality registration-cum-restriction of practice basis, a package resisted by industrialists and employers in societies where it has been tried. The earliest published comment on this backstage activity was produced by the Council of the Civils in 1912-13: "The Council have not ceased their efforts to secure acceptance of the principle that Civil Engineers in the Public Services should possess such technical and other qualifications as are generally recognized by the Civil Engineering profession. The Council's views upon this subject were placed before the Prime Minister in a letter, to which he gave a reply that they regard as encouraging."(63) The problem was that not all civil engineers in the public service held the Institution's qualifications, in fact only about half of all professionally graded engineers did so while a further quarter had failed the Associate Member examinations, a remarkably high proportion given that enclaves of other specialities were included in the definition of the public service.(64) The ICE urged that promotion should be made to depend on attainment of their qualifications, even if entry into subordinate positions was not, because the standard of the Civil Service Examinations in engineering, which the Council had reviewed, could be improved upon. Naturally there was no mention of the other Institutions: the Civils, stressing their incorporation by royal charter, suggested that they incorporated all branches of the profession.(65) The reply, conveying Prime Minister Asquith's response, raised the problem of a monopoly peculiar to the Institution of Civil Engineers (later strenuously denied as the primary aim of the overture). Although no Institution was mentioned by name, the Prime Minister alluded to the existence of other such bodies. There was also the further problem that the Institution of Civil Engineers demanded standards of general education not required by the Civil Service, and as the Commission and Departments determine the qualifications of the service it was suggested that the Institution should get in touch with them.(66). This they did. Later, success in particular departments was reported.(67) Further steps were taken just after the War in 1920-21 when the Civils again solicited the cooperation of the Civil Service, but the Institution deemed it "not expedient" to print details of this activity in its Report,(68) presumably lest other Institutions got wind of it. In 1922 the framework for the entire policy was laid out: "It has been the object of the Institution of Civil Engineers to establish the position of its members upon their possession of a special professional knowledge."(69) The possession of this special knowledge enhances employment prospects and incomes, so that membership in the Institution makes it unnecessary for the Members, should they be so inclined, to join associations with trade union functions.(70) Later in his Presidential Address of 1928 Trench, speaking of registration and monopoly, said" "Whatever developments in this respect take place in the future((i.e., registration)) it seems clear that they may be awaited with equanimity by a body of engineers which is constantly doing its utmost to ensure the highest possible qualifications on the part of its members; and it is also clear that persons who possess such qualifications have a prima facie title to be regarded as the most suitable source from which to draw at all events those engineers who are responsible for the expenditure of public money on engineering work. The Institution has taken steps from time to time to bring this consideration before the notice of the proper authorities. Its representations have, in general, been sympathetically received, and its views on this question are becoming accepted and being acted upon. For the present, as one of my predecessors, the late Sir James Inglis, said in his Presidential Address: 'Our primary object is to make the Institution strong and efficient in the promotion and dissemination of engineering knowledge, and thereby to advance the status of engineering as a profession'."(71) Other Civils were more ambitious: Magnus Mowat, Secretary of the IME, recalled that "A former President of the Institution ((ICE)) told the writer that it was his endeavour to make the status of a Member of the Institution of Civil Engineers as high as that of a King's Counsel, and the Associate Membership equivalent to a Junior Counsel on admittance to the Bar. Whether this has been attained is debatable, but the practical and theoretical qualifications required are most exacting, and the status maintained from generation to generation."(72) While this was true in terms of the profession's internal status hierarchy, Mowat did not foresee the unintended consequences of the Civils' policy of ideological catholicity and speciality exclusiveness. The eventual upshot of these approaches and those of other Institutions on similar lines has been the recognition by the state of all the chartered bodies, not just the Civils, as qualifying organizations to a professional, university level, standard in the respective specialities.(73) The Institutions have encouraged this practice, looking towards its informal adoption in industry, and have sought to recommend their membership in every way as professionally qualified above all others for the speciality positions. Thus the possession of a royal charter giving professional status to the speciality has been one of the main instruments of state-sanction and recognition.

Symptomatic of the narrow outlook of the major Institutions on the role of the engineer is multiple membership. Many engineers who seek generalist managerial positions and higher status positions do so by acquiring as many qualifications as possible. Among the Mechanicals about half the members over the age of 45 were found to be members of more than one Institution;(74) and they were not concentrated in any one other Institution. The minor Institutions have welcomed members of the Big Three, especially Civils virtually regarded as celebrities by some groups, to give them stature in their early progress. Prominent Civils have been elected as honorary members and as officials. In turn members of the Big Three have sought to differentiate themselves by gaining entry to as many Institutions as possible. It is not uncommon for a prominent engineer to have some 13 to 14 designatory flourishes to his name from this source. Such multiple membership is associated with high income and high managerial status.(75) Some engineers have complained that minor non-chartered Institutions, of which there are over a hundred, thrive entirely by offering further designatory letters that are sought by engineers for advancing their status and developing a generalist image.

The only joint-action recorded in the annals of the profession between 1947 and 1960 undertaken by the Institutions on a question of the position of engineers within practice, rather than joint-action aimed at blocking the status aspirations of specialist colleagues, which was frequent after 1922, took place in 1926 when, in the eyes of engineers, the status of naval engineer officers was reduced by the Admiralty during a reorganization of staff nomenclature. The Big Four and the Institution of Engineers and Shipbuilders of the North East Coast lodged a protest with the First Lord of the Admiralty, asking for the reversal of the decision. The matter was debated in Parliament but to no avail, the Admiralty denied any slight, more perceived than real. Acting together the specialist Institutions were not in a strong position to urge that the general classification of naval engineers as general military line officers rather than staff specialists, ought to be retained, or present any other arguments about fine distinctions concerning the designation or titles of the Navy's personnel, and it is hardly suprising that they failed to do so. AS the Engineer put it, a unity organization "would double and treble the influence that could be exerted," on the Admiralty. (76)

In line with the Institutions' narrow outlook on questions of engineering professionalism, registration, etc., ethical issues have received only limited attention. Standardization is one such important issue potentially bound up with registration, monopoly and professional ethics. The Engineering Standards Committee was set up in 1901 by the ICE, the IME, the INA, and the Iron and Steel Institute with the immediate object of standardizing the sizes of rolled steel joists and sections. The IEE added its support in 1902. In 1918 the title was changed to the British Engineering Standards Association, and with a further extension of the range of activities and its composition and scope, to the British Standards Institution in 1831. The extent and nature of standardization is a potentially volatile issue for the engineering profession: a potential arena for the acting out of the conflict inherent between the professional service ethic and business interests. As early as 1917 a professionally minded engineer such as Wordingham could complain that the absence of registration, a monopoly of practice for engineers, meant that the rules regulating electrical practice (embodying both practical working needs and the ethical ideals of engineers) formulated by the IEE could not be made compulsory. Contractors observing the codes were at a competitive disadvantage with the less scrupulous, resulting in non-observance, and considerable waste, inefficiency and loss to the community. (77) But the issue of standardization has never been taken up, in the absence of registration, in its wider ethical context. Although contributing much useful work, the profession has been less energetic than that in the U.S. and on the Continent, which have a greater number of educationalists and idealists in their councils. The actual work of the BSI, because it is carried out by enthusiasts, has exceeded the demands of Institutions and of practicing engineers who have complained that the BSI sets standards that they cannot match up to.(79) In 1935 the IME allegedly reduced its annual grant to the BSI because of dissatisfaction with the standardization of worm gears.(80) At the same time, in a brief wave of interest in the broader aspects of standardization largely promoted by developments abroad, the *Engineer* distinguished between two kinds of standardization" that of dimension and that of qualities; while not objecting to the former, the latter, though acknowledged to be bound up with the needs of the purchaser, engineering ethics, and public service, "would bring them((standarized items)) all to a common level, and would remove a rivalry which, despite modern tendencies, we still believe to be conducive to progress."(81) The policy of the editors of the *Engineer* has been considerably more liberal on professional questions than that of the Institution Councils. In short, the profession, rather than the Committees formulating the standards, has held a conservative attitude towards the issue. Thus in 1922 the *Engineer* argued against the standardization of parts and products in the motor industry on the American model of, e.g., Ford. (82) Later in 1927 the Structurals desired membership of the BESA to exert a moderating influence; they had not been invited to become a constituent Institution of the BESA, and could not therefore influence its policy through the Main Committee, leaving only the publications "some of which are not worth the paper they are printed on."(83) The Structurals were quite opposed to standardization "taken to an extreme degree", and the Council agreed that the new BESA's scope was far outside that of the old British Engineering Standards Committee: "Yes, far outside, and if we let them go on in this way there is no knowing what they will do. They will be standardizing eventually the side of the head on which one should part one's hair, if one has any."(84) The ISE hoped to keep

BESA activities "within proper bounds".(85) The attitude of most Institution Councils over the development of the BSI has been one of cautious optimism, a realization of the values of standardization, tempered with business realism. The enthusiasm of a few has not become linked with any organized move to politicize the issue of standardization in the context of engineering ethics, registration, or monopoly. Still the efforts of the BSI in the direction of standardization have of course been informed by the professional service ideology of British engineers.

As in the case of standardization, the Institutions have not attempted to enforce a more general code of ethics as part of a move to gain a higher responsibility, authority and status. Many Institutions have had informal loosely worded codes specifying that a high standard of conduct is expected of members. Others have no formal code at all outside the usual provisions in the articles of association of corporate bodies making for the expulsion of members inimical to the objects of the group. In either case there has been relatively little attempt at enforcement, except on the question of using the Institutions for advertising, selling, or touting, which is generally prohibited, and in the case of the Structurals, Civils and Consultants in private practice (usually in the building industry where the scope for the abuse of trust, mainly bribes, is greater).(86) Again, as in the cases of registration and standardization, individuals have argued for a higher standard, more developed codes and for machinery of enforcement, but no organized support is evident from the annals of the profession. Institution officials argue that the lack of codes and expulsions signifies the existence of a code in actual practice and adherence to it by members: they do claim codes and a high standard of conduct and ethics. There are two comparative measures of the low gear in which the U.K.Institutions have approached ethical questions: their response to the intitiatives in the U.S. and to the U.K. "science and society" movement in the thirties. The ethical issues involved in these other movements were no less relevant to the situation of British engineers, but they failed to make any impact whatsoever on the profession outside a few individual practitioners (often educationalists like the bulk of activists in the other two movements).(87)

The Movement among Engineers in the United States

The profession in the United States led by educators and their students responded to the massive expansion of engineering education with the formation of professional associations, unity organizations, and pressure for licensing, the passage of engineers into management and industrial leadership, and other provisions directed at the control and extension of engineering practice.

The first U.S. unity organization, the Engineering Council (f.1917), concerned itself with the conditions of engineering practice, claiming to have negotiated the security and reemployment of 350 New York engineers whose positions had been threatened,(88) and pressured for the adoption of its model registration law. Much of the Minutes of the EC are taken up with plans and reports on actions for the establishment of a Department of Public Works under the leadership of a cabinet-level professional engineer,(89) a project for which there is no British comparison. But EC members felt constrained, in the range and intensity of these efforts, by the Council's federal structure and constitution with a veto power for each constituent, allowing sabotage by business interests, and so they helped launch the short-lived Federation of American Engineering Societies among the leaders of which was Herbert Hoover, later elected President of the United States, a high point for technocratic visionaries in the profession soon to be disillusioned.(90) The FAES's constitution provided for a 30 man Executive Board made up of 6 officers of national engineering Societies and 24 engineers elected directly by the grassroots membership of local (State and regional) and national Societies;(91) under such an arrangement the FAES gave vent to technocratic idealism rather than business interests, which was eventually to bring it into conflict with the national Societies. The Federation of American Engineering Societies conducted a number of studies, producing a report Waste in Industry,(92) on such topics as the widespread "doping" of leather to hide imperfections in the manufacture of shoes, preventable industrial sickness, and accidents, the lack of standardization notwithstanding the activity of the American Standards Committee(in sharp contrast to the complaints of British Institutions about the "overactivity" of the BSI). Other ethical problems such as restriction of output by management, by labour, underemployment, the seasonal fluctuations in employment in the building industry,(93) and especially its semi-official report on the 12 hour day in the steel industry, sprang from an overt concern with scientific management informed by the professional service ideal applied to the conditions of engineering practice. The Federation's activities antagonized the "mature members who reflect the interests of the organizations by which they are employed"(94) and who were represented on the Councils of the constituent Societies; some of these Societies withdrew, others threatened withdrawal, and the prospect of financial collapse led to its reconstitution as the American Engineering Council, which was more representative of the views of the Council members of the major Societies. The AEC was a relatively active body, continuing to carry out the policies of the FAES, but in a less extreme and more realistic form, emphasizing efficiency and other technocratic themes.(95) Yet it also developed an excessive zeal in the cause of unity, and was reorganized in 1934, after a drastic cut in contributions from member Societies opposing its policy.(96) It was active for 12 years until 1940. A special committee of the American Society of Civil Engineers on the AEC's demise, concluded "There was no requirement that the AEC delegates be or to have been at any time members of the governing bodies of their societies. This fact proved to be a major cause of the eventual breakup of the AEC".(97) This constitutional defect, not confined to the AEC, was not reproduced in the Engineers Joint Council, the AEC's successor, formed in 1945.

Ideological initiatives among progressive, professionally orientated engineers paralleled these organizational developments, and provided the justification for closure of the profession. The professional ideology of engineering occupations is technocratic in content--a product of the application of the service ideal to the peculiar client-practitioner relationship pound in the profession. One aspect of this ideology was scientific management, the rationalization of production and manufacturing on the basis of"engineering" methods, the revamping of industrial organization on the image of the machine. The originator of the doctrine, Taylor, whose writings exude his practical experience in engineering,(98)was a prominent member of the American Society of Mechanical Engineers (when elected President of the ASME in 1906, he attempted to apply scientific management to the ASME's own administrative structure).(99) For the American engineering profession, scientific management was not only a means to increasing industrial efficiency, but also the basis on which its technocratic demands could be realized; not only were engineering methods to be applied to industrial organizations, but also this should be done by engineers operating at the highest levels.(100) The organized profession, particularly the ASME,(102) used scientific management as a way in which to extend the jurisdiction and authority of their membership into what had been purely managerial concerns; <u>engineers</u> were to run industry on the basis of engineering methods. The scientific basis of engineering practice and management equipped the engineer to act as a mediator between capital and labour. Under his jurisdiction production would be increased and efficiency enhanced to the benefit of the community as a whole. No longer would the engineer operate as a mere tool of owner interests; he would, like the doctor, give a valued service to all members of society through the application of engineering knowledge by organizations modelled on mechanism and manned by engineers. The claim for "social responsibility" (for the engineer to be responsible for the <u>social consequences</u> of the application of engineering science, just as the doctor applies his technique in a socially responsible way, to increase the health of the community), in the movement documented by Layton,(103) had as its reverse side a demand for power, authority and status by means of which responsibility could be exercized and ethical ideals enforced. Veblen, mistaking this demand for professionalization for a potential source of radical action on the part of engineers, provided a manifesto for the occupation, The Engineers and the Price System, the classic statement of the logical extreme of engineering professionalism, urging them to take over industry from the "financiers", "captains of industry", "absentee owners", and others, so that their production engineering could usher in the "age-of-plenty". The ideas in the manifesto lead on from Veblen's distinction between "industry" and "business";(104) but his primary knowledge of the engineering profession came from the activity and ideology of members of the American Society of Mechanical Engineers.(105) Later, in the thirties, "technocracy" became for a few months a household word, the outcome of a social movement aimed at a technocratic solution to the country's economic ills. The principal organizations involved were the Continental Committee on Technocracy, and Technocracy Inc; individual engineers were active but the outcome was to bring the terms "technocrat" and "technocracy" into disrepute within the profession.(106)

Technocratic and other ideological expressions of the demand for "social responsibility" provided justifications for state-sanction through the introduction of licensing laws; if engineers were to fulfil a special mission in society, to have responsibility for industrial progress, they must also be qualified for the task. The frequency distribution of licensing statutes in five year periods (excluding periods when none were enacted) is as follows: 1 in 1906-1910; 10 in 1916-1920; 11 in 1921-1925; 3 in 1926-1930; a rise again to 8 in 1931-1935; 7 in 1936 to 1940 and thereafter a decline to 6 in 1941-1945 and 2 in 1946-1950.(107) The major wave took place during the primary period of professional development, and another in the consolidation of the thirties.(108) As a result, all States have licensing laws and registration machinery, provisions differ between States, there are differences in the composition of the boards, the extent of registration and the functions and the positions reserved to the registered or licensed.(109) In 1920 seven

State boards established the National Council of State Boards of Engineering Examiners, to represent common interests and work towards uniformity. By the mid-thirties the scope was extended "to promote the public welfare by improvement of professional engineering standards through uniform administration of State Engineering Registration Laws, the facilitating of reciprocal relations between state boards and by defining and maintaining National Qualifications for Registration."(110) A National Bureau of Engineering Registration was also set up in the thirties to permit engineers to gain a certificate to practice in more than one State. The licensing laws were the outcome of the pressure from engineering Societies, associations and the unity organizations working in the individual States.

The American Association of Engineers developed into the National Society of Professional Engineers, formed in 1934 as a national association to represent the interests of the State societies of professional registered engineers. As well as the unification of these societies, "The National Society is organized to do for the engineer what the Medical association and the Bar association have done for their respective professions, in increasing prestige, legal protection and professional recognition."(111) In 1935, the year after formation, action included: the organization of State societies and the promotion of new ones; assistance to ten States in the drafting of registration laws; securing the cooperation of the Associated Press, the United Press and individual newspapers in a campaign to restrict the designation "engineer" to members of the profession, and to substitute "engineman" for operatives; pursuit of the old engineering aim to see a Department of Public Works in the National Government, headed by an engineer in the Presidents' Cabinet as Secretary of Public Works; successful opposition to legislation introduced into Congress on behalf of the legal profession, which would have deprived engineers and other persons of the right to appear for clients and organizations at hearings before state boards and agencies; as well as other action.(112) The position of the NSPE on national registration has not been unequivocal; peculiarities in the structuring of interests between national and State organizations have forced it to support registration in principle, rather than in practice. In 1931 the NSPE, then the AAE, was not fully endorsing a uniform law sponsored by the ASCE and other Societies, in favour of State's autonomy.(113) The proposal for a Bureau of Engineering Registration to be sponsored by the National Council of State Boards of Engineering Examiners and operated by a board consisting of representatives of the Societies, in particular the Founders, setting national minimum standards, was supported in principle, but not in its details.(114) The NSPE is largely composed of registered civil engineers in State employment, and represents about 10-15% of the total profession, depending on how it is estimated, but it has also concerned itself with engineering professionalism in industry,(115) and opposed unionism among engineers.(116)

In 1952 the Engineers Joint Council became independent of the five Societies that established it; engineering Societies with a majority of qualified graduate engineers in their membership (a criterion never applied in analogous British situations) became eligible for affiliation, resulting in a loss of control by the Founder Societies, and a decline in the activity of the EJC on questions of engineering professionalism.(117) The Founder Societies have more consistently demanded that their members should be professional engineers (at least when first joining) than many other Societies, some of which border on trade associations. In the late fifties and early sixties it was urging greater production of engineers, rather than raising the level of qualification and entry, and was criticized by professionally orientated engineers for representing business interests.(119)

Although the organizations formed in the movement among American engineers in the twenties have a surface similarity, especially in name, with those in Britain, the extent and range of activities were incomparably greater in the United States, and in many cases had goals directly contrary to those in Britain. The outcome was in some ways satisfactory for the profession:

it is now considered as a suitable background for non-engineering management; it has even been argued that Veblen was correct in predicting the emergence of "technical elite" in industry.(120) (See below for further details.)

The American movement illustrates the interrelationship between the ideas and action that make up engineering professionalism when found in an extreme form. Community closure, the demand for unity and the restriction of practice to the qualified, necessitates the sanction of the state, which in turn is sought through an appeal to the public interest rather than the self interest of engineers. There is an affinity between the state and profession at this level of ideology, which complements the special relationship whereby professions become organs of the state through the delegation of functions and authority in return for a pledge to serve the public good. The demand for state recognition of status and authority, the main instrument of their realization, is accompanied by the rationale that qualified engineers will give a better service to the public by virtue of their superior knowledge and honour, their adherence to a higher code of ethics. In the extreme, the concept of public service central to professionalism conflicts with the business ethic, and typically professions eschew such methods, ban advertising, restrict competition, etc., in the interests of the client, but the engineer an employee of a business concern, faces the dilemma of a tension between demands of the employer "client" and those of the "public" client. The professionalization of engineers through adoption of non-business ethics and restrictions on practice and monopoly, by conflicting with employer interests, also leads (in the extreme instance) to the demand that engineers should themselves control industry so that the professional service ideal may be realized. It is in this manner that ideal and material interests coincide in movements for professionalization: the demand for a monopoly, restrictions on supply and higher incomes, is sought through an ideology that stresses the client-public over the practitioner interest, the service ideal, and the realization of both brings professions into closer relations with the state. At the ideological level the professionalization of engineering leads to a technocratization of industry. In England this complex of ideas has not, in the history of the organized profession, been raised in an extreme form: the resistance to registration, lack of professional ethics, absence of militant employer-employee conflict in the profession, self-identification as a narrow technical specialist, are part of a complex of ideas and action that inform each other. (When professionally orientated engineers have made their isolated demands for unity, these are typically accompanied by the other elements of ideology and action illustrated in the American movement.)

Fragmentation, Specialization and Engineering Management: 1921-1939

In contast to the movement among engineers in the United States, chapter three documented the opposition of the British profession to registration and its ideological and organizational concomitants. The British Institutions' efforts to ground professional status on speciality had as a consequence the neglect (combined with in many cases actual opposition) of attempts to promote the passage of engineers into general managerial and leadership positions and the establishment of a modern technocratic ethos in the profession, developments ordinarily conducive to a higher status.

One group that did take up some of the U.S. ideas was the Institution of Production Engineers, formed in 1921 (the same year as the Production Division of the ASME), partly because the Institution of Mechanical Engineers was unwilling to sponsor production engineering as it was not a "professional" subject. At the first meetings some debate and confusion, polarizing around the profession/trade split in the founders' backgrounds, emerged over the Institution's purpose; some wished to style it the Institution of Production Engineers, others the Institution of Manufacturing Engineers. The latter were works managers and others who wanted the Institution to include non-engineering managers in its corporate membership (the decision to restrict membership to engineers only led to the resignation of one such Council-manager later in the year).(121) At the start it was stressed that scientific management, not as popularly understood, but the reorganization of workshop methods on scientific lines, should be a "principal prop in their platform",(122) and others viewed the

Institution as a pressure group for the infusion of engineering techniques into management. In 1927 newly recruited full members included General Manager, Chief Jig and Tool Designer, Engineer and General Manager, Shop Superintendent, Assistant Works Manager, Manager, Director, mostly in the automobile or related manufacturing industry.. This catch-all policy was reflected in a broad syllabus for the first projected examinations in 1929, inclusive of managerial, commercial and social sciences that the established Institutions eschewed. It was divided into three parts: c) workshop organization and practice inclusive of the study of scientific management and its applications, and drawing and technical work; b) economics and commerce; c) psychology.(123) By now there were 172 Members, 107 Associcate Members and other grades a total of 306. Later in 1932 the IPE sent a representative to the Fifth International Management Conference with a paper entitled "The Best Methods of Interesting Workpeople in the Maintenance and Increase of Efficiency and Production", and at the 6th conference the narrower "Production Management Technique". In 1936 the General Secretary represented, at the invitation of the Federation of British Industries, the Institution on the newly formed British Management Council.(124) But such interest in broad management questions waned; the IPE became increasingly over the period 1921-1939, and even more so after WW11, a narrow technical speciality aiming at qualifying the professional production engineer. That segment of the original membership who looked to the Institution to "establish the status and designation of the production engineer", and to bring "some authority for the production engineer" both to alter general methods and look after total costs,(125) became the most powerful voice in the Council, with a resulting decrease in the scope of management interests, and an increase in the techniques of production engineering. By 1939 the "production engineering specialist" had emerged, expert in the techniques of production (e.g., choice of manufacturing site, type and layout of building, selection of machine tools, jigs, fixtures, planning of the manufacturing process and estimation of costs) and engineers in industry began to describe themselves and their offices as that of a "production engineer", previously functions undertaken by the works director, general manager, works manager, efficiency engineers and others (some of whom could also carry out functions of the production engineer, depending on the size and nature of enterprise). In accord with the increasing specialization in relation to Institution qualifications (the Civils bullied the IPE into trimming the scope of its objects in 1931)(126), the broad curricula for the examinations were replaced with more technically relevant subjects, a change hammered out by the Mechanicals further reducing their scope, after "long and difficult" negotiations between the two Institutions, to establish an HNC in Production engineering as a speciality within Mechanical engineering.(127) Rather than affecting the passage of engineers into general management in the interwar years, the IPE provided, in its early growth, some managers on the production side with what was to become a specialist engineering qualification. Later, with the formation of the Institute of Works Managers such demand was lessened.

The Mechanicals themselves responded to the developments in the United States with the Introduction of an optional paper, the "Economics of Engineering", into their examinations in 1924. Before the War, while giving a hearty reception to Taylor's technical paper "The Art of Cutting Metals", delivered in 1906, when Taylor himself visited England in 1910 and attempted to bring the Mechanicals into a discussion of scientific management methods, he was "roundly snubbed by the chairman of the only meeting which lent itself to a discussion of the subject" at the Institution of Mechanical Engineers.(128) The engineering press, the Engineer and Engineering aired views on management questions, but even there the reception was lukewarm. Engineering concluded in 1913 that scientific management was nothing but "a system of extreme specialization"; defined this way it was a matter of degree, we already had specialization in Britain, Dr. Taylor wanted more, British opinion was against that.(129) Later in 1934 the Electricals also introduced a paper based on the Mechanicals', this time titled "Engineering Organization, Management and Economics" for the Graduate examination, but it was dropped from the syllabus by 1945. Unlike the Mechanicals' paper, which was mandatory by 1934, the Electricals' paper was optional. The Civils took even less interest in management questions than the Electricals during this period. After WW11 more interest was shown: in 1953 a paper on "Management and the Water Industry" was delivered before the Institution of Water Engineers,(130) but apart from such occasional utterances, activity has been anything but pronounced. None of the Institutions took official action to ensure passage of engineers into non-technical leadership positions of control in the engineering or other industry.

Although these developments are minuscule compared to those in the United States, where the management division was by the end of the interwar period, the most important in the internal structure of the ASME, they had potentially far-reaching consequences. If the Institutions had acted more vigorously they could have stimulated the widespread adoption of management training into courses for engineers in the technical education sector, and to a lesser extent encouraged their growth in the university departments of engineering and applied science. The simple fact of adoption of an optional paper by the Electricals in 1935 for example, in itself meant relatively little; 86% of the members applying to transfer to the Associate Membership or for election directly into that grade had gained exemptions from the Institutions' examinations by virtue of the attainment of outside qualifications. At best only 14% would then be taking a paper in "Engineering Organization, Management and Economics", and in practice the demand was never that high. It did of course open the door for the introduction of the subject in technical colleges offering an HNC in Electrical engineering. These establishments had shown a willingness after the War to introduce such subjects, and the Mechanicals' compulsory paper had led by the time of the introduction of the Electricals' in 1934, to the adoption of courses in fundamentals of industrial administration and works organization and management at technical colleges with schemes leading to endorsements of the Higher National Certificates in Mechanical Engineering. These colleges numbered 33 teaching the Institutions' syllabus at a time when the Mechanicals alone had nearly 139 schools in their HNC scheme. But the Mechanicals did not intend that this paper should prepare engineers for wider occupational roles: it was designed as part of the equipment of an HNC-bred Mechanical, who would, after his long climb through the years of endorsements, otherwise be wholly self-taught on practically all non-technical subjects.

The arguments for and against the introduction of these strictly limited measures are indicative of the problem and their potential impact. Mr. E. Hopkinson in his October 1919 Presidential Address before the Mechanicals looked upon it as one way to "prevent further encroachments upon our established position in the engineering world", which was being eroded by specialists in commerce, management and administration. This was taken up by enthusiasts(131) at the Electricals with no success. The case in favour was forcefully put by Byng in a 1935 paper before the Electricals. He argued that in the absence of education in the techniques of administration for the engineer, those who had already demonstrated administrative and commerical efficiency in areas such as sales management, accountancy, etc., were more likely than engineers to be promoted to positions of general manager or managing director. In practice specialists in departments requiring "trade knowledge", as constrasted to engineering "technical knowledge", acquired administrative and managerial techniques, while engineers specialized outside these spheres, the consequence was an influx of personnel from accountancy and other commercial occupations to the top positions in the electrical engineering industry, a tendency complained about again and again in the discussion following Byng's paper. Financiers not engineers were the new captains of industry.(132) Opposition to Byng's statement recalled the themes voiced at the time of the introduction of the Mechanicals' paper in 1924. "Management" and administration were not "professional" subjets, the knowledge involved was not comparable to that of their technical specialities.(133) The lack of academic prestige, especially in the universities, thus inhibited the adoption by the Institutions of these subjects. Institutions were too concerned with the status of their own speciality to risk attaching it to academically suspect areas. Another important factor in Council opposition, for the marked lack of concern with management education, was that senior members, by virtue of their professional dominance in industry and higher managerial and administrative positions, had no interest in promoting schemes for the training of young engineers in skills that they themselves did not possess, and that would eventually give those possessing them, at least in theory, an advantage in promotion up the administrative hierarchy, perhaps over the heads of senior colleagues.(134) Another, and earlier argument, defended the purity of the specialist, hoping that administration would be "delegated" to others: "there are many who feel that there is something wrong with a system which takes a man away from that field in which he has by years of study and by the gaining of experience become an adept, and employs him in a vocation where the direct value of his high training is but little used."(135) While it was recognized that there was an argument in favour of raising the status of the profession by encroachment into managerial functions, this was opposed: "If engineers cannot maintain their status as engineers without sacrificing engineering they are in a bad way. We suggest that they will in the long run do better by insisting on the status that is their right through their scientific and technical attainments than by seeking to secure it through incursion into functions that can be equally well, and perchance better, performed by non-technical men."(136) Engineers were indeed becoming in a bad way: specialist status does not necessarily mean a low status, witness medicine, law, and science, but speciality as a source of status coupled with fragmentation as its instrument in the end reduced all to the lowest common denominator, while at the same time closing routes to the commanding heights of industry.

In conclusion, by comparison with the professions in the United States and Germany(137) where management studies were from an early date enthusiastically adopted by the U.S. engineering Societies (and the VDI), in Britain the Institutions combined, on the whole, an attitude of neglect with skepticism, considering that management studies had no right in a spcialist Institution.

Professional Associations and Practice

As long as the bulk of Institution members supported Council policy on questions of professional organization, i.e., the actions leading to the structure of fragmentation described in chapter 3, no professional association of engineers could, of course, really hope to attract professional engineers to objects radically different or opposed to Institution survival, such as registration and unification of the profession. Such groups in England have therefore been noticeably weak, though naturally the attainment of their stated objects would raise the profession's status.

The Engineers' Guild, the main association and unity organization, grew out of the "Committee on the Status of the Engineer", originating in 1937 as a lunch-group of young engineers. The Committee, all MICE's, set up the Guild in 1928 with a higher status as its guiding star, "The objects for which the Guild is established are to promote and maintain the unity, public usefulness, honour and interests of the Engineering profession."(138) Modelled on the medical profession, "broadly speaking ((the Guild aims)) to do for professional engineers the sort of thing that the BMA does for doctors,"(139) the Guild drew up a four point program: firstly, representation of the engineering profession at the highest levels of planning, control and direction; secondly, acceptance of engineers as eligible candidates for the most responsible administrative posts; thirdly, protection of the public from unqualified practitioners; fourthly, recognition and adequate remuneration of the services of engineers at all levels.(140) Limited successes indicative of the receptivity of public and client to any overtures from the profession rather than the strength of the Guild, were scored. In 1956, for example, the Guild began urging the British Transport Commission to open senior managerial positions to professional engineers. In 1960 no more than 4 or 5 engineers were in top management in all the Commission's undertakings; in 1963, after the Guild's pressure, 3 of the 6 railway General Managers were graduate or professional engineers, a further dozen senior management posts were held by engineers, who were also now being included on management courses. The increase did not apply to Docks and London Transport Board.(141) But the really noticeable thing about the Guild and a point that has already attracted comment(142) is that it has had no success outside isolated examples.

From its inception the Guild had great difficulty in gaining support from the Institutions; the early years were dominated by the usual wrangle over what Institution membership would qualify for the Guild, eventually being restricted to the Big Three for fear of disapproval of a wider net.(143) The Institution of Electrical Engineers in any case, for example, declined to give official support or recognition to the Guild, falling back on the rationale that the IEE was in its aims "purely scientific", while those of the Guild included the promotion of the interests of the profession.(144) In fact, the lack of sympathy for the Guild's aims was because the established Institutions sought, under the guise of learned societies, to carry out the kernel of the Guild's objects themselves.(145) In 1949, for example, the Guild began to explore registration possibilities,(146) the lynchpin of its four point policy, eventually concluding that registration would be in the public interest, and that "The Guild would be a proper body to take the lead in obtaining registration if it had the support, or at least the encouragement of the three Institutions in doing so. Without this support it would be most unwise for the Guild to take active steps in promoting legislation and if it did so, it would certainly not be successful."(147) As the Institutions opposed registration the Guild could only adopt an "educational" role, pointing to the benefits of registration, hoping that the Institutions' would notice, but, members were strictly warned: "it would be most improper for the Guild to seek to modify the views of the Institutions on a matter which lies equally in their province and that of the Guild, and Branches should be warned against actions which might give legitimate cause for complaint by the Institutions."(148) The Guild took to heart the lesson of the Society of Technical Engineers, which collapsed after the failure of the Engineers' Bill of 1926 and 1927 by noting that the STE without the confidence of the Institutions, was not "sufficiently strong to survive initial failure" and that the Bill was "too ambitious in its scope".(149) Right from the start the Guild laboured under an insurmountable disadvantage: they were deprived of the main instrument, registration, necessary for the realization of their objects, opposed by the Institutions with their "purely scientific" concerns. Subsequently, with 5 to 10% of the profession in its ranks, the Guild has carried out some salary surveys and published a journal.

A far older noteworthy professional association and unity organization is the Society of Engineers (the same Society of Engineers that the Civils stopped from getting a royal charter in 1867), formed in 1854, among former students of the engineering school at Putney House (the Putney College, known as the "Putney Club" for the first three years of its existence), before the Civils admitted them. In 1861 it absorbed the Young Engineers Scientific Association, and in 1910 it joined with the Civil and Mechanical Engineers' Society, another small student association composed mainly of marine engineering pupils and draughtsmen.(150) The members of the new Society of Engineers were drawn from among the most established Institutions, and it continued to emphasize the needs of young engineers. Throughout its long history, it has consistently advocated, at least in principle, statutory registration, but it balked at all those junctures when registration proposals were actually formulated for fear of incurring Institution displeasure. Its activities are largely confined to study functions and social gatherings.(151) A number of other associations and unions cater for professional engineers, not all exclusively so, but they have had little to no real impact on the development of the profession as a whole, far less than the Engineers' Guild, and have functioned to service engineers and other professional workers in particular employment areas, especially within the state service.(152)

When compared to the interest groups in the Scandinavian societies and in France and Germany, groups that have the stated object of pressuring for the advancement of their members into generalist or policy making positions as well as raising the status of engineers by other means, the British associations have been extremely ineffectual bodies. On a comparative basis there has been a noticeable lack of concern over the status and employment conditions in the British profession.(153) European professions, with a one or two tier system of engineering schools, usually also have an active professional association, such is the case in Sweden, Denmark, Norway, Germany and France.(154) The German VDI recruits from both the Technische Hochschulen and Ingenieurschulen, it is internally stratified as a result, and has pursued professional objectives and concerned itself with the conditions of practice throughout its history.(155) Even before the Technische Hochschulen gained university status (largely as a result of VDI initiatives), the VDI was pressuring for the passage of engineers into general administration and by 1911 it was felt that "administration of general public affairs might well be placed in the hands of engineers, and that could the ideas and spirit of technical science be generally introduced into municipal and state matters, economy and efficiency should result."(156) The 24,500 man strong VDI sought the realization of this goal in promoting the study of law, administration and economics not only in the technical high schools (aided by the very strong professorial element in the Society) but also in holiday courses for older engineers.(157) In the twenties and thirties the VDI was extremely active in the rationalization and standardization movements, taking advantage of the technocratic elements in the National Socialist Movement, and consistently (with measurable success) pressuring for the passage of engineers into higher management.(158) These status raising activities have been kept up by the VDI(with objects like the Engineers Guild and a membership like the Institutions) throughout its history, to the great benefit of German engineering.

In the sixties the VDI sought a tighter definition of the profession.(160) In 1963 a registration bill was promoted and action taken in the past,(161) to gain protection for the title Ingenieur,(162) and a more rigid demarcation between the higher and lower echelons. Graduates of the Ingenieurschule sometimes aspire to positions of greater responsibility and authority than graduates of the Technische Hochschulen, (163) a problem of all engineering professions outside organizations where positions are strictly defined in relation to qualifications.

Along with the Société des Ingénieurs Civils de France, which has concentrated its attention on study rather than professional questions though not entirely so, an active French pressure group for the interests of engineers exists in the Federation of the French Associations and Societies of Diploma Engineers(FASFID), a federated body of the societies of former students of engineering schools, certainly a powerful formula from the standpoint of activism on professional questions.(164) The FASFID concerns itself with recruitment and training in schools, retraining of engineers, the role and participation of the engineer in the organization, the position of engineers in official and other bodies, the environment and other professional issues, mostly questions receiving scant attention from the English Institutions. It is associated with the scientific and industrial societies, e.g., the Society of Electricians, the Society of Automobile Engineers (study associations) and is active in the Conseil National des Ingénieurs Français (CNIF), which maintains links with the Principals of the Schools and heads of large industrial enterprises, and also like FASFID has close links with FEANI and WFEO (the World Federation of Engineers). (165) While FASFID has not had the struggle of the VDI to achieve a high status and position for engineering because of the differing relation of profession, state and industry in the early development of technical education, which gave the French technocrat a high position in industry and state from the outset, it has done much to maintain their high standing. Most recently FASFID has urged the restriction of the title "Ingénieur" by law (only the designation Ingénieur Diplômé followed by the name of the awarding school is covered by the 1934 law), (167) and closure on that basis. This unity in collective action accompanies a strong feeling of community in the French profession" "French engineers are conscious of belonging to a 'social body', concerned with the general public and national interest. They have achieved unity in action and devote their efforts to maintain and develop higher educational establishments to train higher grade personnel for the industrial and commercial world by selection and multi-disciplinary training, which are characteristics of the French system of 'Grandes Écoles'." (168)

Commonwealth professions provide some interesting contrasts on the point of associational development and activity. The inclusiveness and dominance of the Institution of Engineers Australia, has led it to reject, on a number of occasions after investigation, the possibility of introducing a comprehensive system of registration in Australia, on the grounds that it is unnecessary, given the strong position of the Institution,(169) but its opposition is lukewarm compared to that of the British Institutions and there are some registration provisions, for example the Registration Act of Queensland. Parallel to the IEA and working in conjunction with it, is the Association of Professional Engineers of Australia, established in 1946 as a separate body after an investigation by the IEA into salaries. One of its objects is the attainment of salaries that "will enable all professional engineers to maintain a standard of living and a status in keeping with the reasonable needs of a professional man",(170) and has had some success in the establishment of minimum salaries for engineers in industry.(171) The success of the APEA was made possible by the inclusiveness of the membership of the IEA, so that the minimum qualifications for engineering positions are relatively well defined,as well as the intimate relationship between the two bodies. Although there are peculiarities in the system of industrial relations in Australia, which inhibit a strictly analogous development in Britain, the fragmented structure of the British profession militated against such an inclusive association. British engineers have been too concerned with the supposed advantages of membership in an established versus a non-established Institution to join a pressure group cutting across speciality groupings, a pattern much reinforced by the localism in orientation resulting from apprenticeship and pupilage, both less prominent in the Australian profession.

<u>The Engineer and Industrial Leadership</u>

The natural consequence of the fusion of fragmentation and specialization in the British profession in the manner described, has been a <u>decline</u> of the engineer in positions of industrial leadership. The engineer is considered first a specialist, then maybe a professional, and certainly not suitable material for general management: an attitude held first and foremost by the profession itself. In other societies, parallel to the patterns of collective action documented above, the trend in the industrial leadership of engineers has been reversed.

In the early 1920s complaints about a 10 to 20 year old process became increasingly common: the engineer was having to attempt to "maintain his status against the encroachment of men who know just about as much of engineering as he does of business".(172) The decline of the engineer also hit the railways, the breeding ground of the Victorian Civil and Mechanical engineers, where at one time the engineer was the "strongest officer at a railway board meeting", by 1926 the director and chairman had found it convenient "to have the greater part of their business put before them by one officer--the general manager."(173) Again in the gas industry, in 1937 the President of the Institution of Gas Engineers, Stephen Lacey, summed up the process of increasing technical specialization of membership and decreasing managerial and administrative authority as follows: "For many years the Institution was primarily a professional body of Gas Engineers (in what was the generally accepted but somewhat limited sense of the term), its great influence being in part due to the managerial responsibilities of the majority of its members. The development of complementary national bodies during the past 25 years, while relieving the Institution of special responsibilities with regard to administration and commerical affairs, has, at the same time, greatly increased the scope ot its responsibilities for scientific technique and development of education in all branches of the Gas Industry".(174)

Systematic data corroborates these observations. In the steel industry Erickson(175) found that the percentage of engineers who held office in a top management capacity fell from 33% in 1865, to 27% in the period 1875-1895, to 26% in 1900-1925, to 16% in 1935-1947, with a slight increase to 19% in 1953 due to the reconstitution of the boards after nationalization, and concludes: "Although professional engineers have consistently played an important role in the steel industry, their strength in positions of leadership was problably greater in the 19th century than in the 20th century."(176) Interestingly, this overall decrease in the percentage of professional engineers is accompanied by a relative increase in the proportion of metallurgists,(177) from 0 in 1865, to 2% in 1875-1895, 3% in 1900-1925, 3% in 1835-1947, and 10% in 1953. The percentage of lawyers rose steadily from 4% in 1865, to 7% in 1935-1947 and then fell to 1% in 1953.(178) In a 1951 survey Copeman also found a declining proportion of engineers: 19% of directors over 50 defined their early work and career as engineering, only 15% of those under 50 did so; for accountants the trend is reversed, 15% of those over 50 began in accounting, compared to 18% of those under 50.(179) The engineers were also less likely to hold other independent directorships than accountants.(180) A study by the Acton Society Trust in 1956 points in the same direction. Although the proportion of managers (defined as "all those above the level of foreman in production and of equivalent rank elsewhere, and below that of executive director")(181) with professional qualifications had been increasing, those with non-technical qualifications (primarily accountants, secretaries and lawyers) were doing so at a faster rate.(182) Persons with non-technical professional qualifications are more likely to reach "top management" positions than are those with technical qualifications,(183) a finding consistent with those of other studies. In a study of Mechanical engineers, Bosworth Monck found a decreasing percentage in top management over the course of the century. A sample was drawn from the Council of the Institution of Mechanical Engineers, who are leaders of the profession, in positions commanding the highest status among the membership; the findings are presented in Table 1. Data for the Institution of Electrical Engineers, comparable to Monck's, indicate a similar pattern, which is probably just as pronounced at the Civils.(184) The decline of the Council member on the directorate is a noticeable feature of the pattern for both the Mechanicals and Electricals. On top of this, the 1902 directors in Monck's sample were directors of larger companies than the 1952 Council-directors. A further analysis of 725 public companies in the engineering industry (accountable for about 4/5 of U.K. engineering output) found that over 2/3 of directors have no professional qualifications; 40% of the boards (representing one-quarter of the capital) have no technically qualified director. The main nationalized industries, by comparison, are stronger in technical qualifications at the top than the engineering industry as a whole and stronger than any part of it save the aircraft industry. Monck concludes: "The truth therefore seems to be that British engineering companies are not directed by leading engineers to the extent they were when we led world trade in this field." (185) The status of the engineer in the direction of industry had declined.

All these longitudinal studies point to the same conclusion: a relative decrease in the representation of engineers and the technically qualified at the commanding heights of British industry and a relative increase in accountants and those with other financial and commercial qualifications during the course of the half century up to the early fifties. Studies of the situation at that time confirmed that the outcome of this process was an extremely low proportion of engineers among industrial leaders. A 1947 study of the professional qualfications of directors of 436 large public companies found 127 accountants, 88 directors with technical qualifications and 53 lawyers; about 6%, 4% and 2% respectively. In the largest companies (with a capital of over £500,000) those

Table 1

MEMBERS OF THE COUNCILS OF THE INSTITUTION OF MECHICAL ENGINEERS HOLDING DIRECTORESHIPS

	Year (percentage)							
	1952	1942	1932	1922	1912	1902	1982	1882
IME	29.5	22.5	29.0	52.0	45.5	67.5	51.5	51.5

Source: Monck, op.cit.

with technical qualifications were 4.2% of all directors, and accountants 7.6%.(186) Similar findings were the outcome of Copeman's 1951 survey of British directors on the boards of large public companies.(187) Although the study probably considerably overemphasizes the extent to which engineers were represented on the British directorate in the early 1950s,(188) nevertheless, only 14% of the directors defined their early work as engineering; an equal percentage described it as clerical, and 13% as accounting.(189) Many other surveys have since been conducted as well as a number of reviews of the literature.(190) Most recently, from a thorough and extended review of the period 1950-1974, Glover concluded: "Yet there is still no evidence to suggest that graduates in technical subjects have begun to occupy positions in senior management and on boards significantly more often than in the past....All survey evidence...emphasizes a continuing tendency for boards to disregard technical men."(191) In fact no study since conducted has found an appreciably higher percentage of engineers on the boards than Copeman found in 1951, and many find less. In accounting the trend in the postwar years has been towards a continuation of the influx of qualified men into leading positions that was evident for the interwar period.(192) The Chartered Accountant has become the dominant figure, with a professional qualification, in top management in Britain.(193)

A further peculiarity of the deployment of engineers in British industry is the great unevenness in the proportions of technically qualified personnel in otherwise comparable firms, partly reflecting the uneven strength of the Institutions. The Acton Society Trust (194) found that 9% of managers were engineers, but that within this pattern there was considerable diversity. Some electrical engineering companies have a far higher proportion, in one of the two companies studied, three-quarters of the managers(195) had professional qualifications, in the other one-third.(196) But by contrast with the directorate, the trend in the postwar period has been for these middle management positions to recruit the more technically qualified.(197) Other studies suggest that accountancy is seen as a qualification suitable to industrial direction and higher management per se, whereas engineering qualifications are industry specific, and even then vary by companies within industry groups.(198) Clements also found that when persons with technical qualifications reach top management or the board of directors, they remain tied to technical work.(199) Technical work, contrasted with accountancy, is not recognized as a route to top positions.

In the United States engineering is recognized as a route to positions of industrial leadership and more of a generalist qualification than accountancy. There has been less opportunity for accountants, partly because of the practice of recruiting lawyers for management.(200) Over the course of the century the biggest gains in representation among industrial leaders have been made by engineers and scientists, principally the former: from 7% in 1900 to 20% by 1950 and 33% by 1964.(202) A 1950 study by the American Institute of Management of 238 "excellently managed companies" found that 17% of the presidents, the chief executive offier, of these companies were engineers, only 7% were accountants, 8% lawyers, 4% scientists,(203) figures that compare well with the other American studies. It is extremely difficult to make accurate Anglo-American comparisons, but it is quite clear that the proportion of engineers among top executives has been increasing over the course of the present century. By the early 1950s engineers were far more numerous in positions of leadership in the United States, perhaps in some instances twice as numerous, and much more so than accountants.(204)

In Germany the trend in the representation of occupational groups among top management follows a substantially different pattern from that found in Britain. Hartmann estimates that at the turn of the present century top management was largely non-technical.(205) Before the First World War, graduates of faculties of philosophy appear to have been disproportionately represented among the few with academic backgrounds. There were few engineers, and most of these were specialized graduates of the mining schools, who had monopolized positions in the mining industry. After the War, and through the

1920s into the National Socialist period, there was an upsurge of engineers, leading to a "strong predominance", which was followed by an influx of lawyers in the late thirties, and in the post-World War 11 period, experts in business administration and economists.(206) An analysis of the occupational and educational background of top management in the mid-fifties found that 31% of the Unternehmer who were active in top management had graduated from the Hochschulen, and 36% of these from the Technische Hochschulen or as many as the graduates in law (19%) and in economics (17%) combined. The remaining 28% included 4% from philosophy faculties, 5% with combined degrees in economics, engineering and law, 1% from medicine and science, and 18% unknown.(207) These figures are not easily comparable with American and British data, but this does not hinder the conlusion, widely substantiated elsewhere, that a professional engineering background is seen as appropriate for general management careers at the highest levels.(208)

In France graduates of the elite Grandes Écoles have monopolized high positions in the civil service and industry since the early 19th century. In the late fifties, some 61% of the presidents and directors-general of great firms with their headquarters in Paris came from these schools. Of the sample of 31 only 2 had a non-scientific education, a sharp contrast with the U.S., Britain and Germany.(209) An eminent French engineer describes the pattern from the professions' standpoint: "Engineers often occupy leading positions as heads of firms---Chairman, Managing Director, Manager, Secretary General or Chief Engineer. 24% of all the school ((French engineering schools as a whole not just the Grandes Écoles)) attain such a status---47% for those schools that provide management training."(210) In the British profession, taking the membership of the top fifteen Institutions, less than 2% reach positions of non-engineering general management.(211) In the absence of survey data on any trends, the contemporary predominance of the engineer in French industrial and government institutions, the subject of French sociological theorizing, is too well-known to need further documentation.(212)

In other advanced industrial societies the engineer is also more likely to be found in positions of industrial leadership.(213) Nowhere else does the phenomenon of an actual <u>decline</u> in the access of engineers to these elite positions seem to have occurred, and in some societies, the United States, Germany and probably the Soviet Union,(214) there is evidence of an increase.

<u>Conclusion</u>

In England the role of the engineer is seldom that of the technocrat, only ambiguously that of a professional, almost always that of the specialist. The growth in this, what is on European and American comparisons, peculiar specialist <u>cum</u> would-be professional role out of the great Victorian Civil engineer, parallels the decline of the profession in industrial leadership. The reason is simple: fragmentation in the professional organization of engineers precluded all action to further and legitimate status except the effort to found professional status on speciality, the process documented in this chapter. Collective action in pursuit of status has almost entirely consisted of actions designed to further the status of a speciality grouping in relation to other specialities, to the damaging exclusion of the broader measures, taken by the professions in the United States, Germany, France, Australia, to advance the interests of engineers against non-engineers. Fragmentation and specialization have thus combined yielding as an unintended and for the most part unforeseen consequence, the decline of the British engineering profession from a position of authority on an international scale, from the position of first among engineering professions, to its contemporary standing as the lowest-status engineering profession in the industrial societies.

Footnotes to Chapter 5

1. Cf. F.M.L.Thompson, Chartered Surveyors, London, Routledge & Kegan Paul,Ltd. 1968, pp.57-63.

2. On the careers of the members of the Society of Civil Engineers who were present at the Inaugural meeting at the Kings Head on March 15th,1771 (i.e., Yeoman, Smeaton, Grundy, Nickalls, King, Thompson, and Mylne), see E.C.Wright, "The Early Smeatonians", Trans.Newcn.Soc., Vol. XVlll (1937-38) pp.101-110, and cf. idem, "The Genesis of the Civil Engineer in Great Britain", 1931, Ph.D. thesis, Radcliffe College Library, and not availabe at present; cf. E. Robinson, "The Profession of Civil Engineer in the Eighteenth Century: A Portrait of Thomas Yeoman, F.R.S.,1704-1781", Annals of Science, Vol. 18 (December 1962) No. 4, pp.195-215, the careers and social origins of these early members are heterogeneous. On Smeaton's career see M. Dixon in Robert Mylne, Preface to The Reports of the Late Mr. John Smeaton, F.R.S., London, S. Brooke, 1797, Vol.1, pp.vx-xxx,xxi, (and reprinted in 1812 for the Society of Civil Engineers); cf. D.F.Duckham, "John Smeaton, the Father of English Civil Engineering", History To-day, Vol. XV3 (March 1965); cf. S. Smiles, James Brindley and the Early Engineers, London, John Murray, 1864.

3. Smeaton's Reports., op.cit., pp.vi-vii.

4. S. Pollard, The Genesis of Modern Management, A Study of the Industrial Revolution in Great Britain, London, Edward Arnold (Publishers) Ltd., 1965, pp.86-88.

5. Cf. D.H.Calhoun, The American Civil Engineer, Origins and Conflict, Cambridge, Massachusetts, The Technology Press, MIT, 1960, p.35 distinguishes on the New York Canal System in the early 1820s a principal or consulting engineer, senior resident engineers, resident engineers, senior assistant engineers, junior assistant engineers, which is a more differentiated hierarchy than on earlier projects, but may not have been atypical of the large projects of the period. Calhoun stresses the early relative absence of private practice among U.S. engineers compared with other professions.

6. C. Hans Straub, A History of Civil Engineering, Trans., E. Rockwell, London, Hill, Leonard, 1952, p.216.

7. Ibid.

8. Sir Alexander Gibb, The Story of Telford, The Rise of Civil Engineering, London, Alexander Maclehose & Co., 1935, p.196.

9. Thomas Tredgold, "Description of a Civil Engineer", Library of the ICE, and reprinted in "Report of the Council, Session 1885-6", Min.Proc.ICE., Vol. LXXXVl (1886) p.1, and see also ICE, "Charter of Incorporation", June 3 1828, in Trans.ICE., Vol.1 (1836) pp.xxxvii-xli.

10. "Report of the Council, Session 1885-86", Min.Proc.ICE., Vol. LVXXXVl (1886) pp.153-183,166-7.

11. These figures and others in this and the next sections taken from confidential membership forms and applications are based on small random samples generally between 50 and 100 or all those for the time period referred to, and should be taken as a rough impression only.

12. Eng., Vol.9 (January 13, 1860) p.26.

13. Engrg., Vol. XCl (March 17,1911) pp.364-6.

14. "The Railway Signal Engineers", Eng., Vol. 142 (December 31, 1926) p.718.

15. Ibid.

16. Ibid.

17. "The Railway Signal Engineer", letter Eng., Vol. 143 (January 21, 1927) p.83

18. O.S.Nock, Fifty Years of Railway Signalling, In Celebration of the Golden Jubilee of the Institution of Railway Signal Engineers, 1912-1962, London, IRSE., 1962, p.19.

19. ILO, Transactions, Vol.11(2), (1912) p.7, in Annual General Meeting, speech of Mr. Bennett, Vice-President in Chair.

20. "Locomotive Engineers", Eng., Vol. 139 (Febuary 27,1925) pp.244-5.

21. "The Institution of Chemical Engineers", Eng., Vol.132 (November 18, 1921) p.542.

22. "Chemical Engineers and their Training", Eng., Vol.135 (June 15,1923) p.635.

23. "The Engineer in the Chemical Factory", Eng., Vol.135 (January,26,1923) pp.84-5,84.

24. Ibid. 25. Concrete Institute, Transactions,Vol.1 Pt.1, pp.v,vii.

26. E. Fainder Etchalls, "The Evolution of the Engineering Institutions", Journal of the Institution of Structural Engineers, Vol.1 (June 1923) pp.190-198; July, pp.206-215; August, pp.244-48; September, pp.278-82; October, pp.292-98. The new title was adopted in 1922, another proposal from the trade element have been "Concrete and Steel Constructors Institute", Structurals,"Minutes"., 27th April, 1922, p.2. In Etchalls, ibid., see especially sections Vl, Vll, Vlll. Cf. Sir Hugh Beaver, "The Chemical Engineer" PE., Vol.6 (January 1960) No.5, pp.169-171, for an account of the fragmentation of the profession in the context of the ICE definition of Civil Engineering.

27. Etchalls, JISE., op.cit., p.278

28. Ibid., p.289.

29. Ibid., p.382.

30. On early problems of petition see Structurals,"Verbatim Reports"., 13th Jan., 1927, pp.11,13-15. The Civils' reasons for opposition are outlined in the counter petition.

31. "The Association of Consulting Engineers", Engrg., Vol.XVlll (January 26, 1912) p.122.

32. "The Association of Consulting Engineers", letter to editors, Engrg., Vol.XClll (January 19, 1912) p.81; cf. Engrg., Vol.XClll,(January 12, 1912) p.58.

33. "Specialization and Team Work", Eng., Vol.134 (November 24, 1922) p.559.

34. Ibid.

35. Ibid.

36. Ibid.

37. From a letter of December 31, 1859 from E.J.Read (Hon.Sec.,INA) to Mr.J.R.Napier an original member of the Council, cited in K.C.Barnaby, The Institution of Naval Architects,1860-1960, London, RINA, 1960, pp.8-9.

38. Ibid.

39. "Bye-laws and Regulations of the INA", Article 3, reprinted on p.xv, Trans.INA., Vol. IV (1863) p.xv.

40. Ibid.

41. "List of Honorary Members, Honorary Associates, Members and Associates", Trans.INA., Vol.V (1864) pp.ix-xiii.

42. See "Report of the Council, 18th March, 1869",Trans.INA., Vol.X (1869) pp.xvii-xviii.

43. "The Institution of Naval Architects", letter to ed., Eng., Vol. 26 (September 11, 1868) pp.264-5.

44. "The INA"., letter to ed., Eng., Vol.26 (September 25, 1868) p.239.

45. "The INA"., letters to ed., Eng., Vol. 27 (March 26,1869) p.222.

46. "The INA"., Eng., Vol.26 (October 9, 1868) p.280.

47. See "Report of the Council, 8th April 1870", Trans.INA., Vol.XI (1870) p.vii.

48. See "Officers of the Institution", Trans.INA., Vol. XVIII (1877) p.vii.

49. See "Bye-laws and Regulations", Trans.INA., Vol. XX (1879) pp.xv-xvi.

50. "On Tripod Masts and the Arrangement of Rigging Connected With Them", by Admiral Paris, C.B.,French Navy, Associate, (Trans., A. Vizetelly, Assistant Secretary of the INA), Trans.INA., Vol. XIII (1872) pp.21-29,29-38,38.

51. In this they had some success: Barnaby, op.cit., p.89.

52. Reprinted in Walter T.K.Braunholtz, The Institution of Gas Engineers, the First Hundred Years, 1863-1963, London, IGE.,1963, the official history and abstract of proceedings and Council Minutes, pp.260-270, as "Original Regulations of the British Association of Gas Managers".

53. Braunholtz, op.cit., pp.8-11.

54. Ibid. p.226.

55. Ibid. pp. 31-37.

56. Ibid., p. 228.

57. Quoted by Braunholtz, op.cit., p.43.

58. See Incorporated Gas Institute, Transactions, 1901, "The Proposed Amalgamation", pp.27-68.

59. Abstracted from appendix D infra.

60. See appendix B infra.

61. "Colleagues or Competitors?", by Sir Walter Puckey, PE., Vol.8(Jan.Feb.1963) pp.9-16,15.

62. And or course on salaries, which they do not concern themselves with at all. For criticism of Councils here, see "The Salaries of Engineers", letter to ed., Eng., Vol 159 (May 3, 1935) p.460.

63. "Report of the Council", Min.Proc.ICE., Vol. CLX1X (1908-9) Part 1V, pp.137-8.

64. Ibid., Appendix 1.

65. Ibid., Appendix 1, pp.346-351, reprinted letter from W. Cawthorne Unwin, President of the ICE, to the Right Hon. H.H.Asquith, KC., MP., dated 26th April 1912, headed "Civil Engineering Appointments in Public Services".

66. Ibid., pp.353-4.

67. Ibid., p.337.

68. "Report of the Council", Min.Proc.ICE., Vol. CCX11 (1920-21) Pt.11, p.305. The Civils along with the Electricals and Mechanicals gained an advantage in the Armed Forces by cooperation with the Air Ministry and the War Office; their Associate Member examinatations were recognized as the basis of entry into the Royal Army Service Corps., the Tank Corps (Technical Branch) and the Royal Engineers, see H.S.Hele-Shaw, "Address of the President", Proc.IME., Vol.103 (June-December 1922) Pt.,11, pp.985-1011,989,and "Report of the Council for 1923-24", JIEE., Vol.62 (December 1923) No.324 p.527.

69. "Report of Council for 1920-21", Min.Proc.ICE., Vol.CCX11 (1920-1921) Pt.,11, p.305.

70. "Report of the Council for 1919-20", Min.Proc.ICE., Vol.CCX (1919-20) Pt.,11, p.299.

71. E.F.C.Trench, "Address of the President", 1928, ICE., A Brief History of the ICE., London, ICE.,(Printers: Messrs. William Clowes & Sons), 1928, pp.71-79.

72. Brig.-General Magnus Mowat, "British Engineering Societies and their Aims", Paper prepared at the Semicentennial meeting of the Engineering Institute of Canada in Montreal, June 1937 and reprinted in The Engineering Journal, August 1937 issue, Library, IME.

73. The result has been the monopolization of specialist positions, see R.G.S. Brown, The Administrative Process in Britain, London, Methuen & Co. Ltd., 1970, pp.64-6, passim; Report of the Committee on the Civil Service,1966-68, (Fulton Report), Cmnd. 3638, 1968, Vol.1, para. 215, Vol.5, pp.20-31, H.M.Treasury and pp. 303-7,335-45,IPCS, Vol.1 para 35. There is evidence that Britain is peculiar in the extent to which engineers have been confined to specialist positions.

74. Gerstl and Hutton, op.cit., p.130.

75. Cf. ibid.

76. "Technical Societies", Eng., Vol. 142 (December 17, 1926) p.666.

77. C.H.Wordingham, President of the Institution of Electrical Engineers, "Inaugural Address of the President of the IEE", JIEE., Vol.56 (December 1917) pp.1-16,5.

79. PE., Vol.8 (May-June,1963) pp.98-9.

80. "What is Standardisation?" Eng., Vol. 159 (March 29, 1935) p.331.

81. "Standardization as a Moral Code", Eng., Vol.159 (May 17, 1935) p.515.

82. "Standardization Again", Eng., Vol. 134 (December 29,1922) p.693.

83. The President, Structurals, "Verbatim Minutes", Feb., 10, 1927, p.17.

84. The President, Structurals, "Verbatim Minutes", Feb.,10, 1927, p.16.

85. Ibid. Cf. L. Urwick, The Meaning of Rationalisation, London, 1930, p.142 comments on the conservatism of the BESA and problems from the standpoint of participation in the scientific management movement and industrial rationalization.

86. The ICE has been the most active. Over the period 1944-1949, 117 cases were dealt with, 115 arose over a breach of the rules of conduct and two as the result of a criminal conviction, 58 were proved resulting in four persons being expelled, 37 being reprimanded and so on. By contrast over the same period the IME only reviewed 2 cases and the typical number for chartered Institutions as a group is usually 6, excepting the ISE, which had 33 cases. Monopolies Commission, op.cit., Appendices, Table XIII.

87. Cf. "Engineering and Ethics", Eng., Vol.160 (December 27, 1935) pp.675-6.

88. Edwin T. Layton, The Revolt of the Engineers, Cleveland, The Free of Case Western Reserve University, 1971, p.123. It was Chicago based, and a coordinating body for regional associations; cf. Monte A. Calvert, The Mechanical Engineer in America 1830-1910, Professional Cultures in Conflict, Baltimore, The Johns Hopkins Press, 1967, p.133.

89. Engineering Council"Minutes", (1919-1920), Engineering Societies Library, New York, see especially Min. for Jan. 30,1919.

90. FAES, Engineers Unite,(Highlights of the 1920 Conference), New York, McGraw-Hill Inc., n.d., circa 1920, p.58. Cf. Theodore J. Hoover and John C.L. Fish, The Engineering Profession, 2nd Edition, Standford, California, Standford University Press, 1950.

91. FAES, op.cit., p.58.

92. FAES, The Committee on Elimination of waste in Industry of the FAES, Waste in Industry, Washington, DC.,New York, McGraw-Hill Book Co. Inc., 1921, and cited by Stuart Chase, The Tragedy of Waste, New York, The Macmillan Company, 1926, p.73.

93. FAES, Seasonal Operation in the Construction Industry, The Facts and and Remedies, Report and Recommendations of a Committee of the Presidents Conference on Unemployment, New York, McGraw-Hill, Book Co., Inc., and cited by Stuart Chase, op.cit., pp.128-129.

94. John Mills, The Engineer in Society, New York, D. Van Nostrand Co. Inc., 1946, p.136; cf. E.Layton, "Science, Business and the American Engineer", in R.Perrucci and J.E.Gerstl, The Engineers and the Social System, New York, John Wiley & Sons Inc., 1969, pp.51-72.

95. A.F.Bochenek, The American Engineering Council, An Experiment in Unity, New York, ASME, 1951, (and copy presented to IME Library).

96. EJC, A Progress Report, 1945-1965, New York, EJC, 1965, pp.6-7, "A Message from the President", Walter L. Cister.

97. Ibid., p.6

98. In particular the emphasis on increasing production and efficiency, requiring a "mental revolution" on the part of both labour and management, it typical of the ideology of engineers who frequently view their role as that of a "mediator" between thse two interest groups/ See F.W.Taylor, Scientific Management, (comprising Shop Management, The Principles of Scientific Management and Testimony Before the Special House Committee), New York, 1947, and especially "Taylor's Testimony Before the House Committee," (Thursday January 25, 1912), pp.27-33 (on "mental revolution").

99. Layton, op.cit., p.155 et.seq.

100. Of course engineers have also been prominent among industrial leaders before the movement, see Raymond H. Merritt, Engineering in American Society, 1850-1875, Kentucky, University of Kentucky Press, 1969, passim.

102. There was conflict within the ASME over the extent to which the Society was to become exclusively a spokesman for scientific management and (about 1912) a society of Taylorites was formed. Cf. Milton K. Nadworny, "The Society for the Promotion of the Science of Management", Explorations in Entrepreneurial History, Vol. V (May 15, 1953) pp.244-247; cf. Calvert, op.cit., pp.235-243. The ASME nevertheless played a considerable role in its development, see ASME, Fifty Years of Progess in Management, 1910-1960, New York, ASME, 1960.

103. Layton, op.cit., cf. Calvert, op.cit., p.276.

104. T. Veblen, Theory of the Business Enterprise, New York, 1904.

105. T. Veblen, The Engineers and the Price System, New York, 1963, (first published in 1921) and see the introduction of the 1965 edition by D. Bell on Veblen and the ASME.

106. On the technocracy movement, see Henry Elsner, jr., The Technocrats; Prophets of Automation, Syracuse, 1967, and on some of the ties with the profession, see Joseph Dorfman, Thorstein Veblen and His America, New York, 1964.

107. Occupational Licensing Legislation in the States, The Council of State Governments, Chicago, 1952, p.23, Table A.

108. Cf. Layton, op.cit., chapter on Depression and New Deal, pp.236-242 for pressure in the 1930s. Cf. Elsner, op.cit.

109. Council of State Governments, op.cit. Cf. Milton Lunch, Engineering Legislation, NSPE, n.d., Albert M. Sarpgent, A Study of Engineering Registration Laws, Detroit, 1948, and Alfred L McCawley, Professional Engineering Registration Laws, 1954.

110. Cited by E.L.Brown, The Professional Engineer, New York, Russell Sage Foundation, 1936, pp.50-51.

111. NSPE History Committee (Chairman D.B.Steinman), "Early History of the National Society of Professional Engineers", 1956, typescript MS at the Engineering Societies Library, New York, p.14.

112. Ibid., pp.94-96.

113. "Proposed Uniform License Law", American Engineer, Vol.1 (January 1931) No.1, p.16.

114. "A National Bureau of Engineering Registration", American Engineer, Vol.1 (Febuary 1931) No.2, pp.11and 72.

115. Among a number of publications, see especially, NSPE, A Professional Look at the Engineer in Industry, Washington, DC., NSPE., 1955.

116. Ibid.;cf. Joel Seidman, "Engineering Unionism" in Perrucci and Gerstl, op.cit., p.224.

117. EJC., Annual Report for 1960, EJC, 1961.

118. Ibid., pp.23,6-9, "Presidential Report", and pp.13-16.

119. The officers of the EJC are elected by the constituent Societies on a proportionate basis. EJC, Annual Report for 1960, EJC., 1961, pp.23-29, "Constitution and Bye-laws".

120. Jay M. Gould, The Technical Elite, New York, Augustus M. Kelley, 1966, pp.7-15,79-88,103-118.

121. Production, "Minutes", Min., 17, Sept., 1921, p.2.

122. Production, "Minutes", Min., 26th Feb., 1921, p.4; cf. IPE, Proceedings, Vol. 1 (1921-22) pp.1-7.

123. "Report of Meeting of Education Sub-Committee", July 5, 1929, IPE, Council Papers, Min., 1929-30, pp.11-12.

124. IPE,"Minutes", Min., 25, Nov., 1936, p.6.

125. IPE, "Minutes", Min. 4 March, 1921, p.2, and Min. 26, Feb., 1921, p.3.

126. IPE., "Minutes", Min.28 March 1931.

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128. Cf. L. Urwick and E.F.L.Brech, The Making of Scientific Management, London, Management Publications Trust, 1945, 3 Vols., Vol. 1, p.34.

129. "Industrial Management", Engrg., Vol. XCV (June 27, 1913) p.877.

130. F.H.Bullock, "Management and the Water Industry", Journal of the Institution of Water Engineers, Vol. 7, (August 1953) No. 5, pp.352-422.

131. See W.A.J.O'Meara, "The Functions of the Engineer: His Education and Training", JIEE., Vol. 57 (1919) p.225; and F.Gill, "Presidential Address", JIEE., Vol.61 (1923) p.1.

132. E.S.Byng, "The Engineer Administrator", JIEE., Vol. 77 (July-December, 1935) pp.491-502,502-513.

133. Ibid.

134. This point emerged in H.Shaw, "Training for Administration", Tee-Side Sub-Centre: Chairman's Address", JIEE., Vol. 90, (1943) Pt.1, pp.109-112.

135. "Engineers and Administrators", Eng., Vol.132 (December 16, 1921) p.651.

136. "Engineers of the Future", Eng., Vol.136 (December 21, 1923) p.672.

137. See below.

138. EG,"Report of the Executice Committee", January 1945 (typescipt) the objects and aims are from the statement on the "constitution" attached to the report.

139. E.G, The Engineers' Guild: an Introduction to Its aims and achievements, London, EG., 1959.

140. EG.,"A Memorandum of Importance to all Chartered Civil, Mechanical and Electrical Engineers", London, EG., n.d., circa 1950.

141. "Engineers in ETC Management", PE., Vol.8 (Sept.-Oct.,1963) No.5, pp.166-7.

142. K. Prandy, Professional Employees, A Study of Scientists and Engineers, London, Faber and Faber Ltd., 1965, ch.6, pp.186-7,121. "The most obvious fact about the Engineers' Guild is really its weakness". Prandy's study includes a survey of Guild members.

143. See P.St. L. Lloyd, "The Engineers' Guild--How It all Began", PE., Vol. 8 (Sept.-Oct., 1963) No.5, pp.147-150.

144. EG.,"Report and Financial Statement for the year 1940-41", typescript.

145. E.G., "Report of the Executive Committee", August 1945, (typescript); see for an account of a BBC broadcast in which the objects of the Civils were portrayed as similar to the Guilds'.

146. EG., "Report of the Committee on Statutory Registration of Engineers". London, EG., typescript document, 1951. The Committee produced with its report a draft "Professional Engineers' (Registration) Bill" for discussion.

147. "Report of the Committee on Statutory Registration", EG.,op.cit., pp.8-9.

148. Ibid., p.9.

149. Ibid., p.2.

150. "A Brief History of the Society of Engineers(Incorporated) and its work", Trans.Soc.Eng., 1927, pp.101-103; cf. Trans.Soc.Eng., 1907, pp.65-70; and Presidential address to the Civil and Mechanical Engineers' Society, 1st Oct., 1908, in Transactions of that society for 1908-9.

151. Ibid., and cf."A Short History of the Society of Engineers (Incorporated)", Trans.Soc.Eng.,1941, pp.10-25.

152. For an account of some of these associations, see Prandy, op.cit.

153. See chapter 7 infra. International Labour Office, Engineers and Chemists: Status and Employment in Industry, Studies and Reports, Series L., No.1, Geneva, 1924, pp.85-7; Walter M. Kotschnig, Unemployment in the Learned Professions, London, 1937, observed that the professions in England had less of a problem than elsewhere during the thirties with unemployment.

154. See Conference of Representatives from EUSEC, Proceedings of the Third EUSEC Conference on Engineering Education, London, 1958, p.72,82-3; EUSEC, "Aims of some Engineering Societies of Western Europe and the U.S.A.", London, 1956; E. McCronsky, Scientific Manpower in Europe, New York, Pergammon Press,1958.

155. EUSEC, 1950, op.cit.; EUSEC, "Aims of Some Engineering Societies of Western Europe and the U.S.A.", London, 1956; EUSEC, Report on Education and Training of Professional Engineers, Brussels, 1961, Vol.11, p.75 and passim.

156. "The VDI", Engrg., Vol. XC1V (December 20, 1912) p.851.

157. Ibid.

158. Robert A. Brady, The Rationalization Movement in German Industry, Berkeley, California, University of California Press, 1933, pp.18-19,386,422-6; Wickenden, op.cit., pp52 et.seq.; Heinz Hartmann, Education for Business Leadership: The Role of the German Hochschulen, Paris, OEED, 1955.

160. "A Parliament of Engineers", PE., Vol.8 (September 1963) No.5, pp.159-60.

161. EUSEC, Proceedings of the Third EUSEC Conference in Engineering Education, London, IME., 1958, Session V1, p.100.

162. EUSEC, Report on Education and Training of Professional Engineers, London, 1961, Vol.11, p.75.

163. EUSEC, 1961, op.cit., Vol.11, p.75.

164. College based associations, those with a high proportion of graduates and engineering educators in control are among the most militant on professional questions.

165. Rene Alquier, "Status and Education of Professional Engineers in France", PE., Vol.17, (Nov.,1972) No. 4, pp73-75,75.

166. Frederick B. Artz, The Development of Technical Education in France, 1500-1850, Cambridge, Massachusetts, The Society for the History of Technology and MIT Press, 1966, pp.155-166. "They continue the tradition of the"Commis d'etat", the King's trusted attendants who served the monarchy in times past."; Pierre Morel, "Engineering Schools in France", French Bibliographical Digest, No. 28, November 1959, Series 11, p.21. On the technocratic idealism of the graduates of French engineering schools, especially polytechnicians, see Artz, op.cit., pp.241-243; and F.H.Von Hayek, The Counter Revolution of Science, Glencoe, Illinois, The Free Press, 1952.

167. EUSEC, 1961, op.cit., Vol.11, p.75; EUSEC, 1958, op.cit., p.99.

168. Alquier, op.cit., p.75.

169. Cf. A report by the IEA, "Registration of Engineers" in PE., Vol.9 (March/April 1964) No.2, pp.44-52.

170. "Engineers' Petard", reprinted from the Australian Nation in PE., Vol.8 (November-December 1963) No.6, pp.192-194.

171. APEA, "The Professional Engineers Case", Melbourne, APEA, 1960; Cf. R.J.O'Dea, "Some Features of the Professional Engineers' Case", Journal of Industrial Relations, Vol.1V (Oct., 1962) pp.90-170.

172. "Engineers of the Future", Eng., Vol.136 (December 21 1923) p.672.

173. Eng., Vol.142, December 31, 1926, p.718.

174. S. Lacey, "Presidential Address" Trans.IGS., 1936-37, pp.758-771,760.

175. Charlotte Erikson, British Industrialists: Steel and Hosiery, 1850-1950, Cambridge University Press, 1959. The engineers are defined as members of the Institutions of Mining, Civil, Mechanical, Chemical, Production and Automobile Engineers.

176. Ibid., p.59.

177. Metallurgists are persons trained at university or technical college and or members of the RIC and/or IM.

178. Ibid., pp.58-62; Erickson notes: "The most significant change in the recruitment pattern of British steel has been the great increase in non-technical professional men who formed only 7 per cent of the 1865 sample but 28 per cent of the 1935-47 sample and possibly an even larger proportion in 1953." Ibid., p.60. This applies particularly to accountants. Cf. ibid., p.61 for an American comparison, and below.

179. G.H.Copeman, Leaders of British Industry, London, Gee and Company, 1955, pp.121-2, Table 13-9; these are double choice.

180. Ibid., pp.120-121.

181. R.Stewart, Management Succession:The Recruitment, Selection, Training and Promotion of Managers, The Acton Society Trust, 1956, p.5.

182. Ibid., pp.16-17.

183. Ibid., pp.27-28. Cf. Rosemary G. Stewart, and Paul Duncan-Jones, "Educational Background and Career History of British Managers, with some American Comparisons", Explorations in Entrepreneurial History, Vol.IX (Oct., 1956) - No.2, pp.61-71.

184. Data from IEE membership analysis.

185. Bosworth Monck, "Status of the Engineer in Management", read before Section G of the British Association at Oxford in Sept.,7, 1954, and reprinted as "The Eclipse of the Engineer in Management", Engrg., Vol. 178 (10 September 1954) No.4624, pp.329-34,333.

186. P. Sargent Florence, "The Statistical Analysis of Joint Stock Company Control", Journal of the Royal Statistical Society, Part 1, 1947. The data on companies were taken from the Stock Exchange Year Book for 1936.

187. Copeman, op.cit., p.74 for a description of the sample and response. The public companies were worth £1 m. or more.

188. This conclusion is based on a careful and reasoned analysis of the sample, see Copeman, op.cit., pp.84,93,90,78,18, for relevant sample peculiarities, and is a conlusion that is suggested by later studies, see below.

189. Ibid., pp.90-92.

190. See Theo Nichols, Ownership, Control and Ideology, London, Allen and Unwin Ltd., 1969, ch.VII "Technocracy without Technocrats", which reaches conclusions essentially similar to those following in the text.

191. Ian Glover,"The Backgrounds of Managers in Four Countries--British

Evidence", discussion draft, Herio-Watt University, 1974; this paper is based on a lengthy review, Ian Glover, "The Backgrounds of British Managers", Heriot-Watt University, 1974, a copy of which is housed at the British Institute of Management, London.

192. Cf. Roger Betts, "Characteristics of British Company Directors" The Journal of Management Studies, Vol. 4 (Febuary 1967) No.1 pp.71-88, who concludes that amatourism is still a charactoristic of British boards.

193. Glover, op.cit. p.7.

194. Acton Society Trust, op.cit.

195. "Managers" are defined as above.

196. Ibid.,p.12.

197. Glover, op.cit. p.5.

198. This conclusion is based on an analysis of data in D.P.Barritt, "The Stated Qualifications of Directors of Larger Public Companies", Journal of Industrial Economics, Vol. V (1955-57) No.3, pp.220-224.

199. R.V.Clements, Managers: A Study of their Careers in Industry, London, George Allen & Unwin, Ltd., 1958, pp.52-3: "Even those qualified specialists who are now directors practically all remain firmly tied to the type of work in which they made their way."

200. There is a wealth of material supporting the propositions, which it is unnecessary to present because the pattern described is given intuitively where the British is not. On the position of lawyers and accountants, see Jay M. Gould, op.cit., chart 23, pp.164-165, and chart 25, pp.168-9, from The Big Business Executive, 1964, New York, Scientific American, 1965, undertaken to update Mabel Newcomer, The Big Business Executive; The Factors that Made Him, 1900-1950, New York, Columbian University Press, 1955, Newcomer found that the percentage of leading executives with engineering as their first full-time position was 7.7% in 1900, 12.2% in 1925 and 16.8% in 1950 (Ibid., p.92); the percentage of accountants was low, 0 in 1900, .3 in 1925, 2.8% in 1950, and for lawyers constant at between 9 and 10%,(ibid., p.87).

202. Gould, op.cit., p.82. Other studies of executives indicate that 36% of those in the age group 55 to 65 (early sixties) had technical degress, ibid., p.83.

203. The Corporate Director, June and November 1950, cited by Copeman,op.cit.

204. See footnote 200.

205. Heinz Hartmann, Authority and Organization in German Management,Princeton, New Jersey, Princeton University Press, 1959, pp.162-166.

206. Ibid., pp.162-3.

207. Ibid., pp.164-6.

208. Two observers of the postwar Anglo-German industrial scene stated: "At present it is rare to find men with a scientific training on boards of directors,

208. and still rarer to find among that number the head of a firm's research department, however important he may be to the operations of the undertaking. He may have high scientific qualification, with an education greatly superior to many of the directors, but he is regarded only as a valued employee to be summoned as and whne required to explain issues beyond the scientific comprehension of the directorate. He takes no responsibility in the policy of the firm. In Germany, contrary-wise, it is common to find that half or more of the directors of an industrial concern are scientific graduates." Sir H.F. Heath and A.L. Hetherington, Industrial Research and Development in the U.K., London, Faber and Faber, 1946.

209. David Granick, The European Executive, New York, Doubleday & Co., 1962, pp.40, et. seq.

210. Alquier, 1972, op.cit., p.75.

211. CEI, The 1971 Survey of Professional Engineers, London, CEI, 1971, pp.16-7.

212. Cf. Jean Meynaud, Technocracy, London, Faber and Faber, 1968, first published in 1964 and translated by Paul Barnes; cf. J. Ellul, The Technological Society, London, Jonothan Cape, 1965, trans., J.Wilkinson.

213. In a 1943 study by Sune Carlson of 200 Swedish managing directors and vice-managing directors, found that of the 64% in industry (rather than commerce), who had an academic training, 31% were graduates of the technical universities, 12% from a commercial university, 8% lawyers and 13% others. Even in industry and commerce combined (with a total of 56% with adademic training) 21% were graduates of a technical university, compared to 12½% from commerical university, 13% lawyers and 9% others. Sune Carlson, Foretagsledning & Foretagsledare, Stockholm, 1950, and cited by Copeman, op.cit., pp.137-9. One European study found that of the top management who were graduates with science or engineering desgress, Britain had the smallest percentage in any country in Continental Europe except Italy. (ISEAD, 1969, cited by Glover, op. cit., "Background of Managers", BIM.

214. Engineering studies are seen as a suitable basis for industrial leadership in the Soviet Union, see D. Granick, The Red Executive, London, Macmillan & Co.,1950; Joseph S. Berliner, "The Situation of Plant Managers", in Inkeles and Geiger, op.cit., eds., Soviet Society, London, 1960, pp.364-5, for some comments on the prestige of engineering careers compared to others; cf. Albert Parry, The New Class Divided, Science and Technology, versus Communism, New York, The Macmillan Company, 1966; and Jeremy Azrael, Managerial Power and Soviet Politics, Cambridge, Massachusetts, 1966; among an extensive literature.

Chapter 6

Professional Organization of Accountants

Introduction

Accountancy is the recognized profession most like engineering in its organization; only the "land professions" of surveying, estate agency, auctioneering, when classified together, approximated engineering and accountancy in the degree of fragmentation.(1) But there are differences in the structure of the organization of the two occupations that go some way to account for the marginal differences in status. An examination of these differences should illustrate on a comparative basis the way in which the structure of the organization of the two occupations has contributed to their status as well as the generality of the explanatory factors identified in this study, thereby supporting the hypotheses and explanation advanced in ch.2.

The Early Development of the Accountancy Societies

While bookkeeping and other accountancy work originated in antiquity,(2) the emergence of the modern accountancy profession began with the foundation of the Scottish Chartered Institutes, the first in Edinburgh in 1853, followed by Glasgow later in the same year and Aberdeen in 1866.(3) The early Scottish development, and the high status of accountants in Scotland,(4) is partly the result of opportunities provided by differences in the law of England and Scotland: "The profession of accountancy did not attain a position of importance in England or in Ireland at so early a period as in Scotland, which was probably due in great measure to the laws of Scotland affecting the estates of bankrupts, pupils and other incapacitated persons, and the Courts of Justice, being so different in character. In England questions of accounting, which in Scotland would have been remitted to professional accountants, were dealt with by Master of Chancery: and estates in bankruptcy or belonging to persons under some legal disability were entrusted to the care of the officials of the Court. The Scottish system fostered the growth of a body of men relying on their merit for success, the English system maintained a number of court officials and commissioners---many of them ill-qualified to perform accounting work--- and left little business for the independent practitioner".(5) In England the Companies Act of 1862 permitted the professionalization of the occupation: "The Companies Act of 1862 may well be termed 'the accountant's friend', for it provides him with an occupation (and incidentally with remuneration) at the inception, during the progress, and in the liquidation of public companies".(6) The Act increased both the rate of formation of joint-stock trading companies and the demand for accountants. Other acts had similar results. The Bankruptcy Act of 1869 abolished the Official Receiver, increasing employment opportunities for accountants. The Companies Act of 1879 included statutory requirements for banks to appoint auditors. The Companies Act of 1900 provided for the complusory audit of private and public companies, as before the Act it had been possible for boards of companies to exclude themselves from the operation of the audit provisions of the 1862 Act. These measures contributed to the emergence of the accountant in private practice,(7) and provided the backdrop for a pattern of collective action and organization that would achieve for the British profession a position and status within the occupational structure in advance of that of most other accountancy professions.(8)

The first known Society of accountants in England was the Incorporated Society for Liverpool Accountants, established in 1870 a century after the Society of Civil Engineers(Smeatonians). Later in the year an association formed in London. These were quickly followed by other regional bodies: Manchester in 1873, Sheffield in 1877. In 1880 (after an unsuccessful attempt by the Institute of Accountants to introduce a registration Bill in 1878), the Institute of Chartered Accountants in England and Wales was established after a merger by royal charter. Members of the Institute of Accountants, Society of Accountants in England, Sheffield Institute of Accountants, Incorporated Society of Liverpool Accountants, and the Manchester Institute of Accountants, the participating Societies, were automatically eligible for membership in the new chartered organization, as were persons practicing for three years, in service for five years, or in service and practice for five years. The Institute was established as a professional organization, adopting an ethical code, examinations annually at the preliminary, intermediate and advanced levels, and practical requirements of a period of five years service under articles of clerkship.(10) Other accountants in practice outside these five associations, who wanted to become mmembers, were required to take the newly established examinations. In the early years of the ICAEW 's growth, a number of applications from established practitioners were rejected, along with some failures of the examinations. These efforts of the original, and professionally inclusive organization, to raise and further the status of the occupation by increasing the exclusiveness of the qualifications of the membership, resulted in the generation of a pool of unqualified accountants. Movements for the formation of a rival organization followed. The Society of Incorporated Accountants and Auditors (at first known as"The Society of Accountants") was formed after some opposition, as "The Society of Accountants and Auditors" in 1885, just five years after the Institute,(11) in order to "elevate the status and procure the advancement of the interests of the profession".(12) The "Incorporated Society", as it became known, introduced examinations in 1887, and a system of articled service in 1889, although it put less emphasis on this latter requirement than did the Institute. At first it included those accountants excluded from the ICAEW due to the peculiarities of the merger scheme, and who did not wish to undergo the newly introduced admissions procedure, considering their status to be already reasonably established by comparison.(13) A further body, the Institute of Municipal Accountants Incorporated, (at first the Corporate Treasurers' and Accountants' Institute), formed in the same year, 1885, and incorporated in 1901, sought to "elevate the status" of municipal treasurers and accountants.(15)

The fragmentation of the profession, along non-speciality segments, invited attempts at registration. A number of Bills were formulated and some presented in Parliament between 1891 and 1911.(16) The attempt before 1907 failed largely because of the rivalry between the Institute and the Society (later known as the Incorporated Society). The first Bill was promoted by the Institute of Chartered Accountants in 1891, and simply sought to protect and monopolize the title of "chartered accountant".(17) It was successfully opposed by the Society. The Society of Accountants and Auditors sponsored inclusive Bills in 1893, 1894,1896,1899, for the registration of all accountants in practice. These met with the vigorous opposition of the Institute of Chartered Accountants in England and Wales. The ICAEW, in turn, promoted Bills in 1893 and 1895, which were opposed by the SIAA. The 1895 Bill also excluded the members of Scottish Institutes, and was followed by a Bill sponsored by the three chartered bodies in 1896, and later in the year, one by the rival Scottish Institute of Accountants. These met with the opposition of the English chartered body. In 1897 the Institute planned another Bill, but this met with opposition within the Institute itself. In 1903 however, a joint Committee of Chartered Accountants including all the chartered organizations, was established to explore the possibility of registration, resulting in the Chartered Societies Protection Bill, which was withdrawn in 1907, again because of the SIAA's opposition. In the same year the Society was able to gain legal protection for the designation "Incorporated Accountant", changing its title to the Society of Incorporated Accountants and Auditors in the following year.(18)

While the established organizations were engaged in this bid for closure and professional status, other associations sprang up. A factor here was Section 13 of the Revenue Act, 1903, which authorized accountants, defined as members of an incorporated Society without further specification, as well as solicitors and barristers, to represent appeals before the Commissioner of Taxes. The new associations included the Institute of Certified Public Accountants Limited, 1903, the Central Association of Accountants Limited, 1905, and the London Association of Accountants Limited, 1905, which was "attempting to legislate for that large number of unassociated and unattached gentlemen--- a larger number than many are aware---who, having the requisite knowledge, capacity, experience and training gained from actual pratice, are yet barred from membership of the older established societies mainly through the compulsory and often expensive articles enforced by them."(19) The threat posed by these bodies to the established organizations led to joint-action by the ICAEW and the SIAA, resulting in the introduction of a Bill into the House of Lords in June 1909.(20) The Scottish and Irish chartered accountants were excluded from its provisions, and it failed because of their opposition, combined with that of the new associations. One of these, the Glasgow-based Corporation of Accountants, introduced a more inclusive retaliatory Bill in 1910, which also failed.(21) The 1909 Bill reappeared in 1911 as a Bill promoted by the ICAEW, the Scottish and Irish Chartered bodies and the SIAA. Read for a second time in the House of Lords, and supported by the Government, it failed in the Commons due to the objections of Sir Frederick Banbury, who pointed out that it excluded women, members of the Society of Municipal Treasurers and Accountants, and "railway accountants", full-time officials of railway companies. It was also opposed by the new bodies, not so much because they would be excluded from its provisions as individual practitioners, but because they would be excluded as corporate bodies from a role in the new authority, which was to be the instrument of the established organizations. The amendments demanded were not acceptable to the promoters of the Bill, because "registration on a basis which would adequately safeguard the public and be acceptable to the profession would not be forthcoming."(22) A further, more inclusive, Bill was presented by the London Association in 1912, but no further serious attempts were made until after the War.(23) The proliferation of minor Societies dampened the interest of the ICAEW and the SIAA in registration, and Parliament has been unwilling to enact measures that involve the abrogation of existing privileges. As the younger bodies grew in stature and membership, the established organization became more exclusive and more threatened by the necessary dilution, and the presumed immediate loss in status following registration. The status of the Chartered Accountant, and to a lesser extent the Incorporated Accountant, was further enhanced by the privileged position they occupied in respect of municipal audits. It had been customary, after the precedent set by the Accrington Corporation Act, 1890, for Parliament to adopt a clause in Corporation Bills that empowered a Corporation to appoint auditors from any members of the ICAEW and SIAA.(24) This monopoly became in time the source of continual agitation on the part of the smaller rival bodies, especially the London Association of Accountants Limited (LAAL).

The Interwar Years

Accountants participated in the burst of activity in the professions starting after World War I and lasting well into the twenties. The growing exclusiveness of the established organization provided scope for the growth of even further associations. Some of the pre-war newcomers were themselves becoming recognized and established. The LAAL introduced examinations in 1920, and contributed to the growth of rivals, along with the ICAEW and the SIAA, by tightening up admission requirements. In the period 1920-1929, the average percentage of passes at the ICAEW was 58%, at the SIAA 57% and at the LAAL 48%,(25) although the last-named body had, of course, a far smaller percentage of its total membership entering through the examinations, by 1929 58% had done so, the remainder being exempted. Nevertheless, it was not quite the window-dressing that it was in other Societies, for example, the Central Association of Accountants Limited (CAAL) admitted by 1927 only 37 out of 800 members by examination.(26) Another source of stimulation was Section 137 of the Income Tax Act, 1918, which like the Revenue Act of 1903, made provisions for accountants defined as members of an incorporated body.(27) Associations would use this provision in their advertisements for new members.

Among these new associations was the Institute of Cost and Works Accountants (ICWA), formed in 1919 in order to "promote the use of scientific methods in Cost and Works Accountancy; to improve the professional status of Cost and Works Accountants", as well as to institute professional control of colleagues, promote education, and to examine and test competency,(28) partly because of the growth in the use of highly specialized techniques during the

War, involving the measurement of the expense of production of commodities, (there was some overlap with the IPE), as well as the exclusion of the bulk of practitioners from the established organization. A petition for a royal charter in 1922 met with the resistance of the ICAEW and the SIAA, on the grounds that costs and works accountants "are not engaged in professional work, but are employed in the service of traders".(29) Unlike the ICAEW, the ICWA's members were located in employee-accountancy and clerical positions within industry, though not exclusively in the specialized cost accountancy work. By 1930 out of a total membership of 796, only 55 or 7% of the total were, according to officials of the ICWA, practicing on their own as consultants or in partnership with other Members.(30) About 100 or 12% of the members of the ICAEW and the SIAA were also, in 1930, members of the ICWA according to officials, joint membership arose because of the recognition of the ICWA as a specialist body going beyond Chartered Accountancy (yet strangely no further requirements were made in many cases of applicants from the more established bodies). Examinations and some practical requirements were introduced in 1920,(31) but by 1930 it was still possible for aspirants in practice to gain Membership without taking the exams of the ICWA, or becoming a "registered student" in lieu of the provisions for articled clerkship (students were required to register themselves with the ICWA while studying for their examinations). The strong emphasis on apprenticeship, characterstic of the ICAEW weakened in the case of the ICWA (who cast a broader net as they were not so threatened by competition from new firms, i.e., free-lance practitioners). Something of the demand for qualifications in accountancy can be seen in the fact that even the ICWA had in the twenties about 500 persons a year approaching it with a view to membership, about 20% of whom were eventually successful.(37) The other associations included: the Institute of Poor Law Accountants and Auditors Limited, 1923; the Society of Statisticians and Accountants Limited, 1925 (and incorporated in 1927); the Professional Accountants Alliance Limited, 1927; and the Faculty of Auditors Limited, 1927 (and incorporated in 1928); and the Institute of Company Accountants Limited, 1928 (incorporated in

1929).(33) With the exception of the ICWA, which legitimated its claim to speciality status by extending the boundaries of accountancy technique, these other associations catered for accountants ordinarily coming within the technical jurisdiction of established Societies, but not meeting the membership requirements. In some cases a partial claim to "specialist" status arose by virtue of the confinement of members to a particular type of employment. The IMTA, founded partly to raise the status of municipal treasurers and accountants,(34) restricted its Fellows to those in the position of Chief Financial Officer to a Municipal Corporation, County Council or District Council, its Associate class to accountants in finance departments of local authorities (having passed the Institute's Finals).(35) Its counterpart in engineering is the Institution of Municipal Engineers. A further splinter group arose in local government because of the exclusion of Clerks to the Boards of Guardians, the Poor Law Authorities from the IMTA---this was the Institute of Poor Law Accountants Limited (with a counterpart in engineering under the title Institution of Engineers-in-Charge). The IPLAL included, before the reorganization of Local Government following the Act of 1929, the majority of those Clerks and other accountants in the County Accountants Department and the County Borough Accountants Department, who did not meet the IMTA's standards. After the reorganization of 1929 the IMTA made provision within its organization for qualified members of the IPLAL. The technical specialization of the IPLAL was negligible; its officials looked upon the positions as ones involving qualifications that would otherwise be suitable for the position of Clerk to a public company, or the secretary, or accountant of such a company. In other cases the self-proclaimed speciality status was even more spurious. The Institute of Company Accountants Limited (ICAL) confined membership to chief and assistant accountants to public companies, salaried employees. This claim to a unique role was based on the exclusion of accountants in private practice and auditing, not on technique or knowledge.(39) But again these positions were also commonly occupied by members of the ICAEW and the SIAA. It did try though to push up its membership by portraying itself as a speciality grouping, otherwise as reputable as the accountants and auditors in public practice, and , after an advertising campaign using registration as a device to recruit, membership shot up from 450 to 600 in the two and a half months between the submission of its original statement to the Departmental Committee and the presentation of their oral evidence.(38) Many of the minor organizations had no pretense to any kind of speciality status whatsover and could not therefore explain or justify their existence on that basis as did the minor and wholly insignificant less-than-minor engineering Institutions. The largest, the LAAI's approximately 2,900 members in 1930 were deployed 32% in private practice, compared to the SIAA's 40% and the ICAEW's 49-50%.(40) The Professional Accountants Alliance Limited (PAAL) had a membership that was anything by specialized. Describing the accountant as a "Jack-of-all-Trades" an official indicated that members carried on audit, taxation, railway, and general accountancy work, about 91 of the 158 doing so in "public practice". Its main object in forming, after the Income Tax Acts, was to represent "unattached" accountants not included in the established organizations.(41) The Socity of Statisticians and Accountants Limited (SSAL) attempted to project itself as specialist, but was in no way confined to accountants of a certain ilk. Of the 300 odd members in 1930 something under 25% were in practice on their own account even though it had been formed to provide services to accountants employed in national and local government, "in the public and pseudo-public services---that is hospital and trade union and social services---"(42) not being catered for by existing Societies. In the hope of boosting membership the SSAL also "specialized" into the work of "statisticians", the examinations included provisions for this. Yet not to lose out on the "good many" accountants not affiliated with any Society, the SSAL's officials stressed the very comprehensive and unspecialized nature of the examinations as a whole, which were copied from the Intermediate and Final examinations of the Institute of Chartered Accountants "with slight verbal alterations".(43) These and other minor bodies came to resent the position of professional ascendancy achieved by the ICAEW, and the SIAA; their privileges and state recognition under the various legislation relevant to accountancy engendered discontent. The monopoly of function, especially on the contentious question of municipal audits, achieved by the two senior bodies was, in itself, of perhaps less direct significance for professional practice and employment, than the legitimacy it conferred,(44) and the consequent demand for their qualifications, which steadily increased over the first quarter of the century.(45) State sanction of the claim to status also furthered the myth of exclusive monopoly. A contributory factor was an administrative decision made by Baldwin, while Financial Secretary to the Treasury, restricting audits of the accounts of Friendly Societies to members of the ICAEW and the SIAA. Before 1920 the list of public auditors had included 325 members of the London Association of Accountants Limited.(46) The amount of employment provided by this and other legislation, though not large in itself, when combined with the element of state sanction and recognition involved, implying the possibility of further sanction and monopoly, made inclusion essential for the new associations, as a precondition of really substantial growth in numbers. Their increasing demands and the changing entry requirements provided grounds for a reexamination of the basis of the privilege of the ICAEW and the SIAA. Between 1911 and 1922 the LAAL opposed 59 private Bills, provisional orders and other measures, with some degree of success in breaking the monopoly of the Institute and the Society.(47) In 1930 the LAAL received some recognition when the Local Legislation Committee of the House of Commons included the LAAL in its ruling on the Cardiff Bill.(48)

In 1929 the Select Committee of the House of Commons on Local Legislation, after hearing a petition from the LAAL and a counter-petition from the ICAEW and SIAA, recommended the reorganization of the profession on a unified basis similar to other learned professions.(49) This, along with the continued appeals before this body by the LAAL, the ICPAL and the CAAL, led to the establishment of the Departmental Committee under Viscount Goschen in the Board of Trade, to examine the entire question of registration of the accountancy profession.(50) The Departmental Committee's investigation marks, along with the Bills of 1909 and 1911, another watershed in the development of the profession. The failure to recommend registration, thereby not raising the status of members of the smaller Societies, on the grounds that there was no strong demand from the interested public,(51) was a testimony to the power and establishment of the ICAEW. The Institute was the only accountancy Society giving evidence before the Committee (along with its Scottish counterparts) to steadfastly oppose registration of the profession.(A contrast to the situation among the Institutions in the twenties when all those that thought they could aspire to professional status via speciality standing opposed registration.) This the ICAEW did forcefully. It is largely responsible for halting registration at this time. The Society of Incorporated Accountants and Auditors, the London Association of Accountants Limited, and all the other accountancy bodies giving evidence (except for the Institute of Poor Law Accountants Limited, giving no view, and the Institute of Company Accountants Limited, showing only limited agreement), expressed a favourable attitude on the desirability of a register. Sir William Plender (later Lord Plender), President of the ICAEW, outlined the reasons for their abstention from the general approval: "The conditions today are widely different from those prevailing in 1909-1911. The Institute membership has largely increased in the interval; the growth of Accountants identified with other bodies has increased in a greater ratio; the status of the Chartered Accountant has improved and is more generally recognized as being the hall-mark of efficiency and high-standing, and Registration is a device to seek to reach a measure of equality between all accountants."(52) He went on to argue that registration would, by raising the status of the non-chartered accountant, result in an overall dilution of the standards of the profession and hence militate against the public interest. The result would be a "levelling down" of the profession of accountancy, rather than a "levelling up": "You cannot water your capital without reducing the value of your shares",(53) the more so if the definition of the accountant wasn't carefully considered: would "Turf Accountants" be eligible? The Chartered Accountant was differentiated from his non-chartered colleague by (according to Sir William Plender) not only his education, training, (Plender emphasized that the Institute was the only body to require service in the office of a Public Accountant as a necessary condition of membership)(54), and ethical requirements, but also by the state recognition accorded to him. Successive governments had recognized the Chartered Accountant by asking him to serve as Royal Commissioners, on Departmental Committees, and in a host of other ways, which he enumerated.(55) As part of his argument, Plender emphasized the absence of any public demand for registration. He was convinced that the majority of the membership of the ICAEW were against registration, certainly the Council members were.

The position of dominance attained by the ICAEW by 1930 is clearly seen from Table 1 where its members are shown as twice those of the Incorporated Society and ten times that of most other bodies. Of the members of these Societies, some 10,000 were in private practice, and of these 75% belonged to three Societies, the ICAEW, the SIAA, and the LAAL,(56) with the ICAEW as the clear leader. Corresponding to this dominance, the chartered body carried out most of the audits of companies in 1930. Sir William Plender in evidence on behalf of the ICAEW, intending to show that the public discriminated in favour of the Institute so that there was no necessity for registration, indicated that from information extracted from the Stock Exchange Official Intelligence for the year 1929(57) out of a total of 5,518 companies, not less than 4,971 had their accounts audited by Chartered Accountants in 984 firms (the issued capital including debentures of that number of comapanies was £5,595,000,000). Only 160 companies were audited solely by members of the SIAA (with a total share and debenture capital issued of £46,404,827).(58) The smaller associations accounted for an inconsequential part; indeed, some of the 17 accountancy associations recognized by the Departmental Committee were

TABLE 1.

ACCOUNTANCY SOCIETIES: DATE OF FORMATION, TITLE AND MEMBERSHIP FOR 1930.

DATE OF INCORPORATION OR GRANT OF ROYAL CHARTER	NAME	MEMBERSHIP.
1854	Society of Accountants in Edinburgh	952
1855	Institute of Accountants and Actuaries in Glasgow	1,825
1867	Society of Accountants in Aberdeen	163
1880	Institute of Chartered Accountants England and Wales	9,047
1885	Society of Incorporated Accountants and Auditors	5,225
1891	Corporation Accountants Limited	1,927
1901	Institute of Municipal Treasurers and Accountants (incorp.)	642
1903	Institute of Certified Public Accountants Limited	175
1905	London Association of Accountants Limited	2,900
1905	Central Association of Accountants Limited	739
1919	Institute of Cost and Works Accountants Limited	796 (approx.)
1923	Institute of Poor Law Accountants Limited	409
1923	British Association of Accountants and Auditors Limited	333
1927	Society of Statisticians and Accountants Limited	300 (approx.)
1927	Professional Accountants' Alliance Limited	158
1928	Faculty of Auditors Limited	200 (approx.)
1929	Institute of Company Accountants Limited	600 (approx.)

Source: Dept. Comm. on Reg. of Accts. (1930), Report, op.cit., pp.4-5.

practically insignificant, like many of the engineering Institutions. One witness, Mr. Cross, President of the Faculty of Auditors, giving testimony in answer to the question of why the Faculty had received over 2,000 applications for membership in the past three years, said: "I do not know. I think they had the idea that we fulfilled their requirements, we had a higher standing than the institution of which they were members; and possibly the name had something to do with it; they thought possibly a Faculty might be more of an all-embracing body than the lesser organization."(59) Others also formed out of the potential threat of registration to the livelihood of unattached practitioners, posed by the agitation of the established minor associations in the late twenties. The Departmental Committee found that the admission requirements and educational standards of the non-chartered bodies varied widely.(60) Some of these minor associations later disbanded, or merged with other bodies. In 1939 the Association of Certified and Corporate Accountants (ACCA) was formed by the amalgamation of the LAAL, the CAAL, and the ICPAL.(61) Subsequently, the ACCA has gained more stature, becoming one of the five "recognized" societies. Most of its members are trained and recruited for industry, only a few are in private practice. There were other amalgamations.

The 1930s saw accountancy firmly established among the professions. The jurisdiction of the accountant, "the business doctor",(62) was greatly expanded to include further managerial functions. It was during the thirties that the rise of accountants, continuing in the forties and fifties, began in earnest.(63) The Societies encouraged this broadening of their memberships' activities, though they needed to do little. The absence of alternative education and training for industry, trade and commerce, on anything like a scale comparable to that in the United States and Germany,(64)along with the reluctance of the other major industrial profession, engineering, to broaden its scope, meant that an occupational background could easily be substituted for higher education. The result was that accountancy became a qualification for general management, and a particularly suitable background. In 1950 the Institute itself described the change over the prior two to three decades, evidenced by the "considerable extent to which members of the Institute have taken whole-time appointments in industry and commerce after qualification, instead of practicing as public accountants. The accountancy profession now includes a much wider field than that of public accountants".(65) Neither was this a reason for regret on the part of the ICAEW. Between 1913 and 1950 the proportion of nonpracticing accountants in the three major bodies(the ICAEW, SIAA, and ACCA) increased faster than the proportion of practicing accountants in their membership.(66) Practicing members of the Institute were 60.5% of the total in 1913, 39% in 1939 and 44.7% in 1950. In 1950 the Association of Certified and Corporate Accountants was 68.0% non-practicing. Allowing for qualifications,(67) it may be said that over the period 1913-1950, the proportion of non-practicing accountants in the membership, which was intitially high, increased for all three bodies. Consequently many students enter accountancy with a knowledge of the opportunities and an intention to enter industry, trade or commerce on the strength of their qualification. A survey of 275 students of the ICAEW in 1950, found that 90, even at that early stage, had already decided to go in for commerce.(68) The extension of the accountant's jurisdiction has been at the expense of the engineer. There is considerable rivalry between the two groups of professional staffs within industry, in which the accountant has been the more aggressive partner, even willing to encroach on the technical jurisdiction of the engineer,(69) while the engineering Institutions looked down on anything that smacked of commerce.

Postwar Developments

A number of new Societies formed in the 1940s. These were probably stimulated into being by the registration proposals, aired during the War, and formulated in the Public Accountants Bill, 1945. The Bill was drawn up by a Coordinating Committee established in 1943 by the Chartered, Incorporated and Certified organizations, after some suggestion from the government that unity would not be unwelcomed.(70) These same organizations also formed a parallel body, the Accountants' Joint Parliamentary Committee in 1945, at first to shield practitioners from any adverse impact of legislation introduced by the Labour Government, particularly the nationalization program. Among other activities, the profession wanted to protect the interests of independent professional accountants whose audit business was being lost to employees of the nationalized undertakings.(71) The Coordinating Committee submitted the 1945 Bill to the Board of Trade, but withdrew it again, ostensibly over difficulties of defining the profession.(72) The Bill had been conceived in the wartime spirit of cooperation. Moreover, the Companies Act of 1948 recognized the Chartered Institute, the three Scottish Societies (which merged into one body in 1951), the Institute of Chartered Accountants in Ireland, the SIAA, and the ACCA, as practicing accountants, giving them a monopoly over the audit functions defined in the Act. Interest in registration was curtailed by the Act.

In 1957 a scheme first aired in 1954, for the "integration" of the Society and the Institute, reached fruition. The SIAA dissolved, the majority of its members were absorbed by the Institute, and other members of the SIAA, who had not either been trained in, or had not been principals in, a practicing accountant's office, became "Incorporated Accountant Members of the Institute".(73) The integration was a more or less direct outgrowth of the deliberations on the establishment of a body modelled on the General Medical Council, which had begun in 1942 with the formation of the Coordination Committee. The 1957 integration grew out of the close contacts between members of the Society and the Institute on the Committee.(44) In the absence of registration, this integration was in the interests of both organizations. It assured the dominance of the Chartered Institute over all other associations, and it offered members of the Society a place in the more prestigious organization. The majority of the members of both Societies were in favour of the scheme.(75)

These four bodies have continued as the "recognized" Societies. The auditing of the accounts of companies incoporated under the Companies Acts of 1948 and 1967, and the Companies Act (Nothern Ireland) 1960,(76) is restricted to members of the ICAI, the ACCA, . practitioners individually recognized by the Board of Trade under S.161 (1) (b) of the Companies Act 1948, and the English and Scottish Chartered bodies. The same organizations and persons are recognized for the function of reporting on profits, assets, etc., for share prospectuses, etc., under the Companies Act 1948; and also for attesting claims for investment grants under the Industrial Development Act 1966, or other relevant statute. These four Societies, by and large, also have other functions reserved, such as the auditing of the accounts of trustee savings banks, building societies, friendly societies, etc., and attesting to financial statements of individual members of certain associations.(77) In addition to these recognized Societies, the Institute of Municipal Treasurers and Accountants (Incorporated) is a specialist body, monopolizing positions within local government. Membership in it has become a prerequisite for practice, especially among accountants in full-time positions in the finance departments of local authorities(78). Some arrangement was accordingly made with the Society and the Institute in order to facilitate the entrance of their membership into this "specialist" sphere. Like the Institute of Cost and Works Accountants, the Municipal Accountants are now recognized as a "specialist" organization, by the other established Societies.(79) Table 2 presents the membership of major and minor accountancy associations for 1969, illustrating the dominance of the Chartered Society.

<u>Education and the Profession</u>

The accountancy Societies introduced examinations early in their historical development, often within a year or so of foundation. These examinations have largely determined the content of accountancy education outside the universities. There is considerable overlap of examinations' content within the profession, with the main Societies duplicating the broadly-based examinations(far less narrow than engineering Institution examinations) of the ICAEW, exept where they are specialist.(80) Along with this difference are two others of importance.

In sharp constrast to the engineering profession, the chartered accountant has opposed the "sandwich" principle for professional education. For instance

Table 2.

MAJOR AND MINOR ACCOUNTANCY ASSOCIATIONS: YEAR FOUNDED AND INCORPORATED, DATE EXAMINATIONS INTRODUCED, MEMBERSHIP GRADES AND SIZE FOR 1969

Title	Year founded and incorp.	Year exam introduced	Membership grades	Size by grade.
Association of Certified and Corporate Accountants	1904 (1938, name changed,) Incorp. 1947	1906	F.A.C.C.A. A.A.C.C.A. Students	3,589 8,551 20,900
Association of International Accountants	Founded 1928 Incorp. 1932	1932	F.A.I.A. A.A.I.A. Students	451 1,057 5,062
British Association of Accountants and Auditors	Founded and Incorp. 1923	1923	F.B.A.A. A.B.A.A. Students	531 346 243
Faculty of Auditors	Founded and Incorp. 1928	No written exams.	Fellows Assoc. Students	446 69 ---
Incorporated Association of Cost and Industrial Accountants "The Cost Accountants Association"	Founded and Incorp. 1937	1951	M.C.I.A. A.M.C.I.A. Students	122 399 1,232
Institute of Chartered Accountants of E. & W.	Founded 1880 Incorp. 1880	1880	F.C.A. A.C.A. Incorp. Accountant Members Students	24,868 17,368 437 17,500
Institute of Chartered Accountants in Ireland	Founded 1888 R.C. 1888	1888	Fellows Associates Students	1,298 800 -----
Institute of Chartered Accountants in Scotland	Founded 1853 R.C. 1854	1854	Members Students	8,314 2,008
Institute of Cost and Works Accountants	Founded and Incorp. 1919	1920	F.C.W.A. A.C.W.A. Students	1,939 8,327 23,566
Institute of Taxation	Founded 1930 Incorp. 1943	1931	Fellows Associates	1,000 4,600

Sources: Monopolies Commission, Report on Professional Services, op.cit., Appendix 7, Table 2, and G. Millerson, The Qualifying Associations, London, Routledge and Kegan Paul, 1964, Appendix 1.

in 1949 the Institute resisted a recommendation put forward by the Carr-Sauders Committee that "sandwich" courses ought to be introduced into technical colleges, for the training of students for the intermediate and final examinations,(81) on the grounds that it would conflict with the practical training. The ICAEW on the other hand, has supported the private correspondence colleges,(82) to the point of advising students to enter through one of their courses rather than entry through a technical college. The great majority of students prepared directly for the examinations of the Societies through a correspondence course; practically all the students of the Institute entered through its examinations coached in this way.

Although a number of universities established degrees in commerce early in the century, notably London, Birmingham, Manchester, Glasgow, Edinburgh, and Aberdeen, the proportion of graduates entering accountancy was low in the interwar years; in 1925, 51 graduates gained exemptions from parts of the Institute's entry requirments; in 1926, 49; 1927,47; 1929, 53; while in the same years, 513, 509, and 610 in total passed the Final, so about 10% of the entrants were graduates.(83) Some associations notably the IMTA took steps to encourage the recruitment of university graduates after the War. In 1922 the Council reduced the required period of preparatory practical service and in 1927 graduates in commerce and administration were exempted from the intermediate, economics graduates also qualified for this exemption in 1937.(84) Major ties between the profession and the universities only came after World War 11. From 1949, the Institute, Society and Association, and the Committee of Vice-Chancellors and Principals, began discussions on establishing a scheme that served to further differentiate the status of the participating Societies. The principal feature of the scheme was the exemption of the graduate from the preliminary and intermediate examinations of the accountancy bodies, (but not the final) and the reduction of the practical requirements to three years, making it possible to qualify in 5 and three-quarter years.(85) Oxford and Cambridge did not participate at first, but they were represented on the Joint Standing Committee.(86) Earlier in the century, accountancy was rejected at

Cambridge, in marked contrast to engineering, as too vocationally orientated.(87) It is only recently that appreciable numbers have entered the profession through the universities.

Comparisons of the Structure of the Organization of Accountants and Engineers

By the late fifties the accountancy profession was structured into the following major status divisions: Chartered Accountants and the other Societies, "certified" accountants, and the two specialist bodies of the Institute of Cost and Works Accountants and the Institute of Municipal Treasurers and Accountants, and the rest (listed in Table 2).

The structure differs considerably from that of the engineering profession, despite the obvious similarities. Of particular importance is the relationship of the two "aristocrats", the Institute of Chartered Accountants in England and Wales and the Institution of Civil Engineers, to the rival organizations and associations. Both are the oldest and most established bodies in their respective fields, excepting the ICAS but the Institute has the largest membership among accountancy organizations, three times that of its nearest rival in 1969; the Institution has the smallest membership among its two rivals, the Electricals and Mechanicals, a fact that underscores the greater representation of the Society and gives substance to its claim to speak for the profession as a whole. The Institute has a monopoly of the generalist title "Chartered Accountant", whereas the Institution confers the specialist "Chartered Civil Engineer", one among fifteen similar titles. In accountancy, the development of numerous rival minor associations has increased the confusion over the lower limits of the profession while enhancing the exclusiveness of "chartered" status in much the same way as the Civils initially gained from the early stages of fragmentation. The Institute successfully blocked the moves for chartered status among rival organizations; the Civils were not able to do so, so that parallel to the difference in titles is the relative "success" of the minor engineering Institutions in usurping the status of the Civils on the grounds of specialist qualification (a process that in fact lowered the status of the Civils to a point where the professional status of engineers is questionable). The state sanctioned the chartered accountants' claim to exclusiveness but undermined, albeit unintentionally, the Civils' by recognizing other,minor engineering bodies.

These characteristics of the two leading organizations relate to a basic difference in the structure of the professions. Fragmentation in engineering, to a far greater extent than in accountancy, has proceeded along "technical speciality" (i.e., Institution-speciality) segments. Emerging Institutions have been able to legitimate their claim to professional status by adopting the ideology of a learned society, and posing as the equivalent of an established organization, but in a specialist field, while in fact many of the minor bodies have no more stature or basis to such a claim than the crop of accountancy associations produced by periodic registration bids or fears of closure. It was not until the late thirties and forties that the accountancy Societies developed reasearch committees, and the activity was not comparable in scope to that of the major engineering Institutions. The absence of the ideology of the specialist learned society provided a greater rationale for registration; the overlap and fragmentation were clearer in accountancy, the divisions less tradition-bound, and the boundaries easier to draw. Registration has always been an issue in the accountancy professison, only extremely rarely among engineers. Accountants have been on the verge of registration a number of times, but the benefits of the existing organization to the Institute has usually ensured failure of any attempt. But the level of concern has kept the Institute mindful of its relations with other clearly rival bodies, and it has been willing to absorb the Incorporated Society to retain, and secure, its pre-eminent position. In engineering, the consequences of the coincidence of fragmentation with specialization made such action much more difficult; rival professional organizations were not just outcasts, they aspired to independent speciality status.

The differences in the development of the professions in the thirties, in many ways a crucial period for their relative status, is partly due to the passage of accountants into general managerial positions. Accountancy became a management qualification. It was looked on as a suitable and relevant background in Britain but to a lesser extent in the United States and elsewhere. While the accountancy organizations needed to do little in the way of active pressuring for this career structure, they did much by not promoting the narrow specialism that the engineering Institutions became preoccupied with. The Institutions required not only practical experience and examinations, but also that the aspirant should be in a position of responsibility involving professional engineering work. The accountancy bodies, and especially the Institute, have not stressed this latter requirement to such a degree, though professional practice is required for intial entry into the Fellowship grade. They have not demanded that the aspirant hold a position of responsibility in accountancy for corporate membership. This difference between the policies and actions of the two professions is manifest in their internal organization. Where practically all accountancy bodies are stratified into only fellows and associates, with a student grade, the typical engineering Institution includes honorary members, members, perhaps companions, associates, graduates, as well as the student grades. This difference in internal organization relates to differences in policy: the Chartered Accountants have not sought to found professional status on speciality status in relation to other specialist reference groups, but have willingly encouraged a generalist image and the deployment of their members in a wide range of work settings. At the same time as engineers sought to advance the status of specialities, accountants encouraged the idea that the occupation should be seen as a fit avenue for general management positions, a stance that engineering Institutions could not take.

Thus although similar in many respects there are these relevant differences in the structure of the professional organization of the two occupations and the pattern of collective action in pursuit of status. The difference between the status of the two occupations can mainly be attributed to the relationship between the Civils and the Chartered Accountants with the rest of the profession, and the historical pattern of collective action conditioned by these relations. But the difference is slight, and perhaps because of it, there is a considerable rivalry and conflict between the two groups in industry for power, control and status. The contemporary movement among engineers aims at achieving a status for engineers similar to that of the Chartered Accountants, who have become a major reference group for some professionally minded engineers.

Footnotes to Chapter 6

1. Comprising the Chartered Auctioneers' and Estate Agents' Institute, the Chartered Land Agents' Society, Construction Surveyors Institute, the Faculty of Architects and Surveyors, the Incorporated Association of Architects and Surveyors, the Incorporated Society of Valuers and Auctioneers, the Institute of Building, the Institute of Quantity Surveyors, the Institution Business Agents, the Rating and Valuation Association and the Royal Institution of Chartered Surveyors.

2. Richard Brown, A History of Accountancy and Accountants, Edinburgh, T.C.& E.C,Jack,1905, chapter 2,"Ancient systems of Accounting", for Babylonian, Assyrian, Egyptian, Jewish,Grecian, Roman accounting, and accounting under the Emperor Charlemagne; cf. Beresford Worthington, Professional Accountants, An Historical Sketch, London, Gee & Co., 1895.

3. On the origins of the Scottish profession, see A History of the Chartered Accountants of Scotland from the Earliest Times to 1954, Edinburgh, ICAS,1954.

4. Cf. Brown, op.cit., pp.197-198 for an illustration of this higher status.

5. Brown, op.cit., p.232.

6. Brown, op.cit., p.318.

7. Cf. H.C.Edey and Prot Panitpakdi, "British Company Accounting and the Law 1844-1900", in A.C.Littleton and B.S.Yamey, Studies in the History of Accounting, London, 1956.

8. For an account of the profession is wide number of societies, see John L.Carey, ed., The Accounting Profession, New York, American Institute of Certified Public Accountants, 1962, 2 Vols.; on the peculiarities of the status of the accountant in England, see E.F.Jeal, "Some Reflections on the Evolution of the Professional Practice of Accountancy in Great Britain", The Accountant, Vol.XCVI (April 1937) No.3253, pp.521-529; on the demand for a higher status by French accountants, see A. Payrau, "The Accountant in Industry", in The Sixth International Congress on Accountancy, Royal Restival Hall, Southbank, London, 1952, printed by Gee & Company (Publishers) Ltd., pp.312-320, which contains papers on that topic from a number of countries; and for comparative observations on the early development of the profession, see Beresford Worthington, op.cit.

9. The History of the Institute of Chartered Accountants in England and 1880-1965, and of its founder accountancy bodies,170-1880, London, Heinemann, 1966, pp.20-22.

10. History of the ICAEW., op.cit., pp.26-7. On the ethics of the profession see the Royal Charter and D.V.House, "Professional Ethics", Acct., Vol. CXXV (July-December, 1956, October, 13) No.4269, pp.367-373; (October 20th) No.4270, pp. 395-403; (October 17) No.4271, pp.425-432; (November 3) No.4272, pp.464-470.

11. A.A.Garrett, History of the Society of Incorporated Accountants, 1885-1957 Oxford University Press, 1961, pp.1-5.

12. Report of the Departmental Committee Appointed by the Board of Trade, 1930, Registration of Accountants, London, HMSO, Cmd. 3645, 1930, Minutes of Evidence, Memo., no.4, submitted by the SIAA, p.25,para.1. (Cited as Dept.Comm., Report, Min.Evid., etc.)

13. Ibid.

14. T.L.Poynton, The Institute of Municipal Treasurers and Accountants: A Short History, 1885-1960, London, 1960.

15. Dept.Comm., ME., op.cit., p.153, para.3.

16. Nicholas A.H.Stacey, English Accountancy, 1800-1954, London, Gee and Company(Publishers) Limited, 1954, pp.34-36,83-90; cf. A.M.Carr-Saunders and P.A.Wilson, The Professions, O.U.P., 1933, pp.206-227; cf. Dept.Comm., op.cit., p.6, para.8.

17. Such privilege granted by royal charter were not fully protected until the Chartered Associations (Protection of Names and Uniforms)Act 1926.

18. Stacey, op. cit., pp.34-36, 83-90.

19. F.C.Osborne and R.T.Bell, Fifty Years: The Story of the Association of Certified and Corporate Accountants 1904-1954, London, ACCA, 1954, p.7, the statement was made by Arthur Priddle during the first AGM of the LAAL on 21, December 1905.

20. Dept.Comm., ME., p.1 para. 2, evid., of Sir William Plender.

21. It was in every way similar to the 1909 Bill except in scope. All members of the 11 existing Societies (ICAEW, ICAS, ICAI, SIAA, ICPAL, LAAL, FAL, CAAL, CAL,) were eligible for registration, instead of just the ICAEW and SIAA, Stacey, op.cit., p.87.

22. Dept.Comm., ME., op.cit., p.1, para.2, evid., Sir William Plender.

23. Stacey, op.cit., pp.83-90; cf. Dept.Comm., ME., p.1, para.2-8.

24. Dept.Comm., Report., pp.9-10, para.19. In 1923 an informal conference was organized by the SIAA to be held at its headquarters on 17th April 1923, involving the English, Scottish and Irish Chartered Societies and the SIAA. No definite outcome resulted from that meeting. ME., p.1, para.3, evid., Plender. Plender went on to emphasize that the demand for registration was not coming from the public. Ibid., para. 4. Later in 1923 the ICAEW passed a resolution against registration on the grounds that because of the practical problems involved, of increasing the inclusiveness of the profession, registration would not be in the public interest. Ibid. para.5. In October of 1924 the Glasgow-based CAL drafted a Bill, aiming among other goals, to monopolize the title "Registered Accountant". Ibid., para.7. It was not introduced into Parliament because of the opposition of the ICAEW and the SIAA, who took the view that its provisions did not make for a sufficiently exclusive body of accountants. Ibid., para.7.

25. Dept.Comm., ME., p.86, para.81.

26. Ibid., p.19, para.23, and pp.18-19, paras.20-22.

27. Ibid., Report., p.7, para.10.

28. Ibid., ME., p.71, para.1, memo., no.11.

29. "Annual Report", ICAEW, Acct., May 5th, 1923, p.683. The increasing demand for accountancy services among small traders was met by non-chartered accountants because of a belief that the CAs charged exorbitant fees, cf. Dept.Comm. Report., op.cit., p.16, para.39.

30. Dept.Comm., ME., op.cit., p.73, para.762.

31. Ibid., pp.71-73, memo., no.11; cf. Donald J.P.Dunkerley, "An Historical Account of the Institute and the Profession", ICWA, a paper submitted at the 18th National Cost Conference, May 1946.

32. Dept.Comm., ME., p.73, para.767, and p.77, Appendix K.

33. Ibid., Report., pp.4-5.

34. Ibid., ME., p.152, para.2.

35. Ibid., p.152, para.2.

36. Ibid., pp.159-164.

37. Ibid., p.74, para.781.

38. Ibid., pp.142-147, paras.1513-1517, memos., nos. 24 & 25.

39. Ibid., pp.142-147, memos., nos.24 &25.

40. Ibid., p.88, para.830.

41. Ibid., p.66, para.1; p.67, para.662; p.68, para.675; p.69, paras.7,8,9; p.70, para.725.

42. Ibid., p.139, para.1432.

43. Ibid., pp.139-141, paras.1425-1473.

44. In 1930 there were approximately 350 municipal corporations, and at least 10,000 accountants in public practice. Moreover, the audit clause was optional, so no really significant portion of professional incomes and practice was directly involved. Cf. Dept.Comm., Report., p.10, para.19.

45. Ibid., ME., p.23, Appendix C.

46. Cf. Ibid., Report., p.10, para.20.

47. Osbourne and Bell, op.cit., pp.39-44.

48. Dept.Comm., Report., op.cit., pp.9-10, para.19.

49. Ibid.

50. Dept.Comm., op.cit., Terms of Reference, HMSO, Cmd. 2645.

51. Ibid., Report., pp.18-19, para.46.

52. Ibid., ME., pp.1-2, para.8.

53. Ibid., p.3, para.20.

54. Ibid., para.14, evid., Sir William Plender.

55. Ibid., p.2.

56. Ibid., Report., p.8, para.13.

57. Not all the companies provided the necessary information, i.e. a

"considerable" number of the companies enumerated in the SEOI do not give the auditors. These are principally foreign or small companies. See below.

58. Dept.Comm., ME., op.cit., p.4, and Appendix A, p.22, evid., of Sir William Plender.

59. Ibid., p.149, paras.1567-1570.

60. Ibid., Report., pp.7-8, para.12.

61. Osborne and Bell, op.cit.

62. The expression, in use at the time, comes from the examination of Sir William Plender, Dept.Comm., ME., p.8, para.46.

63. See Chapter 1. The qualifications of the chartered accountant were in use as a general qualification for any business career long before the thirties, but there is evidence of an upsurge in the interwar years.

64. The Balfour Committee, Factors in Industrial Efficiency, Committee on Industry and Trade, HMSO, 1927, p.260, the tenfold provision of education in subjects relevant to commerce and which could be substituted for accountancy is referred to by the Committee.

66. Stacey, op.cit., pp.214-218. The 1950 figures presented show a slight rise over the 1939 figures, partly because a category of members practicing abroad in 1939 has been distributed in the two home categories for 1950. "Non-practicing" includes accountants employed by public practitioners.

65. Members' Handbook, August 1950, ICAEW, p.13.

67. Stacey, op.cit., pp.214-218, no more specific details are presented.

68. Sir Harold Howitt, "The Profession of Accountancy, A Survey of the Present Position, Comments and Guidance on the Future of Accountants", Acct., Vol.CXXII (13.May, 1950) No.3934, pp.537-40.

69. N.G.Lancaster, "The Accountant's Relations with Management", A Lecture delivered on 12th January 1949, to the London and District Society of Chartered Accountants and reprinted in W.T.Baxter, Studies in Accountancy, 1950, pp.169-163.

70. Annual Meeting of the ICAEW, "Presidential Address", Acct., May 15th 1943, p.253.

71. Hist.ICAEW., op.cit., pp.114-115.

72. Ibid., pp.155-157. The Coordinating Committee was discontinued in 1955, ibid., pp.157-159.

73. Garrett, op.cit., p.315.

74. Ibid., pp.305-313; cf. Hist.ICAEW., op.cit., pp.155-162.

75. 86.8% of the members of the Society were in favour of the integration, 70.2% of the Institute's members. Garrett, op.cit., p.325.

76. Except for certain exempt private companies whose accountants satisfy conditions laied down by the Board of Trade, Monopolies Commission, Report on Professional Services, 2 Vols., Cmnd. 4463-4, HMSO, 1970, p.159, Table VIII, ftn.10.

77. Monop.Comm., op.cit., pp.158-9, Table 111. Industrial and provident societies, national industries and certain local authorities, statutory corporations, chartered bodies and universities, also having auditing functions reserved, "usually" for members of one of the "four" bodies listed. Again in the caseof attesting financial statements, it is usually members of the four societies who carry out the functions, under the authority of the rules of the body concerned. The four have gained an informal monopoly of function in these areas.

78. Dept.Comm., ME.,op.cit., p.153. Cf. A.H.Marshall, "The Accountant in the Public Services", Sixth Intern.Cong.Acct., op.cit., p.355; and T.L.Poynton, IMTA,Short Hist.,op.cit.

79. Hist.ICAEW., op.cit., p.149.

80. Stacey, op.cit., pp.247-252; cf. Sir Harold Howitt, "Training for the professions: Accountancy", Journal of the Royal Society of Arts., Vol.XCIX (1951) pp.741-748. Cf. ICAEW., Education and Training for Membership, London, ICAEW., 1951.

81. Report of a Special Committee on Commercial Education, Ministry of Education, HMSO., 1949.

82. See Seventy Years of Progress in Accountancy Education, London, H. Foulks Lynch & Co. Ltd., 1955, for a historical account of one of the leading firms, H. Foulks Lynch & Co.

83. Dept.Comm., ME., p.18, para.16, and p.23, Appendix C.

84. IMTA,Short Hist., op.cit., p.100.

85. The Universities and the Accounting Profession,An Outline of a Joint Scheme, July 1954, Prepared on behalf of the Joint Standing Committee of the Universities and the Accountancy Profession and issued by: the ICAEW, SIAA, ACCA.

86. Ibid., p.6.

87. M. Sanderson, The Universities and British Industry 1850-1970, London, Routledge and Kegan Paul Ltd., 1972, p.186.

Chapter 7

The Contemporary Movement

Introduction

In the early 1960s a movement toward professional unity was launched in the enginering profession by the Institutions. This chapter looks at the causes of the movement and discusses its consequences for the status of engineers, conditions of practice, relations with the educational system and kindred occupational groups, and the future of the Institutions.

The Background: Developments in Higher Education

Since the War the state has sought to increase the numbers of qualified engineers, both through existing channels and by new means of creating and conferring status on engineering manpower. These developments in higher technological education provide the backdrop to the present demands for unity in the engineering profession.

The Percy Report of 1945 (1) on higher technological education had highlighted as a central problem of the British system the great diversity in existing provision, the division not only between universities and technical colleges, but also the lack of focus in the latter sector. "The industrialist cannot easily find his way among institutions ((i.e., higher technological education)) so many and so various, and it is uncertain how to make his requirements known to them."(2) Out of 150 colleges that fell within the scope of the report, only 27---10 in London---provided full-time higher technological courses for as long as three years duration. Among the Committee's important recommendations it was urged that: a limited number of colleges ought to be developed to university standards; a national body should be set up, comparable to the existing Regional Advisory Councils, to coordinate technological studies in both sectors; this National Council of Technology should award a "Bachelor of Technology" or a "Diploma in Technology". A futher necessity was "a national campaign to increase the prestige of the technical professions and to counteract the impression that the road to responsible executive posts in industry does not lie through these professions,"(3) which should be specially directed towards the public boarding schools. All technology students should, it recommended, study industrial administration and management.(4) Lord Eustace Percy, the chairman, added a note to the Report suggesting that the colleges selected for development should be called "Royal Colleges of Technology", with the power (subject to the academic board of the National Council of Technology) to confer Associateships (ARCT) and Fellowships (FRCT) of the Royal College of Technology. While these proposals were being debated facilities for the education of the new "technologists" (i.e., in effect engineers at the professional or technician level not qualified through the Institutions but who are graduates of full-time ---or in some cases part-time---technological, engineering, or applied science higher educational establishments) increased steadily in the late forties and early fifties with the designation of "national colleges", direct-grant establishments under the Ministry of Education, devoted to particular technological specialities.(5)

The Barlow Report reiterated the Percy recommendations, especially those for strengthening a group of Colleges of Technology,(6) and for a coordinating body, which took shape in 1947 as the National Advisory Council on Education for Industry and Commerce (NACEIC), originally to advise the Minister on national policy,(7) but evolved in later years into a spokesman and pressure group for the Royal Colleges of Technology.(8) It proposed that the RCT should have a Court, Council and Academic Board, creating associateships at the first degree level; higher awards would be developed by the individual technical colleges that comprised the system, and the RCT would approve these and appoint external examiners.

Other bodies supported the general object lying behind these proposals (as of course they had done since the mid-nineteenth century). A Parliamentary and Scientific Committee Report of 1947 suggested that 27 of the existing colleges should be elevated to university rank capable of turning out 5,000 to

7,000 graduates a year---a suggestion opposed by the other national standards making organization, the City and Guilds.(9) The University Grants Committee, on the other hand, pointed out in a policy statement of 1950 that the British universities stood somewhere between the American and Continental (especially German) by providing some education in technology, but not being the only centres of higher engineering education to do so, or excluding the subjects altogether as in Germany. This situation should continue, with expansion if possible, especially for post-graduate courses (those lasting from 1 to 2 years).(10) In 1951 a government White Paper accepted the proposals put forward by the NACEIC,(11) and expressed intent to petition for a royal charter for the (Royal) College of Technologists.

In effect the projected Royal College of Technologists amounted to an attempt to create a separate profession of technologists outside the control of engineers. The uniformity of the colleges, the potential professional unity among the graduates, the extent of state sanction, the possible monopolization of the title "technologist" in some form that would undoubtedly have followed, represented a considerable threat to the interests of the profession. This proposed system of professional organization for technologists, contained in its structure all those elements conducive to the attainment of a high status for the new "profession", an outcome largely contingent on state-aid and support.

These measures were opposed by the engineering Institutions, especially the Big Three, but some of the minor Institutions, for instance the Institution of Marine Engineers, supported the NACEIC proposals for a coordinating agency for the colleges, a "Royal Council of Technology", but not a new super Institution, a Royal College of Technology.(12) Some of the professional organizations of scientists also supported the RCT proposals. A particularly troublesome aspect was the power of the Royal College of Technologists to award the new qualification without requiring graduates to hold a responsible position in industry before granting the distinction of election to a learned society. This would involve the possiblity of a future government violating the monopoly of the Institutions and forcing the professional and scientific members of the civil service and the nationalized industries to employ the technologists who were members of the Royal College of Technologists on equal conditions with their own membership. One of the major advantages of qualification through the professional Institutions would then be lost, and they would become less attractive to the intending engineer. Indeed, if the RCT had been established and if the process of fragmentation in the engineering profession had continued with royal charters being granted to further minor Institutions, then in the long-term, other things being equal, the engineering profession would have been gradually superseded, and replaced by a profession of "technologists", bearing a relationship to the state similar to that of the Continental professions with the additional British flourish of "Royal College". The unity of this organization and the lack of practical requirements, would be a suitable basis for the formation of a pressure group seeking the passage of technologist into generalist administrative and other high status positions.

With the change of government the proposal was abandoned. In 1951 the Conservative Government raised one establishment to university rank---the Imperial College of Science and Technology at South Kensington, which was subsequently expanded. Yet the problem of shortage continued as a serious consideration in policy formation. In 1954 the Parliamentary and Scientific Committee (originally established by the Association for Scientific Workers) reported that 25,000 "engineers" were being produced per annum whereas 40,000 were needed; the ratio of engineers to population was 3 times greater in the U.S. than in the U.K.; American industry contained more graduate engineers as directors and executives. The Percy/NACEIC proposal for a Royal College of Technologists was supported--- Bachelor of Technology was to be the designation---though the Committee did not want to participate in the "unhappy controversy" over status.(13)

The Institutions were still faced with the problem of expansion in higher education and the prospect that they might lose control over recruitment. The universities were expanding both the total number of students and the relative proportion of engineers compared with other faculties. Between the end of the

War and 1950 the number in the faculties of engineering and technology doubled from 5,288 to 10,933, the percentage rose from 10% in 1938-39 to 16,917 or 19.8% in 1949-50, to 19,899 or 22.2% in 1956-57. Medicine and dentistry either actually declined both in real numbers and percentages or remained constant; medicine 11,884(23.8%) in 1938-1939 to 12,937 (14.4%) in 1956-1957; dentistry 1,488 (3%) to 2,733(3%) in the same period.(14)

The White Paper of 1956(15) proposed further expansion and specified the methods of finance. There was a concern that the U.S.A., U.S.S.R., and Western Europe might be more successful in producing qualified manpower than Britain. The White Paper, in its introductory definitions, distinguished the "technologist" as a person of university level education or a member of one of fourteen Institutions, not just the Big Three. 1955 had seen the partial realization of the NACEIC proposals in the form of the National Council of Technological Awards (the Hives Council) with two Boards of Studies, in Engineering and Technologies other than engineering, to administer new "technological awards of high standing having a national currency"(16)---the Diploma in Technology courses. By 1957 forty-nine courses were accepted and by the time of the second report in 1959 sixty-six courses have been accredited at 20 colleges, with 2,518 students.(17) In 1958 the "Membership of the College of Technologists" was established by the Council as a higher award.(18)

One result was the founding of the Colleges of Advanced Technology, in 1957 at the Royal Technical College, Salford, Loughborough College of Technology, Battersea College of Technology, Chelsea College of Science and Technology, the Welsh College of Advanced Technology Cardiff, Northampton College of Advanced Technology(London), Birmingham College of Technology, Bradford Institute of Technology. In 1960 Bristol was added, along with Brunel College(Acton). From 1961 the CATs were to be direct grant establishments.(19) These colleges were the beginning of a possible high status non-university system of engineering education in Britain. Their appearance on the educational scene was not entirely welcomed by the Institutions, who became involved, especially the Institution of Electrical Engineers, in a wrangle with the Ministry of Education over the number of Colleges to be so designated. The IEE desired to see eight, the Ministry no less than fifteen. Although active in trying to shape the syllabuses of the colleges, the Institutions did not retain the control extended over the HNC program and similar schemes.(20)

Throughout the fifties the Institutions, especially the IEE and the IME, had pursued a policy of restricting entry via the HNC route. This was part of a bid to create all graduate specialities, comparable to the Civils and the rising Chemicals. Such a move would also alter the social class composition and cultural tone of the membership. Between 1940 and 1960 HNC awards in Electrical Engineering, for instance, had increased from roughly 400 to just under 4,000 with a steep rise after the War. The percentage of passes remained, on the whole, constant at between 85% and 65%, showing a slight downward trend over the period, from approximately 75% to 68%.(21) At the same time the proportion failing to attain the necessary further exemptions for full professional status increased. 1957-1960 saw a further upsurge of HNC passes and also a large relative increase in university trained engineers, as well as the first products of the Diploma in Technology courses in 1958-59 and 1959-60.(22) The Institutions sought some way to further exclude the HNC's and include the graduates, efforts that were unwelcomed by the state. In line with this policy the Big Three throughout this period wished to see higher technological education developed wholly within the university sector having been "rather embarrassed by the large number of men" entering through the HNC routes, a policy that conflicted with the interests of smaller largely non-graduate Institutions: "If the policy of the three major Institutions was backed,... it would mean suicide for the Institution of Production Engineers."(23)

But, a fact of unrivalled significance for the Institutions was beginning to make itself apparent. Although their qualifications were sought after by the now spurned HNC's, there was disturbing evidence that graduates and holders of the Diploma in Technology simply by-passed the entire professional structure, as the hall-mark of truly professional status, and were entering practice on the strength of degrees and diplomas alone on the Continental pattern and as a consequence of the low status of the organized profession. Industry and state were accepting the new graduates as fully qualified, diminishing the entire range of needs met by the professional qualifying functions of the Institutions. (Moreover by entering directly into employment at a professional level, graduates by-passed Institution practical training schemes and effectively debarred themselves from meeting Institution entry requirements should they wish to join at a later date to avail themselves of the study facilities.) Such a tendency could eventually mean the end of the Institutions and was a matter for concern. Expansion of full-time higher engineering education and the increase in "unqualified" practice among graduates provided advocates of unification with a powerful and compelling argument for the establishment of some sort of agency through which common interests could be defended. With the progress of higher education in the 1960s, the creation of the CNAA and the new polytechnics, and perhaps as many as 2,000 graduates a year passing directly into practice by 1970, this argument could be continued and it lay behind the growing cooperation that took place during the next ten years and into the seventies.

The Council of Engineering Institutions

The contemporary movement evolved through a decade of debate within the profession. Its immediate origins were in the late fifties with a desire for closer contact between the Councils of the Big Three, rather than just between the Presidents and senior officers,(24) which resulted in some informal meetings. In his 1961 Presidential Address before the Institution of Civil Engineers, Sir George McNaughton, Chief Engineer to the Ministry of Housing, after a discussion of the amalgamation proposals between the Civils and Municipals, stated: "Consequently a new school of thought is gaining a substantial degree of acceptance. It is that the Civil, Mechanical and Electrical Institutions should, if they agree, combine together to form one Institution of Chartered Engineers, which would be so powerful that the other chartered bodies could not afford to stand outside",(25)--an Institution, which it was hoped could do something about the decline in status of the engineer and his retreat from the commanding heights of industry. Later that year, the Engineering Institutions Joint Council formed as a first tentative step to explore the possibilities for raising the status of engineers and restructuring the organization of the profession,(26) and including Institutions recognized by the state as qualifying at a graduate level, chartered bodies. From the outset a problem arose over the constitution: the Big Three had grouped themselves into the "original constituent members" demanding four representatives on the Council, while the others had two, but they were out manoeuvred, all eventually having three.(27) These were representatives selected by the Councils of the constituent Institutions, not engineers directly elected from the corporate membership. Foremost still was the problem of the fragmentation process:"I have read only the other day....The recent formation of the Institution of Cost Engineers nearly brings us to something bordering on the ludicrous, as it should be held to be an essential part of any engineer's equipment to be a cost engineer in the sense of having a reasonable and adequate appreciation of the cost involved in the execution of any works for which he is responsible."(28) Some of these minor Institutions failed to gain membership in the EIJC, e.g., the Junior Institution of Engineers and the Institution of Plant Engineers,(29) others were invited to reapply. The minor chartered bodies faced a dilemma: they feared the threat to their autonomy posed by entry into the EIJC with the possibility that this might open the door to some kind of amalgamation as envisaged by the Big Three, but by the same token they could not stand outside in case the EIJC evolved into an organization conferring truly professional status, supplanting their functions and causing them to decline.(30) This dilemma lies at the heart of inter-Institutional relations on any federated council, making the advocates of unity extremely reluctant to admit further minor Institutions.

The minor Institutions were willing to cooperate within a federated structure and plans went ahead to expand the role of the EIJC on these lines. The EIJC sought to "promote and coordinate in the public interest the development of the science, art, practice and profession of engineering",(31) and its main activity being the conception and creation of the "Council of Engineering Institutions", with an expanded role, by royal charter.(32) Within the CEI framework, the object of "raising the status of engineers, was to be achieved by the introduction of a new qualification, that of Chartered Engineer, the accepted educational standard of which would be not lower than that of a university degree."(33) Disagreement and debate focused on what the basic minimum standard for entry to this status should be, because after Charter Day only those possessing formal qualfications would be admitted to the new Chartered status.(34) At the Marines, for example, only 10% of the members had the level of qualification being proposed by the EIJC (35) and they naturally feared that too high a standard would lessen the demand for membership in a small Institution.(36) A further problem was whether the new status should be open to those qualified by experience as well as graduate-level education. Part of the trouble with this was that new corporate members of a given Institution would not necessarily become Chartered Engineers.(37) There would be for many years a split in the ranks of corporate membership of many Institutions,(38) which might lead to a questioning of the value of the status. On the other hand, restriction to graduates would entail the growth of some of the minor bodies, who resented these moves by the established Institutions. The ultimate intention was that the Charter would lead to a status for the engineer in every way comparable to that of the Chartered Accountant: "How long will it be before the public learns to treat a Chartered Engineer with the same respect which it treats a Chartered Accountant now?"(39) Comparisons were also drawn with the position and status of engineers in Canada, the U.S.A., Belgium, Greece and Italy, where practice is to a greater or lesser degree regulated by law.(40)

The state urged a wider role for the EIJC,(41) and spokesmen for the three main political parties promised their support for measures likely to improve the status of the engineer.(42) These overtures did, of course, figure in the deliberations of the EIJC over the scope of its future role: "Judging from Lord Hailsham's remarks in the debate on Scientific Policy in the House of Lords recently, there will be a sympathetic reception at the Ministerial level to anything which tends to raise the status of engineering."(43) And, just before, the Clerk of the Privy Council had strongly hinted that it was time for the profession to get its house in order.(44) In 1964 R.H.S.Crossman pledged: "A Labour Government will face two immediate problems: first, rapidly expanding training; and secondly, a policy to ensure that the status of the engineer is such that he will as soon work here as abroad."(45) He went on to outline a number of proposals that aimed at the enhancement of the position of the engineer in industry and government. In the event, the CEI was established and began its activities with the blessing of the Ministry of Technology,(46) and the movement became, at first, ideologically fused with the efforts of the Labour government to revitalize British scientific and technological resources and performance.

The new federal body received its royal charter in August of 1965, and has continued under the title of Council of Engineering Institutions.(47) The CEI quickly invited thirty to forty non-included bodies, out of a range with an uppermost limit of 150 Institutions, to participate in a confederation similar to its own, which led to the Standing Conference of Nationally Qualified Technicians. These organizations then participated in the formation of a "register" under the authority of the CEI Charter and Bye-laws. In 1971 the Privy Council approved changes in the Charter, which permitted the CEI to establish the Engineers Registration Board (ERB) and Composite Register, making possible the "registration", i.e., by virtue of the formalization of existing Institution functions, of the "Chartered Engineer"(C.Eng.), "Technician Engineer"(T.Eng.CEI), and "Engineering Technician"(Tech.CEI). The Chartered Engineer title and qualification designates the "professional" engineer grade.(48) Those engineering Institutions with royal charters are members of the CEI and chartered section of the register, and some twenty-nine other major and minor Institutions are members of the other, technician, sections. The Institutions and structure are presented in Table 1. The "register" was welcomed by the government as "an important step in establishing standards for engineers at all levels."(49) The members of these organizations are eligible for registration in the section appropriate to either their position in a chartered organization, or inclusion in a non-chartered. In its distinctive features this structure is as close to

Table 1.

MEMBERSHIP OF THE ENGINEERS' REGISTRATION BOARD BY SECTION

Chartered Engineer Section (C.Eng.)

Royal Aeronautical Society
Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Electrical Engineers
Institution of Electronic and Radio Engineers
Institute of Fuel
Institution of Gas Engineers
Institute of Marine Engineers
Institution of Mechanical Engineers
Institution of Mining Engineers
Institution of Mining and Metallurgy
Institution of Municipal Engineers
Royal Institution of Naval Architects
Institution of Production Engineers
Institution of Structural Engineers

Technician Engineer Section (T.Eng.(C.E.I)

Association of Mining Electrical and Mechanical Engineers
Association of Public Lighting Engineers
Bureau of Engineer Surveyors
Institute of Automobile Engineers
Institute of Hospital Engineering
Institute of Marine Engineers
Institute of Measurement and Control
Institute of Works and Highways Superintendents
Institution of Agricultural Engineers
Institution of Electrical and Electronics Technician Engineers
Institute of Electronic and Radio Engineers
Institution of Engineering Inspection
Institution of Engineers and Shipbuilders in Scotland
Institution of Gas Engineers
Institution of Heating and Ventilating Engineers
Institution of Mining Engineers
Institution of Nuclear Engineers
Institution of Plant Engineers
North East Coast Institution of Engineers and Shipbuilders
Royal Aeronaurical Society
Royal Institution of Naval Architects
Society of Civil Engineering Technicians
Society of Electronic and Radio Technicians

Technician Section (Tech. (C.E.I)

Association of Mining Electrical and Mechanical Engineers
Institute of Marine Engineers
Institute of Works and Highways Superintendents
Institution of Agricultural Engineers
Institution of Electrical and Electronics Technician Engineers
Institution of Heating and Ventillating Engineers
Institution of Plant Engineers
Royal Institution of Naval Architects
Society of Civil Engineering Technicians
Society of Electronic and Radio Technicians
Society of Licensed Aircraft Engineers and Technologists

that of the medical and architectural professions in Britain, as has been possible to achieve, given the peculiarities of the organization of the engineering profession and its internal politics.(50) The CEI and ERB structures however, represent a plan, a drawing board outline, for the closure of the profession around an elite group of "Chartered Engineers". In 1971 (the last date for comparable figures), of the approximately 300,000 members of the CEI chartered bodies, 150,000 are corporate members eligible for the register, while 318,900 persons are within the census definition of a qualified engineer,(81) a figure which does not include "technicians" by state definitions. In other words only half existing qualified engineers were to be included on this "register", in effect the combined speciality registers of the chartered Institutions. Many of the non-corporate CEI Institution-members are working towards this chartered status, which will have the effect of diminishing the number of outcasts. Engineers outside the new profession, now designated as "technicians", have expressed considerable resentment and confusion over the meaning of the qualifications, the end result of routes to entry, and the high degree of obscurantism pervading official and hence press explanations of the objectives and meaning of changes, a confusion that cannot be avoided in the context of the current internal politics of the profession. One organized reaction to the ERB was the July 1969 formation of the Standing Conference for Technician Engineers and Technicians, including over 20 bodies, who proposed to establish their own register, a move needless to add, deprecated by the engineers.(52) Technicians have looked upon the CEI policy as a restrictive practice, especially those of the HNC/D level, who prior to the movement would have had the opportunity to attain full professional status, and a number of individuals have attempted to sue the Institutions and CEI. The CEI intends not to admit the formally unqualified, however competent in practice.(53)

Much of the resentment engendered by the CEI arises because of the arbitrariness of the assignment of the new chartered status. The bulk of chartered engineers, especially the members of small constituent Institutions, do not themselves have the qualifications now being demanded for admission, many do not have formal educational qualifications(outside Institution membership) superior to those of members of the new "technician" Institutions, while on top of that there are better qualified, in terms of formal theoretical engineering education, engineers practicing outside the entire structure. As the royal charter has only really taken on such definitive significance as an instrument of state recognition with the CEI movement, the possession of a charter or not must in many cases be arbitrary, depending on such vagaries as the outlook of an Institution Secretary in the 1930s when they were easier to attain, that is arbitrary in terms of the qualifications of the members of Institutions. Before the CEI movement no Institution was required by the Privy Council to set standards at anything like the level that are now being set by the chartered bodies.

Some of the minor Institutions are undoubtedly hoping to be able to gain charters in the future, and are at present waiting for the result of a test case being carried on by the Institution of Heating and Ventilating Engineers (f.1897). Since 1964 when it first applied, the IHVE has crusaded for a charter: "The Institution was now fighting for its life, fighting to preserve its right to exist in this country, in Europe and the world. If the Institution was not granted a Royal Charter it would not celebrate its centenary, nor even its 80th birthday, and the heating industry would decline for a decade."(54) In this effort they have been bitterly opposed by the Big Three within the CEI group, but in 1973 the stalemate existing to that date was broken by suggestions from the Privy Council and the government departments directly concerned that a revised charter embodying recommended changes might succeed.(55) Described as a "manoeuvre designed by the Institution to circumnavigate the CEI",(52) and equally the reverse, the essential feature of the new petition and bye-laws was the change of title to "Chartered Institution of Building Services" rather than "Chartered Building Services Engineer", effectively meaning "Chartered Technologist" rather than engineer status. The government gave at the same time the undertaking that it would recognize the CIBS as qualifying for the grade of professional engineer within the state service, though this recommendation is awaiting acceptance by the Civil Service Department.(57) This change from engineer to "technologist" status, shades of the RCT, was bitterly resisted by the rank-and-file Heating and Ventilating engineers (spiritually an offshoot of the Mechanicals), already resentful at being labelled "plumbers" when their qualifications are , on average they claim, fully the equivalent of the Structurals. (That claim is probably justified.) A "unanimous" show of hands at the Extraordinary General Meeting considering the revised petition were in favour of the inclusion of "engineer" in the title if possible,(58) but it was not, leaving only the hope, and intention, that they would be both Chartered Technologists and Chartered Engineers in five years time. One CEI and IHVE joint-member located the problem: "I am a Chartered Engineer and I feel that if I was called a technologist by somebody I would feel it would downgrade me."(59) He regarded his fellow members of the IHVE, on the heating and ventilating side, who were not Chartered Engineers as fully professional colleagues. Nevertheless, 94% favoured the new petition on a 56.5% ballot return, as they had no real choice if they were to gain chartered status, and of course the fear was that the CEI will one day effectively close the profession. Along with the change in title the IHVE (with a 1974 membership of 6,992) has cast a wider net in the building services industry, aiming to shed its specialist image, which now in the CEI context, is considered the mark of a non-professional body. They are now waiting for a Privy Council decision, closely watched by the other non-chartered Institutions. (That is as of July 1975.)

The CEI and ERB structures do not yet represent the unification of the profession; it is a federal structure of speciality Institutions functioning essentially as they have done throughout their historical development. Registration as yet confers no benefits further to those of membership in the corporate grades of an individual, quasi-registration, chartered body. In many cases it is a positive disadvantage, a veneer of unity and generality on an undercurrent of rivalry and essential speciality qualification and identification the value of which is undermined by the CEI/ERB definition of the profession. The full meaning of this reorganization is made clearer below in a discussion of the problems of achieving true unity through it, in the context of the survival and future of the Institutions.

Professionalization, Education and Industry

The CEI looks upon its role as that of a mediator between industry and education. The profession should begin to influence education, on the one hand, by virtue of its role in industry and experience of industrial needs, and to influence industry in the direction of technical progressiveness, by virtue of special education, training and qualification, on the other. So far it has concentrated action on the educational front, largely by taking over the administration of the examinations of the constituent Institutions. The examinations for full professional status are in two parts: Part 1 at the level of the end of the first year of a three year engineering degree course; Part 2 at the final examination of a first degree. First degress awarded at universities and by the CNNA are accepted as exemptions from both, as are some long-established college diplomas and associateships. HNDs are recognized as an exemption from Part 1.(60) Officials maintain that only under exceptional circumstances, and then in the period of transition, are HNCs eligible to take Part 2, now largely confined to technicians. Non-degree routes to chartered status are to be phased out by 1977-8, but although the schemes are still operating, admission to the register is restricted to graduates.(61) (On this subject see below.) The Technician Institutions are also to phase out their non-qualified membership over the same period. The CEI examinations as before are part of the qualifications needed for membership in the Institutions, which in turn qualify for the register. The administration of examinations by the Institutions was phased out in the early seventies; but they still retain full responsibility for the practical training, experience and responsibility in position, requirements for membership.(62) Discussion is still going on within the CEI over a common scheme for the practical requirements for entry.

The closing of the traditional routes to entry and the restructuring of the profession along chartered engineer, technician engineer and engineering technician roles (the latter two were non-existent in Britain before the present movement, all were "engineers" or would-be engineers), has created a need for reexamination of the purely technician qualifications.(63) The CEI and the constituent members have been active on this question. In 1969 the Engineering Industry Training Boards, following the lead of the CEI (established under the Industrial Training Act of 1964), identified the two grades of technicians, and urged the use of industrial training schemes to solidify the distinction. The Haselgrave Report (65) recommended four national awards: the Technician Certificate (TC), the Technician Diploma(TD), the Higher Technician Certificate and Higher Technician Diploma. Thus, as well as "closing" the engineering profession (at the level of intention), the movement aims to enhance the status of engineers by facilitating the professionalization of subordinate "technician" occupations,(62) a strategy seen in its most developed form in the medical complex. It is a distinctive feature of British engineering that the technician has remained undefined, a consequence of the structure of professional organization.(68) Chartered Institutions are intending to seal off some of the "ladders" and "bridges" that have been a characteristic feature of the English educational scene, providing opportunies otherwise denied to the late developers from working class homes. No longer will craftsmen be able to work their way towards professional status, save by returning to full-time engineering education, a near impossibility for most. As old routes are closed, others are expanded. Since the early fifties, a concerted effort to recruit public school boys to the profession seems to have produced results,(69) part of the effort to raise its status and tone. It is likely that, with the closure of the part-time HNC route to professional status (its opening was the main innovation of the interwar years), the social class composition of the profession will also change, as apart from what is known about the mechanisms of selection within English education, there is a correlation between the numbers entering through this route and the proportion of sons of skilled (mainly) and other manual occupations in a given Institution (where there are data). For the future an all-graduate profession is envisaged, with engineering education having a broad liberal base.

There has been some, albeit strictly limited, success in the continuous effort to gain a monopoly of function for the Chartered Engineer as defined by the CEI/ERB structure. In 1970 the Department of the Environment, "under pressure from the Institution ((of Civil Engineers)) agreed to introduce a Bill, to amend the Reservoir's (Safety Provisions) Act of 1930".(70) But unlike the other Institutions the ICE can still claim, and produce statistics to back it up, to represent nearly all civil engineering specialists qualified at the university degree level and above, while the CEI Institutions as a whole do not represent all professional engineers, which is the stumbling-block to the monopoly that the state would probably encourage should an equitable definition in terms of present civil service criteria of professional status be reached. One potential source of control over practice lies through the European Economic Community's provisions for mutual recognition of professional qualifications. The EEC under Articles (52 and 66) of the Treaty of Rome looks forward to complete geographical mobility of professional as well as other workers, which presupposes some way of recognizing the qualifications of professional groups in member countries and estimating their level. Naturally, no well-established European profession wishes to see its service diluted by an influx of underqualified British or otherwise foreign praditioners. The CEI has put the EEC in the forefront of its published statements and there is some suggestion in the engineering community that the EEC requirements are its raison d'etre. Of course, this is not so, but the CEI has capitalized on the EEC provisions and much advantage may be derived from them in the future. It is the hope of many engineers active on questions of professionalism that the CEI will eventually be able to raise the level of the status and education of British engineers to that of their European colleagues. An independent international association of engineers, the Fédération Européenne d'Associations Nationales d'Ingénieurs, has set up a two tier register for engineers with degree standard qualifications and their less qualified associates.(71) Registered Chartered Engineers in Britain are eligible for enrolment on the upper FEANI register without further test. No legal rights to practice are conferred, but recognition of the FEANI standard by employers is increasing throughout the Market. The CEI's EEC Committee has links with both the EEC Commission and the UK delegation in Brussels as well as the tie through FEANI, and the CEI is presently "taking such steps as are possible within its scope to provide a link between the engineering profession and the EEC."(72) Should mutual recognition by EEC countries of each others professional qualifications in the engineering field be reached, it is likely that the CEI will act to secure as many advantages for its members as possible and that they would be recognized. But it is improbable that the engineers currently defined by the CEI/ERB structure will gain an exclusive monopoly within the EEC, which given that irrespective of the future of the CEI/ERB and Institutions all entrants to the engineering profession are to be graduates, means that despite the fanfare that is accompanying the possiblity of EEC mutual recognition, the CEI group will have no advantage from this source.

Federation has also forced more formal attention to the position of the engineer in management and non-technical pursuits. Following the logic of engineering professionalism, the CEI actively urges the passage of engineers into management and there is a heightened interest in management training,(83) with steps being taken to avoid the narrow specialism that has dominated the outlook of practitioners.(74)

The CEI has also shown willingness to cooperate in the formation of a professional association. The EIJC was welcomed by the Engineers' Guild, which extended its membership to all 13 Institutions in 1963 (itself an indicator of the "sacrifice" made by the Big Three at that time for the interests of engineering as a whole). Just before the EIJC was set up, links were forged between the Councils of the Big Three and the Guild,(75) which were strengthened afterwards.(76 In 1970 the CEI and Engineers' Guild cooperated in the establishment of a proposed new association that was to be known as Professional Engineers Association Ltd to consist of the Guild and new members with the object of providing "personal services directed to the improvement of the livelihood career and welfare of individual professional engineers."(77) A three-fold structure was envisaged; first, the Institutions, second, a professional association, third, a trade union for professional engineers, but PEAL never got off the ground. The response to the original circular was so low that it was decided not to go ahead with the new body (to date the Mechanicals have had 70 inquiries and this is twice as many as the Electricals and Civils put together).

At the same time, CEI has discouraged non-professional engineering unionism. The "code of ethics" of the Council of Engineering Institutions, and now those of individual member Institutions, imply that strike action is unethical. Although this provision cannot at present be enforced, it has been acted upon (seemingly the only point in the CEI code on which any action has been taken) in an attempt to ensure that professional engineers are not included in bargaining units that also include non-professional workers, with the formation of the United Kingdom Association of Professional Engineers to protect the CEI members from the Industrial Relations Bill 1971. UKAPE membership is about between 2½% and 5% of the total potential membership, depending on whether Guild members are included. The majority are in private industry, drawn mainly from the IME, then from the IEE and ICE.(78) The UKAPE faces the same problem that the profession as a whole confronts: another association, the Association of Supervisory Electrical Engineers (ASEE), seeks to improve status, but includes non-chartered engineers. The UKAPE clashed with the ASEE in the primary test of its claim during the long and bitter dispute at C.A.Parsons Ltd., between the professional unions and the Technical and Supervisory Section of the Amalgamated Union of Engineering Workers (TASS). UKAPE was not able to get an exclusive bargaining unit, because of the problem of unqualified practice in terms of the status as defined by the CEI/ERB structure, the same problem that will halt efforts to gain exclusive rights to recognition in the EEC. The ASEE opposed claims to exclusiveness because its members are located at all levels of the Parsons hierarchy, not just beneath chartered engineers, and also include university graduates who had not joined an Institution. There is no direct correspondence between type of qualification and type of post in the C.A.Parsons set of companies. The Commission on Industrial Relations (CIR) commented:

"Looking at the companies as a whole there is no distinguishable group of posts for which a professional qualification is or will become a requirement in the fore seeable future."(79) And, or course, this situation exists throughout British industry.(80) The UKAPE has since considered merging with the ASEE.

Public Relations and the Development of a Technocratic Ideology

The organizational changes have been accompanied by ideological advances (though not of the intensity that would be dictated by the logic of professionalism should true unity be achieved) creating new images of the role of the engineer in society, his relations with clients, organization and "public", which serve to guide action and legitimate the newly claimed status. The core set of beliefs and ideas stresses the value of the service, the importance of engineering to society, and the corresponding importance of the individual engineer. The engineer is portrayed as a central figure with responsibility for civilization and technical progess. The long history of the profession is also stressed: "We respect the achievements of our great predecessors, all outstanding in their generation, and we know that the art and science or our profession began in the caves of the first man.. ((and for the future)) engineers are the providers of the controlled power that can lift mankind to a bountiful future."(81) The centrality and importance of the role of the occupation in the division of labour and modern society is stressed in the demands for a higher status. It is also argued that this status will enhance the performance of the occupation through more able recruits, and increased technical innovation and change. A campaign to generate awareness among the membership of the Institutions of the important role of the profession in society is under way. The CEI has established committees and regional headquarters to make the role of the engineer known as widely as possible. Problems of "pollution", the establishment of regional "technocentres" and exhibitions, lectures, films in schools on careers, public lectures and other activities are vigorously undertaken to project the broader image of the profession.(82) Of interest also is the introduction, for the first time among engineering Institutions, into the CEI examinations a compulsory paper on "The Engineer in Society". Much attention is directed to the "sociological" consequences of engineering and the wider outcomes of technological change;(83) concerns that are by no means new among engineers.(84) The object of the exam "The Engineer in Society" is to increase the knowledge of engineers about the social and economic consequences and implications of technological innovation.(85) It also touches on questions of professionalism, e.g., why is the status of engineers so low in Britain? what can the engineer do about this? what is a profession? the ethical objectives of the engineer?, questions that are taken up in more detail at the "professional interview" at, e.g., the Institution of Civil Engineers.

There is a growing literature associated with the movement on the engineers' "responsibilities" to society and mankind, and on questions of ethics.(86) For example, the engineer can help realize the "creative society" with innovations that reduce boredom and repetitive jobs, reduce the uncreative working week to 20 hours, improve transport and communication, and develop the creative potential of handicapped people. Towards this end, engineers, like doctors, should subcribe to a kind of Hippocratic Oath, pledging to use their technical skill for achieving the happiness of mankind,(87) a fellowship grade in the CEI might be created for a class of advisers who could be given responsibility for the allocation of natural resources on technological projects.(88) Links have been forged with the medical profession: the Medical Engineering Working Party was set up in 1965, to bring about collaboration between the two occupations. Its activities include a program of research and design on orthopaedic implants with the British Orthopaedic Association.

Technocratic ideology has as a primary characteristic in common with other professional ideology, the drive to depoliticize areas of social life that might come under the jurisdiction and authority of the practitioners and their technical know-how.(89) The promulgation of a code of ethics quickly involves engineers in such orientations. The Council of the Engineering Institutions has a code based on the following principles: "A Chartered engineer shall at all times so order his conduct as to uphold the dignity and reputation of his profession, and safeguard the public interest in matters of safety and health and otherwise. He shall exercise his professional skill and judgment to the best of his ability and discharge his professional responsibility with integrity."(90) The CEI recommends that the constituent Institutions adopt similar rules. The code is highly generalized, and it remains to be seen in what range of circumstances, outside of industrial relations where it provides an ethical basis for employer support by engineers, it can be enforced,(91) so that at this time the code amounts to little more than professional window-dressing. The argument of some Institutions' officials that under present circumstance(see below) the major current and future role of the Institutions as speciality bodies lies in their capability of enforcing through colleague pressure a code of ethics, a function now performed so well that there are few or no breaches of the code, cannot at this time be taken too seriously because sanctions will not be practicable on any count until the registered engineer gains a monopoly of function. Yet the existence of the new code, and the formal emphasis on ethics more generally, in the context of the historical absence of such concern, testifies to the emergence of professional ethos in the contemporary movement, a spirit that in its technocratic elements receives most support from young graduate engineers.(92)

Finally, the profession has also been placing more emphasis on recruiting women. Great Britain falls behind other countries in the percentage of women engineers: it was 0.2% in 1969; in France 3.6% or eighteen times as many, in Norway 10% and in Russia fully 31%. This extremely low number for Britain is thought to reflect the "poor opinion that parents and teachers often have of what the professional engineer does."(93) The recruitment drive was intensified in 1969, designated "Women in Engineering" year by the Department of Education and Science(DES), and also (the same year) the golden anniversary of the Women's Engineering Society. The career committees of the ICE and IChemicalE are trying to encourage women to enter the profession.

The Future of the CEI and Institutions

The central issue confronting the profession at this time(July 1975) is whether the CEI is to stay with its present structure and functions or whether, as did the EIJC, it will give birth to a more unified, powerful and active body involving a further separation of the dual functions of the Institutions. And as a corollary, does a solution to fragmentation spell an end to the system of learned societies?

Professionally orientated engineers have emphasized the relative inactivity, inertia, and ineffectiveness of the CEI. Its lack of authority means that secretaries literally spend days trying to gather the signatures of Institution-Secretaries and officials for all the individual constituents on a single CEI letter. As representatives have to report back to the constituent Institutions, the CEI takes months to act on any issue of import to the profession. Even then the decisions taken by the CEI are not binding on individual member Institutions, a fact of central importance for CEI politics. Moreover, the CEI Institutions, though not for lack of trying(94) have not been able to gain a formal monopoly of function for engineers defined by the CEI/ERB structure. The state, especially the Department of Industry and Trade, has been urging registration, considering the setting up of its own register in April 1974(95) and generally searching for some way to "break the deadlock between the 'learned' engineering professional institutions and the non-chartered associations" over the definition and educational requirements of engineers.(96) Not only are the professional functions ill-performed, but also weaknesses spring from the learned society structure of the study functions of the Institutions, a structure resulting from the peculiar development of study in combination with professional activities: "This is manifested in a lack of flexibility to enable 'cross-disciplinary' subjects to be dealt with adequately in a manner acceptable to the engineers working in these fields, and in the less-than-satisfactory relationships between the CEI and some of the non-chartered learned societies." (97) A CEI problem was that the "exercise of the professional function is still tied to a learned society structure which is not well suited to dealing with such matters."(98) These and other problems stimulated engineers demanding a genuine scheme of unification to intensify discussions in 1973 and 1974 concerning the need for further unity at a level that could not have been even contemplated in discussions between the full range of CEI Institutions at the time of the formation of the CEI or within the EIJC framework. One proposal was for a Royal Society of Engineers with a highly exclusive membership drawn from the elite of the chartered profession, but it was abandoned as unworkable. Any change had to be approved by the representatives of the fifteen constituent Institutions (usually the president, vice-president, and the secretary), and as some of the Institutions are composed of over half persons in qualifying grades other than that of chartered engineer, "the RSEng. would be too much of an elite to swallow and would exclude a large number of people who had every reason to believe that their present status in CEI would not be disturbed."(99) The essential problem according to Sir Kirby Laing, ICE President, was the accomodation of the interests of the small Institutions to those of the big, a problem that lies at the heart of CEI politics.

The main proposal to date was drafted by the CEI's Executive Committee (itself resulting from a rationalization of the CEI committee structure in an attempt to delegate authority for executive action) to the Board of CEI(which determines policy after a vote of all Institution representatives). The essence of the proposal is for a more complete separation of study and professional functions by the formation of a single "Chartered Engineering Institution" (perhaps with the prefix "Royal") the keynote to which would be the inclusion of individual engineers as members partly supplanting the federal structure of the CEI. (100) The NCEI (new CEI) would consist of both corporations and individual engineers; the corporation members would be the old CEI group and any other chartered bodies elected, while a class of "affiliate members" would include other Institutions carrying out both study and professional functions at a level equivalent to the CEI-fifteen (thereby taking the sting out of the reaction of the presently non-included organizations). Individual members of NCEI would be either registered Chartered Engineers with membership of a

Corporation Member or (and this is an, if not the, important novelty) members of an Affiliate Member Institution, on the condition that their invidual qualifications after determination by a NCEI panel merit such registration. A non-corporate class would include those working towards chartered status, and there would also be student members. The 37 members of the new council, with the governing body, would be made up of 15 chartered engineers (not officials as at present, but elected by the Councils of the present CEI group); 3 representatives of the ERB (one for each section); 15 chartered engineers elected by the individual members of the CEI Institutions on a regional representation of "principal engineering disciplines" basis; 4 officials of the present CEI. At this stage, it remains unclear whether the NCEI council would be dominated by employees or by employers (as of course is the present CEI---a source of complaint)(101), but there is a strong probability that it would be more representative of the former. With this new constitution the inactivity resulting from the lack of leadership within the CEI due to the independence of the minor Institutions could be overcome.(102) A wide range of professional activities is envisaged for the NCEI: maintenance of qualifications, examination, practical training, experience, competence; enforcement of a code of ethics; advancing the science and art of practice of engineering; personal services to engineers, outside the negotiation of the terms and conditions of service; maintenance of a register; and to represent and advance the interests of the profession and practice of engineering in relation to all outside agencies, educational, industrial, state, scientific, etc. Study functions would remain the preserve of the individual Institutions, who would be encouraged to form interdisciplinary bodies and "to form themselves into a small number of technological groups", including non-chartered bodies.(103)

As it stands this massive reorganization in all its complexity and subtlety, permits the individual Institutions, at least theoretically, to continue functioning on their pre-CEI basis, awarding "qualifying titles relating to their disciplines".(104) There is a parallel with the Medical Act of 1858, which provided a basic minimum standard of qualification in the profession while permitting the rival medical schools (which were not grounded in specialities in the manner of the engineering Institutions), corporations, and Royal Colleges to continue qualifying at a level above the minimum set by registration (or the NCEI). The doubt is that all the CEI-fifteen outside the Big Three and a select group of minor bodies could be able to do this, and whether the practical training schemes and experience requirements might not be standardized by the CEI at a level that would undermine the professional functions of the smaller bodies. In either case, as the NCEI is essentially a plan for the transfer of power within the CEI framework from the chartered Institutions to the Big Three, it is unlikely that should that take place, future restructuration would serve the interests and autonomy of the minor bodies, irrespective of the details of any current proposal.

The main opposition to the NCEI design is coming from the smaller Institutions presently within the CEI group. Because these smaller Institutions are in a majority on the CEI Board and have equal voting powers with the Big Three (despite superiority in numbers of the latter), some of the Secretaries are confidently predicting that the Big Three's scheme will come to nought. By July 1975 the situation, widely (for the internal politics of the engineering profession) reported in the non-technical press, was that the Big Three along with a few of the minor bodies were willing to withdraw from the CEI and establish the NCEI in some form on their own. While the outcome of the present crisis in the CEI and profession is unknown, some of the general consequences of alternative courses of action as well as the mainsprings of CEI internal politics may be indicated.

The NCEI formula for the registration of qualified engineers (and few can doubt that it would mean that in the end) plus Institution survival comes close to dealing a death blow to the weaker CEI constituents, for which reason it is being strongly opposed. These bodies have a luke-warm view of the CEI; they are happy to be in, but desire no further changes. The Production engineers may be typical of a small Institution with a high proportion of non-graduates; a 1970 survey showed an overall favourable attitude to the CEI, but at the same time members did not want the identity of the Production engineer to be lost.(105) The Secretaries and officials (the CEI group employs some 750 persons at their combined London headquarters) are even less keen than the rank-and-file on a narrower role for their Institutions----they desire as they always have, parity of prestige with the Big Three on the basis of their speciality standing. Not only would the minor Institutions have less power in the NCEI, but also they face the prospect of a decline in numbers. At present, in the transitionary period to meet the CEI requirements, Institutions are still admitting non-graduates (university and CNNA) to full membership. The evidence is contradictory and obscured on whether and to what extent the non-graduate intake has been curtailed as of 1974, or whether these routes are to be closed in 1977-78, or whether the CEI is temporarily not functioning on this question, while the debate on the new CEI continues as constituents are not legally bound by CEI directives. After the CEI fully closes these routes (if it does) the minor Institutions may still admit to the full membership grade non-graduates, but such persons would not be eligible for registration in the ERB or CEI as "Chartered Engineers" as opposed to Chartered Production Engineer, Chartered Marine Engineer, Chartered Municipal Engineer, Chartered Radio and Electronic Engineer, etc. As long as the generalist chartered engineer status fails to be recognized as the fully and exclusively professional status, the minor Institutions may continue to function as they have done from their inception, as speciality quasi-registration boards. Their interest is a simple one: to be inside the CEI "club" thus emphasizing their chartered status, and at the same time to ensure that no unification of the profession takes place through this agency. For this reason the CEI has been 15 years in formulating the scheme that Civils' President Sir George McNaughton outlined in his 1961 Address for an Institution of Chartered Engineers. As the minor Institutions still function to qualify specialists, and to give the equivalent of graduate status to non-graduates, the new Chartered Engineering Institution, would undermine their membership appeal by having the executive authority to implement the chartered engineer status, probably with restrictions on practice in the state service if the net was widely cast. The intending Chartered Engineer would have only the study activities of the minor bodies to attract him, and very few engineers now join for that reason(106) and, in many cases where extreme specialization has led to overlap in activities, would be better off joining one of the Big Three and pursuing aims in an interdisciplinary group. But the provision that all Chartered Engineers must join an Institution (similar to that introduced by the STE into the 1926 Bill to mollify the Institutions) would go someway towards offsetting the decline--assuming of course that such a provision was eventually included after the profession moved towards the NCEI. Fundamentally, the NCEI proposals, by shifting the locus of power towards numerical majorities in the profession away from the false "equality" of federation, would eventually probably result in implementation of the interests of the Big Three and an end to the present system of qualification via speciality Institutions, leaving them only as either study groups or agencies for certification of practical training, both of which are more efficiently provided by the major Institutions, or in the latter case by the NCEI.

While urging on the NCEI, the Big Three are also raising their qualifications above the CEI and projected NCEI standard, by strengthening the practical training requirements and responsibility levels for entry. The Mechanicals have formalized their old practical requirements into an "industrial tutor" route to corporate membership that satisfies both the old training and experience requirements in four years from graduation with about two years in training and about the same time in planned career development under the guidance of established members,(107) now Fellows. But the Civils are the clear leaders in this field with a well-entrenched system of practical training that is to be further supported after the expected implementation of the recommendations of the report of the "Chilver Committee" now in the discussion-approval stage.(108) These proposals, from an eight man committee inclusive of only one Professor of Civil Engineering, represent a model of professional, practitioner-based control over entry for any engineering profession. Highlights are: the reapproval of university courses of civil engineering by the Institution moderators every five yr.

to maintain uniformity and standards; practical training to be more rigorously controlled by a registered "Supervising Civil Engineer"; a three year stint as an Associate Member (another newly proposed grade) gaining practical experience followed by an assessment of professional competence for Membership, and chartered engineer status, i.e., 10 years to professional status reached in "his late 20s or even later".(109) After ten years in Membership, a Civil reaching a "position of eminence" (understood as outstanding achievement rather than the simple attainment of a position of a certain level of responsibility as in the old Membership grade) becomes eligible for the Fellowship (at 41 or 42). This extremely rigorous entry process, hedged in with a series of reports and interviews, will not be automatic for even the graduate: "there will be a number of academically qualified civil engineers who do not wish, or are unfitted, to become qualified professional engineers. Some of these may not remain in civil engineering, and some may be expected to move towards technician employment".(110) Increased standards are expected to lead to a "reduction in the number of chartered engineers and an increase of technician engineers."(111) The Chilver Committee's report represents a blueprint for the formation of an elite within the NCEI structure or some such similar plan for unification. It aims to ensure that membership in the Institution, not graduate status, is the necessary qualification for practice within civil engineering irrespective of developments in professional organization, by pitching the tone of the speciality at a level far higher than could be contemplated for the profession as a whole. But few Institutions outside the Civils and to a lesser extent the Big Three are in a position to even propose the exclusion of graduates through their training schemes.

While the minor Institutions are thus threatened by the machinations of the Big Three, the other central fact of contemporary Institution politics may force them to accept a NCEI. Unfortunately there is no way of accurately estimating the extent of "unqualified practice" among newly qualified graduates at the present time,(112) but hearsay evidence is that without non-graduate intake most Institutions' membership, like the Mechanicals, would be declining, some very seriously so. The graduate was never their historical mainstay; he joined because of the widespread prejudice among employers against the employment of graduates over the practical man. Institution membership guaranteed the practical training and was a sine qua non among industrialists. All that has now changed,(113) or is fast changing. More fundamental still, and the cause of graduaterejection, is the low status of the profession, now so low that there may seem little point in continuing the rivalries that have beleaguered the quest for a higher status in the past.

Conclusions

The consequences of the CEI movement are these: at the very best as presently constituted the federated CEI has staved off a further decline in status for the profession, a decline that other things being equal would have accelerated in the 1960s and 1970s, but it has not, on the analysis of the Institution structure and function presented here, got to the root of the problem. If the organization of the profession remains as it is at present, a consequence will be the slow replacement of the Chartered Engineer of whatever sort by the "graduate engineer" and/or "technologist" on the Continental model. Alternatively the Chartered Engineering Institution, if established, and by virtue of the actions that will occur after that due to its internal logic, could also implement and develop the design for a high status formulated by the present CEI. It remains to be seen whether the profession will be able to transcend its narrow factionalism, pulling itself up by its bootstraps, or whether it will continue with the rivalry that has characterized its long history until the entire structure gives way beneath its own weight. Either way the old system of Institution organization is on the decline: the question is will they be able to adapt to meet the crisis of the profession or will their old age be a dishonourable one?

Footnotes to Chapter 7

1. Ministry of Education, Higher Technological Education, London, HMSO, 1945, (Percy Report).

2. Ibid., para. 5.

3. Ibid.

4. Ibid.

5. Michael Argles, South Kensington to Robbins, An Account of English Technical and Scientific Education since 1851, London, Longmans, 1964, pp.77-80.

6. Lord President of the Council, Scientific Manpower, London, HMSO, 1945, (Report of the Committee on Scientific Manpower, Chairman Sir Alan Barlow, others included P.M.S.Blackett, Geoffrey Crowther, Solly Suckerman, C.P.Snow).

7. 1950 first report: Ministry of Education; NACEIC, The Future Development of Higher Technological Education, London, HMSO, 1950.

8. Tyrell Burgess and John Pratt, Policy and Practice: The Colleges of Advanced Technology, London,1970, p.25. Also the NACEIC, had 72 members, 52 from regional councils, 20 nominated by the Ministry, local authorities and employers and trade unions were represented.

9. See City and Guilds of London Institute, Brief statement of the Institute's views on the future of Higher Technological Education, with reference to the Report of the NACEIC, Annual Report of the City and Guilds Council, 1950, also issued as a two page report on August 1951.

10. University Grants Committee, A Note on Technology in the Universities, London, HMSO., 1950.

11. Higher Technological Education: Statement of Government Policy,London, HMSO., 1951.

12. Bernard C. Curling,History of the Institution of Marine Engineers, London, IMarE., 1961, p.120; cf. Marine, "Minutes" Min.20th March,1950, pp.375-6.

13. Parliamentary and Scientific Committee, Memorandum on Higher Technological Education, 1954.

14. UGC., University Development 1952-1957, Table 111, p.19.

15. Technical Education, London, HMSO., Cmnd.9703, 1956; cf. the White Paper, Better Opportunities in Technical Education, London, HMSO., 1961, which dealt with manpower below the professional level, technicians, skilled craftsmen and operatives, marking a further step in the decline of the HNC.

16. NCTA, Report for the period December 1955 to July 1957, p.3.

17. NCTA, Report for the period August 1957 to March 1959.

18. NCTA, An award higher than the Diploma in Technology,1958, and The Diploma in Technology and the Membership of the College of Technologists, n.d., and ibid.

19. Burgess and Pratt, op.cit., pp.16-24.

20. R.C.Yarnell, "The Professional Engineering Institutions and their Influence upon Technical Education", Trans.Soc.Eng., 1965, p.195.

21. For an analysis of these trends, see IEE., "Minutes", Document 5200/438, with Min. for 18, May 1961.

22. The numbers in applied science faculties rose between 1956-7 to 1961 from 12,496 to 16,225 and from 13.9% to 15.2% of students, pure scientists continued to by-pass engineers, 18,899(22.2%) to 26,365(25.2%) in the same period. Medicine declined from 12,937(14.4%) to 12,276(11.2%) while dentistry increased absolutely from 2,733 to 3,086 by decreased proportionately from 3.0 to 2.7%, UGC, University Development: Interim Report for the years 1957 to 1961, London, HMSO, 1962, p.9.

23. Production, "Minutes", Min. Thursday 27, October 1955, p.xv.

24. IEE., "Minutes", Min.no. 19, 19th October 1959; Min. no. 71, 7th January 1960; Min. no. 166, 21st September 1960.

25. Sir George McNaughton, "Presidential Address", Proc.ICE., Vol.21 (January to April 1962) pp.1-12.

26. See the debate in The Times, 10,13,15,16,17,18, November 1961 on formation of EIJC.

27. Production, "Minutes", Min. 26th July 1962, pp.viii-ix.

28. J.A.Jellett, "The Integration of the Engineering Profession", PE., Vol.7 (October 1962) No.4, pp.105-111.

29. EIJC report attached to Marine, "Minutes", 21st October 1963, p.156, Vol.33.

30. E.g., Marine, "Minutes", Vol.33, 12th December 1963, p.203.

31. EIJC, "Annual Report of the Joint Council for the Year 1963", p.6.

32. EIJC, "Annual Report of the Joint Council for the Year 1964", p.3.

33. IEE, "Minutes" Min. no. 124(b), 15th Semptember 1965.

34. Supplementary Report of the General Purposes Committee", IEE, "Minutes", located at 16th September 1965, para.6.

35. Marines, "Minutes", Vol.33 Min. 12th December 1963, p.198.

36. Marines, "Minutes", Vol.33 Min. 12th December 1963, p.149.

37. IEE, "Minutes" Min. no. 124(e), 16th September 1965.

38. IEE, "Minutes", Min. no. 124, 16th September 1965.

39. Eng., Vol.220 (August 13, 1965) No.5716, pp.251-252, leading article. Cf. P.J.Wallace, "Engineers and the Charter, No. 1", Eng., Vol.220 (November 19,1965) No.5730, p.836.

40. EIJC, "Professionalism", London, EIJC., 1963, Appendix D, typescript document marked "confidential" in Library of the IME.

41. Annual Report of the Advisory Committee on Scientific Policy, 1963-4, London, HMSO., Cmnd.,2538, 1964, Appendix B, "Findings and Recommendations of the Interdepartmental Committee on Improvement in the Status of Technology", pp.29-35.

42. See: Rt. Hon. Sir Edward Boyle, Bt., M.P., Minister for Education and Science, "The Expanding Role of the Engineer, Conservative Performance and Plans", PE., Vol.9 (July/August 1964) No.4, pp.121-122; Eric Lubbock, M.P., "Liberals and the Engineer", PE., Vol.9 (Octobet 1964) No.5, pp.147-8; and, R.H.S.Crossman, M.P., "Labour and the Engineer", PE., Vol.9 (May/June 1964) No.3, pp.83-4.

43. EIJC, "Professionalism", op.cit.

44. See EIJC, "Annual Report of the Council for the Year 1963", p.5.

45. R.H.S,Crossman, op.cit.

46. Eng., Vol.220 (August 13,1965) No.5716, pp.251-2.

47. Royal Charter and Bye-laws, London, CEI, 1965.

48. CEI,ibid., 16th Febuary 1971 amendments, article 3 and bye-laws 30 to 47, "Engineers Registration Board".

49. Reply to a question in the House of Commons on 15th Febuary by Mr. John Davies, Secretary of State for Trade and Industry, and reported in CEI, "Registration Board for the Engineering Community", Bulletin No.4, London, CEI., April 1971, (marked "confidential"). Also in a written reply on the registration of engineers, Sir Keith Joseph, stated that its purpose was to raise the status of engineers.

50. See EIJC, "Professionalism", op.cit.

51. CEI, Annual Report 1971, London, CEI.,1971.

52. CEI, "CEI Composite Register for the Engineering Community", Bulletin No.3,London, CEI, August 1970, marked "confidential".

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55. IHVE, "Annual Report", 1974, pp.1-2.

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57. "E.G.M.", Building Services Engineer, (Journal of the IHVE), Vol.43, (May 1975) p.32.

58. Ibid. p.33.

59. Ibid. p.33.

60. CEI, Education and Training,London, CEI, 1968, "Statement No.3",

61. CEI, Bulletin No.6, op.cit.

62. Interest in practical training has been intensified rather than dampened by the formation of the CEI, see "Education and Training Committee, Notes for the Guidance of Sponsors and Graduates in Training in Electrical and Electronic Engineering", IEE, document attached to "Minutes", for 16th September 1965.

63. Differentiation among types of technicians by the state goes back to Better Opportunities in Technical Education, (White Paper) London, HMSO, Cmnd. 1254, 1961.

64. CEI policy was first outlined in a CEI discussion draft, "CEI and the Technician", London, CEI, 1967.

65. Dr. H.L.Haslegrave, Report of the Committee on Technician Courses and Examinations, London, Department of Education and Science, HMSO, 1969.

66. Ibid. Cf. Proc.ICE., Vol.48 (January to April 1971) pp.359-362, for a discussion of the report.

67. A.Kleingartner, Professionalism and Salaried Worker Organization, University of Wisconsin, Industrial Relations Research Institute, 1967, pp.29-35. The American profession has adopted similar strategies.

68. B.C.Roberts, Ray Loveridge, John Gennard, J.V.Eason, et.al., Reluctant Militants: A Study of Industrial Technicians, London, Heinemann Educational Books, 1972, see chapter 2 for a discussion of the problems of definition.

69. Cf. IEE, "Minutes", Min. no. 159(3), 21 September 1961, on continuation of financial aid and support for the activities of the Public Schools Appointments Board. Cf. Chapter 1 supra. Hutchings (1967).

70. ICE, "Annual Report", 1970, p.7.

71. "A Parliament for Engineers" (FEANI) PE., Vol.8 (1963) No.5, pp.159-160 reprinted from Engrg.; cf. FEANI, "5th International Congress of Engineers, London, 1971", The Training of Professional Engineers, London, ICE, 1972; cf. CEI, Bulletin No.3, London, CEI, August 1970, "Feani European Register",(marked "confidential-not for publication"). The CEI has also been a vocal participant in the WFEO, which is active on questions of engineering education and has ties with UNESCO. See WFEO, "Summary Record of the Fourth General Assembly", New York, Library of the United Engineering Centre, 1973, Appendix C., "Report of the Committee on Engineering Information", pp.1-4, dupicated document, copy Library IEE.

72. CEI, Bulletin No.8- EEC Information, London, CEI, October 1972, para.5, CEI and the EEC.

73. CEI, Education and Training, 1971, Statement No.9, Guidelines on Education and Training for Management, London, CEI, 1971; cf. D.L.Marples and S.H.Wearne, "Management Training for Engineers", Proc.ICE., Vol.34 (May 1966) pp.108-109.

74. CEI, 1971, op.cit., pp.4-5,9.

75. IEE, "Minutes", Min. no. 44(e), 3 December, 1959.

76. The formation of the CEI is 1965 led to proposals for a division of labour between the two bodies: "Engineering and engineers cannot always be dealt with in isolation from each other and the Council's work, at times, will inevitably

be concerned with general matters of professional interest." Some of these were to be pursued through the CEI/Guild Joint Committee. Eng., Vol.220 (November 12, 1965) No.5729, p.803. On the other hand the CEI was opposed by the Society of Engineers on the grounds that many engineers would find themselves excluded from the benefits of the Charter, which included only those who have purely academic qualifications. The Society had originally applied for membeship in the EIJC, but was refused. Otherwise it supported registration, wishing to see an Engineers' Registration Act, similar to the Architects' Registration Act of 1931, C.L.N.Laing, "Presidential Address", Trans.Soc.Eng., 1965, pp.11-12.

77. CEI, Bulletin No.3, London, London, CEI, August 1970, (marked "confidential-not for publication").

78. Linda Dickens, "UKAPE: What future for the Professional Union", SSRC Industrial Relations Research Unit, Discussion Papers, Conventry, 1972.

79. Paragraph 69 of the report printed in "The Verdict in CA.Parsons", PE., Vol.18 (January 1973) No.1, pp.3-4.

80. The Engineers' Guild has actively concerned itself with the problem. "A Study to Define Levels of Professional Engineering Responsibility", PE., Vol.10 (January 1965) No.1, pp.2-4. "Levels of Responsibility", PE., Vol.11 (August 1966) No.3, pp.131-4; cf. idem, (November 1966) No.4, pp.163-4. UKAPE's definition of "professional engineer" is singificantly different from the U.S. defintion under the Taft-Hartley Act Section 2.12, which is based on job performance. The U.K.efinition is based on qualifications and a code of personal conduct. PE., (Febuary 1971) p.6.

81. "You can br proud of your status", Institution of Mechanical Engineers, London, IME., 1973, p.1.

82. Cf. CEI., Annual Report, 1971.

83. See CEI Annual Report, 1971, p.17, "Examinations and Training".

84. There has long been a special affinity between the professional ideology of engineers and sociological modes of thought, manifest in the numerous engineers later turned sociologist, Spencer, Pareto, Sorel, Le Play, etc. Le Play, in particular, a graduate of the Ecole Polytechnique, was concerned with the relations between technology and society and with the status of the engineer, arguing that it could be enhanced by infusion of managerial and social scientific skills, and professional ethics, so that technical skills could be used for profit and result in social and especially managerial dominance. Cf. Michael Z. Brooke, Le Play: Engineer and Social Scientist, London, Longman Group Limited, 1970, pp.46-49.

85. A.Vickers, "The Engineer in Society: Economic Factors---1",Eng., Vol.224 (13 October, 1967) No.5829, pp.487-88; and idem, Vol.224 (20 October 1967) No.5820, pp.517-8.

86. See K.S.Jewsen, "The Engineer---a time of Greatness", Lecture in Library of the IME, November 1961; David Nutting, "Professionalism: The Qualifying Associations in Technology", the Institute of Management and Control, 1969; J.B.Bradshaw, "One Man's View, our profession the way forward", London, ICE., 1971; F.B.Roberts, "Our Public Image", PE., Vol.10 (January 1965) No.1, pp.26-29. And a series of articles from the Chartered Mechanical Engineer, 1962-1971, and reprinted in E.G.Semler, The Engineer and Society, London, IME, 1973.

87. Ibid., and M.W.Thring, Man, Machines and Tomorrow, London, Routledge and Kegan Paul, 1973, pp.120-121. M.W.Thring, "The Social Responsibility of the Engineer", Electronics and Power. Vol.13 (August 1967) pp.292-4.

88. M.W.Thring, "The Chartered Engineer of the Future", Proc.IME., Vol.181 (1966-7) pp.10-15.

89. As part of a wide literature, see especially The Engineer in the Community, Joint American Society of Civil Engineers and Institution of Civil Engineers Engineering Conference, Bermuda 1970, London, ICE., pp.42 and passim.

90. CEI, Bulletin No.7, September 1972 (CEI).

91. There has been an upsurge in concern with safety, cf. ICE, Report on Safety in Civil Engineering, London, ICE.

92. A summary of the attitudes of engineering students on questions of social responsibility central to technocratic professionalism, found that in some cases a majority were in favour of technocratic intervention by the technical expert. His role should not simply be that of the neutral expert, but he should accept consequences and responsibility for the results of his work. John F. Clark, "A Phsychological and Sociological Study of Students in Higher Technological Education", London, Ph.D. thesis, June 1951, pp.200-202.

93. "Women in Engineering", Eng., Vol.228 (10 April 1969) No.5907, p.39.

94. Structurals, "Minutes",op.cit., "Minutes of the Working Party on CEI Affairs", Friday, 20th July 1973.

95. Production, "Minutes", op.cit., Min. 25th April 1974.

96. Eng., Vol.240 (27 March 1975) No.6211, p.15.

97. New Civil Engineer, 8 August 1974, pp.21-22,21, "CEI Reorganization: the Problems".

98. Ibid., p.21.

99. "Towards an 'Engineering Voice", New Civil Engineer, (8 August 1974) p.19.

100. "Report of the CEI Executive Committee to the Board of CEI on the Future Organization of the Engineering Profession", The Radio and Electronic Engineer, Vol.45 (May 1975) No.5, pp.257-261.

101. Cf. W.Howie, "CEI-Where have we got to?", New Civil Engineer, (2 January 1975) p.19.

102. Cf. "IE? Biggest may not be best after all", New Civil Engineer, (17 April 1975) p.17.

103. "Report of the CEI Executive Committee", op.cit., para.28.

104. Ibid., para.27.

105. "Report of Membership Survey", by A.E.Clifford, in Council Papers with Production, "Minutes" op.cit., Min. 29th July 1971, p.2.

106. K.Prandy, Professional Employees, London, Faber and Faber, 1965, presents some survey findings on this point which has been taken as axiomatic above, for the Institute of Metallurgists. Out of a total of 246 respondents over half, 154, gave qualification as their reason for joining, a further 32 "need for a professional body", i.e., mainly to carry out professional functions, 12 support standards, 11 publications, 11 raise status, 10 keep in contact, 14 other, and 1 no answer.

107. *The Industrial Tutor Route to Corporate Membership*, London, IME, n.d., circa. 1973, (pamphlet).

108. *Report of the Chilver Committee on Education and Training of Civil Engineers*, London, ICE, 1975.

109. Ibid., p.25, para.6.5.

110. Ibid., p.21, para.3.22.

111. Ibid., p.21, para.3.24.

112. The CEI has the figures as do the individual Institutions, but they have not yet been made available to this researcher.

113. On graduates finding Institution membership unecessary for employment in industry, see C.St. John-Browne, "What's wrong with the Institutions", *PE.*, Vol.18 (October 1973) N. 4, p.68; cf. *PE.*, January 1973, p.9; cf. *Production Engineer*, November 1972.

Chapter 8

Summary and Conclusions

The British engineer has a lower status than other British professional men, doctors, dentists, accountants, architects, university lecturers, pure scientists, and than the engineer in most, if not all, other industrial societies relative to these established professions (it is extremely high in Russia, Scandinavia, France, many developing countries, and also higher than in Britain in Germany, Canada, Australia and the United States). This was not always so: the Victorian Civil engineer, considered at the forefront of the new professions at home, was looked up to by French, German and American engineers, but by the early 1900s the Civil engineers' status was being eroded, a decline set in that accelerated after the First World War, while other professions, the lower branches of medicine and law, dentistry, accountancy, were upwardly mobile. In modern Britain, the engineer has declined in influence, status and prestige, been forgotten, confused with and eclipsed by, the applied scientists, who with other professional men have encroached on his jurisdiction and usurped his status.

The primary objective of this research has been to explain the problem so defined and measured. Existing explanations are inadequate. The most common is that British culture has produced a gentlemanly amateur ethic leading to a high valuation of the theoretical "pure" scientist engaged in the pursuit of knowledge for its own sake over and against the "practical" and applied. Gentlemen pursue pure science, technology is left for the lower social classes. The public schools have nurtured such attitudes and the universities have cultured and perpetuated them. Engineers are looked down upon because of the contamination by industry, their (in some cases) non-university training, short occupational history, class backgrounds and technical specialization. The lack of secondary education in the 19th century and the Anglican religious tradition are among the institutional developments that have perpetuated these values. But few such explanations can take account of the decline in the status of the engineer.

A further set of potential explanatory factors concerns the ability of the occupational group to determine its own status through collective action taken to establish and legitimate an independently derived claim to special status and authority for the occupation. Professions can and do act to establish and maintain their status, and in doing so can be more or less effectively organized for the purpose. Engineering professions as a whole tend to rank, in the industrial and political democracies, below traditionally free professions such as medicine and law. Unlike these latter occupations, engineering is embedded in large-scale non-professional organizations pursuing disparate goals, goals that are not necessarily identified with status-raising group ideologies and actions. The difference in interests engendered by the diversity in the work situation of engineers, their employee status, or where successful employer identification, militates against cohesive action to further the interests of engineers, as does (to view the situation negatively) the relative absence of a fiduciary client-practitioner relationship. The subordination of the engineer role to managerial and administrative authority does in itself preclude the development of the highest status, which is only achieved where occupations are able to maintain their autonomy as do doctors in hospitals, lawyers in courts, lecturers in universities, and so on. This general condition of the lower status of all engineers can and does vary; engineers may have a greater or lesser access to top positions in non-professional organizations, and their status and position as engineers as specialists within organizations may also vary. The conditions of the very highest status for engineers include a thoroughgoing technocratization of industry, as well as the monopolization (on the basis of a unified and autonomous system of organization) of positions of non-technical leadership. All positions would have to be rigorously defined in terms of qualifications the standard of which was subject to the independent control of the occupational group. Under such circumstances (the professionalization of industry) technical experts in positions of status and authority would run industry for the benefit of society and their clients as a whole. Consequently those societies most identified with technocratic modes of organization, Russia and France for instance, also have high status engineering professions.

Professional Organization of Engineering Occupations

The origin of association among British engineers dates to 1771 with the formation of the Society of Civil Engineers(Smeatonians), a group of leading practitioners, many practicing as independent consultants, who banded together to advance their status and authority as engineers by recognizing and communicating with each other prior to presenting expert testimony in Parliament on matters connected with canal bills. (Before the formation of the Smeatonians, the engineers were asked to give conflicting and contradictory testimony on behalf of their employers' interests, which threw the occupation into disrepute and prohibited it being recognized as a learned profession.) The Smeatonians, without rivals for the last three decades of the 18th century and the first two of the 19th, gradually became too exclusive to cater for the growing numbers of would-be civil engineers, creating a need, especially among younger engineers, for an association to carry on its original activities with more vigour. The Institution of Civil Engineers formed in 1818 for mutual improvement, the communication of technical knowledge, and the consolidation of occupational status and authority. It quickly became the leading body in the field while the Smeatonians atrophied, becoming a dining club for the very eminent. The ICE functioned to define and qualify the professional Civil engineers as distinguished only from the military engineers, and by the 1840s the few Smeatonians who had remained aloof now joined the Institution. But in 1847 a new rival group of engineers styled the Institution of Mechanical Engineers arose after the exclusion of George Stephenson and a rising tide of followers among the workshop, railway, and manufacturing engineers from the Civils on the grounds of insufficient qualifications for professional stature. Other Institutions followed, though not necessarily beginning as rival professional organizations in the style of the Mechanicals. The circumstances of the origins of the Institutions differ widely, reflecting the wide range of activities undertaken by them.

Prominent among the reasons for formation was the need for carrying out what was to become the essential dual functions of the Institutions: professional qualifying and status raising activities, and communication of and development of the occupation's technical-knowledge base. While the former are more important for the well-being of the Institutions, the latter are usually given as the reason and justification for actions taken and Institution policy, defined in the ideology of the learned society, a term used by the Institutions to describe their peculiarities. The professional nature of the Institutions, often denied, can be seen through a description of their historical actions on issues involving engineering professionalism.

The fragmentation of the profession continued apace through the closing decades of the nineteenth century up to the present, but not all the Institutions so formed are of equal standing in the eyes of the engineering community where an elaborate hierarchy has arisen. Collective action in pursuit of status has been structured into a number of status divisions manifest in relations of cooperation and conflict between Institutions during their historical development, the most important of which are: the ICE and the rest; the Big Three (Civils, Mechanicals and Electricals), and the rest; the chartered organizations and the rest. The structure of the organization is apparent from the inter-Institutional relations documented in what follows.

The Civils at first ignored then sponsored the formation of the new Institutions: fragmentation (as long as the minor bodies were not recognized as professional organizations) boosted their own status by increasing their exclusiveness. Throughout the 19th century the ICE maintained that only Civil engineers, MICE, were truly professional engineers, that they were a non-speciality group of high standing, while, if recognized at all, the minor bodies were speciality groups working in professional areas by virtue of the inclusion of Civil engineers among their membership, but not professionally qualifying specialists. In 1886-8 two of the new Institutions, the Electricals and the Mechanicals, joined with the Civils to block an attempt at the registration of engineers, an attempt that came from outside the established profession, which in the ICE already had a quasi-registration system. During the closing decades of the 19th century and the early decades of the 20th, the new minor Institutions were increasingly successful in claiming for themselves the professional status previously only afforded to the Civils---a claim based on speciality standing and legitimated by the state-sanction and recognition formalized in the grant of royal charters by the Privy Council. Originally just a way of creating a corporate group (the Civils' 1828 charter was sought not as a means of gaining state-sanction for status claims, but as a method of incorporation), the charter gradually came to have a special significance for engineering as a form of incorporation that distinguished the professional from the non-professional groups, a function much aided by the state practice (following pressure from first the Civils and then other Institutions) in the interwar and postwar years of recognizing members of chartered bodies as persons fit for professional classification as engineers in the civil service. The first main step in the transformation of the functions of the charters was the bid by the Civils to close engineering mainly around their own membership through a registration act of 1920-21. They hoped that Parliament would give the ICE the authority to register "civil engineers"(to be a restricted title) who were defined as ICE members (with limited provisions for individual outsiders) who would then have a formal monopoly of certain practices, but the minor Institutions, some with newly obtained charters, successfully opposed this measure, reflecting its lateness and the fact that the Civils were only willing to consider registration after their exclusiveness was already being undermined by the recognition of the specialities that sought to usurp their status. Not able to differentiate themselves completely from the other Institutions, the Civils then sought to cooperate with the leading minor bodies in blocking any inclusive attempts at registration and stopping the spread of further royal charters, this it did in conjunction with the Mechanicals and the Electricals, and a small and changing group of minor and mainly chartered bodies. Through the Engineering Joint Council, a non-executive consultative committee formed to oppose the growth and recognition of the minor organizations by the major, the Civils, Big Three, and other minor Institutions, shot down the Engineers' Registration Bill of 1926-7, the product of a group styled the Society of Technical Engineers, which formed for the purpose. The reason for the opposition of the major Institutions was a simple one: they themselves functioned as quasi-registration authorities, specialist registration boards; should an inclusive statutory register be formed their own professional qualifying functions would be supplanted and a decline in membership would follow. Moreover, registration, in the political circumstances of the day, would have to be inclusive of all who could lay claim to the status of engineer, detracting from the position of the Civils, a consequence supported by some minor newly-formed Institutions. Cooperation between Institutions for the remainder of the interwar years focused on the blocking of royal charters, an activity usually carried out by the Big Three alone, who would claim that the new speciality grouping claiming a charter was not of professional standing because a) the technical knowledge base functions were already being carried out by the Big Three, b) that the members of the new speciality, except where also members of the Big Three, are not professional engineers but craftsmen, technicians, traders, manufacturers, commercial agents, etc. The resistance of the Big Three to the new grants of charter greatly increased their worth, the arguments used against the new speciality by the established Institutions implied that, if a petition was successful, the new group was indeed a new <u>professional</u> speciality. The Privy Council has therefore naturally sought to ensure that certain standards are met before a petition is granted, but because of the changing function of the charter and the informal nature of evaluating standards, the grant of charter has been somewhat arbitrary, far easier to obtain in the interwar years than postwar by Institutions of similar standing. By the 1960s only 15 out of a maximum of 150 Institutions had charters.

The British profession differs from the French, German, American, Australian and Canadian in the extent and structure of fragmentation. In these other professions the dual functions of the Institutions, the professional and the study, are usually separated out into organizations catering solely for them. Most professions have a system of study associations superficially similar to the British Institutions carrying out technical knowledge-base related activities, but while the membership in a British Institution signified professional or would-be professional status, in other engineering professions membership in comparable study associations does not. Though the members of these study associations (which in their structure and relative size parallel the Institutions only approximately) are usually professional engineers, it is not by virtue of membership that this is so----instead they qualify through a system of professional schools, e.g., France, Germany, and the U.S., registration as engineers, e.g., U.S., and Canada, or through the membership in a single Institution comparable to the British, as in Australia. These systems of professional organization have a unified structure unlike the British.

The fragmentation of the British profession has undermined the claims of engineers to professional status, thrown them into question. Minor Institutions have usurped the status of the major, claiming it for themselves by virtue of their speciality standing, and throwing its legitimacy into question. The profession itself has failed to secure agreement on its boundaries, and has not thereby been able to secure the effective sanction of the state for the status within the occupational order to which it aspires. Fragmentation originally furthered the status of an elite, but as it continued and the claims of specialists became recognized, the basis of the status of the profession as a whole was undermined. The status divisions within the profession are not sufficiently distinct to be recognized by the lay public, as they are in accountancy. Status within the profession has been sought at the expense of the status of the profession as a whole.

Professional Organization and Education

In England the engineering profession emerged in practice early on during the industrial revolution; it was not, in the main, the product of engineering schools as on the Continent. Recruits to the profession came from the apprentices and pupils of the established practitioners who had proved their worth by success and competence in the execution of practical engineering works. Although the universities had from an early date shown a willingness to incorporate engineering, there was at first little demand for such courses, and through most of the 19th century the active practitioners and their students formed the vast bulk of the profession, dominating the internal political scene and dictating the policy on education. Such practical men, though eager that their learned status should be legitimated by inclusion of the subject into universities, did not wish to see "theoretical" or "scientific" engineering education on the Continental model supplant the "practical" training given on the job under their supervision of apprentices and pupils. Pupils paid a high premium to the established practitioner, eased his work load, and readily subordinated themselves to his authority on technical matters. The ICE thus fairly controlled the supply of Civil engineers till late in the century, as industrialists and employers (in many cases also members of the Institution) resisted hiring those with purely theoretical or scientific education, so that even those with a degree had to gain practical experience under the guidance of an established practitioner. The French and German professions, by contrast, expanded by increasing the output of state-sanctioned engineering schools; pupilage was unknown and practical training gained while at school or during the early years of employment. The associations of practitioners originated among graduates of the engineering schools.

In the latter part of the century an expansion in engineering education, largely based and argued for on the example of the Continental schools, took place in Britain, the United States, Canada and Australia at approximately the same historical period, but at a significantly different juncture in the growth of professional association. While in Britain practitioners were organized and established, in the other societies associations developed along with or as a result of exapansion in education with a consequence that educators and graduates of theoretical and scientific education came to be prominent among their membership and officials. (Only the British Institutions have insisted on Members having acquired practical experience in a position of practical responsibility, a provision often excluding educators from the highest grades of membership.) The practitioner-dominated British profession sought at first to resist expansion of non-university theoretical engineering education on the Continental model, its voice was absent among the pressure groups that stimulated the expansion of technical education using the Continental example as their argument, and when it became clear that formal and scientific engineering education would have to be accepted as a necessary part of the education of all recruits to the profession, the Institutions mobilized their resources to ensure that purely theoretical and scientific engineering education did not replace the practical requirements for entry over which they had absolute control. In this they were successful and qualification for the professsion in the early decades of the twentieth century demanded both theoretical and practical education. By maintaining the practical requirements the Institutions also ensured the continuance of their customary monopoly over practice, which in turn gave them a great say in the affairs of technical education, which became, especially in the non-university sector, geared to the requirements laid down by the Institutions' own examinations. Such control over theoretical and scientific education became formalized in schemes such as those for national certificates. Diversity of standards in the technical education sector and autonomy in the university sector contributed to the development of this role of the organized profession as a "post-graduate" style qualifying system, which in the extent of its recognition is unique among the engineering professions studied. Naturally the greatest threat to the British Institutions as a form of social and economic organization lies in the possibility of a Continental-style professional school, the graduate of which needs little to no further qualification before practice. Such a school system would replace a large part of the professional functions of the Institutions, leading to a decline in their membership , on the American example. Relatively few engineers join British Institutions for study reasons. A consequence of this conflict of interest between the practitioner-dominated associations and establishments of scientific engineering education of all kinds in Britain, has been a lack of supporting actions by the former for the latter, a pattern that to varying degrees is reversed in other engineering professions that did not develop prior to the growth of theoretical and scientific engineering education. This is not of course to say that the profession is antagonistic to engineering education per se, to the contrary it has done more on the practical side than any other profession.

A result of the control exercised by the Institutions over engineering education is that it is one of the most autonomous and exclusive (in terms of the ratio of engineers to supporting staffs and population). Such autonomy, monopoly and control over entry, and exclusiveness would normally have led to a high status---contrast the American profession which though unified admits at a far lower standard than the British---but the fragmented structure militated against the development of status on that basis. The exclusiveness and control of the major Institutions has been undermined by the inclusiveness of the minor.

Professional Organization and Practice

The fragmentation process in the British system of professional organization served as a strategy to maintain and further the status of speciality groups, but as such it precluded more effective actions taken by other professions, to advance their members' interests and position.

The new Institutions recruited mostly from among engineers in positions of subordination to established practitioners, rather than developing in different employment areas, though that also occurred. Thus at first Civils were located in all areas of practice, Mechanicals then arose in some of these areas in positions subordinate to Civils. Much the same applies to the Big Three in their relations with many of the specialist associations. Once formed the object of a new Institution was to establish the standing of their speciality on a footing equivalent to the Civils---the essential feature of Institution policy throughout the entire development was to found professional status on speciality standing. Unlike in, for example, medicine, specialization in engineering did not mean the growth of post-graduate specialities, more difficult to enter and more prestigious than general practice, but the professionalization of groups of practitioners working in subordinate positions in particular employments with a special technique, who had no formal education at all (at the professional level). Specialization became a substitute for theoretical and scientific engineering education, minor Institutions claiming parity with the Civils and Big Three on the grounds of practical involvement and experience in a special area. The basic policy of all Institutions then became to ensure that their full membership grade did indeed signify a qualification for practice within the speciality, to create a parallel between their hierarchy and the position of engineers in practice. Most Institution activity focuses on the maintenance of the purity of the various internal orders. If a royal charter was obtained then an informal monopoly in the state service in the relevant positions would come into operation, otherwise Institutions sought to secure the patronage of employers within host industries by electing them to Honorary Membership. Little else, however, was done to secure the status of the membership. A reinforcing factor is that the successful engineers, who dominate the Institution councils and presidencies, are often also employers or identified with employer interests, and they are less vocal in support of engineer interests than would be purely professional engineers--- all the same there are few examples of an open conflict of interest emerging within the profession on employer-employee lines. The main reason is that, given fragmentation, there was little else that officials could devise, or members urge, to advance the status of a given Institutions' membership other than to try to reach a status similar to the Civils for the given speciality by maintaining the exclusiveness of membership. As representatives of speciality interests within engineering, the Institutions and their resources were wholly committed to strategies aimed at advancing the relative status of their membership vis-a-vis other engineers; no Institution represented or took any action of anything other than the most minor significance, to advance the interests of engineers as engineers in society and economy.

Professionalism in engineering involves a complex of logically related and practically associated ideas, the lynchpin of which is the demand for unity. The movement among engineers in the United States, a response to educational expansion, demonstrates some of the relations and outcomes of engineering professionalism, illustrating the potential status-raising measures forsaken by the British profession for its fragmented structure and its illusory benefits, the internal gains over the external. American engineers during the first three decades of this century sought state-sanction for legal restrictions on practice and control over entry, and in doing so developed the rationalizations and ideology necessary to justify and legitimate a monopoly position for the engineer as engineer. In content the professional ideology of the engineer, which has as its form the professional service ideal, is technocratic: engineers should serve the public and client by applying special knowledge and engineering methods to the efficient running of the industrial machine for the public good. It is the demand that experts run the industrial system for the good of all. Unity and registration are justified in terms of this ideology stressing that legal sanctions for the qualified are in the public interest, a better service will result and a higher standard of ethics observed. The assumption of "social responsibility" by the profession went hand in glove with the propagation of licensing laws, restricting certain areas of practice to qualified engineers. Technocratic idealism easily lent itself toward a demand that engineers should be in non-technical positions of control, influence and power within industry, and at one extreme the profession sought to advance itself through scientific management, the rationalization of production not just on the basis of engineering methods, but by engineers whose expertise gave them a special mission in reconciling capital-labour conflict in terms of the general public interest. The profession as a whole and the ASME in particular has backed the passage of engineers into higher management, advocating that avenues for the professional man be opened up into higher positions via engineering, and American engineers have been willing and eager to make such moves.

In Britain by contrast all these ideas have been absent, except in isolated instances among individuals. Scientific management was not taken up, there was a minimal interest in ethics or social responsibility. Although they had the ability to dictate curricula in engineering education, the British Institutions very largely ignored and rejected the inclusion of non-engineering subjects relevant to business and management during the interwar and postwar years up to the 1960s. The Institutions sought to qualify specialist professional engineers, not managers or administrators, and speciality identification was so strong that they disliked the idea of having to gain status for the profession by leaving it. In this, the fragmentation of the British profession compared to the American "unity" does not represent less cohesion in the former than the latter, rather identification with the general engineer status in America goes along with an absence of the strong speciality orientation of the British engineer, an orientation that doubtless owes much to the routine of apprenticeship and pupilage, the practical training and experience requirements necessary to become an engineer. While the British profession largely rejected the idea that engineers should have management training or should be employed in the top managerial or administrative positions (the higher authority and status of these positions made them desirable career goals all the same), the German and French like the American have consistently had this as an object of their pressure group activities. In England, in the few isolated incidents where engineers have urged that some among their number ought to be represented at the highest levels, a marked success is evident.

One measurable result of these differences in the kinds of action taken by the various professions concerns the position of the engineer in industrial leadership over the course of this century. As specialization and fragmentation became fused, a visible decline occurred in the representation of enjineers in positions of industrial leadership , a decline made good by an influx of accountants over the same period. In the U.S.A. and Germany, however, the reverse took place——a measurable increase in authority for the profession at the highest levels. These trends reflect differences in the actions and organization of the respective professions.

Fragmentation in British engineering has fallen largely on speciality lines, at least ideologically. The failure to identify a general interest of engineers vis-a-vis the wider society and occupational order, to unite, largely precluded actions except those designed to advance speciality groupings within the corpus of engineering itself. Small wonder that the British engineer has, compared to the Continental technocrats, been considered a narrow specialist suitable only for a narrow technical jurisdiction. At the same time that fragmentation forced this overriding concern with speciality, it was undermining the status of engineers by throwing it into question so that the formula, as applied to and within engineering, that specialists are not professional became common. In other professions specialization has been built up on top of requirements of general professional education, in engineering speciality groups emerged among those with no formal education whatsoever, among the outcasts in terms of educational standards. In its combination with fragmentation, the crucial variable, specialization took on an especial colour in engineering. So in Britain the engineers are not only subject to less positive status evaluations, but also they are located in positions, at the top end, of less authority, generality and power.

The Contemporary Movement

The contemporary movement among British engineers aims to professionalize the occupation through unity and cohesion in organization. Stimulated by the development of Continental style engineering education outside the universities, the extremely low status of the profession in practice, with the consequent problem of recruiting the new graduates, the movement so far has achieved only a federal structure in the reorganization of the profession, it has not reached a fundamental unity nor solved the problems that stand in the way of a wider role for the profession in society and economy. But such changes as have already been made will probably, through an internal logic compelling them towards a solution to a growing crisis, lead to further reorganization, rationalization (especially of the study functions), and eventual unity. Under such circumstances the profession would be able to gain state-sanction for legal restrictions on certain practices and adopt other status enhancing measures. Such unity is being urged by the larger Institutions, the smaller fear a loss of autonomy. Whatever the case, the system of professional organization in Britain has fallen so low in public and client esteem that unless it acts positively to unite the profession, to halt fragmentation, through an inclusive measure that will gain the sanction of the state and an eventual exclusive monopoly in the EEC, the Institutions as professional organizations are likely to decline, to be replaced by a Continental style all-graduate profession, with some sort of association emerging out of the debris of the Institutions to represent the new graduates' interests. This very real possibility, coupled with the need for a revitalization of the British engineering profession to put it back on a footing equal to the German and French, are likely, in the end, to impel some further restructuration.

The low status of British engineers, then, when compared to the status of other engineering professions has as its cause the fragmented structure of its professional organzation and the collective action in pursuit of status conditioned by that structure. Engineers are not effectively organized to legitimate a claim to a standing similar to other professions; the contemporary movement shows a marked potential of achieving such an organization, which could then take the kind of actions that would eventually result in a higher status. Through these means the occupational group has determined its relative status compared with other engineering professions, and contributed an all important necessary condition in the determination of the status of engineers within the professional complex as a whole. Thus just as high status is an outcome of the collective pursuit of status by an occupational group, in engineering the low status in Britain has been an unforeseen and unintended consequence of actions taken to achieve the reverse.

Appendix A

Numerous methodological problems beset the occupational prestige surveys, and it would be a separate task to enter into these areas.(1) Accordingly, this appendix is confined to a comparison of the findings of the relevant surveys, noting only those methodological details that bear directly on these findings.

The only available British survey based on a national sample is that of Gerstl and Hutton, which was conducted in collaboration with Social Surveys (Gallop Poll) Ltd.(2) The rank order is presented in Table 1. In comparing the rank order with that found in other surveys, intervening occupations will be omitted in order to produce rankings for engineers in relation to those other occupations for which there are British ratings. Some occupations that do not appear in the Gerstl and Hutton survey are also mentioned if cross comparisons permit them to be placed in the U.K. rank order. Table 1 indicates that British engineers are accorded relatively less prestige than a number of other professions.

Table 2 presents some American findings.(3) Occupations appearing in the NORC and in the four earlier surveys are underscored. The truly remarkable correspondence between upper ranks of the Nietz, Counts and Deeg and Paterson surveys, despite differences in sample and date, can be attributed to the use of the same questionnaire in the three studies. The samples differed slightly but were primarily composed of high-school seniors. Hartmann's findings may have been influenced by the composition of his sample; forty-two of the ninety-two respondents were from a "small industrial and railroad town of about 5,000 inhabitants". Similarly, the definition of "Civil engineer" used by Counts, Nietz, and Deeg and Paterson was slightly more ambiguous than that for the other professional occupations. The NORC "prestige scores" are used in Table 2 rather than the "standard scores". The range and variance of the prestige scores are greater than that of the standard score, which makes it more useful for comparisons at the extreme. The prestige scores more accurately reflect the prestige of the occupations as they are the summation of the percentage of "excellent" and "good" evaluations. As the research problem concerns the relative position of occupations at one extreme of the hierarchy, the use of the prestige score based on the proportion of good and excellent ratings is more applicable on statistical grounds; its use results in less tied ranks and less tied blocks of occupations. The purely positive evaluations are of more importance here, though the other categories may have altered the response. The rankings based on standard scores for the occupations in Table 2 are presented in Table 2a for comparison; there are tied blocks of ranks making the overall pattern of rankings misleading.(4)

Some provisional observations may be made on a comparison of the findings reported in Table 2 with the British survey. If the various types of scientists are classified together and ranked in terms of the proportions of good and excellent ratings accorded to them, then there is no difference between them. The average score for the five groups of scientists and for civil engineer is precisely the same in both the 1947 and 1963 surveys. If engineers had also been differentiated by speciality grouping, it is likely that a slightly different rank order would have obtained. In terms of the relative position on scales of socio-economic status, civil engineers rank behind certain other specialities. Duncan's socioeconomic index(5) yields a relatively low score for civil engineers; e.g., civil engineer 84, aeronautical engineer 87, chemical 90, the mean score for engineers being 85.5. Some professions ranking above engineers in prestige surveys have relatively lower socioeconomic scores. For instance, chemists 79, clergymen 52, college presidents, professors and instructors 84, natural scientists 80. Accountants and auditors have a socioeconomic index score of 78. A similar pattern is found in the more recent scores by Nam and Powers.(6) Although socioeconomic scores for occupations in the professional complex do not parallel prestige scores (which means that argument on the basis of higher scores for other branches of engineering is unfounded); there are other indications that specialities other than civil engineer might receive a higher rank. In this respect title is extremely important, especially qualifying adjectives. For example, Coutu found it necessary to use the title "electrical engineer" to denote professional engineer, as it was more readily understood as a professional title.(7)

The relative prestige of other industrial occupations, particularly company director, in the two countries is of interest. From the American surveys the prestige of the company director appears to be marginally lower than in Britain; or at least it is not significantly higher. In reaching this conclusion the findings of the Hall-Jones survey must be taken into consideration. They found the following rank order: medical officer, company director, works manager, nonconformist minister, farmer, elementary school teacher, among the ten highest ranking occupations. In the Gerstl and Hutton survey the company director ranks in the block of closely placed professions (albeit at the bottom behind solicitors, university lecturer, research physicist). In the Counts, Nietz and Deeg and Paterson surveys the "auto manufacturer" is defined as "owner of a factory"; whereas the "banker" is defined as "part owner and director of a bank of moderate size". The "factory manager...manages but does not own a garment factory". This latter occupation ranks relatively lower in the surveys of Counts and Nietz than in Hall-Jones (i.e., if factory manager and business manager can be compared): nor is the "auto-manufacturer" placed above the more established professions. Similarly in the NORC findings the two industrial positions of "member of the board of directors of a large corporation" and "owner of a factory that employs about 100 people" do not rank above the main block of established professions. In the latter case the rank is relatively low in both cases. In the former the position of director is located within the block of professional occupations and below some such as "dentist" above which the director ranks in Britain. Moreover, the director in both the 1947 and 1963 samples ranks below positions such as "US. Supreme Ct. Justice", "state governor", "cabinet member in the Federal Government", "U.S.Representative in Congress", "Diplomat in the U.S. Foreign Service", "county judge".(8) These findings are substantiated by Montague and Pustilnik's comparison of ratings in the Hall-Jones and their own study in Spokane. In Spokane the "business executive" ranked fourth; in England the "company director" ranked second; in Spokane the certified public accountant ranked fifth;(9) in England the chartered accountant ranked fourth. Accountancy is an industrial and commercial occupation of lower status in the United States than in Britain, in the survey findings; there are other data that support this inference. But it cannot be inferred that the industrial position of "director" is more prestigious in the United States than in Britain.

For European societies (excluding the Scandinavian) there are few prestige surveys available. However, for the German case there is an unpublished survey conducted by the Institute of Sociology at Kiel University.(10) The findings are reported in Table 4.(11) It is uncertain what precisely is meant by "electrical engineer", or where this occupation would stand in the internal stratification system of the German profession, without further information. It can be seen that this survey indicates that professions within the teaching complex have a particularly high prestige status in Germany. The prestige of teachers in the higher public schools is high and university professors rank above doctors. The relatively low status of military officers is noteworthy in terms of the interrelations of prestige and esteem. It is not possible to draw any conclusions from a comparison of this particular rank order with that of Gerstl and Hutton at this point; these conclusions will follow further evidence.

Surveys in the Commonwealth countries of Australia, New Zealand, and Canada generally indicate that engineers have a higher prestige status than they do in England. Congalton on the basis of a Sydney sample found the rank order presented in Table 5.(12) The engineer ranks just below dentist. Taft's findings indicated the following rank order: doctor, civil engineer, clergyman, school teacher, among the professional occupations included in the survey. This finding conflicts slightly with that of Congalton.(13) There is a far wider range of occupations and positions included in Congalton's survey, and a difference in titles, "civil engineer" rather than "engineer professional", and "clergyman with a university degree" rather than clergyman. But the two surveys, and others conducted by Congalton(14) do suggest that there is not the differentiation between engineers and other professions that is so evident in the British survey. Congalton ahd Havighurst conducted a survey in New Zealand that points to similar conclusions.[15]

There is some evidence that Canadian engineers have a higher rating in prestige surveys than is the case in Britain. Pineo & Porter's 1967 survey was designed to be compared with the NORC studies.[16] The civil engineer ranks well among the other Canadian professions, and about the same (as far as comparisons can be drawn) as in the NORC (1963) survey (see Table 18). The accountant again received a relatively low evaluation.

Engineers in the Scandinavian societies also rank above British engineers. Svalastoga[17] found that "civilingeniør" ranked approximately equal to attorney, teacher, secondary school, below physician, professor and apothecary (i.e., scientific chemist) and above army captain, architect, minister (National Church), superintendent of elementary grade school and considerably above accountant. Accountants ranked below elementary school teacher and librarian. Svalastoga and Carlsson argue that the prestige of occupations is more or less uniform in Scandinavian countries.[18]

For the Soviet Union, Table 7 presents the findings of Rossi and Inkeles.[19] The occupations are ranked on five dimensions none of which are specifically a prestige dimension. The desirability and degree of respect accorded to an occupation are perhaps the nearest approximation to a prestige evaluation, but there are problems in using them as such. Political bias may also have entered into the sample, affecting the evaluations. The position of the doctor is probably higher than a Russian sample would accord, if the survey was conducted within the Soviet Union, and the position of the engineer, factory manager, and most notably, party secretary, may be understated. Rossi and Inkeles observe that the sample "may have been further self-selected to include a disproportionately large number of those hostile to the regime....More than a third of them asserted that they had once favoured the Soviet Regime, more than half gave the fear of political repression as their reason for not returning...".[20] The political orientation of the sample is of some importance. In periods of change such as this sample had experienced the prestige status of occupations is likely to become uncertain and more political in nature than would otherwise be the case. Even without these qualifications, though, the position of the engineer is relatively high, other studies (See Chapter 1) support the view that the engineer has a higher status than a number of such traditional professions as law and medicine. Matthews reports on a 1964 study conducted by V. V. Vodzinskaya into the attitudes of secondary school students towards occupations. The most popular occupations among the students were, research worker in physics, engineer or radio-technician, research worker in medicine, engineer-geologist, research worker in mathematics, research chemist, radio technician, pilot, chemical engineer, research worker in biology, doctor, specialist in literature and arts. These occupations (from a total of 80) are listed in order of desirability.[21] Other studies further support these findings.[22] There is some limited evidence that a similar situation to that in the Soviet Union obtains in certain Eastern European countries. In a survey of Warsaw inhabitants, which employed three rank dimensions, prestige, material rewards, and job security, Serapata and Wesolowski found that the rank order presented in Table 8 resulted.[23] Mechanical engineer ranks above lawyer, minister of the national government, priest and accountant, and below, university professor, doctor and teacher (in that order). The "mechanical" engineer ranked relatively that much lower in terms of "material rewards" and "job security". In the former case "mechanical engineer" ranked 12th, below lawyer, doctor, university professor and priest (in rank order from high to low). In terms of security, defined as the likelihood of having a "stable job in the occupation" the engineer ranked 8th below doctor, university professor, priest and lawyer.

Table 12[24] presents the findings from four surveys conducted in developing societies. The engineer is underscored for oase of comparison. Carter and Sepúlveda's survey among residents of Greater Santiago, Chile, is in some respects designed to be comparable to the NORC studies, fifteen of the sixteen occupations are duplicates and the standard scores are calculated in the same way as in the U.S. inquiry.[25] The civil engineer in Santiago ranks above "industrial executive" (member of the board of directors of a large corporation), lawyer, priest, dentist, armed forces officer, and only below physician and university professor (in rank order from the highest). The authors note, "The rank-difference correlation (corrected for ties) is +.93. The only substantial contribution to the difference is the relatively high rating the Chileans gave to the occupation "civil engineer"." Marsh's survey conducted in Taipei, Taiwan, is also, in certain respects, comparable to the NORC surveys; again the method of scoring was similar.[26] Chemist and civil engineer are equally placed above supervisor in board of education, general manager of a company, middle school teacher, accountant, army captain (in rank order from the highest). The four occupations above civil engineer are university professor, physician, public prosecutor, and factory owner-manager. The findings of Thomas[27] and Tiryakian[28] similarly indicate that the prestige of engineers is high in developing nations. The Indonesian engineer ranks above lawyer, member of the People's Representative Council, head of government department, military officer, director of a private corporation. In the Phillipines engineer ranks above university professor, priest, manager of an industrial company, officer in the armed forces, and intermediate school teacher. In all four surveys the engineer is placed in a high position relative to those professional occupations for which there are both British and American rankings, and also higher than many positions included in the NORC surveys (omitted from the adapted tables presented below), such as legal and governmental officials.

Similar findings are reported for India. Interestingly though, in this study by Bopegamage and Veeraraghavan,[29] physician is found, in some cases, to rank below engineer. For both the rural and urban samples, engineer ranked third, behind industrialist, and "agriculturalist"; the urban sample ranked physician fourth, behind engineer, and the rural sample fifth behind "money lender". Other occupations ranking below engineer are primary school teacher, (no.8) and priest(n.11

These comparisons of the rank of engineers in the Gerstl and Hutton survey, and in surveys conducted in other societies, are beset with methodological problems, and cannot themselves be taken as constituting sufficient evidence. The major problem is the accuracy and meaning of the British survey itself,[30] as all comparisons are based on it. By comparing these findings with those of the specifically comparative surveys, a more accurate statement can be made, as well as an estimation of the validity of the British findings.

Hutchings' study of the attitude of sixth form boys to technology includes a comparative prestige survey, as well as evaluations on a number of other criteria for Britain, France and Germany.[31] Table 11 presents the evaluations of British sixth form students on the three dimensions of pay, intelligence, and prestige, towards a number of professional occupations.[32] Civil engineers and technologists do not rank in the first six occupations on any of the dimensions. Civil engineer and development engineer, ranked, respectively, 7th and 8th for pay, 11th and 18th for prestige, and jointly 10th for intelligence.[33] Other occupations listed include: geologist, scientific civil servant, metallurgist, fuel technologist, zoologist, veterinary surgeon, pharmacist, chartered accountant, and glass technologist.[34] The glass technologist ranked at the bottom of all three lists. The rankings of the different technologies by three groups of students (with doctor included for comparison) is shown in Table 12.[35] The civil engineer ranks higher on the prestige dimension than the development engineer and other technologists, but lower on intelligence than the development engineer. Excluding the pay dimension there is a distinct gap between the percent response on prestige and intelligence.

Comparative data on the three dimensions are presented in Table 13. The evaluations of the West German students parallel those in the German survey cited above and reported on by McCrensky, (where the occupations are listed in both surveys) and except for the relative rank of schoolmaster and scientific civil servant on prestige, and development engineers and schoolmaster on intelligence. In both cases the relative rank is reversed by one place only.

Two factors may account for these differences: the occupation of schoolmaster is one of them and the sample is of schoolboys; in both cases (and this is perhaps the more important) the titles of the occupations differ slightly, "electrical engineer" instead of "development engineer". Of the fist six occupations ranked on the three dimensions, not once does that of engineer or technologist appear for the British sample, whereas it does for the German and French.

The low prestige of British engineers and technologists can be inferred from Table 12, column headed "total sample rank of career", which gives the rank of the various technologists (apart from the discrepancies noted). These ranks are low. Even the highest on the prestige dimension of rank 11 (or 10) for civil engineers means that a number of other occupations ranked above this one. It is implied by Hutchings that if all the data were presented (this not being necessary on the strength of the given evidence and also in the context of the problem of the study) the German engineers and technologists (and the French) would rank higher. That can be inferred from Table 14, which shows career choice on a comparative basis; the West German sample has a marked preference for the engineering function of design. Given the relationship between this pattern of choices and the prestige evaluations, it is reasonable to presume that German students rank engineers on the prestige dimension higher than do the British students. This is implied by Hutchings, but the precise figures for the rankings of all occupations by the three samples are not available, at this time. The findings also indicate that French engineers tend to have a higher status than German engineers; the responses on the dimensions of prestige and intelligence for the three samples indicate that the same goup of occupations are ranked in the first six places; this tends to suggest that evaluations of intelligence and evaluations of prestige are closely correlated. There is much other survey evidence to support this view, but Hutchings' findings may well have been influenced by the fact of the three dimensions. However, another possibility is that evaluations of intelligence reflect normative rather than cognitive judgements, or that there is a stronger element of this in them (the former). Certainly the question on prestige asked for a cognitive judgement, and the question on intelligence for a normative or truly evaluative one (see below); from Table 12 it can be seen that there is not the agreement over relative intelligence levels tha there is on prestige.

Four remaining comparative studies all compare various occupations with those in the United States. Tuckman compared Deeg and Paterson's findings with a sample drawn from Montreal, yeilding the rank order in Table 15.[36] Among the professional occupations the largest upward change in the rank order was for civil engineers. The Canadian sample ranks civil engineer behind doctor and lawyer and above banker and superintendent of schools, foreign missionary, army captain and elementary school teacher, whereas in the Minneapolis sample civil engineer ranks below banker and superintendent of schools as well as below doctor and lawyer. This change in rank order did not occur in the three strictly comparable U.S. samples (see Count's, Neitz, and Deeg and Paterson). Tuckman employed the same questionnaire and methods used in these other surveys; the only major change between the series is the steadily decreasing number of occupations selected from Counts' original list of 45. Counts himself noted the problem experienced by respondents with long lists; and it was not necessary to include so many in the other surveys (which concern relative changes in the status of occupations with a focus on teachers). Tuckman duplicates Deeg and Paterson's occupations.

A study conducted in Christchurch, New Zealand, for the purpose of comparison with a U.S. study indicates that the prestige of the civil engineer in New Zealand is marginally higher than in the United States.[37] The difference in rank order is so slight and the number of professional occupations so small that this evidence is of a negative sort: its import lies in the absence of a drop in the prestige of the civil engineer.

Simenson and Geis compared the response of two samples of men students and found the rank order presented in Table 16.[38] The great upward change in the rank order is for civil engineer. The Norwegian sample ranked the civil engineer third behind college professor, and banker, and above prosperous businessman, priest, or minister, teacher, artist and politician. The American students' rankings are generally in accord with those of other studies except for the relatively low status of civil engineer in relation to "teacher". McDonagh, Wermlund and Crowther compared the rankings of Swedish and American students on a number of dimensions, three of these rank orders are presented in Table 17.(39) On the prestige dimension Swedish students ranked civil engineer marginally higher than the Americans did; above rather than below dentists. On the dimension of "relative usefulness to society" the Swedish students ranked civil engineer second behind medical doctor whereas the American students ranked civil engineer sixth behind doctor, university professor, grade school teacher, minister, and dentist. On the scale of "relative intellectual ability" the Swedish student ranked engineer third rather than fourth; above instead of below lawyer.

Conclusions:

In drawing provisional conclusions on the basis of the survey materials presented, the hazards of comparison must be re-emphasized. Small shifts in rank are practically meaningless where the inquiries utilize different methods. Indeed the hazards are such that if the British engineer did not have a very low prestige status it would not be expected to find what is so evident: in no other society for which comparable occupations are listed does the engineer not rank above at least one of the occupations that the engineer ranks below in Britain. In some cases (particularly where more comparable occupations are included in the survey) the position is even clearer: the engineer ranks above a number of occupations for which there are British rankings. The two British surveys show a precise rank correspondence between the occupations listed in both. Moreover, use of the term "professional engineer" may have led to an over-evaluation of its position. Even so, it ranks at the bottom of those occupations commonly regarded as professions, rather than semi-professions. This is not the case in the other surveys.

Footnotes to Appendix A

1. For a review of the literature see, N.D.Richards, "An Empirical Study of the Prestige of Occupations", University of Nottingham, unpublished M.A.thesis, May 1962.

2. J.E.Gerstl and S.P.Hutton, Engineers: The Anatomy of a Profession, London, Tavistock Publications, 1966, pp.114-116; cf. J.E.Gerstl and Louis K. Cohen, "Dissensus situs and egocentrism in occupational ranking", British Journal of Sociology, Vol.15 (1964) pp.254-61.

3. The sources of Table 2 are as follows: George S. Counts, "The Social Status of Occupations: A Problem in Vocational Guidance", School Review, Vol.133 (January 1925) No.1, pp.16-27, (the rank order presented in table 2 is adapted from Table 1, pp.20-21); George W. Hartmann, "The Prestige of Occupations: A Comparison of Educational Occupations and others", Personnel Journal, Vol.13 (June 1934 to April 1935) pp.144-152 (the rank order is adapted from Table 2, p.148); John A. Nietz, "The Depression and the Social Status of Occupations", Elementary School Journal, Vol.XXV (Febuary 1935) No.6, pp.454-461.(the rank order and prestige scores are adapted and calculated from Table 2, p.457). The NORC rank order and prestige scores are adapted and calculated from table 1 pp.324-5 in Robert W. Hodge, Paul M. Siegal, and Peter H.Rossi, "Occupational Prestige in the United States:1925-1963", in Reinhard Bendix and Seymour Martin Lipset, Class Status and Power, London, Routledge and Kegan Paul Ltd., second edition, 1966, pp.332-334. The Deeg and Paterson survey is not available at present (i.e., Deeg and D.G.Paterson, "Changes in Social Status of Occupations", Occupations, Vol. XXV (1947) pp.205-8), but it is reported in detail in Jacob Tuckman, "Social Status of Occupations in Canada", Canadian Journal of Psychology, Vol.1 (June 1947) No.2, pp.71-74. The rank order is adapted from table 1, p.73 in Tuckman.

4. For a discussion of the merits of the prestige scores over the standard scores as a measure of prestige, see Otis Dudley Duncan, "A Socioeconomic Index for all Occupations", in Albert J. Reiss jr., et.al., Occupations and Social Status, New York, The Free Press of Glencoe Inc., 1961, pp.117-118, Hodge et.al., op.cit., p.323.

5. Duncan, op.cit., Appendix B, Table B-1, p.263.

6. Charles B. Nam and Mary G. Powers, "Changes in the Relative Status Level of Workers in the United States, 1950-1960", in Social Forces, Vol.47 (December 1968) No.2, pp.158-170.

7. Walter Coutu, "The Relative Prestige of Twenty Professions as Judged by Three Groups of Professional Students", Social Forces, Vol.XIX (May 1936) No.4 pp.522-529.

8. Cf. Hodge, et. al., op.cit., p.324.

9. Cf. Joel B. Montague and Bernard Putilnik, "Prestige Ratings of Occupations in an American City with Reference to Halls and Jones' Study", British Journal of Sociology, Vol. 5 (June 1954) No.2 pp.154-160.

10. The survey is reported in Edward McCrensky, Scientific Manpower in Europe, New York, Pergamon Press, 1958, p.35, this study in the original is unavailable at present.

11. Table 4 is adapted from McCrensky, op.cit. The orignal survey includes

34 occupations (all of which are listed by McCrensky).

12. A.A.Congalton, Status and Prestige in Australia, Adelaide, 1969, table 5 is adpated from the rankings presented on pp.56-7.

13. Ronald Taft, "The Social Grading of Occupations in Australia", British Journal of Sociology, Vol.1V (1953).

14. Cf. Congalton, A.A., Occupational Status in Australia, Sydney, 1963; and A.A. Congalton, Social Standing of Occupations in Sydney, Sydney, 1962.

15. A.A.Congalton and R.J.Havighurst, "Status Rankings of Occupations in New Zealand", Australian Journal of Psychology, Vol.6 no.1, pp.10-15.

16. Peter C. Pineo and John Porter, "Occupational Prestige in Canada", Canadian Review of Sociology and Anthropology, Vol.4 (Febuary 1967) pp.24-40.

17. Kaare Svalastoga, Prestige Class and Mobility, Copenhagen, 1959, Table 2.5 "The Danish Occupational Hierarchy 1953-54".

18. K. Svalastoga and C. Carlsson, "Scandinavia" in M. Scotford Archer and S. Giner, Contemporary Europe, Class Status and Power, London, Weidenfeld and Nicolson, 1971.

19. Peter H. Rossi and Alex Inkeles, "Multidimensional Ratings of Occupations", Sociometry, Vol.20 (1957) pp.234-251, table 7 is reproduced from Table 1 p.238.

20. Rossi and Inkeles, op.cit., pp.236-7.

21. Mervyn Matthews, Class and Society in Soviet Russia, Allen Lane, The Penguin Press, 1972, pp.121-122.

22. Ibid.

23. A. Sarapata and W. Wesolowski, "The Evaluations of Occupations by Warsaw Inhabitants", American Journal of Sociology, Vol.66 (1960-1961) pp.581-591, table 8 is adapted from Table 7 p.585.

24. Table 10 is adapted from Tables presented in the following: Robert M. Marsh, "Evolution and Revolution: Two Types of Change in China's System of Social Stratification", in Leonard Plotnicov and Arthur Tuden eds., Essays in Comparative Social Stratification, Pittsburgh, University of Pittsburge Press, 1970, pp.149-172, Table 1, p.156; Roy E. Carter and Orlando Sepulveda, "Occupational Prestige in Santiago de Chile", The American Behavioural Scientist, Vol. 7 (September 1964) pp.20-24, Table 1, p.21; Edward A. Tiryakian, "The Prestige of Occupations in an Underdeveloped Country: The Phillipines", American Journal of Sociology, Vol. LX111 (January 1958) No.4, pp.390-399, Table 3, p.394; R. Murray Thomas, "Reinspecting a Structural Position on Occupational Prestige", American Journal Sociology, Vol.67 (March 1962) pp.561-565, Table 3, p.564.

25. Carter and Sepulveda, op.cit. Some corrections have been made for typographical errors in the presentation of the data in Table 1 (Carter and Sepulveda) op.cit., in adapting them for table 10.

26. Marsh, op.cit.

27. Thomas, op.cit.

28. Tiryakian, op.cit.

29. A. Bopegamage and P.V.Veeraraghavan, Status Images Changing India, UNESCO Research Centre, Dehli, Bombay, Manaktalas, 1967, pp.160-161.

30. Perhaps the main reason for concluding on the essential accuracy of the Gerstl and Hutton findings is the correspondence of relative rank of professions included in all the available U.K. surveys (Hall-Jones, Richards, Gerstl and Hutton, and Hutchings). Further support is provided by the response of Anglican ordinands to the question of how difficult they thought the training for a range of occupations was. The rank order computed gave: doctor, lawyer, clergyman, dentist, accountant, engineer, social worker, armed forces officer, and librarian, or the rank order found in the prestige surveys. Anthony P.M. Coxon, "A Sociological Study of the Social Recruitment, Selection, and Professional Socialization of Anglican Ordinands", University of Leeds, Ph.D. Thesis, 1965, pp.269-270.

31. D. Hutchings, Technology and the Sixth Form Boy, Oxford University, Department of Education, 1963.

32. Ibid., p.35.

33. Ibid.

34. Ibid., Appendix Bii, p.50. The relative position of other occupations is not presented by Hutchings (1963).

35. Ibid., p.37, Table 20.

36. Jacob Tuckman, "Social Status of Occupations in Canada", Canadian Journal of Psychology, Vol. 1 (June 1947) No.2, pp.71-74. Table 15 is adapted from Tuckman Table 1 p.73.

37. Cora Vellekoop, "The Meaning of Occupational Prestige and the Semantic Differential", The Australian and New Zealand Journal of Sociology, Vol.2 (April 1966) No.1, pp.45-49.

38. William Simenson and Gilbert Geis, "A Cross-Cultural Study of University Students", The Journal of Higher Education, Vol. XXVI (January 1955) No.1, pp.21-24, table 16 is based on the findings presented on p.23.

39. Edward C. McDonagh, Sven Wermlund, and John F. Crowther, "Relative Professional Status as perceived by American and Swedish University Students", Social Forces, Vol.38 (1959-1960) p.65.

Table 1

RANKINGS OF OCCUPATIONS BY NATIONAL SAMPLE

Occupation	Median Rank
1. Doctor	2.21
2. Solicitor	4.25
3. Univ. Lecturer	4.36
4. Research Physicist	4.62
5. Company Director	4.65
6. Dentist	5.96
7. Chartered Accountant	6.45
8. Professional Engineer	7.07
9. Primary School Teacher	7.67
10. Works Manager	8.27

N. = 1063

Source: Gerstl and Hutton (1966).

Table 2

Rank	Counts (1925) N=450	Hartman (1935) N=92	Nietz (1935) N=1,622	Deeg & Paterson (1947) N=475	NORC (1947) N=2,920	Score	NORC (1963) N=651	Score
1.	Banker	Doctor	Banker	Physician	Physician	97	Physician	96
2.	College prof.	Senator	College prof.	Banker	College prof.	93	Scientist	95
3.	Physician	Lawyer	Physician	Lawyer	Gov.Scientist	92	Gov.Scientist	94
4.	Clergyman	College prof.	Clergyman	Superintendent of Schools	Banker	92	College prof.	94
5.	Lawyer	Civil Engineer	Lawyer	Civil Engineer	Scientist	91	Dentist	94
6.	Auto manufact.r.	Dentist	Super.of Sch.	Army Captain	Chemist	90	Nucl. physicist	93
7.	Super.of Sch.	Clergy	Civil Engineer	Foreign Missionary	Dentist	90	Member of the Board of Directors of a large Corporation	93
8.	Civil Engineer	High-Sch.teach.	Army Captain	Elemen.sch.teach.	Architect	90	Civil Engineer	92
9.	Army Captain	Factory supertnd.	High Sch.teach.	Machinist	Lawyer	89	Architect	92
10.	High.sch.teach.	Merchant	Foreign mission.	Insurance Agent	Member of the board	89	Chemist	92
11.	Foreign mission.	Grade Teacher	Elem.sch.teach.	Electrician	Civil Engineer	88	Lawyer	91
12.	Factory Manager	Salesman	Factory Manager	Farmer	Phsychologist	87	Phsychologist	90
13.	Elem.sch.teach.	Nurse	Machinist	Grocer	Minister	87	Banker	90
14.	Dry goods merchnt.	Actor	Electrician		Nucl.Physicist	87	Biologist	88
15.	Man of leisure	Mail Carrier	Dry goods merchnt.		Priest	84	Minister	86
16.	Farmer		Bookeeper		Accountant for a large business	82	Priest	85
17.	Machinist		Locomotive enginr.		Owner of a factory that employs about 100 people	81	Instructor in Public Schools	83
18.	Travelling salesm.		Grocer		Biologist	80	Captain in the regular army	83
19.					Captain in reg.arm.	77	Accountant for...	82
20.					Inst.publ.sch.	73	Publ.sch.teach.	77
21.					Publ.sch.teach.	71	Owner/empl. 100.	77

Notes: Nietz used only fourty of the fourty-five occupations listed in Counts' questionnaire; Deeg and Paterson further reduced the number to twenty-five. For details of these three surveys see Appendix a,p.
The NORC scores are the "prestige scores", rather than standard scores. (see Appendix A. for rank order based on standard scores).
Sources: see footnote number (28).
For further details of the methodology employed in each survey see Appendix A.

Table 4

RANK ORDER OF OCCUPATIONS IN GERMANY

Rank	Title
1.	Professor
2.	M.D. Doctor of Medicine
3.	Industrial director
4.	Regierungsrat (Higher civil service)
5.	Teachers in higher public schools
6.	Electrical Engineers
7.	Owner of a large estate
8.	Pastor
9.	Teacher in a lower school
10.	Technicians
11.	Military Officer
12.	Auto-mechanic, owner of his own shop
13.	Opera singer
14.	Banking employment
15.	Clothing store owner

Source: McCrensky (1958)

Table 5

STATUS RANKINGS OF OCCUPATIONS IN AUSTRALIA

Occupation	Medians
1. Doctor	1.61
2. University Professor	1.62
3. Solicitor	1.87
4. Director, large financial or industrial enterprise	1.90
5. Architect	1.92
6. Owner Business, valued at more than 1,000,000 (dollars)	1.99
7. Clergyman, with university degreee	2.09
8. Dentist	2.11
9. Engineer, Professional	2.22
10. University lecturer	2.28
11. Veterinary Surgeon	2.36
12. Manager, large financial or industrial enterprise	2.50
13. School Principal	2.54
14. Owner Business, valued at 30,000-100,000 (dollars)	
15. Registered Public Accountant	2.62
16.	
39. Social Worker	3.98
40. Owner Business valued at 3,000-15,000 (dollars)	4.07

Source: Congalton (1969)

Table 6

POPULARITY OF OCCUPATIONS FOR EMPLOYMENT FOR SONS OF SUFFICIENT ABILITY

Metropolitan Area	Engineer	Physician
Copenhagen	29	18
Oslo	17	30
Stockholm	11	19
Finland (National Sample)	15	21

(In all four samples these were the most frequently cited occupations).

Table 7

RATINGS OF SOVIET OCCUPATIONS ACCORDING TO THEIR GENERAL DESIRABILITY, MATERIAL POSITION, PERSONAL SATISFACTION, SAFETY AND POPULAR REGARD.

Occupation	Rating				
	General Desirability	Material Position	Personal Satisfaction.	Safety	Popular Regard
Doctor	75	59	59	57	76
Scientific worker	73	64	57	37	70
Engineer	73	62	54	26	68
Factory Manager	65	84	61	22	48
Foreman	65	52	48	44	60
Accountant	62	53	48	45	54
Officer in armed force	58	70	53	35	53
Teacher	55	42	41	46	66
Rank & File Worker	48	23	28	65	63
Farm Brigade Leader	46	46	39	45	41
Party Secretary	41	86	62	41	17
Collective Farm Chairman	38	67	43	35	30
Rank & File Collective farmer	18	8	9	57	57

Source: Rossi and Inkeles (1957)
Notes: Safety; a high score on this dimension means that the occupation was regarded as being safe from the dangers of arrest.

Table 8

RANKS, AND SCORES FOR OCCUPATIONS IN RELATION TO SOCIAL PRESTIGE IN WARSAW

Rank	Occupation	Score
1.	University professor	1.22
2.	Doctor	1.44
3.	Teacher	1.721
4.	Mechanical Engineer	1.78
5.	Airplane pilot	1.83
6.	Lawyer, attorney	1.97
7.	Agronomist	1.97
8.	Minister of the national Government.	2.07
9.	Journalist	2.13
11.	Priest	2.35
13.	Machinest	2.51
16.	Accountant	2.54

Source: Sarapata and Wesolowski (1960-61)
Notes: see Appendix A. for the method of scoring.

Table 9

OCCUPATIONS CHOSEN FOR SONS AMONG WARSAW INHABITANTS

Occupation	No.Responding	Percent
Engineer	285	37.8
Doctor	152	20.2
University professor	35	4.6
Journalist	20	6.7
Lawyer, attorney	20	2.7
Actor, musbian, sculptor	22	2.9
Diplomat, politician	16	2.1

Source: Sarapata and Wesolowski (1960-61)

Table 10

THE PRESTIGE OF OCCUPATIONS IN FOUR DEVELOPING NATIONS

CHILE (1) Rank	Occupation	Score	INDONESIA (2) Rank	Occupation	PHILLIPINES (3) Rank	Occupation	TAIWAN (4) Rank	Occupation	Score
1.5	Physician	90	1.	Physician	1.	Physician	1.	University professor	88
1.5	Minister of State	90	2.	University professor	2.	Congressman	2.	Physician	87
3.	University professor	89	3.	Engineer (chemical, civil architect)	3.	Lawyer	3.	Public prosecutor	85
4.	Civil Engineer	88	4.	Lawyer	4.	Engineer	4.	Factory owner-manager	80
5.	Industrial Executive	84	5.	Member: People's Representative Council	5.	University professor	5.5	Chemist	77
6.	Lawyer	83	6.	Head of government department	6.	Priest	6.5	Civil Engineer	77
7.5	Priest	81	7.	Military officer	7.	Manager of industrial company	7.	Supervisor of board of education	74
7.5	Dentist	81	8.	Director of private corporation	8.	Officer in the armed forces	8.	General manager of a company	72
9.	Armed forces officer	80	9.	Airline pilot, ship officer	9.	Intermediate school teacher	9.	Executive secretary of a company	71
10.	Land owner	79	10.	High-school teacher	10.	Professional artist	10.	Building contractor	70
11.	High-school teacher	78	11.	Newspaper reporter	11.	Farmer	11.	Shop owner (large scale)	69
12.	Newspaper reporter	75	12.	Artist, pianist,author	12.	Midwife	12.	Newspaper reporter	67
13.	Elementary teacher	71	13.	Farm owner-operator	13.	Office clerk	13.	Middle school teacher	66
			14.	Small businessman	14.	Policeman	14.	Accountant	61
							15.	Army captain	60
							16.	Political party worker	58
							17.	Clerk	55
							18.	Owner-cultivator	54

Sources: 1, Carter and Sepulveda (1964); 2, Thomas (1962); 3, Tiryakian (1958); 4, Marsh (1970).
Notes: for details of the methods used and samples see Appendix A,p.

Table 11

CAREERS LISTED ACCORDING TO THE NUMBER OF TIMES CHOSEN AS BEING "HIGHEST" FOR PAY, PRESTIGE AND INTELLIGENCE

PAY	PRESTIGE	INTELLIGENCE
1. Doctor	1. Doctor	1. University lecturer
2. Solicitor	2. Solicitor	2. Doctor
3. Dentist	3. Univ.lect.	3. Nucl.physicist
4. Accountant	4. Architect	4. Solicitor
5. Architect	5. Schoolmaster	5. Schoolmaster
6. Nucl.physicist	6. Nucl.Physicist	6. Statistician

Source: Hutchings (1963).

Table 12.

THE RANKING OF TECHNOLOGIES BY DIFFERENT TYPES OF STUDENT WITH DOCTOR USED FOR COMPARISON

Occupation	Engineer-ing %	Pure Science %	Medicine %	Total sample Rank of career
		PAY		
Doctor	58	53	73	1
Civil Engineer	44	34	26	7
Development engineer	31	26	21	8
Fuel technologist	29	25	22	10
Metallurgist	19	21	13	11
Glass technologist	6	5	5	17
		PRESTIGE		
Doctor	83	81	93	1
Civil engineer	19	15	12	100
Development engineer	9	6	4	18
Fuel technologist	3	5	2	12
Metallurgist	6	5	2	16
Glass technologist	1	1	1	19
		INTELLIGENCE		
Doctor	61	66	77	2
Civil engineer	25	19	12	11
Development engineer	33	27	23	9
Fuel technologist	20	18	14	10
Metallurgist	16	20	17	13
Glass technologist	4	5	6	19

Source: Hutchings (1963)
Note: In the text it is stated that civil engineer and development engineer ranked 11th and 18th on prestige, and jointly 10th for intelligence; whereas from Table 12 it can be seen that civil engineer ranks 10th on prestige and 11th on intelligence. This discrepency is taken from Hutchings (1963) verbatim as there is no means of telling which is correct from the information presented. The % in Table 12 represents the number of times each occupation was ranked within the first six (of all occupations for the respective samples): the number of times being recorded as a%.

Table 13

CAREERS LISTED ACCORDING TO THE NUMBER OF TIMES CHOSEN ON BEING "HIGHEST" FOR PAY, PRESTIGE, AND INTELLIGENCE: FIRST SIX OCCUPATIONS CHOSEN

ENGLAND & WALES	PAY FRANCE	W.GERMANY
Doctor	Doctor	Nucl.Physicist
Solicitor	Dentist	Architect
Dentist	Fuel Technologist	Solicitor
Accountant	Pharmacist	Doctor
Architect	Engineer	Engineer
Nuclear Physicist	Architect	Univ.Lecturer
	PRESTIGE	
Doctor	University Lecturer	Univ.Lecturer
Solicitor	Nuclear Physicist	Nucl.Physicist
University Lecturer	Solicitor	Doctor
Architect	Doctor	Solicitor
Schoolmaster	Engineer	Schoolmaster
Nuclear Physicist	Civil Engineer	Scientific civil servant
	INTELLIGENCE	
University Lecturer	Nuclear Physicist	Nucl.Physicist
Doctor	University Lecturer	Univ.Lecturer
Nuclear Physicist	Schoolmaster	Solicitor
Solicitor	Engineer	Doctor
Schoolmaster	Solicitor	Development engineer
Statistician	Civil Engineer	Schoolmaster

Source: Hutchings (1963)

Table 14

BOYS FIRST CHOICE OF SCIENTIFIC CAREER IN ENGLAND AND WALES, FRANCE, AND WEST GERMANY

England and Wales	%	France	%	West Germany	%
Research	35	Research	27	Research	18.5
Medicine	12	Design	14	Design	18
Development	10	Teaching or Lecturing	12.5	Works Manag.	10.5
Design	9	Testing & Insp.	11	Medicine	10
Works Manager	7	Works Man	10.5	Development	10
Testing & Inspection	7	Medicine	5	Teaching or Lecturing	10
Teaching or Lecturing	6	Other	7	Testing Inspection	7.5
Tech.Sales	1	No.Ans.	13	Tech.Sales	5
Other	5			Other	5.5
No.Ans.	8			No.Ans.	5
	100		100		100

Source: Hutchings (1963)

Table 15

COMPARISON OF RANK ORDER IN SOCIAL STATUS FOR TWENTY-FIVE OCCUPATIONS IN MINNEAPOLIS AND IN MONTREAL

Occupation	Minneapolis N=475	Montreal N=410
Physician	1	1
Banker	2.5	4
Lawyer	2.5	2
Superintendent of Schools	4	5
Civil engineer	5	3
Army captain	6	7
Foreign missionary	7	6
Elem. school teacher	8	8

Source: Tuckman (1947)

Table 16

COMPARISON OF RANK ORDER IN SOCIAL PRESTIGE FOR EVALUATIONS OF AMERICAN AND NORWEGIAN MALE STUDENTS

Occupation	American	Norwegian
College professor	1	1
Banker	2	2
Prosperous businessman	3	4
Priest or minister	4	5
Teacher	5	8
Civil engineer	6	3
Artist	7	7
Politician	8	6
College student	9	9.5
Small storekeeper	10	11
Farmer	11	9.5
Soldier	12	14
Policeman	13	12
Factory worker	14	13

Source: Simenson and Geis (1955)

Table 17

EVALUATICN OF AMERICAN AND SWEDISH STUDENTS OF EIGHT PROFESSIONS ON THE BASIS OF PRESTIGE, USEFULNESS AND INTELLIGENCE

PRESTIGE	Order of Means	
Occupation	U.S.	Swedish
Business Executive	3	4
Civil Engineer	7	6
Dentist	6	7
Elemenrary School Teacher	8	8
Lawyer	2	5
Minister	5	3
Physician	1	2
University Professor	4	1
"RELATIVE USEFULNESS TO SOCIETY"		
Medical Doctor	1	1
University Professor	2	3
Grade School Teacher	3	4
Minister	4	7
Dentist	5	6
Civil Engineer	6	2
Lawyer	7	8
Business Executive	8	5
"RELATIVE INTELLECTUAL ABILITY"		
University Professor	1	1
Medical doctor	2	2
Lawyer	3	4
Civil Engineer	4	3
Dentist	5	7
Minister	6	5
Business Executive	7	6
Grade School Teacher	8	8

Source: McDonagh, Wermlund and Crowther (1959-60)

Table 18

RANK OF PROFESSIONS BY NATIONAL

Occupational title	Score
Accountant	63.4
Architect	78.1
Biologist	72.6
Catholic Priest	72.8
Chemist	73.5
Civil Engineer	73.1.
County Court Judge	82.5
Druggist	69.3
Economist	62.2
High School Teacher	66.1
Lawyer	82.3
Mathematician	72.7
Mine Safety Analyst	57.1
Mining Engineer	68.8
Physician	87.2
Physicist	77.6
Protestant Minister	67.8
Phsycholcgist	74.9
Public Grade School Teacher	58.6
University Professor	84.6
Veterinarian	66.7

Source: Pineo and Porter (19 7), adapted from Appendix 1.

Appendix B

Membership of the Engineering Institutions and the Engineer in the Census

TABLE 1.

Institution of Civil Engineers: Membership by Grade of Membership for census dates.

	Hon. Memb.	Ord. Memb.	Assoc. Memb	Grad.	Totals.
1841	35	181	241	68	525
1851	33	247	406	30	716
1861	22	369	542	12	945
1871	14	724	1,048	0	1,786

	Hon. Memb.	Memb.	Assoc. Memb.	Assoc.	Totals.
1881	18	1,209	1,287	568	3,082
1891	20	1,743	2,965	422	5,150
1901	19	2,067	3,990	300	6,376

	Hon. Memb.	Memb.	Assoc. Memb.	Assoc.	Stud.	Totals.
1911	17	2,330	4,862	243	1,682	9,134
1921	19	2,312	5,805	144	718	9,918
1931	19	2,294	6,585	69	1,642	10,609
1941	16	2,237	7,819	49	3,077	13,198
1951	16	2,373	9,416	36	5,997	17,838

	Hon. Memb.	Memb.	Assoc. Memb.	Assoc.	Grad.	Stud.	Totals.
1961	20	2,988	13,679	41	3,932	4,546	25,206.

	Hon. Memb.	Fellows	Memb.	Companion	Assoc. Memb.	Stud.	Totals.
1971	18	4,598	22,579	56	9,169	7,114	43,534.

Source: Reports of the Council.

TABLE 2.

The Institution of Mechanical Engineers: Membership by Grade of Membership.

Date	Hon. Memb.	Memb.	Assoc. Memb.	Assoc.	Grad.	Total.
1847	4	103				107
1851	15	184			4	203
1861	18	443			3	464
1871	4	819		31	21	875
1881	n.a.	1,170		29	80	1,276
1891	n.a.	1,825		75	160	2,077
1901	n.a.	n.a.		n.a.	n.a.	3,491
1911	7	2,550	2,533	56	682	5,828
1921	12	3,079	4,103	78	722	7,994

Date	Hon. Memb.	Memb.	Assoc. Memb.	Comp.	Assoc.	Grad.	Stud.	Total.
1931	19	3,144	5,064	39	168	1,366	1,351	11,161
1941	28	3,011	7,581	18	261	2,595	1,341	14,934
1951	34	4,761	15,068	32	956	12,082	4,698	37,649
1961	29	4,909	26,646	34	686	17,187	6,169	55,660

Date	Hon. Fell.	Fell.	Memb.	Comp.	Assoc.	Grad.	Stud.	Total.
1971	30	6,336	41,512	35	1,725	19,921	3,903	73,462

Notes: Membership figures by grade for 1881 through 1900 have been inferred from the accounts of the institution and are only approximate. The totals are from annual reports. Figures are for the date nearest to the first month of the census year.

TABLE 3

The Institution of Electrical Engineers.

Date	Hon. Memb.	For. Memb.	Memb.	Assoc.	Stud.	Totals.
1871(1)						110
1881						981
1891	3	172	468	1,027	89	1,759

Date	Hon. Memb.	Memb.	Assoc. Memb.	Assoc.	Stud.	For. Memb.	Totals.
1901	4	832	774	1,712	521	175	4,018
1911	n.a.						

Date	Hon. Memb.	Memb.	Assoc. Memb.	Assoc.	Grad.	Stud.	Totals.
1915	8	1,533	3,539	581	374	909	6,944

Date	Hon. Memb.	Memb.	Assoc. Memb.	Grad.	Stud.	Assoc.	Totals.
1921	10	1,732	4,610	843	2,037	422	9,654

Date	Hon. Memb.	Memb.	Assoc. Memb.	Comp.	Assoc.	Grad.	Stud.	Totals.
1931	13	1973	5,527	119	1,653	1,794	3,032	14,103
1941	10	2108	7,400	101	1,356	4,720	3,400	19,088 (c)
1951	10	3380	13,944	86	2,691	9,382	7,536	37,029
1961	19	4288	20,191	76	2,587	14,508	4,824	46,481

Date	Hon. Fell.	Fellow	Memb.	Hon. F.	Comp.	Assoc. Memb.	Assoc.	Stud.	Totals.
1971	7	5,511	25,130	5	85	24,702	2,161	5,945	63,546.

NOTES: Figures are in all cases the most accurate available and taken from the <u>List of Members.</u>

TABLE 4.

The Institution of Automobile Engineers: Growth of an Interwar Speciality Grouping.

Date	Hon. Memb.	Memb.	AssocM.	Post G.	Grad.	Stud.	Assoc.	Total.
1906	n.a.							n.a.
1810	n.a.							n.a.
1911	n.a.	236	173	-	184	-	30	623.
1916	2	319	379	-	224	-	48	972.
1921	3	494	713	-	382	-	79	1,671.
1922	3	515	767	-	489	-	83	1,877.
1926	4	509	819	-	700	-	78	2,124.
1931	4	559	1,028	25	698	51	72	2,478.

Date	Hon. Memb.	Memb.	Assoc.M.	Assoc.	Post G.	Grad.	Stud	Total.
1936	5	663	1,181	57	42	647	55	2,893.
1941	5	786	1,493	46	70	706	80	3,394.
1946	3	980	1,669	38	139	760	173	3,762.
1945	4	963	1,690	43	137	804	185	4,210.

Notes: Source, Annual Reports, Membership is for December 31st of the year recorded. The decline in total membership between 1945 and 1946 is partly due to 382 affiliated firms being transferred to the Motor Industry Research Association. The four categories of membership for corporate bodies are not presented.

TABLE 5

Internal Stratification of selected Engineering Institutions (Major Grades) and Numbers in each (1969).

Institution and Grades	Membership.
Institute of Marine Engineers:	
Members	6,385
Associate Members	5,968
Associates	1,583
Graduates	1,086
Students	2,877
Total:	17,941
Institute of Road Transport Engineers:	
Ordinary Members	781
Associate Members	1,154
Associates	1,611
Graduates	373
Students	245
Total:	4,244
Institution of Chemical Engineers:	
Members	89
Associate Members	3,059
Graduates	3,331
Students	2,110
Total:	9,401
Institution of Civil Engineers:	
Fellows	4,340
Members	20,291
Associate Members	7,795
Students	7,570
Total:	40,067
Institution of Electrical Engineers:	
Fellows	5,249
Members	24,116
Associate Members	22,754
Students	6,416
Total:	60,452
Institution of Electronic and Radio Engineers:	
Fellows	591
Members	4,023
Associates	793
Graduates	4,967
Students	2,660
Total:	13,071

TABLE 5
(Cont.)

Institution of Gas Engineers:	
Fellows	1,255
Members	2,022
Associates	1,005
Associte Members	163
Students	255
Total:	4,780
Institution of Heating and Ventilating Engineers:	
Fellows	799
Members	2,133
Companions	59
Graduates	1,301
Students	437
Total:	2,071
Institution of Mechanical Engineers:	
Fellows	5,697
Members	30,673
Associates	1,052
Graduates	21,199
Students	5,056
Total:	69,743
Institution of Mining Engineers:	
Fellows	1,399
Members	2,365
Associate Members	0
Associates	480
Students	127
Total:	4,414
Institution of Mining and Metallurgy:	
Members	868
Associate Members	1,633
Affilistes	204
Students	871
Total:	3,619
Institution of Municipal Engineers:	
Fellows	1,744
Members	5,070
Students	2,674
Total:	9,506
Institution of Production Engineers:	
Fellows	2,062
Members	8,627
Licentiates	3,882
Students	1,560
Total:	16,516

TABLE 5
(Cont.)

Institution of Structural Engineers:

Fellows	1,847
Members	6,378
Associates	79
Associate Members	3,829
Students	1,401
Total:	13,542

Royal Aeronautical Society:

Fellows	937
Associate Fellows	6,165
Associates	2,151
Graduates	1,326
Students	735
Total:	11,712

Royal Institution of Naval Architects:

Members	1,488
Associate Members	2,459
Associates	678
Students	404
Total:	5,029

Source: Memoranda submitted to Monopolies Commission, 1969.

TABLE 6

Professional Engineers in the Census.

Date	Total	Civil	Mining	Mech.	Elect.	Chemic.	Others.
1841	853						
1851	3,009						
1861	3,329						
1871	5,234						
1881	9,415	7,124	2,291				
1891	9,605						
1901	11,052						
1911	7,208[1]						
1921	20,880	17,429[2]	1,476	1,975[4]			
1931	35,585	21,821[2]	2,620	11,144			
1941							
1951	78,711	22,549[3]	3,757	24,905	19,938	5,313[5]	2,249[6]
1961	210,300	32,440[3]		48,030	41,080		86,157
1971[9]	318,900	52,800[3]		95,800	39,400		131,400[8]

Notes: (1) Articled pupils, articled clerks and other professional students were excluded for the first time.

(2) Include Surveyors.

(3) Include Structural and Municipal.

(4) Include Electrical.

(5) Include Gas.

(6) Ship designers, ship surveyors and naval architects.

(7) Technologists N.E.C.

(8) Includes electronic, work study, progress engineers, planning producti[on] engineers, engineers N.E.C. and technologists N.E.C.

(9) 1% sample survey returns.