Thesis
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ENGINEERS AND MANAGEMENT IN MANUFACTURING AND CONSTRUCTION

Paul James Tracey

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Department of Management and Organization
Faculty of Management
University of Stirling
Stirling, UK
FK8 4LA

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ABSTRACT

There is a widespread view in the relevant academic literature that the UK's economic performance would be better if the situations of its engineers, engineering and manufacturing were more favourable. In particular the apparent dominance of accountants and financial expertise and the relative lack of influence of engineers and technical and productive expertise in manufacturing companies have been much discussed. As a presumed consequence of this, and despite a shortage of empirical evidence, engineers are apparently marginalised in managerial hierarchies, particularly in the most senior positions, and there is a subordination of technical to financial and other commercial priorities and objectives. The role of engineers in construction, however, has been virtually ignored despite the sector's economic importance and the relatively large numbers of engineers employed in it.

The author and his supervisor conducted 25 interviews with representatives of the engineering and other main organizational professions, management institutes, employers' associations and a small number of academic and policy researchers. Their aim was to help identify the main issues which were relevant to UK engineers. From these interviews, and from reviewing the literature about engineers and management, the author decided upon the aims of the research. These were: to examine how engineers in manufacturing and construction feel about their influence and career prospects vis-à-vis the members of the other professional groups with whom they work; to explore the perceptions of management-level people in industry about the managerial abilities of engineers and their colleagues; to investigate how engineers feel about the trade unions and professional associations which represent many of them; to examine the views of engineers about issues surrounding engineering education and the importance which employers place on formal engineering qualifications; and to determine how engineers feel about the social place of their profession and about their levels of remuneration.

Eighty-two interviews were conducted with engineers and their colleagues in three industrial sectors: mechanical and electrical engineering, chemicals, and construction. In manufacturing the main functional groups seemed to enjoy more constructive relationships than was apparently the case during the 1970s and 1980s. Although they appeared to form an influential group, the author found little evidence to support the notion that accountants dominate manufacturing companies, and they were generally considered both by themselves and by engineers and other colleagues to be performing a support function. Engineers appeared to enjoy the widest range of career opportunities of all the main management level groups, with the possible exception of chemists in chemicals. These opportunities included promotion to the boardroom. However some respondents felt that engineers needed to become rather less involved in the technical aspects of their work to advance their careers. In construction it was found that the main professional groups appeared to operate in varying degrees of mutual opposition. Their roles and influence depended to a large extent on the nature of the product and on the method of contracting chosen by clients. Architects in building and design engineers in civil engineering appeared to have lost their dominant positions in the management of projects. In both cases the main beneficiaries were contracting companies, which are staffed at management level mainly by engineers, and to a smaller extent quantity surveyors.

The author found no evidence to support the view that engineers are superior or inferior to other professional groups in terms of their 'management' abilities, although the latter are clearly very difficult to measure. Only three of sixty-one engineer respondents were trade union members and most engineers appeared to believe that trade union membership was incompatible with their professional and/or managerial identities. About half of the engineers in the sample were members of professional engineering associations but this varied between sectors, as did the importance attached by respondents and their employers to chartered status. The engineer respondents tended to believe that their profession was poorly organised and ineffectual.

Although employers appeared to rely heavily on formal qualifications to distinguish between different grades of technical staff, most respondents felt that engineering degrees needed to more practically oriented. The social standing of engineers and engineering was generally considered to be low. Many engineers believed that the general public neither understood nor appreciated fully what they did. However, engineers in the manufacturing companies in the study were generally satisfied with their levels of remuneration, although most respondents in construction felt that they were underpaid. The thesis concludes by arguing that when taken together with other evidence, particularly the many useful developments in education for management, the results suggest that the prospects for the UK economy might be considered to be improving, and certainly better than they were during the 1970s and 1980s.

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CHAPTER 1

INTRODUCTION

The Issues and the 'Problem'

This thesis is mainly concerned with the influence and position of engineers in UK manufacturing and construction. In this brief introductory chapter the main issues which the author's thinking and research address are described and the nature of the empirical work is outlined. The structure of the thesis and the main contents of each chapter are also discussed.

The notion that the UK's economic performance would be better if the situations of its engineers, engineering and manufacturing were more favourable has been considered widely in several contexts including social scientific research and government inquiries. The most important and influential of the latter of these eventuated in the Finniston Report which was published in 1980. Its recommendations were set against a background of strong public concern with the relative decline of the UK economy over a century or so, concern which drew in the 1970s on comparisons with the relatively strong influence of engineers in management and society overseas (Glover and Kelly, 1993). Academic writers have also expressed interest in the role and standing of UK engineers. In particular the apparent dominance of accountants and financial expertise and the relative lack of influence of engineers and technical and productive expertise in manufacturing companies has been much discussed (Armstrong, 1987a; Glover and Kelly, 1987; Smith and Whalley, 1996). As a presumed consequence of this, engineers are apparently marginalised in managerial hierarchies, particularly in the most senior positions, and there is a subordination of technical to financial and other commercial priorities and objectives (Armstrong, 1987a; Fligstein, 1990). Various aspects of the UK's financial, educational and social stratification systems have often been blamed for this situation (Glover, 1991; Owen, 1999). Other notions considered in the literature include the one that British engineers tend not to make good managers (Finniston, 1980; Rosenbaum, 1990), the one that the engineering profession is disorganized and ineffectual (Smith and Whalley, 1996), the one that engineering education does not provide an effective preparation for senior positions in industry (Rosenbaum, 1990; Barry, Bosworth and Wilson, 1997) the one that there is a weak correlation between formal qualifications and grading structures, and the one that engineers have a low social standing and are relatively poorly paid (Lee and Smith, 1992). The following quotation probably sums up current and conventional thinking about UK engineers:

'British engineers... are disadvantaged in manufacturing managerial hierarchies, closely identified with manual labour, poorly paid, endowed with an ambiguous social identity, unionized and lacking in credential power' (Lee and Smith, 1992: 10).

However, there is relatively little empirical evidence about the position of engineers in employment, management and society in the UK, and much of the evidence which does exist is rather old. Nevertheless, many academic writers continue to paint a rather negative picture of their position in manufacturing (Armstrong, 1987a; Glover and Kelly, 1987; Lee and Smith, 1992; Smith and Whalley, 1996). Moreover, they virtually ignore construction, despite the sector's economic importance and the quite large number of engineers which is employed in it.

The positions of French, German, Japanese, North American and Scandinavian engineers are apparently very different. It is often argued that in these countries engineers are the dominant group in the management of manufacturing at all levels, including the most senior ones, and that this has resulted in company strategies being more technically focused. They also apparently have more influence and power and higher social status than engineers in the UK (see, for example, Crawford, 1996; Lawrence, 1980; McCormick, 1992; Meiksins and Smith, 1992; and Glover and Kelly, 1987).

Aims and Methods

Between late 1995 and the summer of 1997, although mainly during 1996, the author and his supervisor conducted 25 interviews with representatives of the engineering and other main organizational professions, management institutes, employers' associations and a small number of academic and policy researchers. These interviews were loosely structured but usually focused on three themes: the place of engineers and manufacturing in the UK's economy and society; the relationships between the bodies which represent the UK's main organizational professions and professionals, managers, directors and employers; and what needed to be done, if anything, to improve both of the two former sets of phenomena.

The author felt that there was certainly a need for a comprehensive study of the position of engineers in UK manufacturing and construction which addressed a number of the issues identified in the literature and/or in the exploratory interviews discussed above. These issues formed the aims of the research. These are: to examine how engineers in manufacturing and construction feel about their influence and career prospects vis-à-vis the members of the other professional groups with whom they work; to explore the perceptions of management-level people in industry about the managerial abilities of engineers and their colleagues; to investigate how engineers feel about the trade unions and professional associations which represent many of them; to examine the views of engineers about issues surrounding engineering education and the importance which employers place on formal engineering qualifications; and to determine how engineers feel about the social place of their profession and about their levels of remuneration.

Eighty-two interviews were conducted with engineers and their colleagues in three industrial sectors: mechanical and electrical engineering, chemicals, and construction. The respondents consisted of fifty-two engineers, nine accountants, eight marketing and/or sales specialists (all of whom had engineering backgrounds), four quantity surveyors (one of whom had an engineering background), three architects, three chemists, a buyer, a personnel manager, and a respondent with a background in general management. All of the respondents were employed at senior or middle management levels in their companies. The aim was to produce a descriptive account of the experiences and opinions of engineers and their colleagues regarding the issues identified above.

The Plan of the Thesis

Chapter 2 is concerned with the context in which the debate about UK engineers is set. It considers the economic and industrial performance of the UK and compares it in this respect to competitor countries. A number of explanations have been offered for the UK's apparent relative economic decline. Some of the most influential ones and discussed and evaluated. Finally the economic importance or otherwise of engineers, manufacturing and construction is discussed.

Surprisingly little is known about the educational and occupational backgrounds of the UK's managerial stratum. In chapter 3 the available evidence is examined. The changing character of UK management more generally is also discussed, and some conclusions are drawn about the ways in which the formation of UK managers has been evolving.

Chapter 4 is about the relationships between the main professional groups in manufacturing and construction. Some theories which are relevant to these phenomena are examined. Relevant writings about the positions of the main professional and functional groupings in manufacturing and construction are also examined in some detail. Of particular interest are accounts of the effects of the UK's financial system on the roles and influence of engineers in UK manufacturing and the effects of the different and changing types of project organization on the roles and influence of engineers in UK construction.

In chapter 5 relevant academic and other writings about engineers in the UK are examined. In the first part, other studies which have examined their deployment and employment are described and conclusions are drawn about the main issues which are relevant to them. In the second part more specific aspects of the literature on UK engineers are outlined. First, writings on the managerial abilities of engineers and their career aspirations are examined. Second, relevant aspects of engineering education are discussed. Next, the professional associations and trade unions which represent engineers are discussed. Finally, the social position of engineers and the engineering profession is examined.

Chapter 6 describes and discusses the methods used to conduct the research. It begins with a discussion of the philosophical issues involved in social and management research and outlines the author's philosophical position. It then outlines the aims of the research and discusses how the author developed his research design in order to meet these objectives. It also discusses how he obtained his sample, how the interviews were conducted and how the data were analysed after they had been collected.

Chapter 7 is called 'The Background Interviews'. It reports the interviews conducted by the author and his supervisor with representatives of the engineering and other organizational professions, of management institutes, of employers' associations and with a small number of academic researchers. As noted above, these interviews were mostly conducted before the main body of interviews with engineers and their colleagues. Their aim in the present context was to identify the main issues which concerned UK engineers. Together with the relevant literature, they helped the author to develop the direction of his project.

Chapter 8 reports the interviews that were conducted with engineers and their colleagues in the electrical and mechanical engineering companies visited by the author. The chapter has a number of aims: to examine the influence and careers of engineers; to examine the perceived managerial abilities of engineers; to discover engineers' views on the professional associations and trade unions which represent many of them; to discover engineers' views on engineering education and the extent to which employers use formal qualifications as a means of distinguishing between different kinds of technical staff; and to discuss the views of engineers about their social standing and that of their profession and about their levels of remuneration.

Chapters 9 and 10 report the interviews that were conducted with engineers and their colleagues in the chemicals and construction companies in the study. The issues examined in both chapters are the same as those in chapter 8.

Chapter 11 is the discussion one. It compares and contrasts the views of respondents from the three sectors in the study both with each other and with those of others who have written about engineers, and in particular Whalley (1986), Armstrong (1987a), Glover and Kelly (1987, 1993), Lee and Smith (1992), and Barry, Bosworth and Wilson (1997). Also, two broadly contrasting models of the position of engineers in the UK are constructed. One is based on some of the existing literature and the other is based on the results of this study. The chapter concludes by discussing how the study contributes to the debates about UK industrial management and the prospects for the UK economy.

Finally, in chapter 12, and after summarising all of the foregoing material, some research and policy implications of the study are discussed.

Conclusion

In this short introductory chapter the aims and rationale for the study have been outlined and conventional thinking about UK engineers summarised. The main points which are covered in the chapters which follow have also been outlined. The aim of the next chapter is to contextualise the debate about UK engineers. UK industrial and economic performance are examined, some explanations for the UK's apparent relative economic decline discussed and evidence about the roles of manufacturing and construction in the UK's economy presented.

CHAPTER 2

THE BACKGROUND ISSUES

Introduction

The aim of this chapter is to illustrate the importance of the topic being studied. The role of engineers, particularly in manufacturing, has relevance to the performance and direction of the UK's economy and thus ultimately influences the wealth of the country and the standard of living of its people. For most of the nineteenth century Britain was the world's most economically and politically powerful country (Alford, 1996). During the Second World War the USA and the USSR became superpowers and the economies of France, Germany and Japan became more successful than the UK's. However Germany and the USA began to overtake the UK in the last quarter or third of the last century (Musson, 1978). Today, it has returned to its pre-imperial status as an influential offshore island of a powerful continent (Owen, 1999). In this chapter a number of explanations which have been put forward for the UK's relative decline are discussed. The importance or otherwise of industry and engineers to the UK economy is also considered.

Economic and Industrial Performance

There is no doubt that Britain's economy has declined relative to those of other countries since the nineteenth century, particularly to those of Germany, Japan and the USA (Glover, Tracey and Currie, 1998; Owen, 1999). Much of this decline was clearly inevitable, but much of it was not. It was unlikely that the UK could have maintained the same rate of economic growth, particularly from 1870 to 1914, that it did during its early industrialization, say between 1750 and 1850. Comparisons between the growth rates of the relatively mature UK economy, which had been industrialising for well over a hundred years, with those of economies such as the United States' and Germany's which were only beginning to industrialise in 1850, are of little value. Countries with more natural resources and larger populations would almost certainly have overtaken Britain in absolute terms regardless of what action was taken to stop this. 'Britain could not possibly keep the Industrial Revolution within her own shores... Indeed, British technology and overseas investment had been of immense importance in the industrial development of other countries... Britain had no monopoly of science, technology and inventiveness, nor could she prevent foreign countries from erecting tariff barriers to protect their own growing industries or from encouraging their exports by discriminatory pricing policies and subsidies' (Musson, 1978: 154). Some writers have argued that until the Second World War there is little that could have been done to improve the UK's economic performance (Musson, 1978; Owen, 1999), although its commitment to older industries and technologies, probably at the expense of more modern ones, and its relatively undeveloped concern for vocational and commercial education renders this view uncertain (Alford, 1996). Britain's post-war economic performance, however, has often been weak enough to raise more challenging questions.

One striking feature is that until 1973 increases in productivity and economic growth were impressive when placed in the context of previous economic performance, but poor in comparison to those of Japan and most Western European countries. Between 1950 and 1973 the UK economy grew an average rate of three per cent per annum. This compares to 5.1 per cent for France, 5.5 pèr cent for Italy, 6 per cent for

Germany, and 9.7 per cent for Japan. The USA grew more slowly at 3.7 per cent per year, but from a very high base (Alford, 1996). Increases in the UK's productivity were also high by previous standards but disappointing compared to other countries. In 1945 the absolute level of productivity was roughly the same as those of the Netherlands and Sweden but well behind that of the USA. By 1973 the Dutch and Swedish economies had become significantly more efficient than that of Britain, which had also been overtaken by Germany, France, Belgium and Italy (Feinstein, 1988). Between 1974 and 1979 economic growth and productivity growth slowed throughout the world economy, mainly due to structural changes, but British performance remained inferior to that of its competitors.

The 1980s saw relative economic decline checked for the first time in over a century (Crafts, 1991). Growth in output and productivity were higher in Britain than in any other country in the European Union except Spain, considerably higher than in the USA, and on a par with the record of Japan (Owen, 1999). This improvement has been attributed in part to the attack in the 1980s on restrictive practices and overmanning, rather than to investment-led growth. This has been linked to a major contraction of employment in manufacturing (Crafts, 1991) and construction (Ball, 1988), to a significant increase in general unemployment, and to a reduction of the influence of trade unions on management (Crafts, 1991). By the mid-1980s employment in manufacturing had decreased by 30 per cent from its peak in the early 1960s and employment in services had increased sharply. The number of workers in retailing doubled and it quadrupled in banking and insurance (Millward, 1990). Following a world-wide recession in the early 1990s growth rates and productivity performance again moved ahead of those of many of the country's rivals. Real after-tax personal incomes in the UK are now on a par with those of Germany and Sweden (see, for example, O'Mahony and Wagner, (1995) and O'Mahony and Wagner with Poulson (1995)). However incomes in Japan, the USA and in several other European countries remain somewhat higher than those in the UK, and in general, manufacturing, according to many international comparisons (Williams, Williams and Haslam, 1990; Froud et. al., 1997), remains a source of relative weakness for the country. The picture painted by these authors was one of large UK manufacturing companies increasingly investing in their overseas activities, with a lot of the domestically owned manufacturing that remained in the UK tending to be technically unsophisticated by international standards.

The performance of some sectors of British manufacturing during the post-war period has often been more or less disastrous. Perhaps the most dramatic collapse was that of shipbuilding. In 1950 Britain had 37 per cent of the world's market share and was the leading exporter. By 1974, when global output was at its highest level since the war, Britain's market share had plunged to 3.7 per cent (Hilditch, 1988). The industry had received massive government subsidies but weak management, bad industrial relations, outdated yards, particularly compared to those of Japan and Sweden, a poor record of meeting delivery dates and over-capacity led to a 'spectacular and absolute decline of the industry' (Pope, 1989: 53).

The decline of the British car industry exemplifies many of the worst aspects of the decline of much of British manufacturing. The management of car manufacturers became so bad that by 1976 they and their workers were five times less productive than their American counterparts. Imports, which accounted for 5 per cent of the British market in 1965, accounted for 58 per cent in 1982 (Pollard, 1992). Massive foreign investment has seen Britain again become a net exporter of cars, but British-owned car manufacturers now only account for one per cent of the country's total output (Office for National Statistics, 1998a).

The construction industry's record is little better. A catalogue of disasters since the 1950s has given the UK construction industry a very poor reputation (Ball, 1988). Problems concerning the design and building of high-rise blocks of flats in the 1960s brought suffering to thousands of tenants. Much of the motorway network built in the 1960s and 1970s was also poorly designed and constructed and has not lasted well. This was partly because designers did not consider the heavy loads which they would have to carry and partly because experiments with different kinds of materials proved unsuccessful (Ball, 1988). Thus large sums were needed to rectify these problems. In the 1980s, the construction industry's reputation for poor levels of quality remained. It was also notorious for completing projects late and over budget. Ball (1988), a leading writer on the UK construction industry, said of this issue: 'It is difficult to believe that construction firms deliberately build substandardly. Most advanced capitalist industries are obsessed with quality control in order to maintain business in the face of competition. Something in the construction industry seems to override that obsession' (p.10). The situation did improve during the 1980s as clients, an increasing proportion of whom were from the private sector, sought alternative means of project organization in order to address these problems (Bresnen, 1996).

Nevertheless, despite this, and relatively low labour costs, construction costs in the UK are among the highest in Europe (Barlow, Cohen, Jashapara and Simpson, 1997).

The picture is not all bad. Some industries have managed to turn themselves around and to become very successful again. The British iron and steel industry endured troubled times in the 1970s as productivity failed to keep pace with foreign competition and Britain became a net importer of steel for the first time in 1980. Major restructuring and technical changes in the 1980s and early 1990s resulted in very substantial improvements in efficiency and the British iron and steel industry is now among the world's lowest cost producers and a major exporter (Pollard, 1992). Chemicals is another sector which has seen recent improvements (Office for National Statistics, 1998a). Although it has been Britain's fastest-growing industry for much of the post-war period, technical development compared badly with that of other countries. Traditionally Britain was a major producer of basic industrial chemicals such as organic and inorganic chemicals, fertilisers and plastics, but more recently it has tended to concentrate on speciality chemicals, pharmaceuticals and cosmetics, where it has been very successful (Owen, 1999). The chemicals industry is British manufacturing's biggest single exporter (Office for National Statistics, 1998a).

The mechanical and electrical engineering sectors have performed reasonably well throughout the post-war period (Owen, 1999). After the war British companies were able to take advantage of expanding home and export markets until well into the 1950s, when strong foreign competition began to expose weaknesses in production engineering and management. Nevertheless, electrical engineering has continued to grow at around 4 per cent per year and today Britain has the fifth largest electronics industry in the world (Office for National Statistics, 1998a). Although this is partly because of major overseas companies locating in Britain, there is also a very strong indigenous electronics sector. Mechanical engineering has also performed steadily, if unspectacularly. Britain has around 29,000 mechanical engineering firms employing over 560,000 people and exporting products worth almost £21 billion (Office for National Statistics, 1998a).

Economists, historians, sociologists and educated lay people such as politicians and journalists, have long argued about when Britain's relative decline began and about its possible causes. It is difficult to classify many of these competing explanations, and it is impossible to consider all of them. There are, however, a number of overlapping features of the UK's economy and society featured consistently in discussion. These include social and cultural attitudes towards manufacturing, the financial system, management competence and education.

Of all of the explanations of relative decline the notion that social and cultural attitudes in Britain have been consistently hostile to industry, and manufacturing in particular, is probably the most widely discussed, and it has certainly captured the popular imagination. General or economic historians like D.C. Coleman, D.H. Aldcroft, David Ward and A.L. Levine have all made notable contributions. Two of the most influential and persuasive but in some respects one-sided discussants have been Wiener (1981) and Barnett (1972, 1986, 1995). Wiener wrote that the UK was 'an industrial society with an anti-industrial culture', by which he meant mainly the 'culture' of graduates in the arts and to some extent the natural and social sciences. There appears to be some truth in Wiener's case against these people, as evidenced by their occupational choices and aspects of their life styles, for example, but he overstated it by assuming that the tendency of some of them to despise events in factories had infected most people in the UK. Barnett's focus has been on what he regards as the overly high-minded outlook and behaviour of the UK's governing classes and academics. This was responsible in his eyes for the appeasement of Hitler and the UK's military weakness in the 1930s, for the country's financial dependence on the USA from about 1941 onwards in World War Two, and for developing the 'New Jerusalem' of cradle-to-grave state welfare after the war ended without first ensuring that industry would be strong enough to pay for it.

However Edgerton (1991), probably Barnett's main critic, argued that 'England' has in fact been a 'warfare state', a 'militant and technological nation', which gave great priority to technical and industrial development in the twentieth century. His main example was the aircraft industry from around 1910 onwards, which has indeed been a prominent segment of UK manufacturing industry, and a major focus of government and lay interest since then. Edgerton discussed the widespread public interest in military aircraft, especially during and after the Second World War, and referred to numerous other examples of manufactured goods being sources of considerable interest for very large numbers of people. This point is of massive significance because it emphasises the valid point that the genuinely anti-industrial element in the UK has always been a minority one, something which Wiener and Barnett appeared to ignore. However, perhaps Edgerton should have noted that a glamour industry such as aircraft/aerospace might be more likely to prosper, relatively, in a declining imperial power and industrial giant with a strong naval and military tradition.

Another critic of the Wiener and Barnett theses was Rubinstein (1993). His argument did not deny the sense of some elements of their arguments about various features of UK society helping relative industrial decline to accelerate for over 120 years since the time of the UK's economic and imperial pre-eminence. What he did do was to argue that the UK never fundamentally had an industrial economy. It had always relied more heavily on commerce, finance and other services than on manufacturing for its income. 'Industrial decline' was actually a national transfer of resources into profitable activities by people who were always pro-capitalist and politically moderate.

Rubinstein's analysis offers a stimulating antidote to Wiener's over-dramatised, stereotypical and ultimately shallow, because of its narrow sympathies, argument that the radicalism of the rising Victorian commercial and manufacturing middle classes was simply 'bought off' by admission to elite educational institutions, country houses and drawing rooms. It also suggests that Barnett made a similar mistake to Wiener in focusing too closely on some segments of society's upper ranks, and in forgetting that a very high proportion of innovation and development in UK society has always come from its middle and lower ones.

Although Rubinstein's discussion of UK economic decline is original and challenging, it nevertheless misses the point in one major respect. Although he correctly pointed out that a ten-pound note earned by manufacturing is worth no more than one earned by providing a service, his assertion that the evolution of all economies is towards services and away from manufacturing is too simple. At one point (p.44) he writes that services 'generate far more income' than manufacturing, almost as if this was a universal truth. One does not have to consider the increasingly interdependent nature of relationships between manufacturing and services, with ever increasing proportions of jobs being of services types, to recognise this as rather meaningless. The truth probably lies somewhere between the views of Wiener and Barnett and those of Rubinstein and Edgerton.

Some writers blame weaknesses in the financial system for poor industrial performance (Kennedy, 1987; Ingham, 1984; Williams et. al., 1983). Financial institutions and markets have been accused of being too concerned with maximising returns over short periods and unwilling to invest in long term projects. As a result British industry has apparently been starved of capital for projects which require significant research and development work and which have long gestation periods. Ultimately this is said to have had serious consequences for economic growth and competitiveness since the middle of the nineteenth century.

There is also a widespread perception that the predominant <u>raison</u> <u>d'être</u> of UK firms is the maximisation of shareholder value (Kay and Silberston, 1995; Hutton, 1996). It is said that as shareholders are not directly involved in firms, they do not identify with them. As a result, if the fortunes of a company decline, the shareholders simply sell (Higgins and Clegg, 1988). Quick returns on investment and high dividends are necessary to retain the confidence of shareholders (Fligstein, 1990). This forces senior managers to keep one eye on the stock market when making decisions and thus encourages short-term behaviour (Higgins and Clegg, 1988; Hutton, 1996). The greater involvement and concern of shareholders in German and Japanese companies, on the other hand, allows firms to adopt a long-term perspective more easily (Lane, 1995).

Other writers suggest that the UK's banks and its financial system more generally have been chastised unfairly in many respects (Capie and Collins, 1992; Collins and Hudson, 1979; Hudson, 1986; Newton, 1996; Michie, 1996). They argue that capital has been available at least as easily and as cheaply as in Germany and the USA. When the stability of the UK system is also taken into account it is argued that, if anything, the UK's financial system has been a source of strength rather than weakness. Short-term behaviour such as low levels of investment in technical development and training is attributed to company managers making short-term decisions, rather than to a lack of capital or to pressure from shareholders.

According to Franks and Mayer (1995) and Mayer (1997), differences between the UK's financial system and those of Germany and Japan are less concerned with the source or availability of finance, than with the concentration and nature of ownership. These authors distinguish between the 'outsider systems' of the USA and the UK and the 'insider systems' of Japan and Germany. Insider systems 'are ones in which the corporate sector has controlling interests in itself, and outside investors, while able to participate in equity returns through the stock market, are not able to exert much control' (Franks and Mayer, 1995: 184). They 'have few listed companies, high levels of concentration of ownership and a high proportion of cross-shareholdings between firms and institutions and/or substantial family holdings' (Mayer, 1997: 229). Outsider systems, on the other hand, have a 'few large, controlling shareholdings and these are rarely associated with the corporate sector itself' (Franks and Mayer, 1995:184). They 'are characterised by a large number of listed companies, low levels of concentration of ownership and few intercorporate or family holdings in large corporations' (Mayer, 1997: 298-99).

The insider systems of Japan and Germany apparently promote more direct monitoring and control, increased stability in decision making and increased commitment to other shareholders. But this commitment to particular policies and/or groups may also make companies resistant to technical, market and other external changes. The strength of the UK and US systems is that control is less concentrated and external factors may therefore be more easily adapted to. Each system is probably more suited to particular sectors. Industries in which there is a degree of uncertainty and rapid technical change, such as oil exploration, electronics and pharmaceuticals, may be better suited to the 'outsider' systems of the UK and the US. Sectors which are more reliant on established markets and where technical development is more gradual, such as electrical and mechanical engineering and vehicles, may be more suited to the 'insider' systems of Germany and Japan (Mayer, 1997).

The performance of British managers is another commonly used explanation for industrial decline (Pollard, 1989; Wiener, 1991; Keeble, 1992). Between the wars the

British economy underwent major structural changes as British industry eventually reduced its reliance on older industries and moved into newer ones (Musson, 1978). But in the newer industries British companies were criticised for falling behind German and American ones in terms of technical ability, process technology and the ways in which work was organized (Alford, 1996). According to Chandler (1962, 1977) it was the emergence in the USA of large-scale vertically integrated firms like Ford and General Motors which instituted really large-scale mass production and cultivated elaborate managerial hierarchies and multidivisional corporate structures which were associated with the successes of American firms in the interwar period. Within such structures the administrative parts were separate from, and responsible for monitoring, the productive ones (Ackroyd and Lawrenson, 1996).

Between the wars British engineering was very diverse and 'comprised a series of distinct but overlapping sectors linked by a common set of metalworking processes and associated manual skills' (McKinlay and Zeitlin, 1989:33). Although deskilling and mass production were evident in so-called traditional industries, managers in engineering companies who were 'worried by the inefficiency and inflexibility of mass production... overwhelmingly rejected Taylorism as inappropriate for the high-quality, small batch production' (McKinlay and Zeitlin, 1989:39) which dominated British engineering. Skilled labour was central to engineering in the UK. Many UK companies were customer-specific and competed in relatively small luxury markets (Ackrill, 1987; Ackroyd and Lawrenson, 1996).

Ackroyd and Lawrenson (1996) described what they called the 'craft flow' system of vehicle production which was used successfully during the interwar period. Similar systems were used in much of UK mechanical and electrical engineering. Craft flow production was developed from the 'static build' method of production whereby a team of skilled workers assembled a complete product in one place. Although it borrowed some aspects of mass production such as conveyors and automated flow lines, the two were very different. In particular, the productive process was 'coordinated by the design activities of engineers and cooperative action between semi-autonomous gangs of workers and not primarily by technology' (p.177). Craft flow relied heavily on skilled labour and detailed technical knowledge was required by everyone involved. There were good reasons for organizing work in this way. In relative terms there was a larger pool of skilled labour than in the United States, and it was cheaper too. Also, raw materials were priced differently and UK managers were aware that many markets in the UK were differentiated. Ford discovered this after opening a car factory in Dagenham in 1931. The cars produced there were specifically for the British market, but Ford was forced to cut its prices in order to compete with the more expensive but differentiated Morris cars. Ford's success in the US was based on large-scale identical ordering which did not suit the UK's market. The UK's engineering firms tended to be under-capitalised but they were able to react quickly to technical changes and to changes in demand.

Although this system of production was not perfect, on the whole it was extremely effective. It is probably strange then, that in much of UK engineering after the Second World War it was replaced by methods which used sophisticated machinery and smaller numbers of relatively unskilled workers. 'At precisely the point at which the demand for mass produced consumer durables was beginning to weaken, and the associated Fordist production principles becoming obsolete, there are a series of disastrous attempts to rationalise... on a mass production pattern' (Ackroyd and Lawrenson: 183-4). In the manufacture of vehicles in the 1950s and 1960s, and then later in all consumer durable and capital goods manufacturing companies, there was 'either... a simple withdrawal of capital from involvement in the production of complex products and/or... an amalgamation of other producers of similar weakness and vulnerability in terms of capital investment' (Ackroyd and Lawrenson: 184).

Thus during the 1950s and 1960s there was a 'merger boom' on an unprecedented scale between manufacturing companies (Williams et. al., 1983; Ackroyd and Lawrenson, 1996). These were usually horizontal in nature between firms involved in related sectors. Manufacturing companies tended to be very large compared to those in other countries. Mass production replaced craft-based methods and by 1970 'British big business was dominated by large, diversified multi-divisional firms, just like American big business, which was then supposed to be the very model of efficiency... Paradoxically, however, large British manufacturing firms performed worse than American firms in Britain and worse than European firms on the Continent which were often more traditional in strategy and structure' (Williams et. al., 1983: 90). According to this argument, power and talent moved away from factories to head offices where achievements in financial matters and marketing rather than engineering were thought to be more appropriate for senior management (Armstrong, 1987a).

To understand why this happened the balance of world power after the Second World War must be considered. The USA was the world's dominant economic and military power. It was commonly assumed, both in Western Europe and North America, that US industry's success was rooted in its system of mass production, which involved the separation of management's thought from labour's doing, and in the development of the multidivisional organization which regarded finance, marketing and personnel, rather than engineering, as key components of management (Locke, 1996a). Soon after the war the UK government helped to set up the Anglo-American Council on Productivity in order to try to discover the 'secret' of American success. Between August 1948 and June 1952, 138 teams (over 900 people) were sent to America from the UK. This included groups of managers, workers and other specialists whose task was to document the ways in which American companies operated (Locke, 1996b).

UK management became increasingly arms'-length and engineering matters tended to be considered less important than financial and commercial ones in the formulation of company strategy (Armstrong, 1987a). In 1967 the UK spent the second highest percentage of its GDP among OECD countries on total R&D, and the fourth highest percentage on civilian R&D. By 1983 Britain had slipped to sixth and ninth respectively (Patel and Pavitt, 1987). The international patenting statistics, which have been used as a measure of R&D effectiveness, show a similar decline. In 1958 UK companies accounted for 23.4 per cent of patents registered in the USA. By 1979 this figure had dropped to to 10.1 per cent (Pavitt and Soete, 1980). Ackroyd and Lawrenson (1996) suggested that problems in the UK vehicles industries could neither be solved by accountants nor engineers alone. Thus marginalising engineers on the boards of companies because they could not deal competently with financial matters and replacing them with accountants who did not possess sufficient technical expertise was never going to solve the problems of UK manufacturing. They suggested that senior mangements needed to combine both technical and financial expertise to be successful. As will be seen, this point has significant relevance for this thesis.

Two themes which recur in many accounts of the UK's economic performance are the education system's tendency to reward inventiveness on the part of those at the top of the ability range, especially if it is spectacular, much more than care, precision and perseverance on the part of the rest (Glover, Tracey and Currie, 1988). There has been an associated tendency to overvalue heroism, fame and a commanding social presence (Huntford, 1984; Hampden-Turner and Trompenaars, 1994), so that sights, standards and expectations for the majority of people were set too low. The very idea of a biologically fixed ability range may have been a significant part of the UK's difficulties. The belief that innate ability or potential is distributed quite widely throughout societies seems more in tune with Japanese and much West European management than with conventional management practice in the UK of the USA (Lane, 1989).

Another feature of the UK education system which has been particularly damaging to UK industry is the relatively poor provision of technical education and training (Sanderson, 1972; Ahlström, 1982). There as a limited need for formal technical education and training during the Industrial Revolution because of the relatively low immediate technical requirements of much of British industry (Musson, 1978). Textiles, coal mining, iron, steel, and mechanical engineering were more dependent on the availability of capital and raw materials than skilled human resources (Fores, 1979). For much of the nineteenth century, and well into the twentieth, professional engineers received largely practical kinds of training under the pupillage of qualified engineers, usually for a period of seven years. 'The aspiring engineer and his parents sought an eminent engineer, paid a premium and hoped that the pupil would be taught' (McCormick, 1991: 45). Professional qualifications came to be conferred by the engineering institutions rather than the state, which had little direct involvement in technical education and/or training (Fores, 1979). State provision was greater in France, Germany and the USA, partly because technical education was seen as crucial if productivity and economic growth and were to reach UK levels, and partly because the industries which underpinned industrialization in these countries, including electrical engineering and chemicals, required greater technical expertise (Ahlström, 1982).

At least some informed Victorians of the 1870s and 1880s were aware that the UK's poor provision of formal technical education was connected to its relative decline and took some limited measures to improve the situation (Sanderson, 1988). One significant step taken was the spread of technical colleges in provincial cities and towns following the Technical Instruction Act of 1889, which allowed local authorites to raise taxes to cover the cost (Sanderson, 1988). Another was the growth of the London polytechnics. These were originally intended to 'elevate' the working classes rather than as a means of providing skilled workers for industry. As a result they focused initially on providing basic skills, but later responded to an increased demand for more advanced learning and provided full time courses leading to external degrees of the University of London (Cotgrove, 1958). There was also a growing number of universities which were offering courses in engineering, although the terms science or applied science were often used in efforts to increase their status. Unfortunately many employers did not agree that engineers needed theoretical understanding (Sanderson, 1988). Most industrialists viewed technical education with suspicion and believed that an assiduous apprenticeship served in a good firm could and should provide the necessary training to take those with the ability to lead and motivate colleagues, to senior managerial positions. This liberal or laissez-faire attitude has characterised much of the history of technical education in Britain and at least partly explains its neglect at all levels (Sorge, 1979). It has been estimated that in 1899 the combined number of students who were studying engineering in the institutions mentioned above in England and Wales was only around 2,000. By 1913 this figure had only risen to 2,700 (Ahlström, 1982).

Between 1918 and 1939 university education gradually replaced pupillage as the principal means of entry to the professional engineering elite in many industries, but most engineers continued to receive a mainly practical training combined with some part-time study at technical colleges, usually in the evenings (Sanderson, 1988). There continued, however, to be mutual distrust between the universities and industry. Even in some of the newer industries such as motor vehicles there was a reluctance to employ graduates: companies preferred to recruit school-leavers and to put them through premium apprenticeships (McCormick, 1991). Unlike their rough equivalents in the German technical universities, and until the 1970s and 1980s, British engineering degrees were largely theoretical. There were also far fewer formal links with industry than in Germany and this encouraged and reinforced mistrust between industry and universities (Sorge, 1979).

For much of the post-war period education and training have continued to be viewed as separate. According to this view education implies formal theoretical learning and consideration of values and relationships, and is the responsibility of academic institutions, while training implies 'hands-on' practical utilitarian learning and is the responsibility of employers (Glover and Kelly, 1987). Large scale expansion of UK higher education did not take place until the mid-1960s (Sanderson, 1972). From that decade onwards the proportion of graduate engineers amongst all engineers has increased and the proportion of engineers who receive all of their training 'in-house' has decreased, and in the late 1990s is almost negligible (McCormick, 1988). Recent developments in and debates regarding engineering education are discussed in Chapter 5.

Industry's attitude towards higher education changed dramatically as links between higher education and economic growth were increasingly argued for (Kaser, 1966). In 1961 4 per cent of school leavers attended university. After the implementation of recommendations made in the Robbins Report on the universities (1963), the numbers of students in higher education had doubled by 1969, and today the equivalent figure is over 30 per cent of relevant age cohorts. There was also an increase in the proportion of students studying engineering, partly as a result of the conversion of a number of Colleges of Advanced Technology into 'technological' universities (Sanderson, 1972). By the 1980s over ninety per cent of engineers in the UK were graduates (McCormick, 1988). These developments arguably came far too late for UK industry and long after mass higher education systems with strong industrial and commercial provision had been created in Japan, the USA, Germany and France (Ahlström, 1982; Finniston, 1982). For many years UK engineers were often less rigorously educated and trained than those in these countries, with obvious consequences, for some at least, for the UK's competitiveness (Sanderson, 1988).

Engineering has been neglected to varying degrees in the UK and this has almost certainly had harmful effects on national manufacturing and general economic performance. However many of the reasons offered for this economic underperformance, such as the ones discussed above as well as others such as poor industrial relations and so on, have been too superficially considered and have often tended to be effects of or parts of the underlying problem. Glover, Tracey and Currie (1998) saw this as being a long-running although currently fading problem of collective will and identity. They argued that the UK was so unusually successful in the previous four centuries that its priorities and its perceptions of itself became confused and diffident during the period from mid-Victorian times (say the 1860s) to the present, a period of massive political, economic, social and technical change which has had enormous potential for confusion for any nation or society involved in it.

The notion that the UK has inflicted upon itself some kind of collective identity crisis and failure of will since mid-Victorian times, is far from incompatible with the kinds of argument about educational and occupational choices and changes in social structure (Coleman, 1973) and social movements and ideological and organizational choices (Glover, 1985, 1991) that have long been apparent in the literature on the UK's relative economic decline. The UK's history of the last 150 years is one of great struggle and turmoil, one of massive and sometimes very stressful economic, social, technical and political change, of major wars, of imperial involvement and disengagement and so on. The country has thus undergone many major changes since its pre-eminence in the middle of the nineteenth century but it is still a wealthy and politically stable one compared with most others. On the other hand it is now merely an influential medium-sized power and most of its main competitors of the later decades of the nineteenth century have overtaken it economically (Glover, Tracey and Currie, 1998). The confusion that began in mid-Victorian times about the kinds of social and economic institution needed for a twentieth century (and later) industrial society is itself suggestive of a deeper confusion (Glover, 1985, 1991; Olson, 1992).

Do Construction and Manufacturing Matter?

The economic importance of construction appears to be universally accepted. It is estimated that around 895,000 people work in the construction industry (Office for National Statistics, 1998b). It has an annual output of £33.7 billion (office for National Statistics, 1997b) and accounts for about five per cent of GDP (Central Office of Information, 1996). Perhaps even more importantly, it is responsible for much of the environment in which virtually all social and economic activity occurs, and it is fundamental to the development of economies and societies (Ball, 1988). Engineers are fundamental to the construction industry. In civil engineering, for example, roads, bridges, damns and harbours, they are responsible for the design and construction of projects (NEDO, 1976). In building, for example, houses, factories, shopping centres and hospitals, they design the structures and the services (cabling, heating, lighting and ventilation), although architects are responsible for how buildings look and for most aspects of their layout (Bresnen, 1996). Engineers employed by contracting companies also build the designs produced by architects and design engineers.

By way of contrast, the importance or otherwise of manufacturing has been the source of much contention. The debate concerning the role and standing of engineers has usually been linked to the debate about the role and importance of manufacturing (Finniston, 1980; Glover, 1992). This is unsurprising given that the competitiveness of a company's products and processes are dependent to a large extent on its engineering capability. This does not imply that other factors and groups of people are less important, but there can be little doubt that the role of engineers is normally crucial. The authors of the Finniston report on engineers (1980) sensibly identified what they called the 'engineering dimension' to 'convey the interaction of engineering with non-engineering factors in determining manufacturing performance, and to emphasise the importance of considering the whole manufacturing system and not just aspects of it' (p.22). It is important, therefore, to consider whether manufacturing matters, or should matter, to the UK.

Manufacturing is responsible for a smaller proportion of GDP in the UK, 21 per cent in 1995 (Delbridge and Lowe, 1998), than in several other developed economies such as those of Germany, Japan and France (Glynn and Booth, 1996). The UK's relative decline in manufacturing has been offset at least partly by growth in retailing, tourism, banking, insurance, and other financial services, and in oil and gas extraction from the North Sea (Glynn and Booth, 1996). This has allowed the people of the UK to maintain a standard of living which is generally comparable to that in much of Western Europe, although generally lower than the USA and Japan (Glover, Tracey and Glover, 1998). Some economists have welcomed the growth of services as an indication that the world economy is experiencing fundamental structural change (Rubinstein, 1993). According to this version of the so-called 'post-industrial thesis' more developed economies will tend increasingly to buy manufactured goods from industrialising countries, and sell them financial and other services in return (Rowthorn, 1994).

However, given the many contemporary and likely future ways of classifying and comparing economic activities both within and across national and sectoral boundaries, it is probably the case that discussions of the relative importance of very broad and general categories of activity, such as manufacturing and services, are at best pointless, and more often distractions from a more sensible concern to help all kinds of socially useful activity to become more effective. Glover, Tracey and Currie (1998) used the Latin phrase 'si monumentem requiris, circumspice' (if you want to see his monument, look around you) used by Allan Bullock (1962) in his famous biography of Adolf Hitler, A Study in Tyranny, to convey the importance of manufacturing. Bullock was describing the devastation of Europe caused by Hitler. Glover et al. used his analogy to emphasise the massive general importance of manufacturing. Thus if one looks around oneself in almost any typical environment in a developed society, the enormous importance of manufactured gadgets and other machines and products is very obvious (Glover, Tracey and Currie, 1998).

Manufacturing and services are increasingly interrelated and interdependent so as to be almost indistinguishable. Almost all services depend for their existence and/or efficient performance on manufactured goods, and in general the importance of manufacturing for both employment and living standards has long been growing. Manufacturing is also more important in international trade than services. However both manufacturing and services are of economic and social value and 'either-or', manufacturing 'versus' services, discussions are futile and irrelevant. Manufacturing matters, and services matter, and each increasingly relies on and penetrates the other. While manufacturing is not inevitably the alpha and omega of the UK's economic future, the UK does need to trade internationally in manufactured goods more than most countries of equivalent size and development, and is likely to need to do so for the foreseeable future (Glover, 1992; Delbridge and Lowe, 1998). Because of this UK manufacturing industry should be at least as well managed as its counterparts in other equally or more successful industrial countries, with similar focus on the centrally important 'engineering dimension'.

Other arguments favouring manufacturing include the 'strategic reasons' one, that a country should maintain the capacity to produce weaponry and to sustain itself materially through major economic and political crises. Glover (1992) also pointed out that making a tangible product, 'fascinating fabrication', is far more satisfying than 'boring bureaucracy' or 'servile services'. Johnson (1993) argued that most economic growth had its origins in technical innovation in manufacturing. Innovations in production technologies cut costs and innovative products created new markets. Services generally needed new, better or cheaper equipment in order to improve their productivity, quality or competitiveness. They were rarely able to do so by their own unaided efforts. Johnson cites 'travel, broadcasting and entertainment - and increasingly... education and health care activities and environmental protection' (p.23) as depending on continued technical innovation for their growth.

Kitson and Michie (1998; see also Delbridge and Lowe, 1996) are among the many who have argued that, the UK, because of the nature of its economy, geography and population, is particularly in need of strong manufacturing. Lack of self-sufficiency in agriculture and raw materials and the general maturity of the economy has meant that the balance of payments has depended heavily on manufactured exports, and that balance of payments problems associated with manufacturing decline have led to harmful and deflationary economic policies and to further deindustrialization and to a general downward spiral with particularly damaging effects on investment in human and physical capital. Manufactured goods tended to be more tradable than services and manufacturing productivity growth tended to underpin that in services, rather than vice-versa (Glover, 1992). The UK's lack of commitment to manufacturing had been reflected in uncompetitively priced products and weaknesses in 'other non-price factors, such as product quality, customer service and technological development' (Kitson and Michie, 1998, p.23).

Conclusion

The development of the UK economy from the workshop of the world and economic and military superpower to a fairly influential medium-sized power with a stable but unspectacularly performing economy in terms of growth and productivity which depends less on manufacturing than other developed countries has been a difficult and sometimes painful transition (Glover, Currie and Tracey). It was clearly inevitable that more populous countries with more natural resources would eventually overtake the UK. Nevertheless, the UK's performance in manufacturing, particularly in the post-war period, has been disappointing to very many people and the UK has undoubtedly contributed to its own downfall in some respects. Arguments about UK attitudes to manufacturing have been extremely controversial. A number of such explanations have been discussed in this chapter. However, according to Glover, Tracey and Currie (1998) these factors are, in many respects, merely symptoms of a more general confusion about the UK's identity and its place in the world. The aim of this chapter was to explore some of the wider issues concerning engineers in the UK. The following three chapters will examine literature and evidence about the character and quality of UK management, about relations between managerial groups and about the role and position of engineers in companies.

CHAPTER 3

THE NATURE OF MANAGEMENT IN THE UK

Introduction

Although all managements in the private sector are concerned with profits and other economic factors such as productivity and market share, the ways in which managers achieve such goals are influenced by societal and cultural values (Hofstede, 1980). They are also influenced by their own particular social and educational backgrounds (Stewart, 1985). This chapter has two aims. The first is to examine evidence about the educational and occupational backgrounds of UK managers. The second is to discuss the character of UK management more generally.

Backgrounds of UK Managers

From the mid-1950s to the early 1980s several studies were published of the backgrounds of UK managers (Copemen, 1955; Acton Society Trust, 1956; Clements, 1958; Clark, 1966; Mosson and Clark, 1968; Leggatt, 1972; Heller, 1967, 1970, 1973; Fidler, 1981; Poole et. al., 1981; Matthews et. al., 1997; Barry, Bosworth and Wilson, 1997). Unfortunately between 1982 and 1996 no academic studies appear to have been published. Consequently much of the evidence about UK managers is seriously dated. Also, some of these studies do not include data about the occupational backgrounds of respondents (Heller, 1967, 1970, 1973; Poole et. al., 1981), and the samples of many of the studies which do include such data often comprise companies from sectors in which engineers would not normally be employed in significant numbers (Copeman, 1955; Acton Society Trust, 1956; Fidler, 1981; Poole et. al., 1981; Matthews, Anderson and Edwards, 1997). Therefore data concerning the occupational backgrounds of managers are particularly weak. Moreover, the construction industry has been excluded from all of the studies that the author is aware of. However the available evidence is now examined because it still has relevance for understanding the current staffing of management jobs in the UK.

In an early study Copeman (1955) looked at the backgrounds of directors of public joint stock companies with net assets of at least £1,000,000. His aim was to discover which types of people reached the top of these companies. Three thousand two hundred and fifteen directors were sent postal questionnaires and 1,243 of them responded. It was found that 58 per cent of the respondents had been to public schools and that 36 per cent had attended universities. Twenty per cent had attended Oxford or Cambridge universities and 16 per cent had been to others. However, of the directors under 50, 43 per cent had been to university compared to 29 per cent of directors who were over 50, suggesting that graduates were becoming more numerous at senior levels. Twenty-seven per cent had entered further education after leaving school. Of these, 7.5 per cent had attended technical colleges, 14.5 per cent had studied non-technical subjects such as accountancy or law, and 4 per cent had been in the armed forces and had received some form of education there. Just over five per cent of the respondents, most of whom were scientists, had obtained higher degrees, and 1.5 per cent had studied at a non-university college or for professional qualifications. Thirty-seven per cent had studied for professional qualifications on a part-time basis or had done some part-time studying either at a college or university.

Copeman used evidence from Sweden and the USA to show that directors in other countries were more highly qualified than their UK counterparts. According to one American study (Fortune, November 1952) 81 per cent of American executives had attended universities compared to the figure of 36 per cent which Copeman recorded for UK directors, while in Sweden Carlson (1943) noted that 64 per cent of directors in industrial companies in his country had done so.

Copeman also recorded the occupational backgrounds of directors. He noted that no one type of background was dominant, although those who had joined companies as management trainees made up the largest number (22 per cent), followed by engineers (17 per cent) and accountants (16 per cent). Significantly, however, he found that those with 'technical' backgrounds, by which he meant engineers and scientists, were outnumbered by those with 'non-technical' backgrounds by about three to one. However, because Copeman did not discuss the types of company included in his sample, this statistic may be misleading. It is unlikely that engineers would be employed in large numbers in insurance companies, for example.

The Acton Society Trust (1956) conducted what was arguably the most competent and comprehensive study of UK managers ever. It collected information about the ages, positions, education, professional and other qualifications and career histories of 3,327 managers from 27 companies, each of which employed at least 10,000 people. Less detailed information was also obtained on a further 6,749 managers. The authors of the report used company records supplemented by 600 interviews to collect their data. The definition of a manager was someone 'above the rank of foreman or equivalent' (p.6). Managers in research departments, like foremen, were also a little mysteriously excluded. Fifty-two per cent of managers in the study had attended elementary or ordinary secondary schools, 28 per cent grammar schools, and 19 per cent public schools. The authors concluded that compared to the population as a whole people who attended grammar schools were twice as likely to become managers, and that those who had attended public schools were ten times more likely. Of the 19 per cent of managers who were graduates, 17 per cent had arts degrees from Oxford or Cambridge, 10 per cent had arts degrees from other universities, 6 per cent had science or engineering degrees from Oxford or Cambridge, and 49 per cent had science or engineering degrees from other universities.

Most managers (82 per cent) had no professional qualifications. Twelve per cent had technical, that is engineering or science, professional qualifications, and 5 per cent had non-technical, meaning accounting or secretarial ones. The authors concluded through their use of multiple regression analysis that the latter had more chance of reaching the top than those who had technical qualifications. The authors were not clear about how they distinguished between top and middle management: 'As an indication... the general works manager and in a *very* large works the works manager, were graded as top management as well as the chief engineer, and sometimes the deputy engineer. Works managers controlling several hundreds were graded as middle management and so were assistant accountants, shift managers and most departmental heads' (p.19). In top management there was a higher proportion of people who had attended public school (33 per cent) and who were graduates (30 per cent). Younger managers were found to be much more likely to be graduates than others, and slightly more likely to have professional qualifications.

The authors used multiple regression analysis to measure the influence of different factors in managers' backgrounds on their prospects for promotion. In descending order, having an Oxbridge arts degree, attending a public school, having non-technical professional qualifications and being recruited as a management trainee were found to be the most helpful in terms of promotion prospects. Having a science or engineering degree, technical professional qualifications, and being recruited into a technical role were - again in descending order - also advantageous, but less so than the previous four factors. As with Copeman's study, the authors did not give details of the types of company that they visited. This study was very influential in terms of general perceptions of UK management in the 1960s, 1970s and 1980s (cf. Granick, 1961; Glover, 1978a; Swords-Isherwood, 1980). It helped to build a gentleman (public school, Oxbridge) and player (grammar school, professional qualification and/or provincial university) view of British managers.

Clements (1958) interviewed 646 middle and senior managers in 28 manufacturing companies of varying size and in different sectors in Lancashire and north-eastern Cheshire. The purpose of the study was to collect information about the jobs, careers, education and social origins of UK managers. He identified six patterns of managerial career. The first, 'crown prince', pattern was used to describe the careers of people who had family links to the ownership or senior management of a firm. Four per cent of Clements' sample fell into this category. The second pattern identified was that of management trainees who were expected to move into management jobs soon after joining their companies. Eleven per cent of the sample were of this type. The third pattern included engineers, scientists and accountants and consisted of people who were already expertly trained before entering industry. Twenty per cent of the sample fell into this category. Clements called the next type special entrants. This included people who had joined companies as trainees both in technical and non-technical roles but who were not marked out for management. Eleven per cent of respondents fell into this category. The final two groups consisted of managers who 'rose from the bottom' (p.25). Those in the fifth group had left school after the age of fifteen or with a school certificate (18 per cent of the sample) while those in the sixth group had left school at or before the age of fifteen (35 per cent of the sample).

Twenty-six per cent of respondents had been to public school and 33 per cent had attended grammar schools. Twenty-five per cent had been to university. Of these, 38 per cent had attended Oxford or Cambridge and 63 per cent were engineering or science graduates. In senior management, which was defined as 'those with directorships in the company in which they chiefly function and those earning £2,000 a year or more' (p.21), over 49 per cent of the respondents had attended public school and nearly 30 per cent had attended grammar school. Twenty-three per cent were science or engineering graduates, 13 per cent were arts graduates and 7 per cent were accountants. The rest were neither graduates nor professionally qualified. Crown Princes, former managerial trainees, and special entrants were most likely to have gone to public school and/or Oxbridge, and most likely to reach senior management. Clements concluded that social background was more important than education for promotion to senior positions and also that, perhaps partly as a result, UK managers were often poorly qualified.

Two points are evident from these three studies conducted in the 1950s. First, managers tended not to be graduates. In Copeman's (1955) study, 36 per cent of managers were graduates compared to 19 per cent in the Acton Society Trust's (1956) and 25 per cent in Clements' (1958). Second, former public school pupils were a large group in UK management. Fifty-eight per cent of Copeman's respondents were ex-public school compared to 19 per cent of the Acton Society Trusts and 49 per cent of Clements'. It is interesting that Copeman's sample contains the highest proportion of graduates and the highest proportion of ex-public school pupils. A possible explanation is that Copeman's sample included only quoted companies whereas the other two included all types of firm.

Clark (1966) studied sixty manufacturing companies in the Manchester area. He distributed 1,201 questionnaires to middle and senior managers and received 818 responses. The author was mainly interested in whether UK managers were becoming more formally qualified and the extent to which managers' social origins affected their careers. Clark found that 55.5 per cent of the managers in his survey had been to grammar schools and that 12 per cent had been educated in the private sector. Given that only around 4 per cent of the population was educated privately at that time and that around 20 per cent had attended grammar schools, '24 per cent of the population provided 67.5 per cent of the managers' (p.25). Slightly more than 35 per cent of respondents had been to university, of these, just over 80 per cent had studied technical and/or scientific subjects, nearly 9 per cent were arts graduates, and just over 11 per cent had studied economics or law. Twenty-four per cent of the graduates had studied at Oxford or Cambridge, almost 19 per cent of managers had diplomas in technical subjects and 14.5 per cent had non-technical (mainly accounting) professional qualifications. From his sample Clark identified two subsets: top managers, who were roughly defined as departmental heads, and directors. Respondents in both of these groups were more likely to have attended public schools and Oxford or Cambridge and less likely to have degrees in science and engineering.

Clark used the Registrar-General's five-fold occupational classification employed in the analysis of census data and other national statistics to classify the occupations of the respondents' fathers. Class I includes professional and administrative occupations. Class II includes managerial occupations. Class III includes clerical and skilled manual occupations. Class IV includes semi-skilled manual occupations and class V includes unskilled manual occupations. Twenty per cent of Clements' repondents were members of class I, 17 per cent class II, 55 per cent class III, 6 per cent class IV, and 2 per cent class V. Despite accounting for only 15 per cent of the population, 37 per cent of managers in the study came from the top two classes. The social origins of the top managers and directors were not found to be much different to the other managers in the study, although Class I was slightly better represented.

Over a quarter of managers were found to have begun their careers in clerical roles. Around 50 per cent had started as apprentices, laboratory assistants, technicians or draughtsmen. Only around 8 per cent of managers had begun their working lives in manual jobs and only around 4 per cent had started in sales. Almost eight per cent had started out as management trainees. The statistics for top management were very similar. Significantly, however, Clark found that a higher proportion of directors had begun their working lives as laboratory assistants, technicians or draughtsmen (24.6 per cent compared to 16.9 per cent of all managers in the study) suggesting that engineers were better represented at the very top.

Clark's data were re-examined by Mosson and Clark (1968), to compare the social and educational backgrounds of managers in the chemicals, textiles and engineering industries. There were marked differences between different sectors. Sixty-nine per cent of managers in chemicals had been to grammar school, and 63 per cent were graduates. Almost all of the graduates had studied engineering or science (ninety-seven per cent) and 20 per cent of graduates had studied at Oxford or Cambridge. Managers were drawn mainly from social classes II (37 per cent) and III (44 per cent). Only 7 per cent came from class I. Managers in the textile industry were older, more experienced and less well qualified. More managers came from social class one (15 per cent) than in chemicals (7 per cent). However most came from classes two (24 per cent) and three (47 per cent). Twenty-seven per cent had been to university. Half of all graduates had studied at Oxford or Cambridge and just over half had studied engineering or science. Managers who worked for engineering companies seemed to be a mixture of those in the other sectors. Twenty-three per cent of them were graduates. Graduates from Oxford and Cambridge accounted for 12 per cent of these, and engineering and science graduates accounted for 76 per cent. Managers were also mobile between functions and came from a wide range of social backgrounds. The authors concluded that people of many different backgrounds combined 'to manage an industry of great diversity' (p.231).

This study is significant because it shows that different sectors of UK industry had begun to follow different employment strategies. Most managers in chemicals companies were graduates (67 per cent) and almost all of these had studied engineering or science subjects (97 per cent). However in both engineering and textiles companies more 'traditional' patterns of education were evident with much lower proportions of graduates in both.

Leggatt (1972) distributed postal questionnaires to 1,352 managers in 95 industrial companies. Seven hundred and thirty-two managers responded. The purpose of Leggatt's work was to provide data about the composition of UK management and to compare this to previous studies. Almost 6 per cent of respondents were from the Registrar-General's class I, 20 per cent were from class II, 62 per cent were from class III, almost seven per cent were from class IV and four and a half per cent were from class V. Twenty per cent of managers had attended independent schools, 56 per cent grammar schools, and 24 per cent secondary modern schools. Clark (1966) had found that 27 per cent of his respondents were from class I, 17 per cent class II, 55 per cent class III, 6 per cent class IV and 2 per cent class V. This indicates an increase in the proportion of managers who are from social class III at the expense of those from social classes I and II. Twenty-one per cent of respondents were graduates. Not surprisingly Leggatt found that ex-independent school managers were more likely to have attended university than those who were pupils of grammar and secondary-modern schools. Twenty-five per cent of graduates had been to Oxford of Cambridge. Most graduates (36 per cent) had studied 'applied sciences' which presumably meant mainly engineering. Twenty-two per cent had studied arts subjects, 22 per cent had studied social sciences and 20 per cent had studied natural sciences. This suggests that although the social backgrounds of managers may have been changing the educational background of Leggatt's respondents were not significantly different from those in previous studies.

Heller sent postal questionnaires to the directors of the UK's 200 largest industrial and commercial companies at three-yearly intervals. The studies were published in 1967, 1970 and 1973, but were conducted one year earlier in each case. No information was given about response rates. The aim of the surveys was to establish the extent to which the much talked about 'managerial revolution' (i.e., changes to the recruitment and education of managers) had reached the boardrooms of large UK companies. Seventy-one per cent of directors in all three surveys had attended public schools. In 1972, 49 per cent of directors were graduates compared to 51 per cent in 1966 and 52 per cent in 1969. This trend was apparently in contrast to the studies discussed above which indicated that graduates were becoming more common in senior positions. The proportion of directors who had professional qualifications increased from 27 per cent in 1966, to 32 per cent in 1969, and to 35 per cent in 1972. Seventeen per cent of respondents had family connections with the company that they worked for in 1966 and 1972. The figure for 1969 was 15 per cent. These surveys are interesting because the respondents came from the very largest companies. A remarkable 71 per cent of these directors were ex-public school pupils compared to 58 per cent for Copeman

(1955), 19 per cent for the Acton Society Trust (1956), 49 per cent for Clements (1956), and 20 per cent for Leggatt (1972). A higher proportion of these directors were graduates than in any of the previous studies.

Fidler (1981) interviewed 111 chief executives and 19 directors from a combination of small, medium and large manufacturing, services, insurance, merchant banking and property firms. Sixty-six of his respondents worked for manufacturing companies and 39 for services companies. He also interviewed 3 respondents from insurance companies, 10 from merchant banks and 3 from property firms. Seventeen per cent of his respondents belonged to class I of the Registrar-General's occupational classification, 68 per cent belonged to class II and 13 per cent to class III. The class of the remaining 6 per cent was not known. Fifty-seven per cent had attended public school and 32 per cent had attended state schools, with the remaining 11 per cent being split evenly between direct grant and foreign schools. Thirty-eight per cent of respondents had attended Oxbridge and 15 per cent had attended other universities. Of those who were graduates, 21 per cent had studied science or engineering, 21 per cent studied Arts subjects, forty-two per cent studied economics or commerce, 6 per cent studied law and 9 per cent other subjects. Most respondents (62 per cent) did not have professional qualifications. Eighteen per cent had accountancy qualifications, 8 per cent law qualifications, 7 per cent had engineering qualifications and 8 per cent had some other kind of professional qualification. This small sample of executive directors suggests that professional engineers were employed in relatively small numbers in senior positions at the time of the study's publication, and that the senior positions tended to be dominated people who had attended public schools, and to a lesser extent, Oxbridge.

Poole et. al. (1981) sent postal questionnaires to 2,018 randomly selected members of the (then British) Institute of Management in industrial and commercial organizations in the public and private sectors. The authors received 1,058 usable responses. This was a wide-ranging study which was not only concerned with the educational and social backgrounds of managers but also with their views about their work, the role of government, industrial relations and employee participation, professional organization and trade unions. The authors used the Registrar-General's occupational classification in order to measure the social class of respondents. The results are shown in table 3.1.

Overall, the proportion of respondents drawn from classes I and II was much higher than in the studies by Clark (1966) and Leggatt (1972), but lower than in Fidler's (1981). The authors attributed the differences between the private and public sectors to the greater degree of bureaucratization in the public sector. They argued that the 'universalistic selection criteria' which apparently tended to operate in bureaucracies led to more meritocratic selection procedures. That said, the authors believed that their data, even for directors in the private sector, were 'not strong enough to sustain the thesis of "exclusionary closure" or any argument to the effect that social origins in any direct way determine opportunities to enter into the ranks of management itself' (p.43).

Table 3.1. Percentages of managers' fathers in different occupational categories

Register General's Classification	Private Sector Board Members (N=236)	All Private Sector Managers (N=731)	All Public Sector Managers (N=320)	All Managers (N=1058)
I	35.7	28.8	18.5	25.5
II	25.2	30.9	36	32.2
III	25.9	27.7	29.2	28.4
IV	8.1	7.4	9.7	8
V	5.1	5.2	6.6	5.9

Source: Poole et. al. (1981).

Almost 58 per cent of respondents had attended either grammar or technical schools. Slightly more than 22 per cent had been educated in the private sector and less than 16 per cent had attended elementary or secondary modern schools. Slightly more than 3 per cent attended comprehensive schools which had only recently been conceived. The authors acknowledged that most managers in the study attended academically higher rated schools, but noted that 'entry to careers in management is far from completely closed to those with lower level schooling' (p.46). Around 33 per cent of managers were graduates. Almost 14 per cent of graduates had attended Oxford or Cambridge, 23 per cent were engineering graduates and 32 per cent were pure science graduates. Almost 39 per cent of managers had Higher National qualifications and slightly more than 67 per cent had a professional qualification. Thus even by 1981 it appears that managers tended not to be graduates. Poole et. al.'s 33 per cent compares to Copeman's (1955) 36 per cent, the Acton Society Trust's (1956) 19 per cent, Clement's (1958) 25 per cent, Clark's (1966) 35 per cent, Leggatt's (1972) 21 per cent, and Heller's samples of directors (1967, 1970, 1973) 52, 52 and 49 per cent.

Fidler's (1981) figure from a study conducted around the same time but from a much smaller sample was 53 per cent.

The authors conclude that 'management is a moderately highly ranked occupational group in a stratified social system where mobility is distinctly possible but the dice are loaded against such an outcome for any one individual from a humble social background' (p.50). This reinforces similar conclusions drawn by Clements (1958) and Clark (1966), but appears to contradict Leggatt's assertion that the managerial group has been and remained very open. As far as the author is aware this was the last study conducted about the background of UK managers until 1997.

Matthews, Anderson and Edwards (1997) took a randomly selected sample of a varying number of companies from the Stock Exchange Yearbook at twenty year intervals from 1891 and noted the qualifications of the boards of directors of the companies included. No details of the types of company included in the sample were given. The results are shown below.

Table 3.2. Qualification and titles of company directors, 1891-1991.

Year	Sample	Qualified directors (%)	Graduates (%)	Engineer (%)	Noble title (%)	Military title (%)	MPs (%)	Lawyers (%)	Accountants (%)
1891	2,651	16.8	0.3	0.0	7.6	5.6	4.7	0.1	0.0
1911	2,011	11.6	0.3	0.0	7.6	2.4	1.9	0.0	0.0
1931	1,653	28.9	0.8	1.8	11.4	7.9	1.3	0.7	1.7
1951	1,592	24.9	2.7	4.9	7.3	11.4	0.3	0.6	7.4
1971	1,870	37.8	9.1	6.9	5.6	7.3	0.3	1.8	12.1
1991	2,085	41.3	16.6	5.7	5.9	5.9	0.4	1.5	16.2

Source: Matthews, Anderson and Edwards (1997).

These results indicate that while the majority of company directors have been and continue to be unqualified, of those which are qualified, accountants have become the largest group with engineers employed in smaller numbers. This is probably true of commercial companies across the UK economy as a whole, but given that that it is likely that the majority of companies in this sample are not manufacturing ones, particularly in the most recent years, it tells us little of the occupational backgrounds of manufacturing managers.

Barry, Bosworth and Wilson (1997) examined the backgrounds of the most senior person on the boards of manufacturing companies (the Chairperson or Managing Director). The authors had to piece their evidence together from three kinds of incomplete source: national surveys carried out by or for the government, private surveys and data from professional bodies. Forty-nine per cent of managers in their study did not have a university degree or professional qualifications. Twenty-nine per cent were engineering or science graduates, 10 per cent were qualified accountants and 12 per cent were other types of graduate. They noted how, among the top executives qualified to degree level or equivalent, engineers outnumbered accountants three to one. They went on to argue that 'any ambitious person with aptitude who wants to get to the top in... manufacturing..., has the best chance if he or she first becomes an engineer' (p.28). They also argued that, in fact, engineering and science graduates have always accounted for a significant proportion of managers in manufacturing.

A number of trends appear to have been evident from these mainly dated surveys. First, most UK managers have tended to not to be graduates. Second, of those managers who have been to university, engineers and scientists appear to be the largest group in manufacturing. Third, a disproportionate percentage of graduate managers used to attend Oxford or Cambridge. Fourth, and very unsurprisingly as usual, people from working class backgrounds are less likely to become managers than those from middle and upper middle class backgrounds. Fifth, a disproportionate percentage of managers have tended to have been educated in the private sector. Finally, the influence of social class, type of school, and an Oxbridge university education has been even more evident in senior management.

Given the dated nature of most of these surveys, there appears to be relatively little evidence about the effects of the fairly considerable expansion of higher education in the 1980s and 1990s on UK managers. Some writers believe that the changes which have taken place are beginning to have a significant effect. First, higher proportions of managers are qualified to degree/professional level (Handy, et. al., 1988; Barry, Bosworth and Wilson, 1997). Second, qualifications have tended to be more often relevant, so that there are fewer liberal arts and 'pure' science graduates relative to other kinds of qualified people (Glover, 1999; UCAS, 1999). Third, the strongest growth has tended to be in business and management and related qualifications, for the staffing of commercial, financial, HRM and similar non-technical posts (Glover and Hughes, 1996; Storey, et. al., 1997). Fourth, ever higher proportions of engineers have been graduates rather than holders of sub-degree qualifications (McCormick, 1988; Smith and Whalley, 1997; Wyman, 1998). And finally, qualifications are much more varied - as well as numerous - than they were in previous decades (Glover and Hughes, 1996; Storey et. al., 1997).

Types of Manager: UK Managers in Context

Glover (1977) identified three types of job-holder. Traditionally, in the UK, and to a lesser extent in other English-speaking countries, *custodians* have tended to occupy senior jobs in industry and commerce as well as government and senior civil service posts. Their education has generally been deliberately non-vocational. Often described as 'generalists' or 'amateurs' (Granick, 1962), these people were products of early-mid-Victorian liberalism. The entrepreneurs who were the founding fathers of the Industrial Revolution were 'practical men' or 'players' who came from society's middle strata and were typically skilled craftsmen, yeomen or traders (Cloeman, 1973). However, it was often the ambition of these practical men to assume the leadership role which was exercised by the gentlemen in the countryside and thus to become gentlemen themselves. As this route to gentlemanly status became more tolerated, the sons and grandsons of industrialists were sent to learn gentlemanly arts and 'pure' science subjects at public schools and ancient universities, before returning to their family businesses (Coleman, 1973). Until the 1960s the universities were largely concerned with producing a governing class of politicians, civil servants, lawyers, doctors, academics, teachers and other traditional professionals and/or generalists rather than managers and organizational professionals such as accountants and engineers for industry and commerce (Fores and Glover, 1978). They were usually arts or pure science graduates of prestigious universities who were 'educated' not to be involved at the so-called sharp end, but to be relatively impartial, detached, disinterested and objective generalists.

Professionals were (and sometimes still are) the immediate subordinates of custodians and included engineers, accountants, marketing and sales specialists and personnel/HRM people (Glover, 1977). Historically in the UK the state tended not to become involved in the education and training of future expert specialists and middle managers. This created a vacuum which has been filled to a large extent by professionals. Professionals tended to be trained more 'narrowly' than custodians and were not necessarily considered potential senior managers. Before the expansion and the accelerated vocationalization of university education from the 1960s and 1970s they were usually school-leavers who were formed into professionals by part-time study and on-the-job training, but now they tend to be graduates who often qualify for membership of the relevant professional associations after gaining appropriate experience and/or sitting professional examinations (Glover and Tracey, 1997). In the case of the organizational professionals, such as engineers, IS specialists, marketing specialists, personnel/HRM people, and to a smaller extent management accountants, it is normally the case that membership of a professional association is optional.

In France, Germany, Scandinavia, and much of Continental Europe and to a lesser extent Japan, senior positions in industry, commerce and government have been, and continue to be, dominated by *technocrats* (Glover, 1977). The formation of technocrats in vocational higher education originated in sixteenth century France and expanded considerably in Napoleonic times. This method of producing top job holders was subsequently copied by much of Continental Europe. Technocrats were originally usually broadly educated engineers who had a thorough understanding of commercial, financial and other matters, but more recently (particularly since the

1980s) their ranks have included business economics graduates with diplomas which are partly similar to business studies or management degrees in the UK, but which include more economics (Lawrence, 1992). In general, such people are both broadly educated generalists like custodians and high powered experts like professionals, although Continental business economics graduates receive much less practical training while in higher education than engineers. Technocrats do not in general proclaim to be 'caring' like custodians and professionals in the UK: 'they are products of a more pragmatic tradition' (Glover, 1979: 591-2). They study a much wider range of subjects at secondary school than their counterparts in England and Wales and are normally educated to the equivalent of UK masters level.

Glover and Tracey (1997) added the category of *manager*, later *business manager* to this typology of job-holders. Business managers have their origins in the twentieth century and are usually Anglo-Saxon. They would normally have a management, business studies or business administration degree or an MBA and tend to staff commercial, marketing, HRM and other similar non-technical posts.. According to Glover and Tracey (1997) the four categories discussed above cover virtually all of the backgrounds of top and senior job holders in the UK and other advanced industrial countries with the exception of the unqualified 'practical man' (Barnett, 1972, pp 95, 96; Locke, 1984, 1989).

In the UK and elsewhere it is often the case that the backgrounds of people in industry and commerce combine parts of two or perhaps all of the above. Glover and Hughes (1996) argued that a professional-managerial class may have begun to develop in the

UK and that there has been a 'growing overlap of knowledge, understanding and in some cases skills, between the professional and other expert specialist occupations and functions within UK management. Lay, expert and practitioner understanding of what management level work consisted of and demanded had an increasingly accurate and holistic quality' (p.306). This is partly because of the development and expansion of higher education and partly because of the 'shake-up' of many of the professions in the 1980s when their 'caring' emphasis came to be regarded as dated and irrelevant. It was felt that they should become more financially accountable. There was a drive towards deregulation throughout the economy and society and a realisation that management needed to be more proactive as well as better qualified. The professions were expected to become part of this movement and more and more managerial controls were imposed upon most of them. UK managers increasingly tend to be professional specialists with business management qualifications, or business studies or similar kinds of graduate with professional qualifications. Thus it has been argued that UK managers are becoming more technocratic, while retaining aspects of the custodian (Glover and Tracey, 1997).

Glover and Tracey (1997) also identified three ways of producing, managing and organizing technical (broadly-defined) knowledge, skill and work across the industrial world. The *Professional-Managerial* approach formed expert labour partly through full-time education and partly through on-the-job and post-experience training. Expert labour tended to be subordinated to general management. Anglo-Saxon countries including the UK, the USA, Canada, Australia, New Zealand, and India were examples of this type. The *University-formed Technocratic* approach developed expert labour in full-time higher education, with employer help. Management was considered to be part of technical expertise, unlike the Professional-Managerial approach, where the opposite was the case. France, Germany, the Scandinavian countries and the Benelux countries were examples of this approach. The *Company-centred Technocratic* approach recruited expert labour from higher education but it was trained and developed beyond its theoretical base by employers. Management tended to be subordinated to, or part of, technical expertise. The main examples were Japan and other Far Eastern countries.

The Character of Management in the UK

Professionalism, Managerialism and Scientism

Glover (1991) and Glover and Kelly (1993) identified an 'unholy trinity' of professionalism, managerialism and scientism as significant features of UK management.

The ambition of specialist groups in management to achieve 'professional' standing has been seen as an idiosyncrasy of the English-speaking countries, and of the UK in particular (Anthony, 1986; Armstrong, 1984; Child, 1969; Glover, 1978a; Child et. al., 1983). According to Glover (1978a) the attraction of professional status to these groups was not a new phenomenon. The concept of professionalism can be traced to the development of the three classical professions of medicine, law and the clergy in the sixteenth century which considered status, social standing and gentlemanly ideology to be important parts of their identity. The development of professionalism in industry has its roots in the nineteenth century and came into being partly for social reasons and partly to help fill a vacuum in the provision of state education (Reader, 1966). The new middle classes which were developing during the eighteenth and nineteenth centuries, and which were becoming increasingly powerful, found the concept of professionalism very appealing. They created a number of occupational groups which developed their own study and qualifying associations and which thus became partly self-regulating. These groups used the term 'professional' in order to increase their status and market capacity. According to Reed and Anthony (1992), 'status-oriented professionalism facilitated and supported an expert division of labour *within* management that fostered distinctive occupational entry and mobility in specific functional areas. It also encouraged and legitimised hierarchical differentiations within each specialism of a particularly rigid kind. Segmentalism between and within managerial specialisms became the dominant organizational *motif* in the development of British management' (p.593).

This *laissez-faire* approach to state involvement in education and training has resulted in a confusing proliferation of occupations, professions and qualifications in the UK and has tended to encourage unnecessarily complex divisions of labour (Glover, 1978). Thus there were three types of quantity surveyor in the 1970s, and there still are four main types of accountant and 39 qualifying bodies for engineers. Britain has had what Glover (1977) called a 'non-system' of matching education and jobs with our most able people studying arts and natural science subjects at the better resourced institutions of higher education, while engineers were expected to learn their 'trade' on-the-job. Elements of the 'mismatch' (Glover, 1978) between professionalism and industry has apparently been partly to blame for the high levels of occupational specialization, problems of cross-fuctional integration and overly bureaucratic tendencies in UK companies (Child et.al., 1983).

Managerialism refers to the tendency to consider 'management' as a generalizable competence which is superior to specialist types of work and which encourages an arms'-length stance towards specialist tasks (Glover and Tracey, 1997). It is partly related to the employment of custodians, discussed above. It is 'an enabling generalism which prefers, and whose proponents self-interestedly pursue, the management *of* specialist work to management *in* it' (Glover and Tracey, 1997: 763; also see Enteman, 1993; Locke, 1996a).

Locke (1996a) was concerned with the effects of managerialism in the USA. He compared managerialism to militarism with its 'qualities of caste, cult, authority and belief' (Vagts, 1937:11). Locke believed that managerialism fostered an attitude of superiority towards specialist tasks, such as production, and the specialists which performed them. He argued that the US became an economic superpower in the first half of the nineteenth century by excellence in engineering, mass production and mass marketing. Its dominance was eroded after the Second World War by Germany and Japan which rejected US attempts to convert them to American managerialist management systems. US economic performance had suffered because of a combination of insular complacency and managerial self-aggrandisement.

Enteman (1993) discussed managerialism in a world context. He argued that mangerialism was replacing capitalism, socialism and democracy as the new and dominant political ideology throughout the world. These three ideologies were products of what he felt was the now completed process of industrialization. They were no longer valid in the late twentieth century and, in Enteman's view, were unworkable because of the different vested interests that they had come to be associated with. Managerialism was ultimately a force for evil which continually justified its existence by appealing to the material interests of managers and by simultaneously espousing and exploring for its own ends the notion of efficiency as a value.

Barsoux and Lawrence (1990) noted that UK managers were proud of being 'good all-rounders'. UK managers believed that anything could be managed by anyone providing they understood of the principles of management, which were universally applicable, and had common sense. Thus management was 'externalised' and separated from the technical aspects of work. '"Management" is seen as a set of jobs over and above other jobs' (p.109). One consequence of this, according to these writers, is that UK managers tend not to be technically sophisticated, as this is not considered to be either performance-enhancing or status-enhancing.

Glover (1997) argued that the tendency of UK senior managers to distance themselves from detail was not surprising given the decision of mid-Victorian politicians not to make engineering and business-related courses a significant part of the UK's higher education system and instead to prioritise other types of knowledge which were not especially or directly helpful to industry and commerce. It was not until the 1960s that UK universities began to significantly expand the provision of courses in engineering and business-related subjects. UK management's responses or 'solutions' to poor productivity and performance have sometimes been equally predictable. The use of management consultants and management 'fads' such as total quality management, human resource management, business process re-engineering, and so-called empowerment and right-sizing may be parts of the 'problem' under discussion. Fundamentally, these concepts are a continuation of management's arms'-length position. This does not mean that they are not helpful if used in the right way, but problems and challenges still tend not to be seen in a technical (including directly useful commercial or financial) light, for example in terms of better design or better after sales service and so on (Barsoux and Lawrence, 1990).

Scientism is the UK tendency to value the role of science rather than engineering in technical development, and in wealth creation more generally (Glover and Kelly, 1993). In the UK we distinguish between arts and sciences. This distinction was formalised and became more deeply engrained after Sir Charles Snow's famous 'Two Cultures' lecture at Cambridge in 1959. Engineering does not fit neatly into either of these categories. Snow 'solved' this problem by following the traditional UK practice of splitting science into two branches, namely 'pure' and 'applied', with engineering being the latter. In the UK, pure science is considered central to the process of technical development (Jewkes, Sawers and Stillerman, 1969). The role of the pure scientist is to generate general scientific data, principles, theories or laws which are then translated into new products and processes by the applied scientist (i.e. the engineer). Thus engineering is the application of science. Pure science is more important than applied because the latter is dependent on the former. This British view of technical change has been called the Science leads to Technology leads to Hardware view (Sorge and Hartmann, 1980) and its origins can be traced to the eighteenth century when science was considered to be a worthwhile hobby for gentleman, while engineering was considered to be the domain of those from the lower classes (Coleman, 1973).

However, as far as can be established, science is rarely the source of technical change (Lawrence, 1980). Technical change tends to have a cumulative yet unpredictable quality. The use of scientific knowledge may or may not be part of the process, but technical change is, fundamentally and of course by definition, a process which builds on, and is dependent on, previous technical change. It consists of responses to technical problems and consists of gradual and perceived improvements (Jewkes, Sawers and Stillerman, 1969; Langrish et. al., 1972). The term applied science also implies a congruence between science and engineering, with the latter playing a supporting role. Again, this is very misleading. The output of science is knowledge, while the output of engineering consists of three dimensional artefacts (Lawrence, 1980). Scientists work in laboratories where the environment is relatively controlled. Engineers usually work 'on site' where undesirable variables must be managed as they often cannot be controlled. 'Scientists who study things, seek ideal solutions and universally valid laws. Engineers who make things, seek workable solutions which do not cost too much. In short the "applied science" label is damaging and misleading' (Lawrence, 1980: 96).

Business Management versus *Technik*

Broadly speaking, two contrasting general and ideal-typical philosophies of management and organization have been identified: Business Management and *Technik* (Glover and Tracey, 1997). In recent decades the former has usually been found in the English-speaking countries and it exhibits the features discussed above. The *Technik* countries include France, Germany, Sweden, the Netherlands and Japan. In several respects *Technik* can be considered to be opposed to the Business Management approach. According to Glover and Hughes (1996), *Technik* 'tends to emphasize the value of production, process, the long-term, management *in* specialist activities, and the more positive side of the state's role in economic life' while the Business Management Model 'stresses consumption, outcome, the short-term, management *of* specialist activities, and the more negative side of the state's role' (p.5).

It was noted above that managers in Continental Europe and Japan, which have been called technocrats, tend to be both broadly educated generalists like custodians regard themselves as being and high powered experts like some professionals. In these countries the state was much more involved, normally from the nineteenth century onwards, in the education, training and employment of members of middle-class and (more often than not) other occupations, and independent 'professional' qualifying associations were generally seen as unnecessary (Fores and Glover, 1976, 1978; Glover, 1977; Sorge, 1979). Instead, the high standing of members of occupations such as medicine, law, accountancy and engineering depended on their work and their contributions to society and upon their elite educational backgrounds. Specialist and often very superior institutions of higher education were developed explicitly for the benefit of industry and commerce and were more successful in the process of matching education and jobs than their counterparts in the UK (Fores and Glover, 1976, 1978). Although professional associations do exist on the Continent, they are generally only learned and representative bodies, and they do not construct qualifications or control entry to specialised high-status forms of work and employment (see for example Sorge, 1979, and Jarausch, 1990).

In the *Technik* countries managers tend to take a very different view of the management of specialist tasks and have a much more specific understanding of their work (Glover and Tracey, 1997). In Germany for example there is a 'valorisation of specialism, especially technical specialism' (Lawrence, 1997). All jobs are seen as requiring a mixture of technical and management skills, but managers tend to consider themselves as specialists first and managers second (Barsoux and Lawrence, 1990). This approach emphasises management *in* specialist activities rather than the management *of* specialist activities as is the case in the English speaking countries (Glover and Hughes, 1996).

The *Technik* counties also take a very different approach to technical development (Glover and Tracey, 1997). Indeed, the label 'applied science' is peculiar to the English language (Glover and Kelly, 1993). Snow's two cultures thesis would be difficult to express both culturally and linguistically because knowledge is classified in a different way. In Germany for example the term *Wissenschaft* refers to all formal knowledge and subjects, including what the British call the arts, the natural sciences and the social sciences. *Kunst* refers to art in the sense of the fine and performing or 'doing' arts such as painting, writing, opera and sculpture. (The study of these is part of *Wissenschaft*). The term *Technik* is used to describe the knowledge and skills which are relevant to manufacturing. Engineers and engineering knowledge are of course central to this (Fores and Rey, 1979). In Germany and in much of Continental Europe, science and engineering are considered to be types of knowledge which, broadly speaking, are unrelated. Engineering is the art of making things which are useful (Lawrence, 1980). This relies on a process of gradual improvement and modification. Unlike the English-speaking countries technical change is viewed as a response to technical problems which may, but usually do not, require the use of newer scientific knowledge (Jewkes, Sawers and Stillerman, 1969; Langrish et. al., 1972; Barsoux and Lawrence, 1990).

The skills needed and tasks performed in Continental European *Technik* and in English language applied science are the same, but their essential nature and purposes are very different. *Technik* focuses on the product, its design and the processes involved in making it. Applied science focuses on the input of knowledge which is apparently important to the manufacturing process and is less concerned with the three dimensional object being produced (Fores and Rey, 1979). The word *Technik* has no equivalent in the English language. The word 'technique', which means a skill or art applied to a particular task, is not a precisely suitable translation as it does not necessarily relate to engineering or manufacturing. The word 'technology' is also unsuitable, partly because of its vagueness and partly because although it conveys the relevant knowledge, it does not convey the ingenious and unpredictable mixture of skills of many kinds which is inherent in the word *Technik* (Glover and Kelly, 1987).

Implicit in the above discussion of the Business Management and *Technik* approaches is a perception that the latter is superior to the former in most respects. If the post-war economic performance of much of Continental Europe and of Japan are compared to the UK and the US, this might not seem unreasonable. However, since the 1970s the most prominent Business Management countries, the US and the UK, have taken some significant steps to improve their performance. During the 1980s economic growth in the UK and the US was about equal with the *Technik* countries of Continental Europe, and during the 1990s it has usually been better (Crafts, 1991; Owen, 1999). Japan's growth until recently has been consistently higher during both decades, but has not been without its problems which appear to have been (and to be) partly due to its financial system (Ozawa, 1999).

In the UK since the 1960s there has been considerable and useful development in higher vocational education both in universities and in non-university institutions (Glover and Hughes, 1996). A number of new types of subjects and courses have been developed, particularly although far from entirely in and around the area of business and management. The emphasis of tertiary education has shifted in about a generation from the academic to the vocational. A significant part of this change has been the development of courses which combine commercial, technical, financial and other subjects. Many of the changes have been hard-nosed, vigorous, forceful and imaginative (Glover and Hughes, 1996). According to Glover and Hughes (1996) and

Glover (1999), UK graduates, managers and professionals are increasingly likely to hold a combination of vocational and non-vocational, technical, scientific, commercial, professional and managerial qualifications. These authors argue that attitudes towards management and organization, education and training and occupation formation are becoming more proactive and concerned with detail and less arms'-length. Thus the UK is combining the *Technik* and Business Management philosophies of managing and organizing. It has been constructing 'a sophisticated professional (specialist) and managerial (generalist) class or stratum of senior job holders for employment across most activity sectors' (Glover and Tracey, 1999). This comprises, of course, the development of a professional-managerial class (Glover and Hughes, 1996) discussed above. Such changes suggest that the UK economy may be able to leapfrog, or at least to challenge much more closely, its recently more successful rivals who have perhaps become a little set in their ways.

Conclusion

Most studies of the backgrounds of UK managers are dated. The data on the occupational backgrounds of managers are particularly weak. The available evidence suggests that UK managers have until recently been much less likely to be graduates than their counterparts in competitor countries. In what appears to be the most recent study Barry, Bosworth and Wilson (1997) pieced together evidence from a number of disparate sources about the occupational backgrounds of managing directors of manufacturing companies. They found that engineers outnumbered accountants by three to one, and pointed out that accountants have never outnumbered engineers in the management of manufacturing companies.

A number of trends about UK managers appeared to be emerging. Managers were increasingly likely to be qualified to degree/professional level, qualifications were becoming more relevant to jobs, business and management qualifications were the fastest growing type of qualification, increasing numbers of the graduates in manufacturing management were engineers, and qualifications were more varied than they had been in the past. Two contrasting philosophies of management and organization were discussed: Business Management and *Technik.* Partly as a result of the developments in higher vocational education discussed above, Glover and Hughes (1996) argued that a professional-managerial class or stratum may have begun to develop in the UK. This could perhaps be considered as a fusion of the Business Management and *Technik* philosophies of management and organization which has made the possibility of the UK leapfrogging, or at least challenging much more closely, its recently more successful rivals in terms of management quality as 'defined' by qualifications. In the following chapter, chapter 4, evidence about the relationships between functions in manufacturing and construction is considered. The purpose of this chapter is to contextualise the role of engineers in manufacturing and construction management.

CHAPTER 4

RELATIONSHIPS IN MANAGEMENT

Introduction

In this chapter writing and evidence about the roles and influence of the organizational professions in manufacturing and construction are discussed. The chapter begins by looking at some theories of power which are relevant to this discussion. In manufacturing, the positions of engineers and accountants are of particular interest, as is the possible role of the financial system in explaining the oft-presumed dominance of the latter. In construction, the focus to some extent is on how the influence of the main professions appears to depend on the methods of contracting adopted by clients.

Power, Conflict and Co-operation

In manufacturing companies, as elsewhere, specialists have tended to be organized in different departments based around functional specialisms. Most engineers work in technical specialist functions like design, engineering, production and so on. Engineers of all kinds do, of course, come into contact with other types of specialist, particularly accountants and marketing and sales specialists and to a much smaller extent personnel or HR people. These groups are often employed together in project teams, particularly during product development. In construction, engineers usually work with architects and quantity surveyors. Relationships between functional groups in management have received much less attention over the years than relationships between management and labour. However, there are a number of frameworks which may be suitable for considering the former.

Sherif and Sherif (1953) conducted a well-known social psychological experiment about group formation and inter-group conflict and co-operation. The authors used summer camps for boys as their setting so that conditions could be controlled. The groups were informal and consisted of boys from the same ethnic and socio-economic backgrounds who did not know each other before the camp. The experiment was split into three stages. The first allowed groups and friendships to form with minimal interference. The boys were allowed to choose where they sat at meal times, which bunks they slept in and the activities in which they participated. Small cliques were formed and leaders and their assistants emerged.

The second stage looked at co-operation within groups. The boys were divided into two groups. They had no say in which group they were placed and some of them were visibly upset about being separated from friends whom they had made in stage one. The groups were placed in situations and engaged in activities which required co-operation in order to achieve common goals. Hierarchical structures developed within each group and the roles and statuses of group members became clearly defined. The boys increasingly began to identify with members of their own groups and this resulted in shifts or reversals of friendships which had been established in stage one. Rituals, nicknames, group names, songs and secret symbols were adopted by each group, as well as sanctions for behaviour which was considered contrary to group norms or to the aims of the group.

The third stage was designed to examine inter-group conflict. The two groups were brought into competitive situations by playing games such as tug-of-war and baseball. This created considerable animosity between them. Indeed one boy who had rated another as a 'best friend' in stage one now gave him a negative rating. The effect of this hostility was to solidify the sense of belongingness within each group. Individual friendships within the groups were also strengthened. Later, when activities were introduced which required the two groups to interact in situations which were not competitive, conflict between the groups increased rather than decreased. Only when tasks required mutual assistance between groups did both groups co-operate to achieve their goal.

A number of conclusions, relevant to this chapter, can be drawn from this study. First, conflict cannot be attributed solely to personality clashes but is partly due structural conditions. Second, cohesion and team spirit within groups tends to be highest when conflict between groups is highest. Finally, and most importantly, relationships between groups tends to be strongest when they cooperate to achieve a superordinate goal.

Lukes (1973) described 'three faces of power'. The first was the simplest and involved the actual exercise of power. Thus A forces B or C to do something that they would not otherwise do. B or C may resist A leading to conflict. The second was concerned with non-decision-making as well as decision-making. It considered the ways in which some interest groups had the power to define what is reasonable and valid while declaring or implying that the views of other interest groups were neither. Thus, issues could be kept off agendas if there was 'an observable *conflict* of (subjective) *interests* seen as embodied in express policy preferences and sub-political grievances' (p.20). Power was exercised by suppressing the preferences of other groups so that they were unable to resist or engage in conflict. Lukes' third face of power was more radical and was concerned with latent conflict. He argued that powerful groups within organizations may have the ability to influence and even to determine other people's aspirations and horizons. Thus the latter were not even able to formulate their real interests consciously.

Crozier and Friedberg (1980) argued that game theory was a useful way for understanding conflict between groups: 'We propose to consider [the functioning of an organization] as the result of a series of games participated in by the various organizational actors. By defining the possibilities for gain and loss, the formal and informal rules of these games delimit a range of rational or "winning" strategies, which the actors can adopt if they wish their involvement in the organization to serve, or, at least, not to disserve, their personal aspirations... To say that players play games in no way implies that there is any initial equality whatsoever amongst them or that there is any consensus as to the rules of the game' (p.57). According to these authors organizations are political arenas as well as cooperative groupings of people. Each group usually tries to maximise the number of options available to it while limiting those of its 'competitors', making it easier to ascertain how they are likely to behave. In a similar vein Clegg (1975) compared the relationships between different groups within organizations to chess. 'To the extent that all pieces were able to negotiate their positions more or less, there is a game with a fixed number of pieces; that piece which ended up ruling the greatest number of pieces, serving its interest in preference to theirs, would be the most powerful' (p.49).

According to Armstrong (1984, 1985) the organizational professions in manufacturing, such as engineering, accountancy and personnel management, had been engaged in a competition to become the most important group in the 'global function of capital' (Carchedi, 1977), meaning the combination of activities performed by senior managers in companies which used to be performed by the individual capitalist. Armstrong argued that each group had attempted to develop management control strategies to achieve a dominant position in management by offering solutions to crises within the global function of capital which relied on its professional expertise. Control strategies were developed using existing specialist knowledge for three reasons. First, by imparting only the more basic elements of professional knowledge to people in junior positions, senior members of the profession could reinforce their position in companies. Second, if candidates for promotion were required to hold professional qualifications, competition for senior positions was reduced. Finally, having a hierarchy within a profession implied that there was a managerial element involved in its work. This reinforced members' claims that they should be employed in senior positions.

According to Hickson (1987) there was a dual rationality within organizations. Managers were continually involved in solving problems and seeking to implement rational solutions. However, there were different groups and individuals which wanted to impose their own agendas. Virtually all activities and decisions taken involved some degree of tension between these two kinds of objective. Decisions were not necessarily taken because they were in the best interests of whole organizations, but often reflected the abilities of particular groups to impose their definitions of their situations and their solutions on other groups.

Abbott (1988) also discussed competition between (and within) professional groups working in organizations. He used the term 'professional jurisdiction' to describe the content, control and differentiation of bodies of expertise. Jurisdictions were created in work and anchored in formal and informal social structures. Boundaries between jurisdictions were being continually contested. Control of skills and knowledge and of the ways in which they were used were perpetually called into question. Competition between professions was inevitable and new professions emerged where new skills and knowledge emerged or old ones were relinquished by other groups. Thus there was a 'system' of professions, all competing for a mixture of distinct and overlapping jurisdictions.

A common feature of the work discussed above is that different groups within organizations are in competition with each other for power and for resources. In the remainder of this chapter the literature about the roles and influence of the main professional groups in manufacturing and construction is discussed. Implicit in much of it is that such groups are indeed in competition with each other and that they often prioritise their professional or departmental objectives over and above corporate ones in the case of manufacturing and clients' ones in the case of construction. This would appear to be linked to the notion of professionalism discussed in the previous chapter. Sorge (1979) argued that relationships between functional groups in German and French manufacturing were less problematic than in the UK. He believed that this could be explained to a large extent by considering their education and training systems. In France and Germany the state had played a much more significant role in the formation of managers in industry over the past 150 to 200 years than in the UK where the lack of university level training was filled to some extent by the professions. These encouraged their members to consider themselves as professionals whose priorities may differ from other groups rather than as members of teams whose objectives were congruous, as was the case in France and Germany.

Manufacturing Management

Accountants and Engineers

In manufacturing companies the main functions are design and development, production, finance, marketing and sales, and personnel/HRM. As was noted above, these specialists may be 'competing' with each other for power, influence, resources, and promotion. The relative influence of the organizational professions in manufacturing has been a focus of attention for some writers (see, for example, Armstrong, 1984, 1985, 1987a; Glover and Kelly, 1987; Lee and Smith, 1992; Barry, Bosworth and Wilson, 1997). When statements are made about the 'low status' of engineering or the dominance of accounting, there is often a lack of evidence in support. This is possibly because there is very little evidence, or at least recent evidence. It was noted earlier in this chapter that there appears only to have been one academic study of the backgrounds and careers of UK manufacturing managers in the last fifteen years (Barry, Bosworth and Wilson, 1997), and as far as the author is aware there have only been five studies which examine the relationships between the professions in UK manufacturing, all but one of which was conducted in the 1990s (Beuret and Webb, 1983; Webb, 1992; Lam, 1994, 1996; Cannain, 1995; Bresnen and Fowler, 1996). Many writers appear to have assumed that there is a particular hierarchy between functional groups without a strong body of evidence to support their claims (Armstrong, 1984, 1985, 1987a; Glover and Kelly, 1987; Lee and Smith, 1992; Smith and Whalley, 1986).

Nevertheless, there is strong agreement among most academics (coming from diverse angles and writing at different times) that accountants are, or at least were, the most influential group in manufacturing management, that engineers have tended to be marginalised in it, and that engineers have tended to be less involved in strategic decision making than their colleagues with expertise in finance and accounting, and to a smaller extent than marketing and sales. Glover and Kelly (1987) wrote that engineers 'appear to be employed, not as potential senior managers, but as technical specialists whose assumed lack of wider knowledge and social skills makes them unsuitable for promotion to top posts in which knowledge of finance, markets and the general commercial and political environment is needed... Finance, marketing and even personnel and research offer easier routes to the top than production and related functions' (p.28). In a later chapter they argued that engineers and accountants tended to have rather difficult relationships: 'Engineers and accountants often appear to have little in common and to dislike each other. Some engineers seem to think that water runs in the veins of accountants and accountants sometimes believe that engineers are self-indulgent spendthrifts' (p.144). However they added that it was unwise and unfair for engineers to think habitually of accountants in this way and that there was an element of 'shooting the messenger' in engineers expressing such views.

Lee and Smith (1991) also believed that non-technical functions tended to be more influential than technical ones: 'functional differentiation has long persisted as the central organizational structure within British companies... They [engineers] are concerned with productive activity, which in Britain has less strategic value than marketing, finance and general management' (p.3-4). In a similar vein Meiksins and Smith (1996) noted that 'the spread of graduate status has not created a fast track into management for engineers and their identity remains tainted with manual connotations' (p.56). Alexeichenko (1996) believed that 'the low prestige of engineering is maintained by the employers and senior managers who... provide them with comparatively poor pay rates and promotion prospects against other specialisms such as marketing and accountancy' (p.6).

The Financial System

Although the literature identifies a number of difficulties which UK engineers apparently encounter, and which are discussed in the following chapter, explanations for the apparent dominance of accountants and the supposedly weak position of engineers in UK manufacturing have tended to focus on one or more aspects of the UK's financial system. Broadly speaking, there are three strands to this argument and they relate to three aspects of financial systems. First, it has been argued that the close relationship between German and Japanese banks and industrial managements has resulted in companies being able to rely on relatively stable, long-term supplies of capital (Armstrong, 1987a; Charkham, 1994). Banks have a genuine interest in the well-being of companies so they go to great lengths to ensure that they do not fail (Armstrong, 1997a). In the UK, however, it is argued that there is not, and that there has never been, a close relationship between the banks and industry, and that a lack of capital has always been a serious problem for British companies (Higgins and Clegg, 1988). Thus their managers have been 'forced to devote a considerable proportion of their energies to the search for long-term finance from the stock exchanges and elsewhere. In these circumstances, the priorities and expertise of the accountant were more relevant to the well-being of the enterprise than those of the engineer, especially in times of crisis' (Armstrong, 1987a: 435).

Ackroyd and Lawrenson (1996) supported this view. They believed that the unwillingness of British banks to provide long-term finance to companies in the vehicles industry between around 1920 and 1960 often led to them having cash flow problems. This was interpreted as incompetence on the part of management. Most senior manufacturing managers were engineers during this time. The 'solution' was to reduce the executive powers and responsibilities of engineers, particularly in senior positions, and to increase those of accountants and other non-technical specialists. This trend became more marked during the 1950s and 1960s when large numbers of amalgamations and rationalisations took place. Thus 'accountancy – and financial expertise more generally – was defined as the antidote to the failure of management based on engineering, promoting the view that accountancy rather than engineering was a more reliable basis for executive decisions' (p.187).

Second, it is argued that shareholders in British firms do not become actively involved in the operation of firms as in Germany (Fukao, 1995). Nor do they identify with them as in both Germany and Japan (Higgins and Clegg, 1988). There is often very little shareholder representation on company boards and therefore it is difficult for shareholders to influence the actions of senior managements or to prevent decisions being made which are against their own interests. Both the source and the consequence of this low degree of involvement and control is the dispersed nature of British share ownership which is dominated by financial institutions such as pension funds, life assurance firms and mutual funds, which tend to hold less than five per cent of equity in the case of each institution (Hutton, 1996). The aim of investors is to maximise returns in the shortest time possible. It is also very easy for shareholders to move their investments elsewhere. Although senior managers appear to have freedom to make decisions, in reality the importance of share price forces directors to consider the possible reactions to their decisions in the City of London (Higgins and Clegg, 1988). Also, the stock market gathers only limited information about a company's prospects. Fund managers generally lack the knowledge and expertise needed to evaluate the technical advances being made by manufacturing companies and are more concerned about financial results and the high level of dividend payments to shareholders which are necessary if their confidence is to be retained. This constant need to 'prove financial performance makes for a concentration of accountants in top management positions and keeps firms focused on financial rather than production performance' (Lane, 1995: 51).

The third argument relates to the apparent expansion of UK companies through mergers and divestments, sometimes hostile and sometimes not, rather than through internal expansion as is the case in Germany and Japan. The merger boom in UK manufacturing during the 1950s and 1960s and the subsequent introduction of the multi-divisional form of organization, recommended by American management consultants a means of managing the resultant conglomerates, as discussed in chapter 2, are clearly relevant here (Williams et. al., 1983; Armstrong, 1987b; Ackroyd and Lawrenson, 1996). Power and talent began to centre on head offices and to move away from factories. Skill in finance and marketing rather than in engineering were apparently increasingly regarded as the major components of management, and strict budgetary controls were imposed on functional departments. Performance was measured purely in financial terms and there was a subordination of technical to financial and other non-technical objectives. Accountancy appeared to become the dominant discourse in manufacturing management partly because it provided a means by which business performance in all areas could be evaluated. This apparently led to significantly increased proportions of accountants in senior positions, mainly at the expense of engineers.

Fligstein (1990) was an important contributor to this argument. He believed that an important issue for manufacturing companies in the Anglo-Saxon economies was 'conceptions of control'. This was a 'perspective on how firms ought to solve their competitive problems' (p.12). He described four conceptions of control. Each conception of control was dominant during different periods from 1860 to the present day. Different kinds of manager apparently dominated manufacturing managements during different conceptions of control. The first was the conception of direct control. This lasted from around 1860 until the beginning of the twentieth century and was an era during which entrepreneurs were the driving force behind companies. They directed most of their efforts into undermining their competitors. There were few rules governing behaviour between companies and firms often used clandestine tactics aimed at reducing competition. This was followed by the manufacturing conception of control which lasted from around the beginning of the twentieth century to the beginning of the Second World War. During this period it was felt that stable, reliable, cost-effective production was the most important way of achieving competitive advantage. As efficient production depended to a very large extent on engineering expertise, engineers replaced entrepreneurs as the most influential group in manufacturing.

The sales and marketing conception of control lasted from about the end of the Second World War until about 1970. This focused attention on finding, creating and keeping markets. Product differentiation and advertising were considered important strategies. Thus marketing and sales specialists became increasingly influential in manufacturing at the expense of engineers. Finally, the finance conception of control, which lasted from around 1970 to the present day, emphasised control through the use of financial tools. This conception of control viewed firms 'as collections of assets earning different rates of return, not as producers of goods' (1990: 15). Its goal was to maximise growth and therefore profits. The easiest way to achieve growth was through acquisition. Product lines were selected on the basis of profitability, and therefore financial knowledge became more important than engineering or sales and marketing expertise: 'since the goal is to increase assets and profits... finance driven firms are no longer industrial based' (1990: 15). Leveraged buyouts, stock repurchases, and corporate restructuring, which were all integral to the financial conception of control, had become essential strategies for growth and profit in large firms.

Accountants, Engineers and Managerialism

Armstrong (1987a) took these arguments a step further. Earlier in this chapter it was noted that Armstrong (1984, 1985, 1987b) argued that the organizational professions in manufacturing had been competing with each other for power and influence. They had attempted to achieve a dominant position by offering solutions to problems which relied on their particular professional expertise. Engineers had initially managed to obtain a pre-eminent position by offering Taylorism as a solution to the problems of organizing labour. However, according to Armstrong, for any strategy to be successful it must be monopolised. The problem with scientific management was that it was too lucid and generalisable - it could be understood by others and separated from and elevated above engineering. At the beginning of the twentieth century an 'elite' group of engineers or 'methods managers' began to specialise in the control of labour leaving the majority of engineers as technical specialists who were subordinated to a minority. Similarly, and around the same time, cost accounting techniques, which were developed by engineers and were a crucial part of scientific management, were 'annexed' (1985: 139) by the accountancy profession and incorporated into mainstream accounting. Thus it was accountants and not engineers who, by monitoring production and allocating resources, succeeded engineers as the group best able to offer a solution to the problem of controlling labour.

However, the dominance of accountants could only be fully explained by considering the nature of the UK's financial system, discussed above, particularly the problems of long-term capital and the introduction of the multi-divisional form of organization following the restructuring of much of manufacturing after the Second World War. He believed that because managements were mainly concerned with financial and other non-technical issues, there was 'an ideological divorce of management from the mental labour of production' (p. 428). Management was concerned exclusively with 'with the administration of the capitalist enterprise' (p.428) and was separated conceptually from the production of the goods for sale. It became 'a thing-in-itself... [and] is seen as a state of 'being' not of 'doing'' (p.428). Armstrong (1987a) used the ideas of Alan Fox (1974) to analyse the employment relationship between engineers and other management groups. Fox had distinguished between low and high discretion 'syndromes' which were usually associated with low and high levels of trust. High discretion tasks allowed individuals to rely on their own judgement and expertise and employees were expected to act in 'moral' ways with regard to company interests. To encourage this, employers used training, indoctrination and social assimilation. Low discretion tasks were subjected to supervision, observation, formality and clearly specified instructions. Employees had few opportunities to use their initiative. However, high discretion tasks did not always correlate with high levels of trust. Where an employment relationship fell within the high-discretion, low-trust syndrome, elements of mistrust were built into structures and procedures. This was the position in which engineers found themselves, according to Armstrong.

Armstrong further distinguished between 'unproductive' and 'productive' labour. The former were employees engaged in the capitalist administration of companies, while the latter were involved in the production of goods or services. He termed engineers 'intellectual productive labour'. Other occupations which competed with engineers for senior management positions, such as accountants, personnel people and marketing and sales specialists, were termed 'intellectual unproductive labour'. Armstrong argued that in the UK there had been an effort to professionalise management by establishing a body of knowledge which was universally applicable and which consisted of a mixture of the expertise possessed by employees who were intellectual unproductive labour, and in particular finance and accounting, but which contained little or no engineering element. Thus, 'taking Fox's point that admission to high-trust positions depend on demonstrating a commitment to the values of those who control access to them, the dilemma for engineers is clear. They can only demonstrate their eligibility for senior positions by renouncing any claim which they might make on their distinctive expertise as engineers' (p.429-30). Therefore, although the creative nature of engineers' work made high levels of discretion essential, this was restricted by 'overarching controls' (p.426) imposed by managers who were intellectual unproductive labour. Productive and unproductive intellectual labour were 'assigned to separate positions and the latter placed in authority over the former' (p.427).

Armstrong's thesis is probably the most widely accepted and cited one in explaining the apparent dominance of accountants in UK industry and has never been widely or strongly challenged. One possible exception to this is some work by Matthews, Anderson and Edwards (1997, 1998). These authors argued that although it was probable that 'increased scale [due to mergers], corporate distress, and changes in the financial environment all contributed something to the growing demand from business for accountants... the most satisfactory explanation... relates to the quality of the recruits to the profession and the fact that, until very recently, the accountant's articles were virtually the only formal management training available in Britain' (1997: 421-423). Thus the vacuum which existed in the provision of 'management training' by companies and the universities was apparently at least partly filled by the accountancy profession. Although other professions did provide their members with various aspects of management training they were apparently much narrower and less relevant than that provided by the accountancy profession.

The Financial System and Accountants Again

It is not the purpose of this thesis to explore the merits or otherwise of the UK's financial system. It is discussed here only because some writers have suggested that it affects the position of engineers and their colleagues. However, others do not accept that UK industry suffers from a shortage of capital or from short-termism. Some of these views are explored briefly to give a possibly more balanced view.

According to Holden, Mathews and Thompson (1995), as with industrial companies in all of the OECD economies, retained earnings are their dominant source of finance, but contrary to popular belief banks are the main source of external finance in the UK with the markets providing a much smaller, indeed relatively insignificant amount. The Radcliffe Committee (1959), the Prices and Incomes Board (1967), the Bolton Committee (1971) and the Wilson Committee (1980) all examined the provision of finance in Britain in terms of cost and availability and concluded that British companies have not been disadvantaged compared with their foreign counterparts. More recent evidence also suggests that long-term bank finance is not more easily available in Germany than in Britain (Mayer and Alexander, 1990).

Kay and Silberston (1995) did not believe that shareholders in the UK were pre-occupied by short term gains. They argued that although companies tended to be monitored on a quarterly or annual basis, it did not necessarily follow that they would operate on these time scales: 'Indeed, that is to misunderstand the fundamental role of a stock market, which is to enable the time horizons of investors to be divorced from the time horizons of the firms in which they invest' (p.91). Furthermore, Mayer (1997) argued that although hostile takeovers were more common in the UK than in Germany, share ownership was no more stable in the latter than in the former. Relationships between German banks, shareholders and companies were not as close as was commonly thought: 'The picture of long-term stable share ownership with banks supporting incumbent management does not appear to accord with reality in Germany... partial sales of share stakes are commonplace and appear to have similar control properties to those associated with a market for corporate control in the UK and US... Far from preserving stability, banks may play an important role in facilitating the covert acquisition of shares by potential predators' (p.296).

The influence of the financial system on the position of engineers is unclear. As was noted earlier, it is not the aim of this study to investigate this. However, the study is concerned with whether engineers feel that there is too much focus on financial rather than technical matters, and how engineers feel about their influence in companies in relation to accountants. Although the consensus continues to be that accountants are the most influential management group in manufacturing management, Barry, Bosworth and Wilson (1997) and Roslender, Glover and Kelly (1999) offer a different perspective. The former's study of the occupational backgrounds of managing directors in UK manufacturing was discussed in chapter 3. They pieced together their evidence from a number of sources and concluded that engineers outnumbered accountants by three to one and also that 'any person with aptitude who wants to get to the top in... manufacturing... has the best chance if he or she first becomes an engineer' (p.28).

While Roslender, Glover and Kelly (1999) believed that accountants remained, in general, a very influential group across the UK's economy as a whole, they argued that this situation was not guaranteed to continue in the future: 'there are a number of problems facing the profession which lead us to conclude that it may well have seen better days and consequently for many accountants the future is potentially rather imperfect' (p.199). Five problems were identified and discussed. First, the popularity of accountancy as a career meant that it was likely that there would be an oversupply of professionally qualified accountants in the near future. Second, a professional accounting qualification was in general only necessary for auditing and insolvency. Thus most work carried out by accountants in manufacturing companies and elsewhere outwith private practice did not require accounting qualifications. Given the increasingly large numbers of graduates in accountancy many of whom may not feel that they require further professional training, the increased numbers of Masters degrees in accountancy and finance, and the significant accounting content in many business-oriented undergraduate and post-graduate degrees over and above those in accountancy and finance, it was possible that an increasing proportion of accountants would not be professionally qualified.

Furthermore, companies increasingly recruited all kinds of vocational graduate, including engineers, for whom accounting and finance no longer held much mystery, mainly because they had studied financial subjects as part of their degrees. Perhaps they had taken a finance option while they were undergraduates or perhaps they had studied for one of the Masters degrees discussed above. It is perfectly feasible for engineers, therefore, perhaps with MBA degrees or with Masters degrees in accounting, banking or finance, to be employed in financial roles in manufacturing, and in general most younger engineers have a greater understanding of financial matters than in the past, partly because of the increased 'management' content in most undergraduate engineering degrees. Roslender, Glover and Kelly also argued that much routine and other accounting and financial work was increasingly embodied in software packages which also organised the performance of such related tasks as sales analysis, stock control, elements of marketing research and management, and human resource management. Therefore accountants no longer monopolised the skills and knowledge needed for their work to anything like the extent that they once did.

Third, accounting technicians were emerging as serious competitors for the many accounting jobs previously held by qualified or partly qualified accountants. Fourth, it was increasingly recognised that organization of the profession's associations was not as effective as it could be. Finally, and partly as a result of recent financial scandals and partly because of the general concern with management quality in the UK, the accountancy profession was no longer held in the esteem it once was.

Marketing and Sales Specialists

Perhaps because the UK has long been 'a nation of shopkeepers' to an extent that management research has tended to take them for granted, there has been less focus on marketing and sales specialists in manufacturing than on others such as accountants and engineers. However, some writers have discussed their roles in UK companies more generally. Bresnen and Fowler (1996) argued that despite increased emphasis being placed on marketing as an activity, practitioners had not managed 'to assert its strategic significance and establish clear boundaries around a specialist body of knowledge' (p.161). As a result, marketing was increasingly regarded as a general management responsibility to be performed by everyone rather than confined to specialists.

With the above in mind it is perhaps not surprising that Whittington and Whipp (1991) believed that 'the threat to marketing is that its flexible ideology will become confused with, or deliberately hijacked by, quite different programmes for change. Marketing in its purer sense risks becoming tainted by broader initiatives opportunistically exploiting its legitimacy. The challenge for marketers, therefore, is to retain control over their own ideological resource' (p.56). These authors argued that in order for marketing managers to increase their influence, they needed to make their expertise as inaccessible as possible to managers from other functions. This hardly seems constructive and in the best interests of British industry. Indeed it would be difficult to argue that the fixation on competition between professions which features so extensively in the literature could have anything other than negative consequences for profitability.

This last view was supported by Bathie (1999). He criticised the marketing profession for being more concerned with the ideology of professionalization than with the practice of marketing. The Chartered Institute of Marketing had put much effort into developing codes of practice, ethics of confidentiality, professional qualifications and professional discipline. They had marketed marketing as a functional specialism which consisted of a very narrow range of skills in the hope that it would become the dominant function in companies. This had 'resulted in and will predictably continue to result in negative effects on marketing's progress' (p.191). Bathie questioned the notion that marketing, or indeed any function, could or should dominate companies. It was not even in the marketing profession's best interests to do so. What was needed, both for effective marketing and for organizational success, was the adoption of a marketing orientation by people in all functions.

According to Pitt and Morris (1995), this had already happened in many companies. They argued that in some respects, marketing was a victim of its own success. Marketing measures of performance such as customer satisfaction and 'share of the customer' (rather than market share) were challenging financial indicators as the most accurate way of measuring company performance. More significantly the distinction between marketing and strategy had become blurred: 'it is our contention that a process of unification between marketing and strategy is occurring' (p.23). This is persuasive: one would expect to see such a trend in an advanced, increasingly affluent, capitalist society. However, marketing's success had not resulted in marketing managers becoming more influential as such. Instead, and in a similar vein to Bresnen and Fowler (1996) and Whittington and Whipp (1991) discussed above, these authors believed that marketing was increasingly performed by managers in all functions rather than by marketing and sales specialists. As a result many marketing professionals were in danger of disappearing completely. Specialists with expertise in database marketing, market research, advertising and promotion and customer services training would probably remain. However, they would have to develop new skills to justify their existence and it was likely that these services would be increasingly contracted out. Whittington (1991) noted how in manufacturing, selling, which is of course the activity performed by most people who work marketing and sales, was often carried out by engineers and scientists, and that that marketing specialists who lacked technical expertise and knowledge were often not considered credible by clients or by their technical staff.

Personnel/Human Resources Managers and Other Points

Personnel specialists have for many years tended to be considered as lacking in power and influence in UK management (Drucker, 1961, 1989; Anthony, 1986). The development of HRM in the 1980s led to much debate among both practitioners and academics about how this would affect and had affected their position. Some writers argued that HRM's potential to improve the performance and thus the profitability of companies as well as the working conditions of employees meant that it provided an excellent opportunity to increase the influence of personnel specialists (Sisson, 1995). However, according to Legge (1989) it was unclear exactly what was meant by HRM and doubts remained about whether it constituted 'a sufficiently distinctive body of knowledge as a basis for full "professionalization" of the personnel function' (Bresnen and Fowler, 1996: 162).

According to Glover and Hallier (1996) the terms strategic, integrated, proactive and individualistic were often used to differentiate HRM from personnel management. Also, while personnel management was seen as the responsibility for personnel specialists, HRM was practised by managers of all types. HRM tended to be proactive and personnel management reactive – HRM attempted to address potential problems before they arose while personnel management tended to provide solutions to problems after they had arisen. Furthermore, HRM was concerned with encouraging employees to pursue organizational or managerial objectives rather than occupational or other collective ones. However, the impetus behind the introduction of HRM had not tended to come from personnel specialists themselves (Storey, 1995). Rather, it was managers from other functional backgrounds who had tended to support it, with some personnel managers resistant to it. Because, as noted above, HRM was seen as the responsibility of all types of manager, some personnel specialists considered it to be a threat to their professional jurisdiction.

Evidence suggests that although the language and rhetoric of HRM is often used in UK companies, it has not led to led to a significantly more strategic approach to the management of people (Brewster and Smith, 1990; Kelly and Kelly, 1991; Ogbonna, 1992; Marchington et. al., 1992; Storey, 1992). Sisson (1994) wrote that 'Not only is there very little evidence of the implementation of HRM associated with the new paradigm outside of a relatively few, mostly "greenfield" and foreign-owned, workplaces... It also seems, much more significantly, that a very different approach from that recommended is emerging in many organizations. This is not the people-centred approach of HRM, but its very antithesis' (p.3-4). Thus HRM appears not to have been the ticket to greater influence that some academics and personnel managers had hoped for. There appears to have been a trend towards increased involvement of line managers in the personnel function. In companies where this was the case Fowler (1992) believed that the influence of personnel specialists varied. He identified two possible approaches which many companies had adopted. One involved personnel specialists acting mainly as an administrative support function for line managers with little or no say in what they did. The other involved personnel specialists setting and monitoring defined standards of personnel practice. When the second approach was used, personnel specialists worked closely with line managers to try to ensure that they were as effective as possible when dealing which personnel issues. Thus they tended to be an important and relatively influential group.

A more pessimistic picture was painted by Sisson (1995). He believed that the position of personnel specialists remained weak. He concluded that 'It is difficult to avoid the conclusion that the great majority of personnel managers... are essentially "clerks" or "contracts managers", rather than "architects". Their main activities involve relatively routine administration, which may be critical to the day-to-day operation of the business, but which are far removed from the grander notions of strategy, strategic choice and "regime competition" which have become some of the defining characteristics of HRM' (p.106-7).

Sisson (1990, 1993) has used arguments relating to the UK's the financial system, very similar to those discussed earlier in the chapter in relation to engineers, to account for the weak position of personnel specialists and for the reluctance of companies to adopt HRM. He believed that the focus of many companies on short-term financial matters made the strategic development of people less likely.

Bresnen and Fowler (1996) noted that changes made over the last decade to the ways in which companies are structured may have changed the nature of intra-functional conflict and relationships. Increased flexibility, multi-skilling and teamworking within management had resulted in a blurring of the boundaries between functions. Work in manufacturing, it is felt, increasingly uses project teams consisting of specialists from different disciplines. This apparently facilitates integration between functions (Lee and Smith, 1992; Dopson and Stewart, 1990; Kanter, 1983). In addition, many companies seem have reduced their managerial overheads, resulting in flatter hierarchies which allow easier communication and greater trust between managers (Handy, 1984, Dopson and Stewart, 1990).

Interfunctional Relationships in Manufacturing: Empirical Studies

In the next part of this chapter the small number of empirical studies which have been conducted about the role and influence of functional groups in UK manufacturing are examined so that they can be compared with the views of the writers discussed above. It should be noted, however, that some of the literature on manufacturing management is confused by a tendency of writers to separate engineering and management conceptually. For example, Whalley (1986) noted that UK engineers were not managers and could not be considered part of management because 'they do not routinely engage in supervision... junior staff rarely report formally to senior staff; instead both are coordinated by an office manager'(p.92). On the other hand Whalley argued that accountants in finance departments were part of management because 'to fulfil their functions in financial administration most accountants have assigned to them a small team of clerical staff. To do their job they must be accountants and managers at the same time' (p.92). It will become clear in the findings chapters that graduate and/or professional engineers <u>are</u> part of society's managerial stratum. They <u>are</u> engaged in the broadly defined tasks of planning, organizing and supervising the work of others (Glover, 1979, chapter 1).

Beuret and Webb (1983) were part of a research team which interviewed 250 mechanical, electrical and electronics graduate engineers aged between 25 and 35 in 55 companies in the private and public sectors. They also interviewed 200 non-engineers from different functions. The aim of the project was to establish the 'goals for engineering education'. However, as part of the study the authors examined the position of engineers in their employing organizations.

The authors noted that although engineers often complained about the social standing of their profession, most felt that they were reasonably well regarded within the companies that they worked for. Their data also suggested that members of other functions did not really understand the language of engineering. This was particularly the case for accountants and other financial specialists who were believed to be more involved in strategic decision making than engineers. The sales department was felt to have similarly low levels of participation in strategic decision making. Unsurprisingly given the previous finding, accountants were thought to have a greater awareness of company policy than engineers and sales specialists. Despite this 40 per cent of engineers felt that being an engineer was the best way to achieve a senior position. This compared with 29 per cent for finance and 15 per cent for sales.

Janette Webb (1992) studied a medium-sized UK electrical engineering company, Midas plc, which competed in the computer components industry. The research focused on the way in which the design engineers in Midas were organized and on their relationship with the marketing and production departments. Data were collected by a combination of observation and 32 interviews with design and production engineers, marketing and sales managers, a customer liaison manager, purchasing and personnel managers, and the vice president of engineering.

Midas operated in a fiercely competitive market. Outperforming the competition depended on designs being technically sophisticated and produced and marketed quickly. The central dilemma was the perceived fundamental conflict between technical excellence and commercial success. Two years prior to the project the company had been restructured and a new senior management team put in place. As part of this restructuring the new management team claimed to want to move towards a 'human resources' model of management which would replace the 'closed and arrogant' approach which was inherited. An open and collaborative style of management was espoused which would involve all relevant expertise in the definition and implementation of a business strategy. Functional flexibility, employee development, and share ownership schemes were promised, and a flatter organization structure was introduced.

This formal structure and newly espoused management style did not match the experience of the design engineers. They reported that a punitive and authoritarian style of management continued to exist. This was supported by the authors' observations. The newly appointed engineering manager attempted to disenfranchise the design engineers from the planning process. Time sheets and detailed work plans were introduced. The control of projects and work scheduling became increasingly centralised around the engineering manager. Tight development timetables were also introduced.

To make matters worse there was continual conflict between design and marketing and to a lesser extent between design and production. The design engineers considered themselves to be at the bottom of an informal status hierarchy of marketing, production and design and there was virtually no constructive communication between design and marketing. Design engineers complained that marketing managers interfered in their work by setting design parameters and controlling design timetables. Thus marketing decided when a product should be released, with minimal input from design. From the perspective of the design department, marketing had power without responsibility, while they had the responsibility for making a viable design on time and within budget. They felt that any delay was blamed on their presumed incompetence rather than on unforeseeable technical problems or on suppliers failing to meet delivery dates.

Marketing complained that the design department was 'unreliable'. If a date was set for a design to be completed, they expected it to be ready by that date. If customers did not receive a product on time, they simply bought it from a competitor. In addition to the lost revenue, the company's reputation was damaged, possibly irrevocably. Relations between design and production were less hostile. However, design resented the repeated demands of production for help with what they defined as 'routine' production issues which they believed interfered with ability of design to set its own priorities. As a result, long range development plans tended to be postponed. This caused even more friction between design and marketing.

Clearly this is a very extreme example of the kinds of tension that can exist between functions. Nine months after the author completed her fieldwork the company went into receivership. The author concluded that 'the failure of Midas... was not however rooted in any simple sense in the *lack* of technical knowledge and resources, but in the *failure* to make use of these because of an inappropriate management structure and its informal repercussions' (p.478).

Canainn (1995) used two electricity companies, the Northern Ireland Electricity Board (NIE) in Ulster and the Electricity Supply Board (ESB) in Eire, as the setting for her study, which compared the managerial prospects of engineers in both parts of Ireland. Survey questionnaires were distributed to every engineer and manager in both companies. The response rate was 11.5 per cent for the NIE (108 respondents) and 32.4 per cent for the ESB (266 respondents). In addition 20 interviews were held with engineers and managers in the ESB and 18 with the NIE. According to the author, engineers in Eire have followed the German model while engineers in Ulster have followed the British model in terms of their roles in the management of companies.

The perceived power of accountants, administrators, engineers and marketing specialists was compared by asking respondents two questions. The first asked which occupational group most influenced strategy. The second asked which occupational group's approach was used most in solving problems. The results are shown in the tables below.

Table 4.1. Occupational Group Which Most Influences Strategy

	Accounting	Administration	Engineering	Marketing
ESB (n=218)	**40.3**	**14.7**	**33.5**	**11.5**
NIE (n=93)	**72**	**4.3**	**6.5**	**17.2**

Source: Canainn (1995)

Table 4.2. Occupational Group Whose Approach is Most Used in Solving Problems

	Accounting	Administration	Engineering	Marketing
ESB (n=209)	**26.3**	**25.8**	**44.5**	**3.4**
NIE (n=95)	**42.1**	**15.8**	**37.9**	**4.2**

Source: Canainn (1995)

The dominance of the accounting functions in the NIE in terms of both strategy and problem solving appear to be clear. This appears to support the conventional view about accountants in UK industry. The situation is less clear cut in the ESB where accountants are perceived as being the most influential group in terms of strategy while engineers are considered to be the most influential group in terms of problem solving. According to respondents the situation at the NIE used to be very different. Until fairly recently engineers had dominated senior positions and non-technical managers, including accountants, were apparently seen as 'second class citizens'. However, the company was privatised in the early 1990s and an apparent failure in previous years to control costs and to make profits had resulted in the imposition of a new regime which was dominated by accountants. Many of the engineers in the NIE, unlike their colleagues in the ESB, had been effectively ghettoised into purely technical work. This was partly as a result of privatisation and partly because of their own self-perceptions as improved tradesmen. They had been unable and unwilling, unlike their counterparts in the ESB, to recognise that in order to progress in their organization they needed to engage and involve themselves enthusiastically in non-technical work. They needed to broaden their notions of what it meant to be an engineer and a professional and to form themselves into generalists as well as specialists.

Lam (1994, 1996) compared the work roles and relationships of staff in technical and managerial functions in electronics companies during product development in the UK and Japan. Sixty Japanese engineers from eight firms and 55 British engineers from six firms took part in the study. Data were collected by a combination of questionnaires, interviews, and critical incidents diaries which focused on the engineers' on-the-job training experiences over six month periods. The author argued that the UK firms in the study tended to be mechanistically structured and functionally segmented and that this had encouraged vertical polarisation between technical and managerial roles. Tasks to be performed were clearly delineated and defined and were positioned within a centralised hierarchical structure. The process of product development was sequential and the different phases of the development process appeared to be conducted independently of each other. Design, development, production, and marketing and sales were separated geographically as well as conceptually and this had caused communication problems. Project teams tended to be highly specialised and only included staff from the same functional area. UK engineers were assigned a much narrower range of tasks than their Japanese counterparts in terms of both technical and non-technical work. Job rotation beyond their own functional boundaries was very rare. The lack of communication was most pronounced between development and production and between both of these and marketing. A consequence of this there was a high proportion of 'project abortions' and a lack of understanding about the product in a more general sense amongst engineers because they had only been involved in a very small part of the processes of designing and making it.

A very different picture was painted of the Japanese firms in the study where 'a much higher degree of horizontal co-ordination across functional boundaries and different phases of the product cycle' (1996: 191) was observed. Cross-functional project teams were more common and the Japanese approach to product development was described as 'overlapping' rather than 'sequential', a word which characterised the UK approach. By this the author meant that job boundaries and roles were much more ambiguous in Japanese companies. All team members were expected to acquire knowledge and skills about whole projects and were involved to varying degrees in whole processes. Job rotation was encouraged so that engineers would develop a broader range of technical skills and, perhaps more importantly, as a means of facilitating the flow of information between functions.

In both countries project managers supervised product development and were used for cross-functional coordination and integration. In every case in both the UK and Japan the project manager was an engineer. A major difference between the countries, however, was that UK project managers tended to disengage from their design and development work. Nine out of eleven UK team leaders interviewed said that they did not use their technical expertise. The particular hierarchical way in which the UK companies were organised meant that project managers did not usually supervise members of the project team directly. They tended to interact with managers who supervised one part of the product being developed. Japanese project managers tended to remain technically involved and some described themselves as 'player-managers'. On average between one third and one half of their time was spent on on-site engineering work which most regarded as the most important part of their job. Communication with project engineers and other types of manager at the sharp end was seen as vital.

According to Lam the product development process is a total information system which requires three types of knowledge and information to be combined: 'specialized technological expertise for development and design; organizational knowledge for cross-functional co-ordination; and market information to link technical work to commercial objectives of the firm' (1996: 199). In the Japanese companies technical, organizational and commercial knowledge was the responsibilty of everyone, not just of certain individuals or groups. The division of labour was much less clearly defined both horizontally across functions and vertically between engineers and management.

In the UK companies technical and managerial work were clearly separated, not only in terms of tasks, but also in terms of knowledge and information. Engineers were technical specialists who were given almost complete autonomy. Managers specialized in 'organizational linkages' (1996: 199) and were the providers of organizational and commercial information. The knowledge and information necessary for the product development process was concentrated within the managerial hierarchy. Relevant knowledge and information were filtered down vertically from senior management through the project managers to the engineers and other managers at the sharp end. Thus a vertical information structure was used in product development which ensured that managers were aware of all problems and decisions. According to the author, the clearly defined functional roles and boundaries between engineers and managers 'often generates low trust and further reinforces the split between technical and managerial roles in the British firms' (1996: 200). Engineers often became isolated, frustrated and unable to realise their full potential. Engineering managers no longer involved in technical work often felt vulnerable and sometimes hoarded important organizational and commercial information to demonstrate their worth, defend their status, and reinforce their higher rank and control.

Lam believed that, as a result of the way in which work was organized, the UK engineers in the study tended to be narrow technical specialists lacking in problem-solving and other non-technical skills. Thus they were unlikely to be promoted to senior management. By way of contrast, Japanese work organization encouraged engineers to develop non-technical skills and knowledge which facilitated cross-functional operations and resulted in more well-rounded people suitable for senior posts.

Many of the UK engineers in the study wanted to leave engineering and become managers partly to advance their careers and partly to avoid routinization. Lam speculated that some of the younger engineers in her study might move into senior management posts by switching to non-technical roles such as sales or marketing or after studying for formal management qualifications. She concluded by commenting that if the engineers who make it to senior management are the ones who have left engineering, they are unlikely to bring an "'engineering culture'" into management. Her solution is the adoption of more organic forms of work organization 'to allow better integration between technical and managerial expertise and to enhance the utilization of engineers, leading to the development of a more technically competent management' (1996: 207).

Bresnen and Fowler (1996) argued that the dominance of the accountancy function, the low status of engineering and production, the ambiguous roles of marketing and personnel, high levels of occupational specialisation, and problems of cross-functional integration had long been widely acknowledged features of UK management. However, according to the authors a number of recent changes to UK management had occurred which might affect the 'nature and quality of intra-managerial relations at the level of the firm' (p.162). These included leaner and flatter organization structures, greater flexibility and teamwork within management, calls for more empowerment and 'intrapreneurship' in middle management, and the breaking down of functional barriers between managerial sub-groups (Kanter, 1983; Peters, 1988). The authors argued that virtually nothing was known about the effects of these changes on intra-managerial relations or on the balance of power between functions. Their study aimed to examine these issues.

Their research consisted of four case studies in two industrial sectors: food and materials processing. The food companies were called Cocoa Chocs and Beta Bread and the materials processing companies were called Sigma Steel and Poly Plastics. All four firms were described as medium-sized. An unspecified number of interviews were conducted with a sample of managers from all main departments and across all managerial levels. Information was collected about the roles, functions and procedures within each department and about the relationship between departments.

The authors noted that in each of the four companies an increased emphasis had been placed on the core functions of production and sales and that this was reflected in the dominance of sales and production managers at senior levels. At Cocoa Chocs the whole senior management team, which consisted of five engineers, had recently been sacked due to falling profits with control being centralised in the hands of the managing director, who had a sales background, the finance director, and the factory manager, who was an engineer. Before these changes had taken place the company had apparently been very technically driven and had tended to neglect the needs of markets and customers. At Beta Bread sales and marketing had been centralised at group level to allow its production facilities to concentrate on improving efficiency. At Sigma Steel the management structure was split between the sales and production sides of the business, each headed by a joint managing director. However, the MD for the sales side was an accountant. At Poly Plastics a new managing director had been promoted from sales to replace the finance director and the works director who had jointly run the company before being sacked due to poor profitability. Under the new MD production was given greater emphasis and this was reflected in the greater involvement of the new works director and other senior managers in the running of the factory's logistics, production scheduling and materials purchasing.

The number of personnel specialists and accountants was limited due to the relatively small size of the firms being studied. Both these functions appeared to be considered less important that production and sales. Nevertheless there were interesting similarities and differences in the way in which these functions were used. In all four firms personnel management was very centralised. With the exception of Cocoa Chocs the main aim of personnel policies was very clear: to reduce costs. Cocoa Chocs was the only company to have specific 'human resource management' practices of staff appraisal and development. There was a lot of rhetoric from senior managers about developing 'line' staff, but there appeared to be little substance to this.

All of the firms in the study employed an accountant. However, at two of the companies (Beta Bread and Poly Plastics) their jobs were part time and in the other two companies the functional responsibilities of the finance directors were quite diverse. At Sigma Steel the accountant, as joint MD, was responsible for the plant as a whole, while at Cocoa Chocs the accountant was deputy managing director and was responsible for logistics and personnel as well as the financial side of the business. This was considered by the authors to be partly as a consequence of the size of the firms and partly due to the importance placed on flexibility within management. Significantly, it also suggested that specialist functions are not necessarily the 'natural' province of specialist staff.

The authors noted that the model which all of the companies were trying to adopt was one which 'was informed by notions such as devolving more responsibility, introducing greater flexibility and teamwork and instilling a greater business awareness among managers' (p.176). Although departmental barriers appeared to have become less clearly defined and although there was some evidence of increased cross-functional teamworking, barriers to integration within and between managerial groups remained. This was because economic and other immediate environmental pressures forced managers to concentrate on areas which were critical for commercial success. Thus 'an expressed commitment to "new management ideas" co-existed with a fairly traditional concern with controlling and reducing costs made highly salient by recent past performance problems and/or business strategies that now placed overriding emphasis on maximising production efficiency and achieving bulk sales' (p.176).

Three of the five studies (Webb, Canainn and Lam) appear to support the notion that engineers tend not to be a particularly influential group in UK manufacturing and all of them reported, to varying degrees, that different functional groups often enjoyed uncomfortable relationships with each other. In the case of the company which featured in Webb's study, this presumably contributed at least partly to its failure, although the extent to which the other companies featured in the studies discussed above were successful or otherwise is unclear. Nevertheless, there is clearly a need for further research which examines the roles and influence of different management-level groups in manufacturing and how engineers feel about their position in companies. This is one of the aims of this study. The next section examines the construction industry and the roles and position of the main professions within it.

Construction Management

The Construction Industry

There are a number of (fairly obvious) ways in which construction projects differ from the products of manufacturing companies (Bresnen, 1990; Young, Torrance and Egbu, 1996). Most projects involve the construction of a one-off product which has been tailored to the client's specification, although in some cases similar projects may have been conducted previously. For example the design of many houses, hospitals and schools are similar. Any given project, at least in the UK context, necessitates collaboration between different organizations which have often never worked together in the same way before. Such organizations include the client (the person or organization who or which is paying for the project), the design consultants (the practices or companies which design the project), the main contractor (the company in charge of the construction work) and the subcontractors (companies employed by the main contractor to perform parts of the construction work). Also, in construction the finished product, for example a bridge or a house, cannot be transported and must be produced 'at the point of consumption' (Bresnen, 1990: 47). An important consequence of this is that the physical environment affects the production process. For example, the type of soil dictates the type of foundation needed for a building. Also, as construction work is carried out in the open it is subject to the weather, a factor which cannot be controlled.

Another distinctive feature of construction work is its transience (Bresnen, 1990). Each project is strictly (even if hopefully) timetabled. After the completion date no further activity is expected or (in theory) required. Not only is the system of production disbanded but the whole organization - the one-off combination of design consultants and building contractors and sub-contractors, of whom there can be many - is also disbanded.

The construction industry consists of three main parts: civil engineering construction, building, and engineering construction (Glover and Kelly, 1987). Civil engineering includes large projects such as roads, dams, harbours, airports and some factories and high rise flats and offices which require sophisticated structures. Building includes the construction of factories, housing, schools, hospitals and shopping centres. Engineering construction includes the building of process plants, power stations and railway electrification schemes. Many such projects are undertaken by companies which are more generally recognised as civil engineering ones. However, and clearly, all three parts of the industry, not only two, overlap.

The Professions and Methods of Contracting in the Construction Industry

The three main professions in the construction industry are architects, quantity and other surveyors, and engineers of various kinds. All three professions can be involved to varying degrees in both the design and the construction phases of projects. A number of writers have discussed the relationship between the professions in construction and the possible areas of conflict between them. However, as far as the author is aware, only three empirical studies have been conducted which examine this issue explicitly (Higgins and Jessop, 1965; NEDO, 1976; Bresnen, 1990).

Higgin and Jessop (1965) sent out 220 questionnaires to the main actors in the construction industry including architects, quantity surveyors, design engineers and building and civil engineering contractors. They received 97 responses. They were concerned with how these groups perceived their own and each others' contribution to the building process and how they perceived their own and each others' social status. NEDO staff (1976) interviewed an unspecified number of senior people from twenty organizations in building and civil engineering, including clients from the public and private sectors, private practices of the professions involved in the design process (architects, quantity surveyors, civil engineers, structural engineers and building services engineers), contractors, and professional institutions. The aim was to investigate the roles of the different professions involved in both the design and construction processes in order to suggest ways of improving the industry's competitiveness and efficiency. Bresnen (1990) used five longditudinal case studies to study the management of construction projects and in particular the relationship between the different organizations involved in such projects. A combination of a questionnaires, interviews, direct observation and documentary sources provided the data for each case. The results of these studies have been incorporated into a more general discussion of the ways in which the professions in construction are organized and of the relationship between them.

The starting point of the whole construction process is 'the brief'. This is the client's statement of requirements. It includes the client's objectives in terms of quality, function, build time and cost as well as instructions on procurement and organization. There are many kinds of client. Clients may belong to the public and private sectors and range from small organizations to large ones with their own in-house professional expertise. Production of the brief can be a complicated procedure both technically and administratively (NEDO, 1976).

The next part of the process is the design of the product. In civil engineering projects this is the responsibility of civil engineers. Architects are sometimes involved in the design of some civil engineering projects such as bridges, but the design team is almost always led by a civil engineer (NEDO, 1976; Ball, 1988). In building projects architects almost always co-ordinate the design process (NEDO, 1976; Bresnen, 1996). Architects became increasingly influential after the Great Fire of London when they played an important role in the city's reconstruction (Bresnen, 1996). It was around this time that architects became independent practitioners and the design of buildings was separated from their construction for the first time. As well as being in charge of design, architects tended to take charge of the building process and effectively replaced 'master craftsmen' as coordinators of specialist trade labour (Bresnen, 1996).

As modern building work has become more complex, the design process has become increasingly specialised (Ball, 1988). Since the nineteenth century structural and geotechnical engineers have become an important part of design teams in building projects. Structural engineers design the structural aspects of buildings and are assisted by geotechnical engineers who are experts in soils. During the twentieth century buildings have become progressively sophisticated. Specialist mechanical and electrical services engineers design aspects of the building such as ventilation, heating, lighting and security systems. According to the Centre for Strategic Studies in Construction (1988) the average capital cost of engineering services accounts for more than 50 per cent of the total cost of buildings. NEDO (1976) noted that services consultants tend not to participate at the feasibility stage of projects, and this sometimes caused problems during construction. The consensus in the literature seems to be that although both services and structural engineers can and do lead the design team for some types of building project, it is usually the case that architects fulfil this role (Bresnen, 1990, 1996; Ball, 1988; NEDO, 1976; Higgin and Jessop, 1965). NEDO (1976) noted that some respondents believed that architects were best able to make judgements about quality and cost factors and should therefore lead the team. Others believed that the most able person available should lead the team regardless of their profession. Some respondents thought that the profession of the design team leader should change during the project so that, for example, a structural engineer was team leader while the foundations were being designed and a services engineer was team leader while the heating and ventilation systems were being designed. Respondents also identified a number of skills which were important for design team leaders. In addition to being a good designer who was 'sensitive to the intangible human and environmental factors which partly determine the quality of the finished product' (p.22), they required leadership skills and should be numerate and articulate. An awareness of all aspects of design, and training in management subjects, were also considered to be important.

Quantity surveyors are extensively involved in measurement and cost planning for building work and consequently play an important role in design teams (Bresnen, 1996). Costing in civil engineering projects has traditionally tended to be done by civil engineers rather than by quantity surveyors (NEDO, 1976). In the building industry during the nineteenth century, the development of new but more expensive building materials and techniques and the growth in the size and complexity of buildings often led to discrepancies between the estimated price of a building and its actual cost. Increasing client dissatisfaction led quantity surveyors to develop accurate techniques for estimating costs. When design teams produce designs, quantity surveyors make up a bill of quantities. This measures, itemises and costs the materials and work required and forms the basis for the estimated price of a project (NEDO, 1976). According to Bresnen (1996) clients are becoming much more cost and budget conscious and this has led to consultant quantity surveyors being far more likely to act as the client's main consultant than was the case previously. Thus quantity surveyors, who were previously no more than assistants to designers with very little influence or status, have assumed a much more important role.

The final part of the process is, of course, the construction of the product. During the nineteenth century government regulations were introduced which insisted that all construction work should be controlled by a single or 'main' contractor - a general builder (usually a bricklayer) which employed and organized specialist tradesman. This formed the basis for the way in which construction work is commissioned and organized today (Higgin and Jessop, 1965). Building and civil engineering contractors employ mainly civil and/or structural engineers at management-level, and thus it is engineers who are usually responsible for a project's construction. The main contractor may or may not carry out some of the work itself, but it is increasingly the case that much of it is subcontracted. The primary purpose of the main contractor is to manage and coordinate the construction process (NEDO, 1988).

The problems of coordinating the design and construction phases of projects have been well documented (Higgin and Jessop, 1965; NEDO, 1976; Ball, 1988; Bresnen, 1990; Bresnen, 1996). This is apparently mainly because both phases have traditionally been considered as separate tasks to be performed independently of each other. The relationship between the client, the design team and the main contractor depends on the method of contracting chosen by the client. This establishes the stage at which each party is to be involved in the project, the responsibilities of each party, the lines of communication, and the pattern of coordination and control (Naphiet and Naphiet, 1985). Broadly speaking, four methods of contracting have been identified: 'traditional' contracting, design and build, management contracting, and project management (Ball, 1988; Young, Torrance and Egbu, 1996). It should be pointed out that the term project management is used in the construction industry to mean the person or organization which manages a project (or part of a project) regardless of the method of contracting used, as well as a method of contracting. This can be very confusing. The author has tried to make clear what he means whenever this term is used. Also, it should be noted that the phrases 'type or method of contracting' and 'type of project organization' are used interchangeably.

When the traditional form of contracting is used (see appendices 1(a) and 1(b)), the client appoints independent consultants which act on their behalf to lead the design team and to supervise, or project manage, the project from inception to completion (Bresnen, 1996). In civil engineering these functions are performed by a civil engineer but in building it is usually the case that an architect is both design team leader and project manager. The design of the product is usually completed before the project is awarded to a contractor. The contractor therefore has no input into the design process. Rather the contractor is given detailed plans and specifications to which it must comply if it is awarded the contract (Naphiet and Naphiet, 1985). Despite being appointed by the client, the role of the design team leader and project manager is intended to be an independent one. Their purpose is to offer clients impartial technical and financial advice while protecting contractors against unreasonable demands which might be made by clients (Bresnen, 1996).

The advantage of this type of contracting is its familiarity. However, there has been a growing trend away from traditional forms of contracting to other comparatively new forms, such as design and build, management contracting and project management (Ball, 1988; Bresnen, 1990, 1996; Franks, 1990, 1992, Torrance, 1992). There are a number of reasons for this. First, the very clear separation of the design of a product from its construction can cause problems of communication and integration between the parties, particularly with more complex projects (Emmerson, 1974; Banwell, 1964; Sidewell, 1979). One consequence of this is that designers may give little consideration to the practicalities of a design's construction (Bresnen, 1990). Also, in the building industry the dual function of design team leader and project manager can place a heavy burden on architects (Bresen, 1996). Architects are required to be both generalists and specialists with a thorough knowledge of all aspects of the building. The complex nature of many modern buildings makes this difficult (Bresnen, 1996). Finally, during the 1980s the proportion of work carried out in the private sector increased. Also, local authorities sought greater value for money due to cuts in funding. This led to an increasing proportion of clients seeking more cost-effective ways to organize projects (Bresnen, 1996).

With design and build (see appendices 2(a) and 2(b)) the client deals directly with the main contractor (Naphiet and Naphiet, 1985). The contractor takes responsibility for the whole process from design to construction and assumes the role of overall coordinator and manager of the project team. Indeed the design team is actually employed by the contractor who tends to want to ensure that buildings are designed in a way which make their construction relatively straightforward. Using this type of contracting has the benefit of providing the client with a single point of responsibility which helps to improve communication and reduce conflict (Naphiet and Naphiet, 1985). From the client's point of view some of the risk is removed because any design faults must be put right at the contractors' expense. Critics of this method of contracting argue that it discourages innovative design (Bresnen, 1996). Design and build shifts the balance of power away dramatically from architects in building and design engineers in civil engineering, and towards contractors in both cases. Rather than the contractor reporting to the architect or design engineer, it is the architect or design engineer who must report to the contractor (Bresnen, 1996). As was noted earlier, engineers form the dominant professional group in contracting firms. Contractors have always been very influential in the construction industry (Higgin and Jessop, 1966). It appears that since the 1980s they have become even more influential than hitherto.

The main feature of management contracting (see appendices 3(a) and 3(b)) is that the 'responsibility for the co-ordination of design and construction is made the province of a specialist management contractor employed independently of those with prime responsibility for carrying out the work' (Bresnen, 1996: 254). The management contractor is not directly involved in the design process except as an adviser on issues such as cost and production. Similarly, on site the management contractor subcontracts all aspects of the construction work. Thus the management contractor does not participate directly in either design or construction. It provides all the services essential to the running of the site, coordinates the flow of information, and manages the entire process for the client, receiving a fee for its services (Bale, 1985). The management contractor becomes part of the client's team and is expected to work with the design team on a more or less equal footing, but is also responsible for the management of the whole project. This method of contracting tends to provide clients with a greater degree of control over projects (Bresnen, 1996). However, management contracting has been criticised for adding yet another organization to an already complicated and overcrowded environment making the flow of information even more difficult (Naphiet and Naphiet, 1985). Also, According to Bresnen (1996), management contracting can result in considerable confusion during projects because of the ambiguous nature of the roles of designers and contractors. Although contractors are clearly less influential than in design and build, they are clearly more influential than when traditional forms of project organization are used. Similarly architects in building projects and design engineers in civil engineering projects are more influential than with design and build but less influential than when traditional approaches are used.

Project management is the fourth main type of project organization (see appendices 4(a) and 4(b)). As was noted earlier, this term can be confusing because project managers feature in all projects regardless of the method of contracting used. Contractually, project management can take one of two forms (Bresnen, 1996). In the 'non-executive' model, a project manager is employed separately. He or she assumes complete control of the design and construction of the project on behalf of the client. His or her work thus includes the assembly of the design team and selection of contractors. This form of organization is normally only used for very large projects. In the 'executive' model, which is much more common, either a consultant is hired, or a professional who is a member of the client organization takes control of the management of the project. However in this case he or she is not involved in assembling the design team or choosing the contractors. According to Bresnen (1996) quantity surveying practices are increasingly offering a project management service and have benefited most from this form of project organization. By adopting this strategy quantity surveyors appear to have increased their influence in the construction industry.

The extent to which these newer methods of contracting are used is unclear. According to Bresnen and Haslam (1991), although design and build and management contracting are becoming increasingly popular, the traditional method of contracting continues to be the most widespread. However Franks (1992) estimated that forty-five per cent of projects in the UK were design and build and that this was the fastest growing form of project organization. He also claimed that by 2000 over half of projects would adopt this form of organization.

Thus the roles and influence of the main professional groups in construction appear to depend mainly on the method of contracting used by clients. In building projects architects appear to have become less influential. Unlike traditional approaches to project organization where they usually perform the role of project manager, when other approaches are used their role tends only to involve leading the design team. By way of contrast, quantity surveyors have become increasingly influential, both within the design process as clients look for value for money, and in terms of the management of projects. With regard to engineers, those who work for contractors appear to have become increasingly influential in both civil engineering and building.

Design engineers have apparently never been particularly influential in the management of building projects and the introduction of different forms of project organization do not appear to have affected them significantly. Design engineers in civil engineering, like architects in building, seem to have been weakened by the introduction of such methods. However, the extent to which different types of contracting are used is unclear. There is less open disagreement about the position of engineers in construction than in manufacturing and, although they seem to have had mixed fortunes, in general they appear to be a relatively influential group.

Conclusion

The weak position of engineers and the dominance of accountants has been a significant feature of the literature on manufacturing management. Indeed, Armstrong (1987a) argued that engineering had become a disqualification for manufacturing management. Explanations have tended to focus on the UK's financial system. In construction, architects in building and design engineers in civil engineering appear to have become less influential in the management of projects. Contractors, who are managed mainly by engineers, and to a lesser extent quantity surveyors, have apparently become increasingly influential in this respect. These changes have been attributed mainly to the use of alternative forms of project organization by clients. However, the extent to which these relatively new organizational forms are used is unclear.

Finally, there is clearly a shortage of empirical evidence about the roles and influence of the main professions in manufacturing and construction. The author only found five studies which examined this with regard to manufacturing, and only three in construction. No doubt there are others, but not in the main stream of the management literature. This study seeks to help fill this gap. In the next chapter, the literature on UK engineers is examined. In addition to discussing empirical work which has examined the employment of engineers, literature about more specific aspects of their lives and careers is reviewed.

CHAPTER 5

ENGINEERS IN THE UK

Introduction

In the previous chapter it was noted that the UK's financial system was often considered to be responsible for the apparently weak position of engineers, particularly in the most senior positions. Other explanations for this 'problem' have included an innate or educationally induced incapacity for management, ineffective professional organization, and a weak correlation between formal qualifications and pay and grading structures among technical staff. This chapter explores these and other issues which are relevant to UK engineers. It begins by examining studies of their employment. The remainder of the chapter is concerned with more specific aspects of the literature. First, evidence about engineers' career aspirations and their managerial abilities is discussed. Next, developments in and issues surrounding engineering education are reviewed. Third, writing about the professional associations and trade unions which represent many engineers is discussed. Finally, evidence about the social standing of engineers and their levels of remuneration is examined.

The Employment of Engineers

A number of writers have examined the employment of engineers. However, there has been rather less empirical work done than might be expected and all of it focuses on manufacturing rather than on construction. The first study of UK engineers was provided by Gerstl and Hutton (1966). Indeed, until the 1980s this was the only one which existed. Its aim was to examine the recruitment, education, work and non-work activities of UK mechanical engineers. Nine hundred and seventy-seven interviews were conducted with members of the Institute of Mechanical Engineers, 387 of whom were graduates.

The authors noted that the engineering profession had a two-tier structure. The top tier consisted of graduates while the lower one consisted of those who had received their training in technical colleges. Although both groups had the same title they usually had 'quite different responsibilities and receive[d] widely varying financial rewards' (p.154). However, it was sometimes possible for engineers from the second tier to 'get to the top'. Engineers of all types had to perform a wide variety of tasks and administrative work tended to occupy a large proportion of their time, particularly for graduate engineers. Thus, most engineers were 'actively involved in the taking of decisions connected with various aspects of their jobs and organizations' (p.155). About one third of engineers, more than any other functional group, were in management, mainly technical management. This figure rose to one half for respondents aged over fifty-five. Jobs in 'R&D' and non-technical jobs required a good honours degree. Jobs in design attracted very few graduates.

Mobility between organizations was high, with the average mechanical engineer having had seven promotions or career changes by the end of their career. Both excessive mobility and immobility between companies appeared to harm people's careers. Job titles corresponded with financial success and graduates earned more than non-graduates. Surprisingly perhaps, the authors found that most graduates worked in production rather than in research, development and design. According to the authors 'this would not appear to indicate the best use of professional training' (p.161). This was probably a typical 1960s British view: Lawrence (1980), described production in West Germany as the whole company plus marketing and sales. Gerstl and Hutton also expressed concern about an 'exodus' from technical positions into managerial ones. Although technically literate management was very important, the 'drain' of talent from engineering positions was very damaging, particularly as many engineers had entered management because they were frustrated in their technical roles, and their real interests remained in doing technical work. Furthermore, half of the respondents felt that parts of their job could be done by people who were less well trained. The authors concluded that 'technical ladders are too short and also poorly constructed' (p.161). It was wasteful to employ highly qualified engineers on work which did not need their education and training. Small firms were particularly guilty of this.

Gerstl and Hutton provided the only empirical evidence about the employment of UK engineers until Whalley wrote The Social Production of Technical Work (1986). Whalley used two stereotypical case studies to examine the employment experiences of engineers. One of the companies used, 'Computergraph', was a relatively new one which manufactured electronic and optical equipment and had a 'high knowledge-technology content' (p.18). The other company, 'Metalco', manufactured a wide variety of metal products and had done so since the Industrial Revolution. Whalley noted that 'it would be difficult to imagine a company more clearly embodying the features of a traditional British manufacturing company than Metalco' (p.22). In addition to documentary material provided by both companies, Whalley collected his data by informal interviews and observation which involved the author 'following engineers through their daily routines and sitting in on meetings with customers, management and other engineers' (p.18). He also spent some time 'hanging around' (p.19) with groups of engineers.

Whalley believed that the two main ways in which engineers were identified was by their qualifications and by their positions in the division of labour. He believed that 'the most widely accepted' (p.20) qualification for engineers was an HNC or above, and all technical workers with these qualifications were included in his population. He also included 'engineers' who were not qualified to HNC level but whose jobs normally required an HNC qualification. From this group he randomly selected a one-third sample from each company. This provided 56 respondents from Metalco and 54 from Computergraph. As was noted in chapter 2, most engineers were graduates by the mid-1980s (McCormick, 1988). Thus Whalley's sample almost certainly included respondents whom the author would consider to be technicians.

According to Whalley engineers were employees with autonomy, authority, career expectations, monthly salaries, fringe benefits and relative job security, although they were not necessarily privileged employees. He called them 'trusted workers' because many of the tasks that they performed required considerable discretion. The above benefits existed because direct supervision could not always be carried out and because the consequences of mistakes might be very costly. Thus employers needed to ensure the trustworthiness of engineers. Although the technical expertise of engineers was subservient to employers, it was not necessarily in conflict with them.

Indeed it was sanctioned by employers because it came 'wrapped in a package also containing "trustworthiness" and "responsibility"' (p.195).

However the situation was far from perfect. The recruitment and training system was employer-controlled and graduates were often recruited into low-level technical jobs which were also performed by technicians and by ex-manual workers who had been promoted from the shop floor. To become an engineer it was necessary to work 'through the grades' (p.187). Engineers were not differentiated from other types of technical worker and the title engineer was no more than a 'hazily defined set of positions at a particular point in the company hierarchy' (p.187). Whalley felt that this was responsible for the uncertain social position of engineers and that it limited the extent to which qualifications could be used as exclusionary measures. At Computergraph, where many engineers had high levels of technical expertise, most were unwilling to take on managerial roles. At Metalco, on the other hand, where most engineers were involved in mainly unsophisticated technical work, most wanted to pursue managerial careers.

Smith (1987) examined the position of technical workers using a case study conducted at a British Aerospace Aircraft Division factory in Bristol in the late 1970s. No details of his methodology were published except that he had conducted an unspecified number of 'detailed interviews with technical workers and managers' (p.5). This study appears to have been the basis for much of his quite influential later work (Smith, 1987; Smith, 1990; Lee and Smith, 1992; Meiksins and Smith, 1992, 1993; Smith and Whalley, 1996).

There are several strands to Smith's thinking. One is that engineers are not necessarily the natural allies of management. Although salaried employees, engineers suffered many of the uncertainties of waged labour and this made them different from other professional groups such as accountants, and their 'relationship with management more contested and problematic' (Meiksins and Smith, 1992:137). A second strand of Smith's work is his belief that class conflict existed between manual workers and different grades of 'technical worker'. In his 1987 book he noted that the most highly skilled engineers tried to keep their distance from manual workers and were 'disdainful of the physical skills of middle range technical staff' (p.300).

Another feature is his assertion that the craft tradition has continued to influence the education and training of engineers. Indeed it was the craft association of engineers in the UK which had partly created their status 'problem' (see also McCormick, 1985). Traditionally, skilled workers were able to become engineers and, despite the rapid increase in the number of engineering graduates, traditional recruitment patterns had not disappeared. This was partly because '[educational] credentials and technical positions continue to be only weakly correlated in most of British industry' (Smith and Whalley, 1996: 29). Thus there were no significant barriers between technicians, technical engineers and professional engineers, all being incorporated under the generic title of engineer. Indeed, in Smith's view almost all engineering work had tended to be organized and defined as though it were the apex of the hierarchy of manual work. Smith and Whalley also argued that the move towards an all-graduate profession had not been in the best interests of engineers: 'Not only has university education reinforced the role of practice, the power of employers, and the narrow specialization of technical knowledge, but it has maintained a definition of the engineer as technical expert, not manager or business leader' (p.48). A final strand of Smith's work is his assertion that engineers tended to opt for trade unions rather than professional associations and he has consistently tended to dismiss the latter on the grounds of ineffectiveness.

Causer and Jones (1993) noted that there had been considerable concern about skill shortages of 'professional level' engineers in the fields of electronics and information technology. The authors interviewed 56 personnel and technical managers in twenty companies in the south of England. The aim of the study was to 'examine the ways in which organizations have responded to perceived problems of recruitment and retention of a key group of employees' (p.15).

Only nine of the twenty companies studied had a regular annual intake of new graduates, all of whom were able to meet their recruitment needs. However, the labour market for new graduates was perceived as becoming increasingly competitive. Furthermore, the turnover of graduates was considered to be alarming. Four of the five companies which recruited more than fifteen graduates per year expressed this view. Fourteen of the twenty companies reported having difficulty recruiting experienced engineers. According to the authors it was no coincidence that it was the six smallest companies who reported having no difficulties. This was partly because of the small scale of their recruitment needs, and partly because they were more flexible about the type of staff that they were prepared to employ. Of the fourteen largest companies, ten had considered their recruitment problems severe enough to revise their recruitment procedures. Retention of experienced engineers was considered, on the whole, to be less problematic, although turnover rates tended to vary significantly from year to year.

Given the apparent concerns over the shortage of engineers in electronics and IT, and their importance to corporate success, the authors presumed that companies would use a number of human resource strategies to attract and retain them. However, they found that the situation was not entirely straightforward. Only seven of the twenty companies formally planned the number of engineers that they needed to employ. This was mainly because of uncertainties over how much funding was going to be available for design and development work, as well as uncertainty about corporate restructuring.

As a consequence of increased difficulties in the recruitment of graduates, several companies had strengthened links with specific universities which provided 'suitable' graduates. Suitability was determined on the basis of the relevance of the syllabus as well as the 'quality' of the graduates. For example, one company no longer sponsored students on a four-year M.Eng. degree with a large management component as it was felt that it produced graduates who did not want to remain in engineering roles. There was also an increasing tendency to recruit polytechnic graduates because their courses tended to be more practical.

Recruitment and selection strategies for experienced staff were more varied. Strategies included developing closer links with recruitment agencies, targeting specific areas where there was known to be people with relevant skills, and making recruitment procedures more efficient. Even in the case of highly trained technical specialists, 'acceptability' and the ability to 'fit in' were considered to be very important. Given the perceived shortage of highly trained engineers, the authors anticipated that companies would have relied less on social criteria, but this did not appear to be the case. According to the authors, this may have been because of the team-based nature of most design and development work. Also, engineers were increasingly involved in negotiations with clients.

The salary structures of companies had become increasingly flexible in response to perceived problems of recruitment and retention and line managers often appeared to be able to reward performance with pay increments. However, this often resulted in existing pay structures being undermined. Also, performance-related pay for staff with similar levels of experience and responsibility tended to cause friction. Shortages of some types of engineer often meant that pay did not depend on performance at all, but on the availability of skills.

Training for engineers was found to be rather ad hoc, usually being related to projects which companies were currently working on. Although attempts were made to identify individual training needs, on the whole training was arranged on a 'need-to-know' basis. This seemed to be due partly to time and cost restraints and partly to employers wanting to limit the marketability of engineers. On the whole the shortage of engineers in electronics and IT (real or perceived) tended to work to the advantage of engineers, and employers had devised a number of strategies to encourage engineers to work, and to continue to work, for them.

Jones et. al. (1994) interviewed an unspecified number of senior recruitment and staff development and training managers in eight large UK-owned multi-nationals or 'trans-national businesses' (TNBs). The companies involved operated in the electronics, aerospace, chemicals and machinery/metal goods industries. Their data suggested that graduate engineers were 'often employed in jobs requiring considerably less than their full capabilities' (p.39) and in many cases the use of technicians would have been more appropriate. It was, however, commonly felt that many of the current generation of engineers would eventually take on managerial roles, although the likelihood of this varied between sectors. Engineers employed in electronics and chemicals were less likely to become managers. Barriers to career development were evident in these sectors and several respondents reported that promotion opportunities were restricted. The problem appeared to be that due to the increase in the number of graduate engineers employed, there simply were not enough senior positions available.

The authors identified three models which described the ways in which TNBs might employ graduate engineers. The first model considered engineers as 'general technical labour'. Possessing a degree was not considered to be important. Decisions about the work performed by engineers were made at the level of the individual working unit rather than at corporate level. Technicians and graduate engineers were often thought to be interchangeable. The second model considered engineers as 'specialists'. Engineers were concentrated mainly in 'R&D' and design functions and the roles of engineers and technicians were more rigidly demarcated than in the previous model. However, engineers tended not to occupy management positions. The third model considered engineers as 'a corporate human resource'. Decisions were made at corporate level about recruitment, training and career development. Individual units were forced to implement these decisions. Graduates were believed to have excellent analytic, planning and technical skills as well as leadership potential as future managers. This needed to be nurtured and guided. All engineers were graduates.

The authors found that most of the companies in their study treated engineers as specialists employed mainly in design and development functions. However, even when this was the case, there was some overlap between the work of engineers and technicians. This was a fusion of the first two models. When multi-national companies were willing, as in the third model, to force individual work units to follow company-wide personnel policies, there were clear advantages for engineers. This was the case for two of the companies in the study. 'Partsgroup' developed an optional two-year graduate training scheme which provided placements to the company's UK and international subsidiaries. The advantages for graduates included increased responsibility, the opportunity to learn a foreign language, and overseas employment. Another company, 'chemicals', adopted a sophisticated process of overseeing engineers' career development at corporate level. The company appeared to have managed to plan the career development of engineers successfully and 'over and beyond the needs of and demands of local managements' (p.43). This study, like the literature on engineers as a whole, suggests a somewhat varied and varying situation regarding their employment.

McGovern (1996) conducted 79 interviews with managers, engineers, chemists and technicians in four multinational corporations (MNCs) in the Republic of Ireland. Two of the firms were part of the chemicals industry and two were part of the electronics industry. He used the interview data to construct a self-completion questionnaire. These were distributed to a further 203 managers, engineers, chemists and technicians in the same four companies. One hundred and sixteen responses were received. Data were collected about the recruitment and promotion of technical staff, the division of technical labour, and the tasks and other duties in which technical staff were engaged.

McGovern noted that some writers (Whalley, 1986; Armstrong, 1987a; Webb, 1992) had used the concepts of trust and discretion to explain the division of technical labour and that some of this research had used the work of Allan Fox (1974), discussed briefly in the previous chapter. However, according to the author, engineers' roles did not depend on the trust which employers placed in them, but on the formal qualifications which they had obtained. This meant that a much higher value was placed on formal academic knowledge and qualifications than on firm-specific knowledge. It was thought that those with more formal qualifications would have more knowledge and thus be more able to cope with responsibility.

McGovern also questioned the view that discretion was the main way in which employers distinguished between junior and senior technical staff. Rather, he found that the key difference was the amount of technical and managerial responsibility given to them by management. The amount of technical responsibility that they received depended on the importance of their work to their employer. The amount of managerial responsibility depended on an individual's position in his or her company hierarchy.

McGovern argued that Fox's model lacked 'interpretative relevance' (p.99) because while relationships within organizations inevitably contained some element of trust, it was not the main way in which positions in organizational hierarchies were distinguished. It also obscured other factors such as formal knowledge and levels of technical and managerial responsibility, and it was these factors 'which were of more importance when differentiating between the work of various positions along the technical job ladder' (p.99). Thus Fox's ideas had been 'given interpretative powers beyond their theoretical capacity' (p.88). McGovern also noted that employers often made labour markets for engineers more stable and supportive by sponsoring university students and offering high salaries and promotion opportunities for engineers who did not want to move into management positions. Thus many engineers became part of a technical elite. It should be noted, however, that Armstrong used Fox's model to examine the relationship between engineers and other management-level groups, while McGovern was concerned with the division of technical labour. Thus his criticism of Armstrong is perhaps unfair. This does not imply that the author agrees with Armstrong's views which were outlined in the previous chapter. Indeed, and as will be noted later, the findings of this thesis differ significantly from his arguments.

Carter and Crowther (1997) explored the position of engineers within Coastline Electricity Board (CEB), a Regional Electricity Company, following privatisation. The authors noted that traditionally, in contrast to engineers in some other industries, engineers in electricity supply formed the technical and managerial elite which dominated senior positions. They were given considerable flexibility and complete autonomy over their work. This 'sustained, dominant discourse gave rise to a narrative framework which placed engineers in a central role within the organization' (p.5). However, the privatisation of the electricity supply industry in 1990 brought with it sweeping changes which dramatically altered the position of engineers. The emphasis on strategy changed from maintaining the electrical distribution network to cutting costs and maximising profits. Non-executive directors were appointed and the board was influenced by reports from management consultants and City analysts.

Senior managers believed that major changes needed to be made to the way the company was run now that CEB was a listed company. Perhaps the most significant change which took place in CEB was the 'job redesign' programme. This consisted of two parts. First, team working was introduced. It was decided that seventy-seven teams, each of around fifteen people, would carry out most of the tasks in a particular geographical area. All of the positions within this new structure, including the most highly trained engineers, were termed 'technical support'. The absence of engineering terms in job titles symbolised 'a marginalisation of the discourse of the "professional engineer'" (p.13). Also, none of the seventy-seven team leaders had to be engineers, and an assessment centre was used in order to make the selection procedure 'scientific'. Although most of the successful candidates were engineers, a significant minority were not.

Second, the organization structure was flattened. This was achieved by a combination of redundancies and increasing the amount of administration performed by the remaining engineers. However, this led to a shortage of engineers. CEB 'solved' this problem by introducing 'Rule Based Engineering' which involved non-engineers performing engineering tasks by following a 'step-by-step guide'. Thus, engineering work had been routinised to the extent that it could be performed by people with no engineering training. In 1995 CEB was taken over by an American company which installed its own board of directors. Only one person on the new board was an engineer. The new senior management team believed that further staff reductions were necessary. By the end of 1996 CEB only employed 200 engineers, a reduction of 400 since 1990.

A more positive note on the employment of UK engineers was struck in a survey by the Engineering Council (1997a) of almost 7,000 Chartered Engineers. Some of the questions related to job satisfaction. Over 62 per cent were satisfied with their salary and conditions, over 70 per cent were satisfied with the technical opportunities that they had received, and almost 62 per cent were satisfied with their career development. Sixty-eight per cent of chartered engineers would recommend engineering as a career to young men and 62 per cent would recommend it as a career to young women.

It seems fair to conclude that there is little agreement about the employment conditions of engineers. There are probably two reasons for this. One is that writers often classify engineers in different ways. Whalley (1986), for example, believed that HNC or above was the 'most widely accepted' qualification for engineers, while others have only included graduate engineers in their work. The second reason is that the employment experiences of engineers are very varied. Because writers often base their views on small numbers of case studies it is not surprising that they arrive at different conclusions.

Nevertheless, there are a number of issues which emerge from these studies which will be examined in more detail in the remainder of the chapter. One is the extent to which engineers want to become less involved in the technical aspects of their work in order to take on more 'managerial' responsibility, either within engineering or in other functions. Another is the extent to which both graduate and non-graduate engineers are employed together, and whether there is a clear distinction between different grades of technical staff. A third issue is the quality and quantity of engineering graduates in the UK. Writing and evidence on engineers' managerial abilities, on the collective organization of engineers, on the social standing of the their profession, and on their levels of remuneration will also be examined.

Engineers and Management

The Careers of Engineers

The careers of engineers in construction appear to have been entirely ignored by academic writers. In the previous chapter it was noted that most authors believed that engineers rarely achieved the most senior positions in manufacturing companies (Armstrong, 1987a; Glover and Kelly, 1987; Lee and Smith, 1992; Meiksins and Smith, 1992; Meiksins and Smith, 1996). Earlier in this chapter it was noted that Gerstl and Hutton (1966) found that technical career ladders tended to be too short and that employers needed to do more to encourage the most able engineers to remain as technical specialists. It was also noted that Jones et. al. (1994) believed that engineers' career opportunities varied considerably between companies but that in most cases engineers tended to remain in technical roles.

In general, engineers in manufacturing appear to have three career orientations (Causer and Jones, 1993). Some choose to be involved in technical work throughout their careers and wish to develop their technical expertise as far as possible. Others view engineering as a route into 'management', either general or technical. A third group choose to move into other functions such as marketing or sales where their technical expertise may be put to good use. Bailyn and Lynch (1983) and Roberts and Biddle (1994) argued that many engineers thought that they would be perceived as failures if they had not moved into 'management' by the age of about forty. However, according to Bailyn (1982), Allen and Katz (1985) and Shapira and Griffith (1990) the idea that most engineers were forced to move into 'management' was misleading.

Many engineers enjoyed their work and chose to remain in purely technical roles throughout their careers.

Causer and Jones (1993) believed that companies found it difficult to develop career paths which attracted and retained staff effectively, partly because of the diversity of career orientations among engineers. Larger companies tended to develop elaborate grading systems. A graduate who entered a company at the age of twenty-one might receive three or four promotions by the time he or she was thirty. These promotions may have involved minor increases in responsibility but did not usually result in a change in function.

Some companies have established dual career paths. These provide parallel career structures for engineers and other professional groups which allow them the opportunity to develop their careers as technical specialists with minimal administrative responsibility or to move into roles which require less or no technical expertise (Moore and Davis, 1975; Roth, 1982; Sedge, 1985; Rynes, 1987). It is normally the case that each path has an equal number of levels at each side as well as equal rewards such as money, office space, parking privileges and share options. As was noted earlier, it is apparently the case that engineers in some companies feel pressured into taking 'management' positions because they are perceived as having a higher status than technical ones. By providing dual career paths employers hope to change the perception that a career in 'management' is superior to being a technical specialist and thus to encourage the most technically able engineers to remain in technical positions, should they wish to do so. However, some writers have noted that there are often a number of problems associated with dual career ladders. One is that power may not be distributed equally between the two ladders. For example, Raelin (1987) noted that technical specialists may find themselves reporting to managers who have lower formal positions. Also, and according to Burgower (1990) and Badawy (1995), the technical track is usually less highly regarded than the managerial one, both within companies and in the wider society. Armstrong (1984) went even further and suggested that dual career ladders were 'aimed at deflecting engineers from the positions of real corporate power' (p.107).

However, a later paper by Causer and Jones (1996), which drew on the same evidence as their 1993 one discussed above, noted that in the case of technical management there was often no clear distinction between an 'administrative elite' and 'rank-and-file' practitioners. Rather, 'hybrid' organizational positions appeared to have developed. Such positions combined, both formally and informally, managerial or supervisory elements with expert or professional work. This was not a situation which was unique to engineers in the electronics industry. In hospitals, for example, the role of the ward sister combined nursing with the supervision of junior nurses. The extent to which these 'hybrid' positions were formalised varied between companies. In most cases, engineers worked in project teams. Each project needed to be 'managed' in terms of resource allocation and scheduling. Because companies tended to be involved in large numbers of projects, engineers who were not formally employed in managerial positions often performed managerial tasks, and often it was junior engineers who were most suited to managing particular projects. Thus, the 'roles performed [by engineers] may bear only a limited relationship to the formal grades or job titles of those involved' (p.115). The result of this diffusion between managerial and administrative responsibility was a blurring of the division between managers and their subordinates, although the ultimate responsibility for the projects remained with those in more senior positions. (For the many dubious aspects of the notion of the hybrid manager see Currie and Glover, 1999).

The extent to which dual career ladders are used in the UK is unclear. The evidence suggests that most, but not all, engineers would like 'managerial' careers. This raises important issues concerned with whether good engineers make good managers, and most importantly of all, the degree to which engineering itself demands managerial expertise, as Armstrong asserted very powerfully a few years ago (Armstrong, 1996). Also, if, as has been suggested (Roberts and Biddle, 1994), it is usually the most technically able engineers who tend move into 'management', what effect does this have on the design, development and production of the three-dimensional objects being manufactured?

Engineers as Managers

A perception that engineers do not make good managers is often assumed to be partly responsible for engineers' 'problems'. Rosenbaum (1990), for example, argued that engineers usually had sophisticated technical problem-solving skills which might not be suitable for 'management' positions where interpersonal skills were needed for problem solving. The implication, presumably, was that people with sophisticated technical expertise had inferior social skills to those with non-technical forms of expertise, sophisticated or otherwise. This perhaps supports Armstong's (1987a) point, discussed in chapter 4, that the term 'management' had come to signify a set of skills and 'knowledge' which combined a mixture of expertise in finance, marketing, and business strategy but which contained little or no engineering. The result was 'management specialists' running industrial enterprises with a body of knowledge to which engineering expertise was virtually irrelevant. Technical expertise had become a disqualification for senior positions.

In a similar vein, Finniston (1980) noted that senior managers in manufacturing companies tended to have trained in finance and general administration and that 'the values and priorities of these backgrounds have thus set the tenor of British management culture' (p.36). In Finniston's view this low level of 'technological understanding' (p.37) among senior managers had led to inadequate 'technology-based responses to market changes' (p.37). Senior managers who did not understand engineering issues were likely to consider them as '"mere technicalities", separate and generally subordinate to the issues of general management' (p.37). And Finniston's explanation for this... 'there is a shortage of able engineers with the personal drive and flair required for the leadership of manufacturing enterprises' (p.36). Engineers needed to improve their oral and written communication skills and their financial understanding.

While the broad consensus, especially perhaps amongst many of those experienced in relevant international comparisons, has often appeared to be that these shortcomings can be resolved by education and experience, there is a line of argument which suggests that deficiencies such as poor communication skills are innate. According to

Armstrong (1987a), this was suggested as long ago as 1912 by the Institution of Mechanical Engineers. A notable contributor to this argument was Hudson (1966). He tested an unspecified number of boys aged between 15 and 17 at eight schools. Two types of test were used. One was a standard IQ test, usually in the form of puzzles. These required the boys to choose one answer from a list of alternatives, i.e., to choose the 'right answer' (p.36). The other type was more open-ended and required the boys to be creative and to think laterally without examining any particular line of reasoning in detail.

Hudson distinguished between 'convergers' and 'divergers'. Convergers tended to do substantially better at IQ tests than open-ended tests, and the opposite was the case with divergers. The author believed that on studying the results of these tests he could predict with a high degree of certainty which boys would choose arts subjects and which would choose science subjects in their sixth year. Convergers tended to study science subjects and divergers arts subjects. Divergers were able to think more imaginatively and creatively than convergers, who tended to take more logical approaches. Hudson noted that 'it seems that the arts man is free to use his imagination just because he is not committed to being practical; while the scientist's practical commitment precludes his thinking about any use for an object other than the *right*, most conventional one... some of the cleverest young men the country, the central nervous systems on which the future of British science depends... when asked to reason in a way which was unfamiliar... were tongue tied' (p.44). Hudson did not consider the implications of his results for the performance and profitablility of manufacturing companies, but his work has undoubtedly influenced this debate, as can be seen by the fairly large number of articles in engineering professional institution journals which describe engineers as convergent thinkers.

More recently, an article published in Professional Engineering, an Institute of Mechanical Engineers' publication, on May 8 1994 reported that psychologists at Cambridge University had conducted research which indicated a link between engineers and autism. The research suggested that the parents and grand-parents of autistic children were twice as likely to be engineers as the national average for all occupations. The article noted that 'autistic children and engineers may have a number of strengths in common. Both have strong spatial visualisation... Both have a strong affinity with physical objects... and both are strongly numerate' (p.14). The article added that engineers may also share some 'personality traits' with autistic children and that engineers tended to be 'less interested in social activities and communication' (p.14) than other occupational groups. The article concluded that these findings had implications for the management and profitability of companies because engineers 'may pay less attention to articulating their ideas to non-engineers and understanding the needs of other people and occupations such as marketing or accountancy' (p.14). No details of how the study was conducted or how other occupations compared with engineering were given.

As part of Beuret and Webb's (1983) 'Goals for Engineering Education' project, discussed in the previous chapter, the authors examined the perceived managerial competence of engineers. Two hundred and fifty engineers and 200 non-technical managers were interviewed. Only twenty-three per cent of engineers' colleagues thought that engineers tended to be able to see engineering in a broader business context, and only twenty-four per cent thought that engineers tended to be able to understand costing and business finance. Fifty-nine per cent of engineers acknowledged that engineers had problems with these issues. Sixty-two per cent of engineers and sixty-seven per cent of their colleagues thought that engineers had problems with verbal and written communication, and fifty-eight per cent of engineers and fifty-seven per cent of their colleagues thought that engineers' ability to manage and participate in meetings was a 'problem'. The authors concluded that there was cause for concern because engineers' poor non-technical skills had, in many cases, resulted in their partial exclusion from the decision-making process as part of a 'damage limitation exercise' (p.9) by senior managers. According to the authors, most of the engineers in the study were quite happy to accept this situation and had no great desire to force their way back into the decision-making process.

The above study is quite limited because it does not compare engineers' managerial abilities with those of their colleagues. For example, although around two thirds of respondents thought that engineers needed to improve their communication skills, perhaps four fifths thought that accountants needed to do this. As far as the author is aware, only Barry, Bosworth and Wilson (1997) have compared the managerial abilities of engineers with managers with different backgrounds. These authors tried to assess the extent to which company performance depended on the occupational background of its 'Top Executive'. This is clearly difficult, not least and not only because success and failure are subjective phenomena. Financial data for 151 manufacturing companies between 1990 and 1993 were examined. Other factors such as productivity, return on sales, return on capital, the propensity to undertake research and development, and the use of advanced technology were also examined. The authors concluded that companies headed by accountants tended to be most successful, followed by graduates who did not have engineering or accountancy backgrounds, followed by engineers. It should be noted that these results were obtained using a rather crude statistical analysis.

In the next part of their study Barry et. al. tried to explain why the companies in their sample which were headed by accountants seemed to be more successful than those which were headed by engineers. A survey of forty-seven history and eighty-three mechanical or aerospace engineering undergraduates was conducted. It was argued that the practical, solution-oriented and tough-minded nature of engineers made them ideally suited to middle management but not necessarily to senior management, which required a more flexible approach and which was more concerned with strategy than problem solving. This was underpinned by the narrowness of the A-level system and the highly structured nature of engineering degrees which ensured that engineers got relatively little chance to develop their people or communication skills. Accountants, on the other hand, tended to be arts graduates and were more able to think creatively. This argument was based on the work of Hudson (1966) discussed above. The authors concluded that the preparation of engineers and scientists for top jobs needed to be improved. This could be done either by changing the education process, and/or changing the types of people who chose to study engineering and science. Too much effort had been and was being wasted tinkering with university courses. Thus time and resources would be better spent attracting different types of people into engineering in the first place. It was suggested that a number of steps might be taken to help achieve this. These included reducing the mathematics content in engineering degrees, changing the perception that engineering is for less able people, fighting the myth that accountants and not engineers always get to the top, and informing people that if you study engineering you need not necessarily become or always be an engineer.

The limited data discussed above suggest that engineers tend not to make particularly good managers. In particular there appears to be a perception that engineers are not particularly good communicators and that they have a fairly poor understanding of financial and other non-technical functions. However, this is clearly an issue on which more work is needed before more robust conclusions can be reached.

Collective Organization

In this section the views of academic writers about the collective organization of engineers are discussed. Both trade unions and the professional engineering associations have sought to represent the interests of engineers, although in very different ways. Neither of them appear to have been particularly effective.

The authors of the Finniston Report (1980) argued that engineers were often reluctant to join trade unions because many of them were concerned that their interests might be overridden by or subordinated to the interests of lower level technical staff or manual workers. Also, it was felt that there was a potential conflict between engineers' 'professional' obligations and their obligations as trade union members. In particular, many engineers were unwilling to strike. However, the report's authors also believed that engineers were increasingly joining them in the 1970s because of increased dissatisfaction with their pay and employment conditions. Many engineers were frustrated that the professional institutions were unable to become involved in such matters and were aware of the improvements in pay and conditions which the unions had helped to achieve for other groups.

Whalley (1986) argued that attitudes to trade unions and professional associations could 'no longer, if they ever could, be used as indicators of class or status consciousness' (p.182-183). Rather they were 'pragmatic tools to solve immediate and pressing needs' (p.182). Forty per cent of his respondents were trade union members and slightly over half of his sample viewed trade unions positively. Engineers faced a dilemma when deciding whether to join a union. Trade union membership apparently resulted in a loss of trust by employers. Although many engineers were concerned about their pay and job security, they generally wanted to be seen to be responsible and trustworthy by their employers. Also, trade unions lacked the power to control the labour market and impose a credential-based exclusionary strategy, which was favoured by most engineers. The engineering profession had also been unable to deliver this. Less than one third of his sample were members of a professional engineering association and most were apparently unenthusiastic about them. Whalley concluded that the professional institutions were considered to be more or less irrelevant by most respondents.

Writing a decade later Smith and Whalley (1996) expressed broadly similar views. They argued that the professional institutions had been, and continued to be, irrelevant to the vast majority of engineers in the UK and that they had failed to make any impact upon their employment conditions: 'a case can be made for the ever-increasing irrelevancy of the professional institutes to the actual structuring of the division of labour in British engineering' (p.44). According to the authors this was partly because most of the senior members of the engineering profession were either employers, or sympathetic to the views of employers. Thus many engineers had turned to trade unions to represent their interests: 'with their worker status reinforced, their status in civil society weak, it is not surprising that trade unions should seek to capture engineers' identity and represent and mobilize their grievances. In this they have successfully competed against the professional institutes, which have fought a defensive rearguard action against collectivization of engineers' interests through trade unions' (p.49). They added, however, that trade unions, like the engineering profession, had made very little impact on the organization of technical work.

According to Causer and Jones (1996), engineers' desire for professional autonomy and the pursuit of their own interests were not incompatible with the interests or values of management. This was probably because engineers had tended to follow a model of 'business-professionalism' in which engineer-managers and engineer-employers had been influential. Both the professional institutions and the higher education system stressed a congruence between engineering and engineering management. Thus engineers tended to consider trade unions to be in conflict with their professional or managerial status. Similarly, Glover and Kelly (1987) noted that most engineers found it 'natural to identify broadly with the goals of the organization for which they work – profit, product quality and so on… Engineers are not on the whole concerned with knowledge for its own sake, or even for autonomy, independence and self-regulation… Technical success (a goal of engineers) is reasonably consonant with the commercial and other goals of most employing organizations' (p.204). These authors argued that engineers were often reluctant to join trade unions, mainly because they associated them with unskilled work. However, like the authors of the Finniston Report (1980), they also believed that engineers had increasingly been becoming trade union members in the 1960s and 1970s because their incomes and standards of living were perceived to have fallen behind other equivalent occupational groups.

Engineering unionism has been shaped by politics and class (Glover and Kelly, 1987; Meiksins and Smith, 1992; Smith and Whalley, 1996). The competing unions have tried to differentiate themselves from each other by adopting right wing and left wing strategies and by including or excluding semi-skilled technical workers and manual workers. Currently, engineers who wish to join trade unions face choices between the Manufacturing, Science and Finance union (MSF), the Amalgamated Engineering and Electrical Union (AEEU), and the Engineers' and Managers' Association (EMA). The MSF and the AEEU are both left wing unions whose members also include semi-skilled technical and manual workers. The EMA on the other hand, while hardly right wing in its political leanings, operates on the basis of occupational exclusivity and has the backing of the engineering institutes (Smith and Whalley, 1996). Engineers who work in the public sector may be members of UNISON.

In chapter three it was noted that the ambition of occupations to achieve 'professional' standing has been discussed as a phenomenon peculiar to the English-speaking countries (Anthony, 1986; Armstrong, 1984; Child, 1969; Fores and Glover, 1978; Glover, 1978b; Child et. al., 1983). The historical explanations for this were also outlined (Glover, 1978b, Glover and Kelly, 1987). In addition to the three classical professions of medicine, law and the clergy, occupational groups which have attempted with varying degrees of success to adopt and exploit professional modes of practice and organization include accountants, nurses, teachers, personnel specialists, marketing specialists, surveyors, and engineers.

The professional organization of engineers has long been, and continues to be, characterised by fragmentation (Finniston, 1980; Smith and Whalley, 1996). At the time of writing there are thirty-nine engineering institutions which are affiliated to a central body, the Engineering Council. No other UK profession has experienced institutional proliferation on this scale. The institutions were formed originally as learned societies (Glover and Kelly, 1987; Jordan, 1992). Their purpose was to disseminate knowledge and to improve the practice and standing of individual branches of engineering. Educational criteria for membership were established which specified minimum requirements for education and training. Members were also expected to adhere to codes of professional conduct and the institutions gradually began to take on qualifying functions (Finniston, 1980). Proliferation first occurred in the middle of the nineteenth century, but it is not entirely clear why it happened and continued. Buchanan (1985) suggested that it was a pragmatic and rational response to the proliferation of technical expertise embodied in rapid economic development.

Thus the professional interests of a naval architect or an electrical engineer were substantially different from those of a mining engineer, as well as from each other. Furthermore, institutional proliferation was apparently reasonably successful. In an era in which the state provision of technical education was minimal, the institutions successfully helped to develop and monitor the way in which engineers were formed.

However, Watson (1976), Jordan (1992) and Smith and Whalley (1996) pointed out that technical specialization was not a sufficient explanation for the establishment of, for example, the Institution of Metallurgists, the Institution of Mining and Metallurgy and the Institution of Mining Engineers. They argued that fragmentation was a result of the unwillingness of established institutions to permit engineers from other fields to join them. In the first half of the nineteenth century the Institution of Civil Engineers, which was founded in 1818, refused to allow engineers from the then burgeoning railway, manufacturing, iron and steel industries to join them. This led to the establishment of the Institute of Mechanical Engineers in 1847 by engineers who worked in the these industries. Smith and Whalley (1996) noted that this 'set the pattern for the continual proliferation of specialist engineering institutes that has marked the occupation' (p.45).

Individual institutions became preoccupied with the interests of their own members, and the engineering profession as a whole lacked direction and a coherent voice to represent it (Glover and Kelly, 1987). In some cases fierce rivalry existed between institutions (Buchanan, 1985; Jordan, 1992; Smith and Whalley, 1996). There have been several attempts to unify the profession. The first took place in 1923 with the establishment of the Engineering Joint Council. This involved the Institutes of Electrical, Mechanical, Civil, Marine and Aeronautical Engineers. However, it was largely ineffective and collapsed in 1937 (Jordan, 1992).

In 1962 the Engineering Institutions Joint Council (EIJC) was formed by the thirteen largest institutions (Finniston, 1980). The aim of this body was to provide a forum and voice for professional engineers. A Royal Charter was secured in 1965 and the EIJC changed its name to the Council of Engineering Institutions (CEI). At that time, most of the CEI's constituent institutions had different membership requirements. The CEI wanted to set common minimum standards and to set up a register of engineers which met these standards. In order to do this the Engineers' Registration Board was established. This registered as chartered engineers (C.Eng.), technician engineers (T.Eng.) or technicians (Tech) individuals who achieved the minimum membership requirements. In the case of chartered engineers this was a degree in engineering, appropriate training and experience as an engineer, and membership of an institution affiliated to the CEI. Technician engineers and Technicians required a Higher National qualification and an Ordinary National qualification respectively, plus the appropriate experience and training (Jordan, 1992; Finniston, 1980).

The failure of the CEI to persuade most of the public and/or most employers of the value of the C.Eng., T.Eng. and Tech. titles and the CEI's apparent ineffectiveness as a voice for engineers and as a force in national affairs led to the establishment of the Finniston Committee of Inquiry by the then Labour government (Jordan, 1992). It began to pursue its remit in March 1978 and reported in January 1980. The tone of the Finniston Committee's work was set partly by that of a semi-public campaign on behalf of engineers and engineering based at the Department of Industry from the early to the late 1970s (Jordan, 1992; Glover and Kelly, 1993). The Committee clearly believed that engineering was undervalued in the UK. Various measures were needed to help rectify this but the most important would be the establishment of a new Engineering Authority which would act as an 'engine for change'. This new body would have statutory powers and would be government funded. Crucially, the Authority and its members would be independent of the institutions and the registration and licensing of engineers would be transferred from the institutions to the new authority. Thus it would be able to register engineers without any requirement for them to belong to an institution. The institutions would still exist, but their role would be to advise and assist the new authority rather than to run it (Jordan, 1992).

The institutions were horrified at the prospect of this blatant dilution of their power and lobbied powerfully against the proposals. Perhaps even more significantly, the new Conservative government was ideologically opposed to the sort of professional exclusionism apparently being suggested by the Finniston Committee. Although a new body, the Engineering Council, replaced the CEI in 1981, it was quite different to the kind of body proposed by Finniston. It was not a statutory one, but was established as an independent public one with some state support and with a Royal Charter. Registration and licencing were transferred to the Engineering Council, but engineers who were members of it continued to be required to be members of a relevant institution (Jordan, 1992).

The success of the Engineering Council is open to debate. However, clear progress appeared to have been made in some key areas. During the 1980s a number of initiatives aimed at promoting engineering and improving the training and development available for engineers were introduced (Engineering Council, 1996a, 1997b). The Young Engineers for Britain competition and Women into Science and Engineering (WISE), both organized by the Engineering Council, had some success in encouraging more young people of both sexes to study engineering. Also during the 1980s, the Engineering Council successfully persuaded government to increase the number of undergraduate places for engineering and influenced the teaching of engineering-related subjects in schools. Moreover, it tried to encourage less academically able pupils to take an interest in engineering through its Technology Enhancement Programme. Another useful step was the accreditation of engineering degrees which helped to reduce variations in standards between degree courses.

The system of registration inherited from the CEI was altered only slightly (Jordan, 1992). Engineering Technicians became Incorporated Engineers (I.Eng.) and Technicians became Engineering Technicians (Eng.Tech.). The title Chartered Engineer (C.Eng.) remained as did, broadly speaking, the requirements for registration. It is unclear what impact this had, and continues to have, on employers. The main problem, however, was the relationship between the institutions and the Engineering Council. After the Engineering Council was formed, bitter feuding between it and the institutions hindered progress. The depth of feeling within the institutions was apparent from reading the journals of the major ones from the 1980s and early 1990s. Many of the institutions appeared to believe that the Engineering

Council was autocratic and that it deliberately went out of its way to ignore and antagonise them. The Engineering Council had failed to achieve the united voice that it was designed to provide.

It was against the background of these concerns that a further inquiry into the organization of the engineering profession was instigated (Fairclough, 1994). The Council of Presidents' Steering Group, chaired by Sir John Fairclough, was set up in January 1992. The aim of the Steering Group was to examine the formation, role and organization of a new or reformed body which would be able to address the above problems. The Steering Group published an interim report in April 1993. Three main recommendations were given in the report. First, it was argued that the Engineering Council should remain as the central body for the profession but that it should be altered. Second, there should be a 'new relationship' between the Engineering Council and the institutions. In particular members of the Engineering Council should be elected democratically by the institutions and their members. Finally, and most significantly, it was proposed that this 'new relationship' would be an evoloutionary step towards 'the solution' to the problem of fragmentation, namely, a single institution (Fairclough, 1994). The report was quite clear on the implications of this: 'That would involve transferring all the functions of the Central Body and participating Institutions to a Single Institution' (p.14). As with the body proposed by Finniston, the existing institutions would play a supporting role with no real influence.

However, like Finniston before him, Fairclough found that the institutions were extremely proud of their histories and protective of their fiefs and identities. In the compromise which was finally struck, the idea of a single institution was dropped and the 'new' Engineering Council was created in January 1996. The only significant change was that the Council's fifty-four members were made up of twenty-four elected by the engineering institutions, twenty-four elected directly by registered engineers and six nominated by the Privy Council (Engineering Council, 1996a). This replaced a complex and relatively undemocratic system which involved outgoing members selecting their successors from a list of possible candidates (for a more detailed account of this procedure, see Jordan, 1992: 254). Thus in the 'new' Engineering Council the institutions are much more influential than they were previously. The institutions were pleased with the changes but many companies, employers' associations and trade unions felt that they had been excluded.

It is too soon to judge the success or otherwise of these changes, but already there is a major disagreement between the Engineering Council and the institutions over the former's Standards and Routes to Registration (SARTOR) proposals. If these proposals are implemented, engineers who want to gain chartered status will need to have three A-level grades worth at least 24 points, and an accredited four-year (five in Scotland) M.Eng. degree rather than a three-year (four in Scotland) B.Eng. degree. People with B.Eng. degrees will have the option of being registered as Incorporated Engineers (Engineering Council, 1997b).

On the whole neither trade unions nor the engineering profession have been particularly successful at representing the interests of engineers and the limited evidence suggests that engineers are not particularly enthusiastic about either.

Engineering Education

It was noted in chapter 2 that almost all engineers are now graduates (McCormick, 1988). It was also noted that education and training have tended to be considered, provided and experienced separately (Lane, 1989; Glover, Tracey and Currie, 1998). Education implies formal theoretical learning and is seen as the responsibility of academic institutions while training implies 'hands-on' practical learning and is seen primarily as the responsibility of employers.

Most engineering degree courses in the UK are specialised. Most students register for three year (four in Scotland) discipline-based courses such as mechanical, civil, electrical, electronic or chemical engineering and usually have to make decisions about what kinds of engineer they want to be at quite an early age. UK engineering degrees have been subject to a number of criticisms. In the past some writers have argued that degree courses were too technically oriented with insufficient emphasis upon 'management' subjects and presentation skills, and that engineers were not therefore being adequately prepared for careers in 'management' (Beuret and Webb, 1983; Bolton and Spanyol, 1984). However, almost all undergraduate degrees now include non-technical subjects such as marketing and finance. Another criticism levelled against engineering degrees is that they are too theoretical and do not provide engineers with the practical skills which they need in industry, and that industry and universities do not co-operate closely enough (Finniston, 1980; Francis and Winstanley, 1988; Professional Engineering, October 18, 1995; Fowler, 1996). In April 1998 the chairman of the Engineering Council, Alan Rudge, complained that too many universities were trying to be like Oxford and Cambridge insofar as some of their engineering degrees were very theoretical. They needed to be more willing to develop new courses which included more practical elements and placements (Whitworth, 1998).

The Engineering Council and many of the engineering institutions feel that considerable variations in standards exist between engineering courses, with some accepting students with Ds and Es at A-level (Professional Engineering, November 6, 1996, p.3). In October 1996 Graham Mackenzie, Director General of the Engineering Employers' Federation (EEF), suggested that these courses should be trimmed in order for resources to be concentrated in fewer departments of a high quality: 'If there have to be cutbacks in higher education to protect quality then so be it. We... do not see why higher education should be exempt from the sort of market pressures that exist outside' (Patel, 1996:7). Brian Kent, a former president of the Institute of Mechanical Engineers, claimed that engineering degrees from Cambridge University or Imperial College were of a higher standard than those from one of the new universities (Dunn, 1995). This has led some people in the profession and others in higher education to suggest that a national curriculum for engineering degrees would help to solve some of the above problems (Professional Engineering, October 4 1995, p.3-4). John Spence, an engineering professor at Strathclyde University, believed that part of the problem with engineering education was that many of the academics who taught on engineering degrees had little or no experience of, and therefore little or no understanding of, the needs of industry (Greek, 1995).

Since around the late 1970s there has been a widespread public perception that there is a shortage of engineers in the UK (Finniston, 1980). This perception was reinforced when British Aerospace (BAe) announced in March 1997 that it planned to set up its own university to produce engineers because it was having serious recruitment problems (Professional Engineering, April 16, 1997, p.9). There has been much speculation in the media and within the profession about this issue. More recently the Rover Group, Glaxo Wellcome and SmithKline Beecham have also reported recruitment difficulties (Birt, 1997; Whitworth, 1998). Also, most of the 20 companies which participated in Causer and Jones' (1993) study, which was reported earlier in this chapter, reported that they were finding it increasingly difficult to recruit recent graduates as well as more experienced engineers. The shortage has been attributed to falling birth rates in the 1960s and 1970s and to an increasing reluctance of young people to pursue careers in engineering (O'Neill, 1990). However, if there is a shortage of graduate engineers this does not appear to be because there is a shortage of people who want to study engineering. According to the Universities and Colleges Admission Service (1999) there were 134,754 applications for engineering and technology degrees of which 26,033 were accepted (5:1). This compares to 41,846 applications for accountancy and finance degrees of which 6,240 were accepted (7:1), 84,228 applications for law degrees of which 12,346 were accepted (7:1), and 59,865 applications for medical degrees of which 5,029 were accepted (12:1). However, despite the large numbers of people who applied to study engineering, there was less competition for places on engineering degrees than on accounting and financial, legal and medical ones.

These points are supported by the results of a survey conducted by the Association of Graduate Recruiters in 1997 (Wyman, 1998). Although 58 per cent of the employers surveyed found it difficult to fill vacancies, graduate supply outstripped demand leading to unemployment among graduate engineers. This was because employers often felt that many engineering graduates were not of a satisfactory standard. As a result the engineering graduates who did find employment tended to command higher starting salaries than many other types of graduate. Some companies such as British Aerospace were recruiting 'supergraduates' who earned starting salaries of around £20,000 with a 'fast track' to senior positions (Professional Engineering, April 16, 1997, p.9).

One of the issues which was raised in several of the studies which were discussed at the beginning of this chapter was the importance or otherwise which employers placed on formal engineering qualifications. Whalley (1986), Smith (1987), Jones et. al. (1994) and Carter and Crowther (1997) all suggested that formal qualifications and technical positions tended to be only weakly correlated in UK industry. Other publications have also suggested that this is the case. Smith and Whalley (1996) argued that the 'lack of credential-based occupational closure is not simply the result of technicians and craftsmen receiving individual promotions into the ranks of engineers. Rather, it grows out of employers' practice of recruiting technical staff from a variety of different educational backgrounds. They all then begin employment at the bottom of the technical career ladder, where they must share work conditions, status and responsibility with promoted manual workers' (p.29). The author finds it very hard to believe that in most of UK manufacturing and construction, engineering graduates perform the same roles as former manual workers in any significant numbers and that members of both of these groups enjoy the same pay and conditions on any meaningful scale, particularly in technically sophisticated industries. It is almost inconceivable, although not impossible of course, that former manual workers would play a leading role in, for example, designing and/or building production facilities for complex chemical or other processes, or designing bridges or the next generations of computers or aircraft, unless they had first studied for an engineering degree. Nevertheless, the consensus in at least some of the literature appears to be that the title engineer is little more than a 'hazily defined set of points at a particular point in the company hierarchy' (Whalley, 1986: 187).

McGovern (1996), whose study was also discussed earlier in this chapter, arrived at a very different conclusion. He believed that employers relied very heavily on formal qualifications to distinguish between different types of technical staff. Indeed, he argued that formal qualifications were considered by employers to be more important than company specific knowledge and expertise. Employers believed that engineers with more formal qualifications would have more formal knowledge and would therefore be able to cope with responsibility. One of the aims of this study is to examine the extent to which employers differentiate between graduate engineers and other types of technical staff.

The Social Standing of Engineers and Engineering

Concern about the apparently low standing of UK engineers is a more than century-old recurrent theme in the many UK government and other public reports on technical education and manpower requirements. Since the 1950s, The Annual Report of the Advisory Committee on Scientific Policy (1964), the Finniston Report (1980) and most recently the Interim Report of the Council of President's Steering Group (1993) of the Engineering Council have expressed concern over the position of engineers in UK society.

A number of analogies have been used to indicate the engineer's plight, from being like that of a badger: 'theoretically a species that is admired and respected, in practice an animal confined to increasingly remote habitats and declining in number' (Lewington, 1991: 1) to the invisible man in Ralph Ellison's (1952) classic novel: '... a man who lived between society's lines. He existed yet he remained invisible. His society treated him as transparent, as occupying a status without definition and having an identity devoid of substance' (Downey et. al., 1989:189).

Glover and Kelly (1987) believed that the relatively low social standing of engineers in the UK compared with engineers elsewhere and members of cognate professions in this country was due partly to the notion of scientism discussed in the chapter 3. The inhabitants of the UK did not understand the role or importance of engineers in technical development in particular and economic growth in general. A survey of 2,173 people conducted for the Finniston Inquiry (1980) found that nearly one fifth of respondents had no idea what engineers did. Two thirds thought that an engineer did manual work and only 13 per cent associated engineering with design or development work.

The engineering profession appears to be deeply concerned about status believing that it discourages people from studying engineering at university. The journals of the engineering institutes regularly contain articles about the low status of engineering in the eyes of the public. Typically the status of engineering is compared to those of medicine and law. A number of apparently relatively successful campaigns introduced during the 1980s such as Women into Science and Engineering, the Technology Enhancement Programme, and the Young Engineers for Britain competition, which were discussed in a previous section, were developed by the Engineering Council in an attempt to raise the profile and standing of engineers and engineering.

The most recent campaign was the Year of Engineering Success (YES) which took place in 1997 (Foster, 1998). It had a budget of £1.5 million including £500,000 of government money. Its sponsors included the Ford Motor Company, General Electric Company, Rolls Royce, British Petroleum and the Engineering Council. Around 5,000 events aimed at raising the profile of engineering were organised. The events included open days at a large number of manufacturing companies and visits to schools by engineers. However, the YES campaign appears to have been fairly ineffective. A MORI poll indicated that only one in ten people in the UK had heard of the campaign (Professional Engineering, November 19, 1996). It was also dogged by allegations of financial irregularities (Professional Engineering, January 28, 1998).

Engineers and Pay

There appears to be a perception both in the academic literature (see, for example, Lee and Smith, 1992) and in the mass media (see, for example, Wells, 1997), that engineers are badly paid. Comparisons with other occupations are difficult because the relevant statistics tend to be compiled using different criteria. Gerstl and Hutton (1966) noted that 'the most general statement that might be made [about the pay of engineers] is that engineers are among the top six per cent of all income earners in Britain... They are approximately on the level of a senior executive officer in the civil service, or on a par with the typical ranges of income of professions such as those of architect or university lecturer; they rank above teachers and below solicitors and doctors' (p.103). They also found that graduates were paid more than non-graduates in all branches of engineering and that engineers in management were more highly paid than engineers employed in production who, in turn, were more highly paid than engineers employed in design and development.

Finniston (1980) noted that many of the people who gave evidence to his Committee of Inquiry expressed concern about the low pay of engineers. On reviewing the available evidence, the inquiry concluded that 'there is no ready answer to the assertion that engineers are underpaid, nor to the counter-view that they fare relatively well. Good engineers can do well from an early age while a large number of others - mostly middle-aged with lower academic qualifications - have been caught in what an American employer called "a flat spot, career and salary-wise"' (p.63).

The Engineering Council survey (1997a), which was discussed earlier in this chapter, found that in the financial year before publication the average income of Chartered Engineers was £40,131 including bonus and overtime payments. Earnings had grown by 12.6 per cent in the previous two years. In the same period, the retail price index rose by 4.7 per cent. This meant that real earnings growth was 7.9 per cent, well above inflation. However, there were wide variations within the sample. Ten per cent earned £23,500 or less, ten per cent earned £60,000 or more and 23 respondents earned £250,000 or more. Mike Heath, the Director General of the Engineering Council at the time of the survey's publication, believed the figures to be a little conservative because the very highest earners tended not to return survey questionnaires. The author considers this survey to be a useful indication of the pay levels of engineers. One problem with it is that most engineers do not obtain chartered status until they are around thirty. The survey therefore excludes younger engineers who presumably earn less. However many engineers tend to relinquish their chartered status when they move into more senior positions with less technical focus. Because these engineers tend to be rather well paid, this probably balances out the exclusion of younger engineers. Also, because the survey includes only Chartered Engineers, technicians, who might be classed as engineers by employers, are excluded.

Figures on occupational pay produced the by Office of National Statistics (1997) are shown in table 5.1. No details about how the figures were collected or about how engineers were defined were given. The Office for National Statistics only provided figures for gross weekly earnings. These figures were multiplied by 52 to give approximate annual figures. According to these figures, all types of engineer earn less than the £40,131 suggested by the Engineering Council. However, it is very likely that this survey includes many respondents who are technicians rather than 'professional engineers'. These figures also support Gerstl and Hutton's (1966) assertion that, of the major professions, only doctors and lawyers earn more than engineers. It is also interesting to note that, according to these figures, accountants do not earn more than engineers. Taking all the evidence together, it would seem fair to conclude that engineers are reasonably well paid in the UK.

Table 5.1. Survey of Gross Weekly and Annual Pay by Occupation

Occupation	**Gross Weekly Pay (£)**	**Gross Annual Pay (£)**
Medical Practitioners	869.8	45,230
Solicitors	670.4	34,861
Electrical Engineers	609.9	31,715
Electronic Engineers	556.1	28,917
Chemists	540.6	28,111
Chartered and Certified Accountants	539.1	28,033
Mechanical Engineers	536.4	27,893
Civil/Structural Engineers	536.3	27,888
Management Accountants	535.7	27,856
Production Engineers	517.1	26,889
Design and Development Engineers	495.7	25,776
Architects	486.7	25,308
Building Surveyors	465.7	24,216

Source: Office for National Statistics (1997).

Conclusion

Studies concerned with the employment of engineers appear to indicate that their employment conditions are varied. This is probably partly because they are varied. Also, some writers only include engineering graduates in their samples while others include technical staff with sub-degree qualifications. However, with regard to more specific aspects of the literature on engineers, a fairly clear picture emerged. This can be summarised as follows: engineers who remain as technical specialists are unlikely to achieve meaningful career advancement; engineers tend not to make good managers, either because of an innate or educationally induced incapacity for management; engineers tend to be members of a trade union but not of their relevant professional association; formal engineering qualifications and technical positions are only weakly correlated in much of UK industry; UK engineering degrees have not achieved the appropriate balance between technical and non-technical subjects and between theoretical and practical aspects; the social standing of engineers is low and the general public do not understand much of what engineers do; finally, the notion that engineers are badly paid compared to other UK professionals and managers is not supported by the available evidence.

In the previous chapter writing about the roles and influence of different groups in manufacturing and construction was discussed. It was also noted that this would be an important aspect of the study. The views of engineers and their colleagues on the issues discussed in this chapter will also feature in the results chapters. In the following chapter the aims and rationale of the study and the way in which the author collected and analysed the data are discussed. In chapters seven, eight, nine and ten the findings of the study are reported.

CHAPTER 6

RESEARCH METHODOLOGY

Introduction

In the previous two chapters some of the main issues concerning engineers and management in the UK were discussed. The literature suggests a mixed, but on the whole generally negative, picture of the position of engineers in companies in terms of their influence and careers, their employment experiences, their management abilities and their social standing. This chapter examines the aims and rationale of this study and the way in which the data were collected and analysed. The chapter begins, however, with a discussion of some of the relevant philosophical issues involved in social and management research.

The Philosophy of Research Design

Broadly speaking, there are two different approaches to social research: qualitative and quantitative. The debate about the strengths and weaknesses of these approaches has been set in the context of their differing underlying epistemologies (May, 1997). Positivist (quantitative) approaches assume that the social world consists of measurable, retrievable facts which are external to the individuals being studied (Hammersley, 1990). The assumption behind this paradigm is that objective truths about the social world exist and that they can be examined scientifically by measuring relationships between variables systematically and statistically (Cassell and Symon, 1994). The belief in a science of society has its roots in the eighteenth century Enlightenment (Filmer et. al., 1998). This was a period which was characterized by intellectual innovations in engineering, science and medicine as well as the arts and literature. Significant improvements in people's physical conditions and longer life expectancies as a result of these developments engendered a sense of optimism in the future and a belief that society operated in a rational way. Social theorists such as Saint-Simon, Comte and Spencer believed that society could best be understood by the application of the laws of natural science. Thus the aim of social science was to discover the 'laws' of society, as natural scientists aimed to discover the laws of nature.

However, most positivists do not believe that it is possible to conclusively verify scientific laws and to establish 'truths' which hold true at all times and under any conditions (Keat and Urry, 1975). Unlike the early positivists, Popper (1959) argued that one should not conduct research by observing, developing a theory inductively from these observations, and seeking to confirm the theory by further observations. Rather, the researcher should formulate a theory or hypothesis and seek to disprove or falsify it. A theory is considered to be true until such time that it is proved otherwise. If a is theory is found to be false, it must be rejected and another one developed in its place. This has been termed the 'hypothetico-deductive method' (Keat and Urry, 1975).

Because positivists aim to predict and explain phenomena objectively, it is felt that researchers must remain detached from the phenomena that they are studying. The issues of validity, reliability and generalisability are central to quantitative research (Cassell and Symon, 1994). Validity refers to 'the extent to which an account accurately represents the social phenomena to which it refers' (Hammersley, 1990:

57) while reliability refers to 'the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions' (Hammersley, 1992: 67). In quantitative research results are only considered valid if they are based on experimental data, official statistics or the random sampling of populations (Silverman, 1993) and are only considered reliable if two or more researchers could produce identical results if they observed the same phenomenon. If a research design satisfies these two criteria, the researcher is able to generalise from his or her observations to the wider population (May, 1997).

Positivism probably remains the dominant paradigm in most types of social research, including management research (Gummesson, 1991). However, since the 1970s many social researchers, uncomfortable with the notion of studying human behaviour scientifically, have turned to interpretative (qualitative) approaches. Like positivism, it does not have a standard well-defined meaning and is used to cover a variety of positions including phenomenology, ethnomethodolgy, symbolic interactionism and naturalistic behaviourism (Guba and Lincoln, 1994; Schwandt, 1994; May, 1997; Filmer et. al., 1998). Interpretative researchers assume a very different perspective to positivists. They believe that reality is socially constructed rather than objectively determined. Thus they reject positivist claims of an objective reality. The social researcher is part of the world that he or she is studying and there is no way that they can escape from that fact. Their aim is to 'know what the actors know, see what they see, understand what they understand' (Schwartz and Jacobs, 1979: 6). In other words, to understand the actors' perspectives on social phenomena.

However, the social scientist cannot simply let respondents speak for themselves. The aim is to understand how respondents make sense of the social world, and ultimately some degree of analysis must be performed. Thus social research requires interpretation (Hammersley, 1992; Filmer et. al., 1998). Indeed, subjectivity is considered to be a strength rather than a weakness in qualitative research. Glesne and Peshkin (1992) noted that 'seen as virtuous, subjectivity is something to capitalize on rather than to exorcise' (p.104). However, this does not allow researchers to impose their own assumptions and values uncritically. Reason (1988) used the term 'critical subjectivity' by which he meant 'a quality of awareness in which we do not suppress our primary experience; nor do we allow ourselves to be swept away and overwhelmed by it; rather we raise it to consciousness and use it as part of the inquiry process' (p.12). Interpretative researchers also believe that it is neither possible, nor necessarily desirable, to eliminate the influence of the researcher during data collection. What is important is that researchers understand this and use it productively (Maxwell, 1996). Thus positivists do not consider this type of research to be either reliable or valid. Also, as qualitative research usually involves studying a relatively small number of individuals or situations in detail rather than aggregating data from large samples, positivists argue that it is not possible to generalise one's conclusions outside the group or setting being studied (Cassell and Symon).

Unlike positivist approaches to social research, discussed above, which usually rely on quantitative statistical techniques to measure relationships between variables, interpretative approaches usually rely on qualitative methods. Indeed the terms 'interpretative research' and 'qualitative research' are used interchangeably (Bryman, 1989). Van Maanen (1979) noted that 'the label qualitative methods has no precise meaning in any of the social sciences. It is at best an umbrella term covering an array of interpretative techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world' (p.520). According to Miles and Huberman (1994) the purpose of qualitative research was to 'gain a "holistic" (systematic, encompassing, integrated) overview of the context under study: its logic, its arrangements, its explicit and implicit rules... The researcher attempts to capture data on the perceptions of local actors "from the inside" through a process of deep attentiveness, of empathetic understanding... and suspending or "bracketing" preconceptions about the topics under discussion... A main task is to explicate the ways people in particular settings come to understand, account for, take action and otherwise manage their day to day situations' (p.6). Thus, society cannot be understood by reducing phenomena to a system of categories which are only defined in terms of their relationships with one another. Schutz (1965) believed that positivism did not 'deal directly and immediately with the social life-world, common to us all, but with skilfully and expediently chosen idealizations about the social world' (p.57). The interpretative approach contends that the world is an 'open system' (Taylor, 1979). Even if the social world was governed by a set of rules or laws, and a scientific approach to behaviour could 'discover' these laws, society cannot be studied in an environment which is protected from outside interference as if in some kind of vacuum.

The author takes a pragmatic view of methodology. He concurs with Silverman's (1993) contention that social research has been 'bedevilled by the adoption of misleading polarities' (p.26) and with Hammersley's (1992) belief that 'the retreat into paradigms effectively stultifies debate and hampers progress' (p.182). These writers believe that social researchers should look at the similarities rather than the differences between qualitative and quantitative methods. After all, the process of inquiry is the same regardless of what methods are used. The crucial part of any social inquiry is the quality of the analysis rather than, for example, the way in which the sample is obtained or the extent to which an interview schedule is structured (Silverman, 1993). Hammersley (1992) noted that 'we are not faced, then, with a stark choice between words and numbers, or even between precise and imprecise data; but rather with a range from more to less precise data. Furthermore, our decisions about what level of precision is appropriate in relation to any particular claim should depend on the nature of what we are trying to describe, on the likely accuracy of our descriptions, on our purposes, and on the resources available to us; not on ideological commitment to one methodological paradigm or another' (p.163). This is what the author tried to do. The result is a research design closely aligned to the qualitative/interpretative paradigm.

Research Design

The author and his supervisor conducted 25 interviews with representatives of professional bodies representing the engineering and other mainly organizational professions, management and employers' associations, economic and political interests, and a small number of academic researchers. The main purpose of these interviews, which are reported in the next chapter, was to help identify the main issues concerning UK engineers. The role of engineers in construction was not discussed because the author had not decided to include the construction industry in the study when these interviews were being conducted. Access was negotiated by the author's supervisor who sent a series of faxes detailing his work in the area of engineers and management. The interviews lasted for between 30 and 100 minutes and varied considerably in the extent to which they provided directly useful information. Given their exploratory nature, they were loosely structured. However, they usually focused around three themes: the place of engineers and manufacturing in the UK's economy and society; the relationships between the bodies which represent the UK's main organizational professions and professionals, managers, directors and employers; and what needed to be done, if anything, to improve both of the two former sets of phenomena. The interviews were not recorded, but detailed notes were taken by both the author and his supervisor. From these interviews, and from reviewing the literature about engineers and management, the author decided upon the aims of the research.

This study had a number of objectives: to examine how engineers in manufacturing and construction feel about their influence and career prospects vis-à-vis the members of the other professional groups with whom they work; to explore the perceptions of management-level people in industry about the managerial abilities of engineers and their colleagues; to investigate how engineers feel about the trade unions and professional associations which represent many of them; to examine the views of engineers about issues surrounding engineering education and the importance which employers place on formal engineering qualifications; and to determine how engineers feel about the social place of their profession and about their levels of remuneration.

Thus the aim of the research design was to produce a descriptive account of the experiences and opinions of engineers and their colleagues which would enable the above objectives to be explored. This cannot be done using statistics. Quantitative techniques are extremely useful when the aim of the researcher is to predict and/or control phenomena in the social world (Guba and Lincoln, 1994) but are not particularly helpful for obtaining experiential or descriptive accounts of them because of the restrictions imposed on data collection and analysis due to issues of validity and reliability (Hammersley and Atkinson, 1995). There are other constraints involved in the use of this approach which can be avoided by adopting qualitative methods (Bryman, 1989). First, researchers are required to set parameters which they perceive to be important. These may be different to what respondents think are important. Second, phenomena tend to be studied in isolation. Thus there is little sense of context or of how phenomena relate to each other. Also, in management research, quantitative research tends to involve fairly static analyses of relationships between variables. This makes it difficult to identify the ways in which phenomena can change and develop. Finally, quantitative researchers tend to have relatively little personal contact with the companies which they are studying and consequently they are often unable to get a sense of how companies operate. Using a qualitative approach allowed the author to obtain a holistic perspective by paying detailed attention to nuance, setting, interdependencies, idiosyncrasies and context (Patton, 1987).

Semi-structured interviews on a one-to-one basis were used as the main method of data collection, although the author was usually given some written material about the companies that he visited. The other main techniques for collecting qualitative data are observation and focus groups. Observation was not a realistic option because of the problems that this would have caused in terms of access. Focus groups were considered but it was felt that the relatively sensitive nature of parts of the interview schedule rendered this inappropriate. The author thought that respondents would be more likely to be open and honest about such issues if they were discussed on a one-to-one basis. One-to-one interviews have a number of strengths. It is a highly flexible method of collecting data which can be used virtually anywhere and which can produce very detailed information which has much 'depth'. Also, it is the method with which research participants probably feel most comfortable (King, 1994). Given the time and resources available, the author concluded that semi-structured interviews offered the most suitable method of data collection.

The main focus in this study is engineers. However, engineers do not work alone. The colleagues of engineers have all kinds of effect on the working environments of engineers and also provide different perspectives on their roles. Also, part of the study involved examining the influence of engineers. It was felt that the most effective way of doing this was to explore the relationships between the main management-level occupational groups. It therefore seemed sensible to interview people who work and interact with engineers in order to obtain a more balanced perspective. In electrical and mechanical engineering, engineers in production and design and development work mainly with marketing and sales people and accountants. In chemicals, as well as these groups, engineers also work closely with chemists. In construction, the main colleagues of civil, structural and other engineers are architects and quantity surveyors. The author had originally intended to speak with personnel managers but it very soon became apparent that contact between them and engineers tended to be very limited.

Data Collection

Obtaining the Sample

The findings must be considered in the context of the relatively small size of the sample (N=82). That said, the aim of the research was not to produce statistical generalisations. Indeed, the author concurs with Guba and Lincoln (1981) who questioned the value of such generalizations: 'What can a generalization be except an assertion that is context free?... it is virtually impossible to imagine any human behaviour that is not heavily mediated by the context in which it occurs' (p.62). Cronbach (1980) believed that qualitative research designs which balanced depth and breadth allowed researchers to 'extrapolate' their results. Patton (1987) noted that 'unlike the usual meaning of the term "generalization", an extrapolation clearly connotes that one has gone beyond the narrow confines of the data to think about other applications of the findings to other situations under similar, but not identical, conditions. Extrapolations are logical, thoughtful, and problem-oriented rather than statistical and probabilistic... [and] can be particularly useful when based on information rich samples and designs' (p.168). Thus the author will attempt to extrapolate rather than to generalize. There were recurrent themes and issues in many of the transcripts and the author hopes to be able to say something about the position of engineers in general from the data collected.

Hammersley and Atkinson (1995) noted that whereas quantitative research requires the use of representative samples which have been selected randomly, qualitative researchers are 'rarely in a position to specify the precise nature of the setting required' (p.37). Engineers work in many different sectors in construction, extraction, manufacturing, services and utilities. Quite clearly, their experiences are very varied. Given that it was not possible to study engineers in all sectors, it was necessary to decide which sectors should be included in the study. The ones that were chosen were electrical and mechanical engineering, chemicals, and construction. The author's reasoning was that these sectors provided groups of engineers with significantly different employment environments. Also, they provided access to the main types of engineer, namely electrical, mechanical, chemical, civil and structural. The author had originally intended to study electrical and mechanical engineering separately, but the advice that he received from several respondents was that virtually all products in these sectors involve both types of expertise and that it is rather old fashioned to classify companies in this way. There were mechanical and electrical or electronics components in all of the products manufactured by the six mechanical and electrical engineering companies in the study, and all of them employed both mechanical and electrical or electronics engineers. Thus the author decided to study both types together.

Access to suitable research sites is often one of the most time-consuming and frustrating tasks in social research (Easterby-Smith, et. al., 1991). Conducting research in industrial organizations can be a particularly sensitive process and many companies, especially those with problems, are unwilling to provide researchers with access to the relevant people and information unless they have some influence on the output or receive some commercial benefits from it (Beynon, 1988). Hammersley and Atkinson (1983) noted that 'in many ways, gaining access is a thoroughly practical issue... it involves drawing on the interpersonal resources and strategies that we all tend to develop in dealing with every day life' (p.54). Gaining access to a sufficient number of companies and a sufficient number of interviewees was a cause for concern in this study. A number of different strategies were used in an effort to obtain the sample. Twenty-four companies participated in the study, six in electrical and mechanical engineering, five in chemicals and thirteen in construction. The sample contained eighty-two respondents, including fifty-two engineers, nine accountants, eight marketing and/or sales specialists (all of whom had engineering backgrounds), four quantity surveyors (one of whom had an engineering background), three architects, three chemists, a buyer, a personnel manager and a director with a background in general management. The companies and respondents are discussed in more detail in the results chapters.

The author wrote around 100 letters to managing directors of companies in the relevant sectors. The addresses were obtained from the Kompass (1995) directory of UK companies. Companies were chosen from Scotland, the North of England and the Midlands more or less at random, although in the case of manufacturing only companies with at least 250 employees were selected. The author received fifteen positive responses and all of these companies took part in the study. Access to another three companies was obtained by the author giving a short presentation about his work at a conference of engineering employers' in the Tayside area. He was invited back one year later to present his findings. He also wrote to a contact that he and his supervisor made at the Engineering Employers' Federation. She supplied him with the names and addresses of seven senior managers who worked for manufacturing companies. Letters were written to all seven, only one of which agreed to help. However, this led to a number of very useful interviews. Access to another company was gained through a friend of the author's supervisor who was acquainted with a senior manager who worked for a pump manufacturer in the Midlands. Again, this led to a number of very constructive interviews. The final strategy was to ask respondents if they knew of contacts in other companies who they thought might be willing to participate in my study. Access to four companies, all of which were construction ones, was gained this way. Most respondents, particularly in construction but also in manufacturing, had worked in different parts of the UK, and there is no reason to assume that the sample is regionally biased.

The author stressed the importance of speaking with graduate-level engineers or equivalent. All respondents were employed at management-level. This does not imply that all of the engineers interviewed were 'engineering managers' in the sense of being employed mainly or completely to manage engineers and engineering. As has already been noted, professional or graduate engineers are part of society's managerial stratum, involved in broadly defined management and employed at the same levels of organizations as people who are more obviously managers. The author asked to speak with five or six people at each of the eleven manufacturing companies in the study: three or four engineers of different types, an accountant, and a marketing specialist. In the case of the chemicals companies in the study the author also asked to speak with a chemist. However, the number and occupational background of respondents interviewed varied considerably between companies. In construction, many of the companies from which the sample was drawn were consultancies which only employed small numbers of specialists, in which case the author asked to interview one or two people. However, when the author approached contractors, which tended to employ far more people, he asked to speak with five engineers. The aim was to build up a picture of the position of engineers in the sectors as a whole. However, when appropriate some issues were also discussed in the context of individual companies.

Conducting the Interviews

As was noted earlier, in qualitative research, and particularly with interviews, it is not possible to eliminate the influence of the interviewer on the data collected (Maxwell, 1996). It is important not only to bear this in mind when conducting them, but to use it productively. Interviewing is primarily a process of social interaction (Goode and Hatt, 1952). Most articles which give advice about conducting interviews stress the importance of trust and of building some sort of relationship between the interviewer and his or her respondents. Easterby-Smith et. al. (1991) noted that a lack of trust can lead to respondents telling interviewers what they want to hear rather than what they really believe. Because, in most cases, visits were very strictly timetabled and because the author had never met the respondents before, gaining their trust was very difficult. However, in each instance the aims of the study were explained as clearly and as openly as possible. It was hoped that if respondents accepted the aims of the research and perceived them to be relevant and useful, he or she would be more likely to help the author in his efforts to obtain the necessary information.

As was noted earlier in this chapter, the interviews were semi-structured. All were taped and transcribed. An interview schedule was used in order, as far as possible, to obtain the same information from each respondent. The schedule contained a number of subjects which the author attempted to explore further by probing respondents. The wording of questions, the extent to which respondents were probed and the order in which topics were covered tended to vary. The aim was to establish a conversational style which allowed respondents to talk as freely and as openly as possible about the relevant issues, the schedule being used simply as a checklist to ensure that all of the issues were covered, thus ensuring a degree of reliability, in the positivist sense.

The interview schedule that was used for respondents who were employed in the manufacturing companies in the study was slightly different to the one that was used for those employed in construction (see appendices 5 and 6). This reflects the different issues faced by engineers in manufacturing and construction. Both schedules had five sections. The first section was about the types of work and roles performed by respondents. The second section was about the relationship between the main management-level groups in manufacturing companies and in construction projects and about how engineers and their colleagues felt about their positions in terms of influence and their careers. The third section was about the perceived managerial abilities of people from different functional backgrounds. The fourth section was about such issues as engineering education, collective organization, the social standing of engineering, and the pay of engineers. Finally, the schedule contained a small number of questions about the ages, qualifications and previous employment of respondents. When respondents which were not engineers were interviewed, the author tended to ask them mainly about how they felt about the above issues in relation to their own profession, although they were also, of course, asked their views about engineers.

Data Analysis

Perhaps the strongest criticism made of qualitative research concerns the subjectivity involved in the analysis. As was noted above, the positivist paradigm emphasises the importance of objectivity and a search for 'truth' which is considered in terms of single correct answers. Because qualitative research is generally based on the assumption that there are a number of relevant perspectives on a given issue and thus a number of 'truths', can it really be valid?

Scriven (1972) argued that quantitative methods are not necessarily more objective than qualitative ones. The development of structured questionnaires and the design of experiments are very subjective processes. Thus the notion of any method or study is objective is potentially misleading. Patton (1987) noted that some writers (e.g. Guba, 1978 and House, 1980) believed that, rather than considering methods in terms of their objectivity and subjectivity, one should place more emphasis on the 'neutrality' of the researcher and on reaching conclusions inductively: 'The neutral evaluator is impartial, one who is not predisposed toward certain findings ahead of time. The neutral evaluator enters the field with no axe to grind, no theory to prove, and no predetermined results to support... The possibility of attaining objectivity and truth in any absolute sense has become an untenable position in evaluation. Yet the negative connotations associated with the term "subjectivity" make it an unacceptable alternative. The practical solution may be to replace the mandate to be objective with a mandate to be fair and conscientious in taking account of multiple perspectives, multiple interests and multiple possibilities' (Patton, 1987: 167).

Concerns about objectivity in qualitative research as well as issues of validity and generalisability have led to the development of prescriptive methods of qualitative data analysis (see, for example, Glaser and Strauss (1967), Paton (1980), Strauss (1987), Strauss and Corbin (1990), Dey (1993), and Miles and Huberman (1994)). Such methods use systematic sets of procedures and claim to at least partly overcome the criticisms discussed above. However, Jones (1985) argued that qualitative data analysis was a very personal activity for which there were 'no definitive rules to be followed by rote' (p.56) to ensure that data were analysed correctly or in scientific ways. It tended to be 'rather less mysterious than hard, sometimes tedious slog' (p.56). In a similar vein Janesick (1994) believed that the focus on methods of analysis often led researchers to lose sight of what they were trying to achieve: 'It is always tempting to become over-involved with method and, in so doing, [to] separate experience from knowing... In the final stage of writing up the project, it is probably wise to avoid becoming overly preoccupied with method. In other words, the qualitative researcher should immediately focus on the substance of the findings. Qualitative research depends on the presentation of solid descriptive data, so that the researcher leads the reader to an understand of the meaning of the experience under study' (p.215). The author decided not to adopt a prescriptive method of analysis. The approach taken was based on the above views, the views of Patton (1987) discussed in the previous paragraph, and the views of Reason (1988) and Glesne and Peshkin (1992) discussed in the first section of this chapter. As was noted earlier, there is always subjectivity in social science. Social science requires interpretation. Thus the validity of my study should be measured by the extent to which it provides a useful and credible account of its objectives, and by the extent to which readers believe that the author tried to be fair and conscientious.

Each of the three sectors were analysed separately. The author began by reading the transcripts thoroughly to obtain a feeling for the data and to become familiar with them. A number of categories were developed which partly emerged from the data and which were partly derived from the original objectives. Thus the categories that were used more or less corresponded to the phenomena that were being investigated.

The following categories were used to analyse the transcripts of the interviews from the electrical and mechanical engineering companies visited: organization structure; engineers and accountants; engineers and marketing and sales; engineers in design and production; general influence/ position/ satisfaction; promotion/ career; perceived management abilities; trade unions; professional organization; engineering education; the social standing of engineering; and pay. The categories used for the transcripts of the interviews conducted at the chemicals companies in the study were almost the same as those above, except that 'mechanical engineers, chemical engineers and chemists' replaced 'engineers in design and production'. The categories that were used for the transcripts of the interviews that were conducted with respondents who were employed in the construction industry included all of the categories outlined above except those which were concerned with the relationships between the main professional groups in manufacturing. In their place the following were included: the role of engineers in the design of buildings; the role of engineers in the construction of buildings; the role of engineers in the design of civil engineering projects; and the role of engineers in the construction of civil engineering projects.

The author worked through the transcripts and identified the category or categories which corresponded to each part of the text. Individual sections were then cut out and placed in the appropriate category or categories. Often a section of text would be placed in two, three or even four different categories as respondents often made points which were relevant to a number of different themes. The name of the company, the name of the respondent and the functional background of the respondent was noted on every section that was cut out. Once this somewhat laborious task had been completed, respondents' views on the issues which were of interest were grouped together in folders so that their views could be more easily and accurately interpreted. Thus when, for example, the author wanted to know what respondents in construction thought about the social standing of engineers, the necessary information could be retrieved quickly and easily. This enabled the author to read everything that respondents in a particular sector had said about a particular issue and attempt to make sense of it. The aim was to understand respondents' perspectives on the phenomena being studied without imposing any pre-existing expectations about what might be found. Quotations were picked out which supported and provided some evidence for the points being made.

Conclusion

The aim of this study was to produce a descriptive account of the experiences and opinions of engineers and their colleagues. In particular it sought to explore the relationship between engineers and their colleagues and how engineers felt about their positions in companies in terms of career and influence. It was also concerned with how engineers and their colleagues felt about each others' management abilities. The final objective was to explore engineers' views on more general issues such as the collective organization of engineers, engineering education and qualifications, the social standing of engineers, and their levels of remuneration.

It was felt that a qualitative approach using semi-structured interviews was the most appropriate methodology given the type of descriptive and experiential data which the author was trying to collect, particularly given the time and financial resources available. Eighty-two interviews were conducted with engineers and their colleagues in three industrial sectors: mechanical and electrical engineering, chemicals, and construction. It was noted that qualitative research, indeed any kind of social research, cannot be entirely objective. Social science requires interpretation and this inevitably involves subjectivity. The aim was to understand the phenomena being studied from the perspective of the respondents. The next chapter reports the interviews conducted by the author and his supervisor, discussed above, which helped to develop the aims of the research. Chapters 8, 9 and 10 report the interviews conducted with respondents from the twenty-four companies in the three sectors discussed above.

CHAPTER 7

THE BACKGROUND INTERVIEWS

Introduction

This chapter reports the 25 interviews that the author and his supervisor conducted with senior representatives of a number of the public bodies which represent the engineering and other mainly organizational professions, management and employers' associations, economic and political interests, and with a small number of academic researchers. As was noted in the previous chapter, given their exploratory nature, these interviews were very loosely structured but usually focused on three themes: the places of engineers and manufacturing in the UK's economy and society; the relationships between the public bodies which represent the UK's main organizational professions, and the UK's professionals, managers, directors and employers; and what needed to be done, if anything, to improve these. Their main general aim was to help to identify the main issues concerning UK engineers.

The bodies included the Confederation of British Industry, the Engineering Employers' Federation, the Institute of Management, the Institute of Directors, the Engineering Council and five of its constituent professional engineering associations, namely, the Royal Aeronautical Society, the Institution of Electrical Engineers, the Institute of Marine Engineers, the Institution of Mechanical Engineers and the Royal Institution of Naval Architects, the Engineers' and Managers' Association, the Chartered Institute of Management Accountants, the Chartered Institute of Marketing, the Institute of Personnel and Development and the Institute of Economic Affairs. The interviews lasted for between 30 and 100 minutes and varied considerably in the nature and amount of useful information that they provided. The interviews were not recorded, but detailed notes were taken by both the author and his supervisor. As will be seen, there were almost certainly elements of public relations in some of the answers. Nevertheless, they provided some useful insights into the position and roles of engineers and more generally into the changing character of UK management. Together with the literature discussed in chapters 4 and 5 these insights were used to develop the aims of the study. However, discussions did not include the construction industry as the author had not decided to include it in the study at the time that these interviews were conducted.

The Representatives of Engineers

The respondent at the Engineering Council believed that it had become overly bureaucratic and autocratic since its foundation in 1981 and that it had sometimes lost touch with the engineers that it was designed to serve. Sir John Fairclough, formerly the government scientific adviser under Margaret Thatcher, had been given the task of restructuring the profession. He wanted to replace the thirty-nine institutions and the Engineering Council with a single body, but was forced to recognise that the institutions had histories and traditions which could not be ignored. The reorganized Engineering Council, which was formed in January 1996, was now 'owned by the institutions and nothing but the institutions' and funded by the contributions of individual members. Thus the influence of the institutions had increased rather than decreased.

Although the changes discussed above were mainly positive there were concerns that the role and influence of industry in the affairs of the Engineering Council had been diluted. This was a cause for concern because one of the criticisms of the original Engineering Council was that it did not encourage communication between industry and the institutions. Many companies had 'cut ties' with the profession as they felt that although the Engineering Council was content to accept their financial contributions, it was unwilling to enter into meaningful dialogue with them. This was potentially very damaging because it was the responsibility of employers rather than that of individual engineers or the engineering profession to raise the standing of engineers, engineering and manufacturing in companies. Part of the problem was that the universities and industry were working at cross purposes. Industry needed to be more involved in the formation of engineers. A four year degree followed by two years' professional development in industry, followed by two years of increasing responsibility was the ideal situation.

The (then Conservative) government had also wanted to see the development of a new unified body and felt that the changes discussed above had not gone far enough. However, it too was forced to accept that the institutions had long histories and traditions. The government's commitment to manufacturing was questioned. It was vital that the profession and industry achieved a single voice which would be able to lobby governments effectively. If this did not happen, the UK's manufacturing output might fall even further. The UK needed manufacturing as invisible trade and services did not create wealth to the same extent. Also, revenue from North Sea oil had allowed the UK to live beyond its means. Given that this would only last for another twenty or thirty years the UK urgently needed to invest in manufacturing in order to protect its future.

The social standing of engineering needed to be improved and this was one of the objectives of the of the new body. One of Fairclough's recommendations was the development of a vision for the future in four key areas: energy, transport, the environment and communications. It was hoped if this vision could be articulated to the general public it would raise the profile of the profession. However, the Engineering Council needed to be careful to avoid conflict with government as these were politically sensitive issues.

The five engineering institutes visited offered a study in contrasts. Engineers were generally considered to be an influential group and interviewees at all five institutes expressed the view that it was engineers, not accountants, who tended to run manufacturing companies. However they were generally agreed on a need for engineering education to attract people and to produce engineers with entrepreneurial flair, and they wanted their 'profession' to have a higher and more up to date profile. The important Institution of Electrical Engineers (IEE) seemed to be a little more content with the general development of the Engineering Council and its works than the Institution of Mechanical Engineers (IMechE) and most of the other engineering institutions. The IEE is generally perceived as more confident and forward-looking than most of the other associations. It merged with the Institution of Production Engineers (IProdE) in 1991. This was something of a coup, which made the IEE by far the largest engineering institution. In spite of a past history of friction between the

IMechE and the IProdE, and given the nature of their members' work, one might have expected a merger between them rather than the one that did take place. The second and third largest institutions are the IMechE and the original one, the Institution of Civil Engineers (ICE). The IEE has enjoyed something of a reputation for elitism and impatience with the slightly backward-looking character of some of the other institutions - the term Dickensian was used about the very beautiful if slightly neglected premises of another that was visited - but the researchers' impression of the IEE's current stance in the profession was one of a mixture of confidence and proper humility.

Among the smaller institutions, that of the Marine Engineers (IMarE) exuded an air of constructive and quite energetic self-awareness, especially about the prospects for educating engineers to be entrepreneurial in the widest sense. There was little evidence of complacency, and certainly no bounding self-confidence, in the interviews with the Engineering Council and its constituent institutions. The main impression was one of quiet determination to achieve whatever was possible combined with a realistic awareness of the limitations of the profession and its members, and of society's expectations of engineering. As will be noted later in the thesis, this was not the view of many of the engineers that participated in the study.

The interviewee at the Engineers and Managers Association (EMA) told us that, like many trade unions, it had moved on from the confrontational stance which it had taken with employers in the past. Now its focus was on working with employers in order to assist members with career development. The EMA believed that it had 'a role to play in helping engineers make the most of themselves'. The days when engineers could expect to be employed all their working lives were over. This was a fundamental change in the employment conditions of many engineers. For example, before National Power was privatised, it had employed around 16,500 people. Now this figure was around 3,500. Many of those who lost their jobs were engineers, and most of those who remained were expected to work much harder than before. Also, engineers did not tend to progress very far in companies. This was partly because they received very little management training. The EMA had set up EMA Training Limited which, among other things, offered to its members an MBA in Technology Management in conjunction with the Open University. Engineers needed to take control of their own career development and the EMA was focusing specifically on helping them to achieve this.

The position of engineers was particularly weak in companies which had been privatised. In the past, most senior positions had tended to be held by engineers. After privatisation however, these people were often replaced by management accountants and other non-technical specialists. Also, the work of many engineers had been routinised. As a result some tasks which had previously been performed by engineers were now performed by technicians. The leaner and flatter structures which existed in companies had resulted in fewer opportunities for engineers, particularly within engineering. Engineers were being forced to consider non-technical managerial roles if they wanted to be promoted, but many employers considered engineers to be unsuitable for general management. Engineers felt 'battered' and their influence was much reduced. Despite this, however, most engineers were well paid.

The professional institutions were doing little to help engineers. Many engineers were frustrated about the constantly rising standards needed for chartered status. The institutions had become elitist and seemed likely to become even more so. Also, they did not support part-time or distance learning, and this was irresponsible. However, the Engineering Council was apparently much more forward-looking and supportive than the institutions.

The interviewers also visited the Royal Academy of Engineering (RAE) which had been founded in the 1970s to promote engineering by encouraging and publicising best practice. However, the RAE was not an alternative to, and did not interfere with, the Engineering Council and the professional institutions. According to the interviewee, the social standing of engineers in the UK was low compared with the Continent and the USA. This was partly because people who were actually technicians were called engineers. There needed to be a greater distinction between qualifications. The title Chartered Engineer had not been as successful as was hoped in tackling this problem. The general public didn't really know what a Chartered Engineer was and companies had not shown much enthusiasm for it. A new, clearer system of registration needed to be formulated in order to help solve the above difficulties. Also, no consensus had been achieved between academic institutions about the appropriate balance between the practical and theoretical aspects of engineering education. More debate was needed so that an appropriate balance could be introduced in all universities.

There was not a shortage of young people studying engineering. However, engineering was losing out on many of the most able of them to other professions. Thus the priority for the profession was to encourage the most able students to study engineering rather than simply to encourage more of them. Also, the quality of engineering education was more important than the numbers studying it. One of the most serious problems facing industry was that many of the most able engineering graduates did not become engineers but preferred supposedly more glamorous sectors, such as financial services, which often offered higher starting salaries. Nonetheless, starting salaries for engineering graduates tended to be much higher than most other types of graduate.

Engineering did have an image problem. The best way to encourage young people to study engineering was to target school pupils just before they sat their GCSE examinations as this was a crucial time in terms of career choice. The parents and teachers of these pupils also needed to be targeted. More positively, unemployment levels among graduate engineers were extremely low and engineering graduates were considered in a very favourable light in manufacturing, construction and other sectors.

However engineers did not receive enough management training. Employers needed to encourage engineers to do MBAs at the top business schools in Europe and North America. Unfortunately, most UK companies were not willing to allow their engineers the necessary time off work. Furthermore, UK managers, including engineers, were not entrepreneurial enough. There was no 'Silicon Valley' mentality in most UK firms. Industry needed more go-ahead people with engineering and other backgrounds. Most importantly, it needed high quality products. Without them, it would not survive. To help ensure that they were made and sold it was vital that accountants and marketing and sales people and other management-level groups learned to work alongside engineers, something that which had not happened in the past.

The Organizational Professions

The respondent at the Chartered Institute of Management Accountants (CIMA) explained that the accountancy profession had changed dramatically since the 1950s. At that time accountants were not involved in decision making in companies, their role being more like that of book-keepers. Since then, however, the accountant had 'come out of the closet' both in companies and in private practice. Most of CIMA's members were employed in industrial and commercial companies and management accountancy had become much more fashionable. This was mainly due to the success of accountants of all kinds, including management accountants, in senior positions. Management accountancy was now well known to be an effective route to the boardroom. The Institute of Chartered Accountants (ICA) and CIMA were in competition with each other for members, although training courses and recruitment initiatives were often organized jointly. The last recession had forced companies to think more closely about the kinds of accountants that they needed. The demand for CIMA-qualified accountants had increased at the expense of ICA-qualified ones, mostly because their training was considered to be more relevant. Companies wanted their accountants to be business people as well as auditors and glorified book-keepers, and CIMA-qualified accountants were often considered to be the most suitable.

Developments in IT had made much accounting work less time-consuming. It also allowed more junior technicians to do some work which previously required qualified accountants. Most people could understand figures but interpreting them and integrating them into corporate strategy was much more difficult. Accountants were no longer kept at arms'-length and a closer involvement in executive work had helped them to develop in ways which were beneficial to companies. Because of this, interpersonal skills were vital for management accountants and CIMA had succeeded in recruiting members with very varied backgrounds.

Despite this accountancy apparently had an image problem both in companies and in society. In the past accountants were often feared and distrusted as messengers who brought bad news. However, this was changing. Much of the criticism that they had received was unfair as accountancy was a very useful and important occupation. After all, accountants, engineers and marketing and sales people were part of the same management teams and were increasingly working together to achieve their goals. Accountants tended to dominate boardrooms in services but in manufacturing engineers were the most numerous group. There were no indications that this would change in the near future. That said, even in manufacturing, accountants had become a much more integrated part of management teams.

The respondent at the Institute of Personnel and Development (IPD) believed that competitiveness was the most important issue for UK industry. An important role of the IPD was to help companies to achieve this. The IPD had been formed in 1994 as a result of a merger between the Institute of Personnel Management (IPM) and the smaller Institute of Training and Development (ITD). The IPD had largely rejected the notion of Human Resource Management (HRM). HRM was too autocratic. It involved companies exploiting their employees by downsizing, delayering and cost cutting in order to maximise share prices and shareholder dividends. Although some of the thinking behind HRM was probably well-intentioned, the notion had been abused by many employers. The belief, apparently implicit in the term HRM, that people were simply economic resources was morally unacceptable and the IPD therefore encouraged employers to consider 'Human Investment Management'. This involved employers developing and nurturing their employees as well as keeping them informed and involving them as much as was possible in decision-making. There was no political ideology behind this approach and the IPD was not 'pink' or socialist. Rather, it believed that competitiveness depended to a large extent on employee ability, commitment and morale. There was no point in spending time and money training and developing people if they were under so much stress that they could not perform their jobs properly. The IPD had also moved away from codes of practice because they believed them to be too prescriptive. Instead, they offered 'guidelines', which were more flexible. After all, each employer was different and each needed to find the most effective ways of managing its people.

Representatives of the IPD met regularly with representatives of the Confederation of British Industry (CBI) and the Trades Union Congress (TUC) and this provided a forum for discussing issues such as training and health and safety. Despite some disagreements, some innovative ideas had emerged and all three organizations had tried to convey them to their members. There was also informal contact with the

Engineering Employers' Federation (EEF), the Department of Trade and Industry (DTI), the Advisory, Conciliation and Arbitration Service (ACAS) and the Department of Education and Employment (DOEE). The IPD had no formal relationship with the engineering profession or with any other professional body or bodies. This was something which perhaps needed to be looked at. However, it was the role of personnel departments to work with people from all functional groups, including engineering, accounting and finance, and marketing and sales, to help them to carry out their 'people functions'. There was no competition, it was argued, between personnel and other functions because it was the role of personnel to help all of them. Also, the IPD's membership did not only include personnel specialists. Anyone who was involved in the management and/or development of people could join and the IPD was trying to attract engineers, accountants and others who were employed as line managers. The aim was to develop a 'broad church'.

The personnel function was not particularly well represented in senior positions. In industry and commerce engineers and accountants respectively appeared to dominate these. Most companies had Personnel Directors on their boards, but this was often partly window-dressing rather than indicative of the esteem in which personnel was held. The interviewee said that the IPD was not concerned about the strength or otherwise of the personnel function, and that what really mattered was that there was a genuine interest in the development of people throughout companies.

The Chartered Institute of Marketing (CIOM), formerly the Institute of Sales and Marketing, had received its royal charter in 1989. The interviewee argued that the

CIOM, like many professional institutions during the 1980s and 1990s, had become much more proactive and much less bureaucratic. It aimed to be a bridge between academia and marketing practitioners. It had two main concerns: raising standards of marketing practice and improving the effectiveness of marketing education. Raising standards often meant encouraging and helping employees and members by providing and developing opportunities for professional development and skills improvement. There was considerable work to be done in this area because it had suffered considerably during the recession of the late 1980s and early 1990s. The CIOM also had a responsibility to its members to provide qualifications and training which were relevant to industry and it was linking the National (system of) Vocational Qualifications (NVQ) to its own profitable and growing portfolio of modular employer- and sector- specific courses which led to some of its professional qualifications. Although marketing was a particularly practical profession, its standards were apparently no less rigorous than those of others. The CIOM also had a strong consultancy services division which worked closely with employers and government.

CIOM membership had been growing at between two per cent and four per cent per year and it currently stood at around 60,000. Some 36,000 of the CIOM's members had gained or were studying for CIOM qualifications. Its membership still only included a small proportion of the UK's eligible or potentially eligible marketing managers and specialists. The CIOM was very influential in the recently formed Marketing Council (MC) which also included representatives of the Confederation of British Industry (CBI), the Institute of Practitioners of Advertising (IPA), and the

Direct Marketing Association (DMA). It aimed to provide a united voice for the marketing profession by bringing relevant bodies together, as with the Engineering Council and the engineering institutions.

According to the interviewee, marketing was a relatively new profession and in industry it was often perceived as a junior one. Many members joined the CIOM in order to increase their status in their employing organizations and the CIOM had been working hard and to good effect to achieve this. Increasingly, employers, government and the media were recognising marketing's importance. The CIOM was becoming increasingly influential and had raised its own profile as well as marketing's more generally. However, there was still much work to be done before it achieved parity with accountancy and engineering. Marketing specialists tended to be better than engineers and accountants in terms of setting commercial targets and at looking outwards rather than inwards. Marketing was a philosophy, not only a function, and it needed to be embraced and practised by everyone in companies, not just people in marketing departments. The relationships which had been building steadily between the CIOM and the IPD and the engineering profession would help to achieve this. All of the professional institutions had an important role in making UK organizations effective.

Management Institutes and Employers' Associations

Having discussed the interviews conducted with respondents from bodies representing engineers and other professions, those conducted with a small number of management institutes and employers' associations will now be reported. In 1992 the British

Institute of Management (BIM) merged with the Institute of Industrial (until 1974 Works) Managers to form the Institute of Management (IOM). The IOM represents about 70,000 managers from a very wide variety of organizations, specialisms and levels of employment. It is a qualification-awarding body and a provider of management training as well as a representative and study association. Despite what the interviewers knew of its (or rather, perhaps, the BIM's) elitist and at times defensive reputation, the respondent was at pains to stress that the management courses it offered were not only for those formally employed as managers, and that management was 'a life skill' which was important for a wide range of occupations regardless of job title or formal position. People were increasingly becoming much more capable due to rising standards of education and skill. Organizational delayering, team-working, empowerment and the use of the theory of the learning organization had resulted in an increase in the proportion of employees who performed managerial tasks and allowed people more control over how they organized their time. For example, primary school teachers and nurses had management elements in their jobs, and the IOM encouraged people belonging to a wide range of occupations to apply for its courses. Supervisors, who had previously been excluded from joining the IOM and participating in its courses, were also encouraged to join and use it. As providers of management education and training, the IOM had a strong responsibility to tailor the management development programmes it offered to the needs of companies and individuals. Each person's needs and aims were assessed before any formal training took place. Tom Peters and other consultants and 'gurus' who claimed to offer quick fixes and instant solutions to problems were no longer seen as appropriate.

The IOM was neither the voice of UK management nor its servant. It aimed to represent management and to improve its standing and its standards. Most of the IOM's members were specialists such as engineers and accountants, but the interviewee said little about the roles or influence of engineers or relationships between functions and professions.

This was also the case at the Institute of Directors (IOD) where the interviewee focused on the way in which the IOD had evolved. The appointment of a new Director-General in 1994 had seen political realignment of the IOD. It had changed from being openly right-wing and a supporter of the Conservative Party to being a non-political institution. This was partly due to a belief that the next government would be a Labour one and partly due to the increasingly international nature of business. The IOD was focusing on three relatively controversial issues. One was capital gains tax and inheritance tax, which the IOD felt should be reduced to allow directors easier access to their money if they retired or moved to other businesses. Another was directors' pay which had been targeted unfairly by the media and which was not apparently as high as many people thought, with the average company director in the UK earning between £45,000 and £55,000 per year. Some accountants and lawyers earned more than £300,000 per year but were not criticised, whereas Cedric Brown, the Managing Director of British Gas, who was earning £240,000 per year, was berated by the media. Finally, the IOD spent a considerable amount of its time and energy helping the education and development of directors. This was something that the IOD considered to be particularly important as directors were central to wealth creation. The IOD ran a Diploma in Company Direction as well as masters degrees and doctorates in conjunction with a small number of universities. The 1980s and 1990s had seen major changes to the ways in which companies were run. Previously, nepotism was widespread at board level, but this had changed. The interviewee did not know which occupational group most directors belonged to, adding that he thought that only a small proportion of directors, perhaps ten per cent, had professional backgrounds of any sort, most being entrepreneurs.

The interviewees at the Engineers' Employers Federation (EEF) and the Confederation of British Industry (CBI) were much more concerned about the position of engineers and about manufacturing in general. The researchers were told that the EEF was more than just an employers' association. It was a representative and lobbying organization which was concerned mainly with engineers and manufacturing as well as other matters such as health and safety and the environment. Unlike the IOD and the CBI, the EEF did not act as a consultancy for its members. A fairly close relationship existed between the EEF and the CBI, but there had been some disagreements with the IOD which was too right wing and too focused on small business.

The reorganization of the Engineering Council in January 1996 had not gone far enough and would make no difference to the 'image problem' which affected engineers, engineering and manufacturing. The engineering profession should have moved towards a single institution as had been suggested by the Finniston Committee, and more recently by Sir John Fairclough, the person behind the recent changes to the Engineering Council. However, history was a barrier to true unification and the history of and rivalry between the engineering institutions meant that this would probably never happen. In any case, the problems of engineers were more deep-rooted than this suggested. They began virtually from 'day one' when young boys were given toy cars and young girls were given dolls to play with. At school, children of both sexes were not encouraged to take an interest in engineering. Mathematics teaching was 'pitiful' from primary school to A level, and physics teaching was even worse. Pupils were less likely to take A levels in these subjects because they were more difficult and required more work than Arts ones. The standard of teaching in the UK was very low and this was partly due to the low salaries which teachers received. The Continental baccalaureate and the Scottish Highers systems were superior to A levels because they produced broader and more democratic intellects.

It was crucial for the title 'engineer' to be restricted to graduates. Presently, many technicians were called engineers and this had damaged the social standing of the profession. However, engineers complained too much. They were usually well paid and at least as successful as accountants and lawyers in terms of careers (the interviewee was a lawyer by profession). The general public needed to be told about this. Lawyers and doctors worked longer hours but were not better paid than engineers. Unfortunately the media were not 'the friends of engineers' and did little to help them. Also, many members of the 'chattering classes' did not consider engineering to be a suitable profession for their children.

Manufacturing was essential for the long-term prosperity of the UK, but the UK needed better rather than more engineers. However, there was a very real shortage of technicians. Schools needed to keep their numbers as high as possible to maximise their funding and as a result were reluctant to arrange apprenticeships for their pupils. Recent figures for the West Midlands, with an economy heavily dependent on manufacturing, indicated that only 176 out of 700 vacancies for apprenticeships had been filled.

On the whole UK industry had improved dramatically during the 1980s and 1990s, particularly in terms of productivity. Companies were now benchmarking themselves against their competitors and this had resulted in further improvements. However, serious problems remained. The educational level of UK managers was low in comparison with competitor countries. Also, although many engineers made good managers some very technical ones lacked the interpersonal skills which were needed. Management training for engineers needed to be improved. Furthermore, UK companies did not invest enough in physical capital.

The respondents at the CBI assured us of the organization's non-political stance. The CBI was 'member-led' but was more than just an employers' association. It was the 'voice of industry' and as such, it represented industry in society. Thus it represented engineers as well as other professional groups. However, engineers were not given 'special treatment'. A significant proportion of UK managers originally consisted of engineers, but professional backgrounds were relatively unimportant. Ultimately, the CBI aimed to 'affect the competitive base of British industry'. It campaigned actively on behalf of manufacturing and lobbied government about issues which the CBI believed would improve competitiveness. Where appropriate and practical, relationships with other bodies were entered into. A proposed merger with the EEF had fallen through, but constructive dialogue had taken place with the IOD despite some friction due to the IOD's tendency to favour services.

Although the best British companies could compete with anyone, too many companies were not competitive enough. That said, there had been huge increases in productivity which were due partly to the greater flexibility of employees at all levels, deregulation, and the influx of inward direct investment which had helped UK companies to learn from foreign counterparts. Also, UK management was much better qualified than previously. However, more needed to be done at all levels if the UK was to compete with the world's most successful economies. In the 1980s, manufacturing had suffered from low investment because the economic conditions were not right. Governments needed to provide long-term security for manufacturing to prosper: this meant low interest rates and inflation and better education and training.

Public perceptions of engineers, and of manufacturing more generally, were poor. However, manufacturing was 'coming back into fashion' and increasingly recognised as very important for the UK. It was getting more publicity in the media and manufacturing production was increasingly used as an important economic indicator. As the profile of manufacturing increased, the social standing of engineers would hopefully follow.

Political Interests

The respondent at the right-wing Institute of Economic Affairs (IEA) did not provide us with information about engineers specifically. Rather, he talked about manufacturing and economic policy in general. He was one of the IEA's most senior members and administrators who explained how the IEA communicated through publications, which were circulated widely, as well as conferences and lecture series. The IEA had been founded when the economy was state controlled by people who thought that this was wrong. It had helped to change the public's view of the role of the state in economies and to convert the Labour party to a belief in free markets. However, business people in the UK were still less respected than in the USA and some other European countries. This was partly because academics, particularly in the disciplines of economics and sociology, imparted anti-business values.

The UK's relative economic decline came to an end during the 1980s when its economy grew as fast as or faster than most of its competitors. This change had been sustained during much of the 1990s and the UK's economy was now relatively competitive. However, problems remained. In particular, the prospect of the Social Chapter and European Monetary Union being imposed on employers was cause for concern and the UK needed to resist the drive towards political union between EU member states. Also, it was wrong to focus on manufacturing as if it was something special: after all it only accounted for around 25 per cent of GDP. Furthermore, it was not necessary to have a manufacturing 'base' of a particular size. However, manufacturing was certainly important to the UK economy and more capital investment in people and physical equipment was needed. The author was quite surprised that the interviewee made this point as it is not a view that is normally associated with right wing political and economic thinking.

Academic Researchers

The academic researchers that were interviewed had an interest in engineers and/or manufacturing in common and offered quite differing views on the position of engineers. One believed that that the root of the 'problem' for engineers was the dominance of accountancy and general management. Engineers did not tend to reach senior positions in companies. Indeed, their technical expertise was of little use in management positions. This was due to the UK's economic structure in which companies were disadvantaged by shortages of long term supplies of capital and were invariably concerned about the possibility of hostile take-overs. Thus managements had adapted to an environment in which decisions about capital expenditure were often considered to be the most crucial ones. As a result, finance and accounting were considered to be more relevant than engineering for senior positions and accountants had become a very influential group. However, those who had the power to change it were well served by the present system and consequently it would not change. The interviewee gave the impression that engineers in the UK were doomed to be second class citizens and that there was little hope of their situation improving.

Another academic researcher that was interviewed had very different views. He believed that engineers were numerically dominant in senior positions in UK manufacturing. The 'myth' of the dominance of accountants was partly because researchers had included non-executive directors in their studies of the backgrounds of senior managers. Non-executive directors tended to have experience of finance and accounting and were often invited on to boards because of their financial expertise. However, they were much less influential than executive ones and, according to the interviewee, a more realistic picture emerged when non-executive directors were excluded.

Engineers made excellent middle and line managers. They disliked waffle and found it easy to pick up skills such as those involved in marketing and HRM. Because they made formidable middle managers they were often promoted to senior management. However, engineers tended not to make such good senior managers. This was mainly due to the ways in which they were educated. Engineering courses at university were much more structured than most others, with over twenty contact hours per week. They often did not include much group work and most of them were very technically oriented. Students were often required to work towards a single 'right' answer. This was far from the ideal preparation for senior management. UK engineers were often 'spods' and needed a more diverse education in order to make them into more rounded human beings. Arts and social science students, on the other hand, were usually given vague and ambiguous tasks to perform which involved them collating as much relevant information as possible, using it to create an argument, and debating their views with six or seven peers in tutorials. According to the interviewee, most accountants were arts or social science graduates and thus accountants tended to have had a more useful preparation for the type of work involved in senior management.

Another of the interviewees was a historian who had written about the UK's economic performance. He believed that UK living standards had been much higher than is commonly assumed since 1870 compared to other major industrial countries, and that there was no substantive evidence of serious anti-industrial prejudice either now, or in the past. The 'status problem' of engineers was a myth. Engineers tended to 'talk rubbish' about themselves. They were well paid and often had very successful careers. Some institutions of higher education, such as Imperial College or Cambridge University attracted some of the country's brightest young people on their engineering courses and competition for places was fierce. The researchers were left with an impression of someone at least as dogmatic as those whose work he criticised, but he also appeared to be speaking a good deal of sense for much of the time.

The researchers also visited an expert on management careers. He believed that most employers took a laissez-faire stance towards the development of engineers. Companies had shifted the onus of responsibility on to the engineers themselves. They were reluctant to spend money on engineers' training and development because this increased their marketability and thus their likelihood of changing employers. However, the better managed companies did tend to both retain and develop their most able engineers. The employment conditions of engineers and other managers had deteriorated since the 1970s in the sense that they were expected to work much longer hours than in the past. Professional expertise was not particularly relevant for promotion to senior positions.

The final interviewee was an academic who was concerned with all aspects of the UK's economic, including manufacturing, performance. He argued that UK management quality had been improving quite quickly since about the 1960s, with job holders' qualifications increasingly relevant to industry. Also, levels of individual commitment, intellectual roundedness and international awareness had improved. The UK had learned much from the USA and Germany, although levels of technical competence still needed to be improved. UK companies fared best when service quality, marketing and branding were important. The UK's recent revival in manufacturing was very varied and it was important to know why, both in detail and in general, some sectors and companies did well and others did not. No one had yet made the kinds of systematic comparisons that were needed.

The author's supervisor enjoyed research contacts in the 1970s with most of the professional and management associations discussed above and was struck quite forcefully in the mid-1990s by their greater pragmatism, self-awareness and productivity. Although, and as was noted earlier, there were probably elements of public relations in some of what was said, the emphasis <u>appeared</u> to be on collaboration and on working together with others, where relevant, to maximise the effectiveness of UK industry.

Conclusion

The influence of engineers in manufacturing and their access to senior positions emerged as a contentious issue among interviewees. However, the majority of respondents who discussed this thought that engineers were an influential group who were not under-represented in senior positions. There was also some disagreement about the role of accountants. Our interviewee at the EMA and one of the academics we spoke with believed that accountants enjoyed the kind of dominance referred to by Armstrong (1984, 1985, 1987) and others. However, most of the other interviewees who discussed this issue, including our contact at CIMA, did not concur with this.

There were some scathing comments made about the engineering profession which some interviewees felt was elitist and ineffectual. It was generally felt that the changes made to the organization of the profession were inadequate and that it ultimately needed to move towards a single institution. Trade unions, which some researchers have tended to assume represent significant proportions of engineers, were hardly mentioned. Engineering education received some criticism for attracting weaker students, and for not including large enough management components. Some interviewees felt that engineers needed to be given more opportunities to develop their management skills, but none of them suggested that any managerial deficiencies might be innate. Others believed that there needed to be a focus on the quality rather than the quantity of engineering graduates. There was also some concern that engineers and technicians were often engaged in broadly similar tasks. One issue which appeared to have almost universal agreement concerned the low social standing of engineering as an occupation. Only one interviewee disagreed with this. Also, there was overwhelming agreement that engineers were generally well paid. These issues will be explored in more detail in the following three chapters which report the main body of interviews conducted with engineers and their colleagues in three industrial sectors: electrical and mechanical engineering, chemicals and construction.

CHAPTER 8

MECHANICAL AND ELECTRICAL ENGINEERING

Introduction

The aims of the research were discussed in chapter six. These were: to examine the influence and careers of engineers vis-à-vis other management-level occupational groups; to investigate the perceived managerial abilities of engineers and their colleagues; to examine engineers' views about the professional associations and trade unions which represent many of them; to examine the views of engineers concerning issues surrounding engineering education and the importance which employers place on formal engineering qualifications; and to investigate how engineers feel about the social standing of their profession and their levels of remuneration.

This chapter reports the interviews that were conducted with engineers and their colleagues in the five mechanical engineering companies and one electronics company in the study. Mechanical engineering has a gross output of £12.2 billion (Office for National Statistics, 1997b) and employs around 395,000 people (Office for National Statistics, 1998b). Output includes machine tools, pressure vessels, heat-exchangers and storage tanks for chemical and oil refinery, steam raising boilers, nuclear reactors, water and sewage treatment plant, mechanical lifting and handling equipment, and fabricated steelwork for bridges, buildings and industrial installations (Office for National Statistics, 1998a).

The output of the UK's electrical and electronic engineering industry is £18.3 billion (Office for National Statistics, 1997b) and it employs about 493,000 people (Office for National Statistics, 1998b). The electrical engineering industry manufactures most of its products for the electricity supply sector, including power plant, cable transformers and switchgear, lighting, plugs and sockets. The UK has the fifth largest electronics industry in the world. Its size is partly due to the investment of a number of Japanese and American companies such as IBM, NEC, Compaq and Digital. Products manufactured include computers, communications equipment, and audio and video equipment (Office for National Statistics, 1998a). Vehicles might also be considered to be part of mechanical and electrical engineering. Vehicles includes shipbuilding, aerospace, and motor vehicles. This sector has a total output of £13.9 billion (Office for National Statistics, 1997b).

As was noted in chapter 6, according to several respondents there are very few products which do not include both mechanical and electrical or electronics components and it is rather old fashioned to classify companies as electrical or mechanical engineering ones. Thus both types were studied together. There were mechanical and electrical or electronics components in the products made by the all of the companies visited, and all of them employed both electrical and mechanical engineers.

The aim was not to conduct a case by case analysis by examining the companies separately, but to build up a more general picture of the experiences and opinions of engineers in electrical and mechanical engineering companies. Where relevant, however, some issues are discussed in the context of individual companies. Twenty-seven interviews were conducted in six companies: thirteen with engineers of various types, seven with marketing or sales people, all of whom had engineering backgrounds, five with accountants, one with a procurement manager who worked in production but who was not an engineer, and one with a managing director who had a background in general management.

Company A was a leading aircraft engine manufacturer. The site that was visited employed around 1,500 people. The engines were designed, developed, manufactured and sold at this site. Five people were interviewed: a design engineer, a development engineer, a production engineer, a marketing specialist with an engineering background and a management accountant. Company B was a Swedish owned market leader in the manufacture of submersible pumping equipment and other submersible products for the water and waste water industry. The design, development and manufacture of the basic units were conducted centrally at a different site. The site that was visited employed around 250 people and was involved in the selling, installation and servicing of products, as well as modifying them to meet the requirements of customers. Five people were interviewed: the marketing director who had an engineering background, the finance director, the commercial director who had an engineering background, the contracts manager who had an engineering background, and a sales manager who also had an engineering background.

Company C was an American-owned multinational involved in the manufacture of automated telling machines (ATMs). The design, development, manufacture and selling of ATMs were also performed at this site which employed around 1,500 people. Seven people were interviewed: two senior production engineers, two senior design engineers, a marketing manager with an engineering background, a management accountant, and a purchasing manager who worked in production.

Company D was the British subsidiary of a US-owned manufacturer of tractors and trucks. Around 1,500 people were employed at the site that was visited, where products were designed, developed, manufactured and sold. Four people were interviewed: a design engineer, a production engineer, a marketing manager with an engineering background and a management accountant.

Companies E and F were competing with each other. Both specialised in the design, development and manufacture of clutches, brakes and specialist machine tools. However, company E was much smaller, employing only around 300 people, while company F employed around 3,000. Five respondents were interviewed at company E: the engineering director, a design engineer, a product manager with an engineering background, a sales manager with an engineering background, and a management accountant. Unfortunately it was only possible to interview one person at company F. Clearly, this made it difficult to evaluate the influence of different management-level groups in this company. However the interviewee, who was the chief executive of the company, provided what seemed to be some excellent data and it would be wasteful not to use them. He was not an engineer, but he had started his career in production management before moving into marketing and then general management.

Engineers and their Colleagues

One of the main aims of this chapter is to examine the influence of engineers. This was done by exploring the relationships between engineers and other management-level groups with whom they work. Companies A, C, D and E each contained design and development, production, finance, and marketing and sales departments. Company B did not have a design and development department. All of the design and development work for that company was conducted centrally at a site in Sweden. Company F combined design and development and production into one department called 'engineering'. Companies A and C used multi-functional project teams extensively. In both cases these had been introduced over five years ago. Companies D and F also used project teams but had introduced them within the last two years.

Companies B and E did not use project teams at all. As they were relatively small companies project teams were not considered necessary: the small numbers of management level employees meant that people from different functions worked very closely together in any case. Also, project teams tend to be used mainly in product development. This function was not performed on site by company B and this was another factor in that company's decision not to use them. In the companies that did use project teams most of the team members were engineers, although the teams contained representatives of all the major functions.

Engineers and Accountants

Several researchers have suggested that finance was the dominant function in manufacturing companies and that technical objectives were often subordinated to financial and other commercial ones (Armstrong, 1987a; Glover and Kelly, 1987; Lee and Smith, 1991; Canainn, 1995; Alexeichenko, 1996; Smith and Whalley, 1996). Glover and Kelly (1987) noted that 'engineers and accountants often appear to have little in common and to dislike each other. Some engineers seem to think that "water runs in the veins" of accountants, and engineers sometimes believe that accountants are self-indulgent spendthrifts' (p.144). Also, Armstrong (1984, 1985) believed that accountants and engineers had been the main protagonists in a struggle to become the most influential group in the 'global function of capital'. Thus it might have been expected that there would be considerable tension between the two groups. However, it appeared to be the case that accountants and engineers co-existed rather well. Four of the five accountants believed that engineers were becoming increasingly aware of their financial responsibilities and of the importance of minimising costs. According to one accountant:

'The traditional problem between engineers and accountants was that engineers couldn't care a toss about what anything cost. They just wanted to design something that was intellectually challenging to them no matter what it cost, and that was the situation probably fifteen or twenty years ago. But really that situation has changed radically since then. That isn't to say that all engineers are perfect little businessmen but there is certainly a much greater appreciation that cost is part of the equation in designing a component. Everything in this company from design through to production is aimed at minimising cost because our customers and our suppliers want to keep costs to an absolute minimum' (Management Accountant, company C).

There was a feeling that a very fine line existed between minimising cost and achieving the necessary standards of quality. Three accountants suggested that it was very important to enter into extensive discussions with engineers in production and design and development to ensure that this balance was achieved. Indeed, two management accountants, one at company A and one at company D, were concerned that engineers were becoming too focused on costs! This, they feared, might stifle their creativity:

'I think there is a danger, though, of engineers becoming too cost-conscious because you really do have to have people thinking laterally and openly about design and the functionality of products and how they can achieve the various performance factors without always having tunnel vision on cost as we accountants have. There has got to be a place for the lateral thinker and fortunately engineering tends to throw up quite a lot of these people because if you don't have them you don't develop products which are better than your competitors. We build the best engines in the world and that competitive edge is due to the fact that we have so many gifted engineers' (Management Accountant, company A).

'The only way we can survive is by minimising cost at the design phase because it's very expensive to do it further down the line when you have a customer complaining that a fault has developed after you've handed it over to them. We have to watch that we don't go too far and totally restrict the original thoughts of our engineers. If something costs a bit more during the design phase but it prevents further problems down the line then that's better for us' (Management Accountant, company D).

The author was quite surprised to hear accountants make comments such as these. Indeed, of the five accountants that were interviewed, only one was critical of their engineer colleagues. He was the management accountant for company E and believed that engineers needed to be watched very closely to prevent them exercising their natural instinct to spend money:

'If you left engineers to look after their own budget and they wanted something they would just go out and buy it without making sure they were getting value for money. So there's always a wee bit of tension there. Actually you've got to watch them a wee bit because they try to massage the figures so they look good to the MD. And they sometimes try to get us to be a wee bit creative with their figures so we have to be careful and try to reflect the true picture rather than give the information exactly as the engineers would like it' (Management Accountant, company E).

With the exception of the finance director, he was the only accountant in the company and therefore a fairly powerful figure. His relationship with some of his engineer colleagues was clearly strained. Two of the engineers complained about the finance department's apparent obsession with cost:

'Finance are only interested in the bottom line. Nothing else matters to them. They are too remote from real life, from what is actually going on. They have a costing system which is based on two variables: labour and materials. Jobs which require materials to be out-sourced tend to be sensitively priced with lower profit margins. Finance would certainly question the value of taking the order, whereas we would see this as an opportunity to develop a product which would lead to more orders' (Development Engineer, company E).

'Accountants, in my opinion, are too fixated with cost. They don't look at the broader picture. They are really quite dismissive of engineers as well. Sometimes we just can't develop something for the cost they want. It just can't be done. But they don't understand that' (Product Manager, company E).

This appeared to be the only company in which the relationship between engineers and accountants was problematic. Only two other engineers were critical of accountants:

'Accountants tend to be bean counters who think in terms of pounds, shillings and pence, whereas an engineer realises that if you want to build a Mercedes it's going to cost a Mercedes. If you build a Mini it'll cost a mini, but accountants want Mercedes for Mini prices' (Design Engineer, company C).

'My concern about accountants is that they are great at telling you what went wrong, not what is going wrong or is going to go wrong. It's the emphasis on the past that is worrying about accountants. An accountant might come to me after we've made something and say "we've lost money on it". Now that's very interesting to know. But I would rather have known the costing beforehand so that it didn't happen in the first place' (Production Engineer, company D).

On the whole, however, engineers appeared to be supportive of their accountant colleagues. Some of them felt that they were vital members of any team and could be useful allies:

'It's not an exchange of bullets across a great divide. Engineers and accountants are working together as part of the same team to come up with solutions and optimise the way we do things' (Design Engineer, Company A).

An accountant from company C believed that while accountants may not always be the most popular people in companies, other groups, including engineers, recognised that they performed very important roles:

'They see me as a bloody nuisance a lot of the time and I'm not always the most welcome person at meetings. Unfortunately somebody has to blow the whistle and control spending. So although I'm not always particularly popular I think most of them [engineers] appreciate that at the end of the day the company has to survive financially. And despite all of their ambitions, what determines the success of the company, and therefore their job prospects, is how the company performs at the bottom line. Are our profits acceptable? And so there is an appreciation and an understanding of that as well' (Management Accountant, company C).

An engineer from company B supported this view:

'Accountants are extraordinarily important... if you don't get the cash flow sorted out then engineers can't build anything. Both [engineers and accountants] are vital to the successful evolution and development of a company' (Contracts Manager, company B).

The author felt that there tended to be a, perhaps grudging at times, mutual respect between engineers and accountants, and it is perhaps unfair to suggest that accountants and engineers always tend to be in conflict with each other. The nature of the roles of the two groups means that some conflict is inevitable. Nonetheless, the engineers and accountants interviewed appeared to work together in most instances to try to ensure that resources were used creatively and efficiently.

Despite their relatively small numbers, accountants were clearly very important and influential people in all of the companies in the study. However, there was no evidence to suggest that accountants formed the dominant function in any of them or that engineers were subordinated to accountants in any general way. This point was reinforced by respondents' views on promotion which are discussed in a later section. The following quotation probably sums up the situation very well:

'...this is an engineering company. We produce an engineered product and I am working as an engineer in the engineering department. How can they [accountants] be more influential than engineers?' (Design Engineer, company D).

Although the role of accountants in manufacturing has been a significant feature of the academic literature, for some of the engineers interviewed it was neither an issue to which they had given much consideration nor one which particularly concerned them. According to one admittedly relatively inexperienced engineer in his late twenties:

PT: 'What do you think about the role of accountants in British industry?'

Respondent: 'It's not something that I've ever really thought about. I don't actually have that much contact with them, it's only really project engineers and other basically senior engineers that have much to do with them'

PT: 'What about engineers in general, do you think it's something that they are concerned about?'

Respondent: 'I'm not really sure' (Design Engineer, company C).

However other respondents were more forthcoming. A marketing manager with an engineering background at company C said that the role and influence of accountants was very much secondary to that of engineers:

'Good engineers are the key to a successful engineering company like us. No-one else is going to come in and develop new products. Certainly accountants can't do that. And unlike accountants an engineer's training is company specific. If you lose an engineer you can't just replace him with someone else from another company. That person must be trained in a way that is specific to that company. Without trying to knock accountants or anybody else I think we are the driving force and I think that's the philosophy in this company' (Marketing Manager, company C).

What came across quite clearly was that accountants were generally considered, both by themselves and by engineers, to be performing a support function. An accountant at company A said that although the role of the finance department was to monitor budgets, it was senior technical staff who were in overall control of them. Ultimately they were able to over rule the wishes of accountants:

'Sometimes we just have to bite our tongue with frustration when you get some engineering managers who ride totally roughshod over budgets. But we just have to get on with the job because sometimes they are correct. We could have a situation where we have four or five engines held up because we are trying to restrict overtime, but these engines could be worth twenty-five million pounds and a manager in manufacturing wants to bring in people on a Sunday to get these engines out, otherwise we will miss the shipment and upset the customer plus the fact there is another twenty-five million pounds sales in the corresponding margins through this month. So they say, stuff the accountants, I'll authorise the overtime. Another situation we've had is that they'll pay premium rates to a supplier to get the job done quickly maybe because we were too late in ordering the parts and we are trying to compress the lead times. Things like that happen all the time. And we jump about a bit a talk about how these guys are out of control, but very often they are right. You can't delay a twenty-five million pounds order because you want to save five thousand pounds worth of overtime' (Management Accountant, company A).

It was generally the role of accountants to monitor budgets, but not to set them. Budgets were usually set at board level, and the boardrooms of the mechanical and electrical engineering companies in the study tended to be dominated by engineers. Furthermore, it was the role of engineers, not accountants, to decide on company strategy. According to the Engineering Director at company E:

'Accountants are there to monitor. There is only one way of measuring efficiency and that is financially. There's no point to being like a Russian company and having very good products but not making any money from them. We are a very successful small engineering company. Last year the company's turnover was around twelve million pounds, and from that we made a quarter of a million pounds profit. And that's in a year where we invested the best part of a million pounds in new machinery. That's where accountants come in. We measure efficiency in financial terms and that's why accountants are so important. But they don't get involved in decisions at the highest level about issues which are essentially engineering such as product development' (Engineering Director, company E).

Thus although there appears to be a consensus among many academic writers that accountants are the most influential group in manufacturing management, this was not supported by the data obtained by the author.

Design, Production and Marketing

Webb (1992) studied a medium-sized electrical engineering company in the UK, Midas plc. She found that its engineers, particularly in design and to a lesser extent in production, endured a turbulent relationship with the marketing department. Design engineers believed themselves to be at the bottom of an informal status hierarchy of marketing, production and design, and resented not being involved in setting design timetables. This was the responsibility of marketing and had led to quite severe hostility between the two departments. Other researchers have noted that marketing specialists have not managed to assert themselves in the UK, despite increased emphasis on marketing *per se* (Whittington and Whipp, 1996; Pitt and Morris, 1995; Bresnen and Fowler, 1996). Some conflict was evident between the marketing and sales specialists and engineers in some the electrical and mechanical engineering companies in this study, but not on the scale as that observed by Webb.

All of the marketing specialists interviewed had engineering backgrounds. At first the author thought that this was because the people who had arranged the interviews had presumed that, given the nature of the project, it would be helpful if the respondents from marketing were also engineers. However, it became clear that this was not the case. Marketing specialists tended to be very closely involved with engineers, particularly in design and development. This involvement meant that some technical knowledge was considered to be necessary in all of the companies visited. The following response was quite typical of what was said:

'I don't know how a lot of the roles within sales and marketing could actually be performed by people who aren't engineers or don't have some sort of engineering background. For instance the product managers within the marketing function are specialist engineers and are involved with every aspect of a particular product including the initial designs. They build up a portfolio of the product and present it to customers. So they are involved in every aspect of the product from design through to sales' (Marketing Manager, company E).

All of the electrical and mechanical engineering companies in the study sold their products to other companies rather than to individual consumers. Also, all of them tailored their products to meet the requirements of their customers. This meant that design engineers had to enter into dialogues with customers from a very early stage. The role of marketing or product managers was to liase between the customer, the design department and to a lesser extent with production. Indeed the roles of design engineers and of marketing people overlapped somewhat and the two groups were required to work extremely closely together, particularly when new products were being developed. Although design and marketing did have slightly different objectives, the fact that the two functions were so interdependent and that most marketing people were originally design engineers appeared to facilitate the relationship between them. The following response was typical:

'We are obviously trying to understand what the market needs are and then work with design to come up with a solution. There are often problems... maybe the engineering solutions are not good enough in our view, or maybe they are not competitive enough and don't give us the market share we are looking for. But usually you find that if there is a problem, engineering is conscious of it. And they know they have a responsibility to try to ensure that their product is as competitive as it possibly can be' (Marketing Manager, company D).

Company A was the only one where design engineers reported that there had been more serious problems between marketing and design. It was apparently the case that the marketing department would only negotiate with new customers. Existing customers dealt directly with the design department. This had resulted in engineers tending to prioritise existing customers at the expense of new ones. One engineer said that:

'Marketing's priority is obviously to get out there and consult the customer, react very rapidly to what he wants and so on. We have a slightly different priority in the sense that if we are already serving existing customers and marketing want us to get involved with negotiations for a new customer, we have to decide if we deal with the in-service problem or go out and meet the customer and get involved with the marketing side' (Design Engineer, company A).

Engineers in production worked very closely with their colleagues in design and development and to a smaller extent with marketing or product management to ensure that they were able to build the designs which were produced by design teams. Several respondents said that their employing organizations considered the relationship between design and production to be crucial. With the exception of company B where design and development work was conducted at another site and company E in which, partly due its relatively small size, design and production had always apparently worked closely together, all of the companies visited had either combined design and production into one department or used project teams to facilitate the interaction between the relevant parties. Respondents agreed that design engineers had different objectives to production engineers and that there were usually lengthy and complex negotiations between them during the design process. This appeared to be partly because of a greater emphasis on satisfying the needs of customers:

'We lay down objectives at the start of a new product. We want to carry as many parts as possible from existing products over to new products thereby reducing the amount of time it takes to build and test. We also want to limit what features are put on the new product. These sorts of requirement often directly conflict with the views of the design and product management people who always maintain that the customer requires the breadth of a certain set of features. So we have to get across the message to design and to development that we only ought to be developing, ordering and building features that are going to get us a lot of revenue' (Production Engineer, Company C).

One engineer in company A believed that the different aims of the two types of engineer made some conflict inevitable:

'There is a big conflict between the two because they have different goals and are driven by different attitudes. Engineering [design and development] wants to get the design just perfect, but manufacturing [production] are focused on output, their attitude is let's go forward, lets get fifteen out this week, never mind what they are. It's a different culture in manufacturing' (Design Engineer, company A).

Several respondents at companies A, E and F believed that closer contact and increased communication between design and production had helped to solved many of the problems which had existed in the past between design and production. The following response was fairly typical:

'We have brought engineering and manufacturing together into the same teams, the reason being that, clearly, to get a "design-to cost" or a "design to make" mentality when you design bits you actually take into account the people that are going to make them. In this company the old adage used to be that the manufacturing people would say "if you design it we will make it" and of course that's a load of nonsense and results in manufacturing making a lot of expensive mistakes. The thinking now is when you design a bit, you design it talking to the guy who is actually going to make it because often he has got a very much better idea of how you can achieve the functionality of a particular part than the designer does' (Design Engineer, company A).

However a marketing manager and a management accountant at company A and a design engineer at company E said that, although design and production were working much more effectively together than in the past, some problems of co-ordination remained. Furthermore, at companies C and D engineers in design and production generally appeared to have a fairly uncomfortable relationship. At company C the two production engineers that were interviewed felt that, despite the introduction of project teams which contained engineers from production, design and marketing, there was not enough consideration given to production by design teams. One suggested that design engineers should be forced to spend two years in production before designing anything: 'If they don't understand production they will never be able to design'. He also believed that they had to fight hard to get designers to take on board potential problems in production:

'In production we are only too well aware that we are just one voice amongst many, that for every design criterion that we try to influence there will be others trying to influence design. There will be people who will be looking at design and saying we want you to do it this way for shipibility or reliability or serviceability. And that all comes into it. So as production engineers we can't be bloody minded and say "you must achieve this". We just wouldn't get listened to, so we have to tread a fine line' (Production Engineer, company C).

The other production engineer that was interviewed at company C and a production engineer at company D expressed similar views:

'We have to educate the development community and product management and explain to them why we are trying to constrain their design remit. We work in the same teams as them so we try to influence their position every day, a bit like a parrot sitting on their shoulder' (Production Engineer, Company C).

'The design engineer's first priority is to get something that works. His second priority is to design something which fits the specifications that have been agreed and his third priority is to meet target costs. Only after he has achieved these things will they give consideration to production issues such as minimum parts count, ease of configuration, flexible sourcing and so on. We need to try to influence the developers directly. We have seen time and time again that unless we are actually in there when decisions get made we don't have any input into it and we are just left with the end product' (Production Engineer, company D).

There was no suggestion by respondents, however, that engineers in design and production were not focused enough on the commercial implications of their work. It was noted above that engineers appeared to be focusing more on the importance of cost. Several respondents said that engineering was also becoming more market rather than product driven. This appeared to be indicative of the greater emphasis placed on marketing and sales. This had had two consequences. One was that marketing was seen as having greater strategic importance than had previously been the case. The other was that engineers were expected to consider the wishes of customers to a much greater extent. In marketing jargon, they needed to become 'more customer focused':

'Engineers in this company are increasingly given more commercial exposure and made more aware of the economic and commercial pressures that drive the business. We're not just product driven any more. They don't just go off and design something that we think wonderful but, doesn't sell. We have to design what the market wants us to design' (Marketing Manager, company D).

'The only way you grow your market is to understand who you are supplying. You then apply the technology to support what the customer or the sector of the market you are trying to address is looking for. So you should not be technology driven you should be commercially driven and use the technology to get those markets, and that's what we have been pretty good at' (Design Engineer, company C).

Engineers did not appear to be overly concerned at the increased influence of marketing and sales in their companies. Marketing was seen by many respondents as part of, or an extension of, engineering and of design and development in particular. This is probably because, as noted above, virtually all of the marketing and sales specialists in the companies in the study were engineers and because there was considerable overlap between their roles. Given the concerns of some production engineers about the buildability of designs, it might have been expected that the increased emphasis on meeting the requirements of customers would not have been welcomed by them. However, this did not appear to be the case. They felt that the solution was for production engineers to become more involved in product development.

The Careers of Engineers

In chapter 5 it was noted that a number of researchers believed that engineers tended to be excluded from the most senior position in manufacturing companies and that accountants dominated them (Armstrong, 1987a; Glover and Kelly, 1987; Lee and Smith, 1991; Canainn, 1995). However, and as was noted in chapter three, there is very little recent evidence about the backgrounds of UK manufacturing managers. The only recent study was conducted by Barry, Bosworth and Wilson (1997). These authors concluded that engineers outnumbered accountants by three to one in the most senior positions in manufacturing.

The author attempted to obtain information about the backgrounds of the executive directors of the six electrical and mechanical engineering companies in the study. Company C was the only one which did not provide this information. In the cases of companies B and D, both of which are foreign-owned, the figures obtained were from the companies' UK subsidiaries.

Company A had nine directors. Four were engineers, two were accountants, two had backgrounds in general management and one was a psychologist who had had a career in banking. Companies B and D each had four directors. In both cases three were engineers and one was an accountant. Company E had five directors, four of which were engineers and one of which was an accountant. Company F had four directors. One had a background in general management (the chief executive) and one was an accountant. The other two were both were engineers. Thus of the twenty-six executive directors in these five companies, sixteen were engineers, six were accountants, three had backgrounds in general management and one was a graduate of psychology who had had a career in banking before he became involved in manufacturing.

Table 8.1 Occupational backgrounds of executive directors of five of the six mechanical and electrical engineering companies in the study

Engineers	Accountants	Other Backgrounds
16	6	4

Rather than being employed in small numbers at board level, engineers are the most numerous group in the sample and the alleged numerical dominance of accountants is clearly not supported by this data. As might be expected, there was a consensus among respondents that engineering offered the best route to the boardroom in all of the companies visited. The following responses were fairly typical:

'Obviously every function is represented at senior levels but you tend to find engineers in every function except finance so you tend to find a lot of engineers at board level. I mean materials, manufacturing, engineering, marketing all usually have engineers as their directors' (Production Engineer, company C).

'I think the company has a fair mix at board level. In the past we were much more strongly engineering-led, but I think now there is a much bigger mixture of disciplines in senior management and a greater proportion of people who have been recruited from out with the company. Obviously we have a number of finance people on the board, and we have a chief executive who is a psychologist by training. I think that any company needs people which can bring different skills to the table. But there is still a strong engineering theme at senior levels. In fact I'm sure that most of them still are [engineers]' (Design engineer, company A).

Most engineers will, of course, never serve on the boards of companies. Thus the author was also interested in how engineers felt about their career prospects more generally. Although, as was noted earlier, some respondents which worked in production were concerned that designers tended not consider production issues when they were designing their products, there was no suggestion by respondents that the career opportunities for the two groups were significantly different, with the possible exception that design engineers were more likely to move into marketing. Company A was the only company that operated dual career ladders in order to encourage engineers as well as other professionals including accountants to remain in technical roles, although company C was in the process of developing one. However, there was a feeling in company A that it was easier to move up the 'management' career ladder than the 'professional' one, and there remained concerns that too many engineers were pursuing non-technical careers:

'Never mind finance and marketing, even within engineering there are jobs which are much more management than specialist, and people do tend to feel that they have to get on to the management jobs. So I think more needs to be done to get the balance more equal' (Production Engineer, company A).

Several engineers in other companies, with the exception of company B which was primarily a sales company with only a small amount of design and production work carried out on site, complained that engineers tended to be pressured into taking 'management' positions and several also suggested that both technical and non-technical 'managerial' positions tended to be considered as having a higher status than specialist ones. A design engineer at company D felt that in his company engineers were considered to have failed in career terms if they had not achieved a 'management' position by the age of forty:

'When I first graduated I started work in the car industry with Austin Rover. They appreciated the fact that some engineers would never want to become managers but should still be rewarded so they didn't feel they needed to leave engineering. So they started offering posts to engineers which were equivalent to managerial ones. Here they don't do that... If you've not got a management job by the time you're forty, you're a failure and that's not right' (Design Engineer, company D).

One engineer believed that the large numbers of engineers who became less involved with the technical aspects of their work was having adverse effects on corporate performance:

'Sometimes I wonder when we're going to stop making good engineers into bad managers. Usually it's the best engineers who go take on more managerial responsibility which is not really the most sensible way to go about things. The best engineers should be encouraged to stay in technical posts' (Marketing Manager, company E).

However, the advantage of the above situation was, of course, that if engineers wanted to take on more 'managerial' responsibility or to move to a different function, they were usually able to do so quite easily, which is what several of the respondents had done. According to one respondent:

'I would say that if you take all the managers in this company, no matter what their job title was, you would find that between eighty and ninety per cent of them will have been engineers at some point in their careers, and that would increase the higher up you went' (Production Engineer, company C).

Indeed, while some engineers were concerned that they had to become less focused on the technical aspects of their work or even leave engineering all together if they were to advance their careers, others believed that engineering provided a wide range of career opportunities for engineers which were not available to other groups in their companies:

'The thing about working in engineering or manufacturing is that it's the best way to learn about the industry you're competing in. What that means is that engineers are best able to do a lot of the jobs in engineering companies which don't necessarily require an engineering qualification... But we've also got all the technical side as well which obviously no-one else can do' (Production Engineer, company E).

'A lot of engineers see engineering as a very interesting subject to study and something which is able to provide an interesting career. But they don't necessarily want to stay in the bike sheds for the rest of their careers, so they use it as a means to understand how the business works and they take that experience with them into other functions. Not many seem to go into accounting or finance, but marketing and sales, personnel, business management, you'll find engineers in all these departments, and in the board room as well, as I've already said' (Marketing Manager, company A).

Four engineers argued that the career paths which engineers chose had little to do with status. They believed that many engineers chose to remain as technical specialists simply because they loved their work and because the satisfaction which they gained from it could not be achieved by performing non-technical roles. Thus those engineers who wanted to become less involved in the technical aspects of their work tended not to feel the sense of satisfaction and achievement which many engineers felt when they solved complex technical problems:

'You come across two types of engineer. There's the type who enters engineering and is effectively hell bent on gaining a position where they have managerial responsibility. They want a head count, and a budget, and a large salary. These sort of things. On the other hand you get a lot of engineers who are equally talented but in different ways and are quite happy to stay on the technical side. Certainly a lot of the better engineers I have known, their ambition has been to do the job to the best of their ability, technically speaking, because they love their work. But I know of a lot of engineers who moved into other areas because they felt that they wanted a change or that they were not enjoying their work. I know people who have left engineering entirely for these reasons' (Design Engineer, company C).

The Position of Engineers in Mechanical and Electrical Engineering

The author was left with the overwhelming impression that engineers were the most influential group in the management of all of the companies visited, and at all levels. Everything appeared to revolve around them. This was partly because they were by far the most numerous management level occupational group, partly because they were employed in almost every department and in both technical and non-technical roles throughout their employing organizations, and partly because they tended to dominate senior positions.

A greater emphasis appeared to have been placed on minimising costs and on understanding and satisfying markets and customers in the companies visited. However, this had not resulted in accountants and other non-technical specialists becoming more influential at the expense of engineers. Virtually all significant cost savings came from improved designs and/or from more efficient production processes. Only engineers could achieve this. Similarly, the relatively sophisticated nature of the products which were manufactured and sold by all six companies meant that engineers, particularly design engineers, were required to work closely with customers to develop products which met their requirements. Thus the responsibility for minimising costs and for understanding and satisfying markets and customers lay primarily with engineers. This perhaps indicates that the distinction made by some academic writers between 'management' and engineering is a facile one.

Accountants were generally considered to be performing a support function. More generally, most respondents did not appear to be concerned that there was a subordination of technical to financial or other commercial priorities:

'There is a lot of emphasis on the commercial side of things but I think that's inevitable. This company went bankrupt in 1971 so we know we've got to get the commercial side right. We are a commercial organization and we have to recognise certain commercial realities. That said, I would argue that engineering is this company's main asset. If you asked me what assets we had I would say we've got some factories and some offices, but they are not particularly important. The biggest asset we have got is our engineering capability, that's what you buy when you buy our products' (Production Engineer, company A).

However, some respondents did feel that the best way to advance their careers was to become less involved in the technical aspects of their work and take on more 'management' responsibility, either technical or general. Only one of the companies visited (company A) had dual career ladders for engineers and other professionals, although another was in the process of developing one. However at company A respondents felt that it was easier to move up the 'managerial' ladder than the 'professional' one.

The relationships between design and production engineers appeared to be the most turbulent ones in the companies visited. Several of the latter felt that designers did not tend to consider fully the 'buildability' of their designs. However, engineers, accountants and marketing and sales specialists appeared to enjoy generally constructive relationships. In the author's view view, none of the engineers in any of the electrical and mechanical engineering companies in the study appeared to suffer from 'low status', despite some of the problems discussed above. Most engineers appeared to feel that they were, by the very nature of what they did, pivotal to the companies in which they worked:

'In this company the status of engineers isn't really an issue. Decisions are taken on their merits and people are advanced on their capabilities and I think we have examples of that at virtually all levels of the organization' (Marketing Manager, company B).

'I think that engineers have always had a strong influence in this company, although I don't think we are engineering-led any more. But I don't have a problem with that. The company is there to make profits and to earn money from selling engines, but it is primarily the quality of the engineering that underpins that' (Design Engineer, company A).

Management Abilities

The author wanted to know what respondents thought about the strengths and weaknesses of engineers as managers compared with other groups. Fifteen respondents believed that there were no differences in the management abilities of different groups. According to one accountant:

'I think the strengths and weaknesses of people as managers are due to people as individuals and not to their professional training' (Management Accountant company A).

The chief executive of company F said that he wasn't entirely sure whether his senior management team were engineers or not, and that whether someone was an engineer or an accountant or neither was considered to be more or less irrelevant:

'I remember joining a company in 1980, and each of the divisions had photographs of the divisional management team in the annual report. And I had sort of labelled them all before hand in terms of who was the salesman, who was the accountant, who was the design engineer and whatever. I got them completely wrong. I think they are much more of a homogeneous unit than say thirty years ago' (Chief Executive, company F).

However some respondents believed that engineers had some strengths and weaknesses compared to other groups. Five respondents (all engineers) believed that engineers' ability to solve problems in a rational way gave them an advantage over other types of manager:

'I think a major strength of engineers is their ability to grasp problems. If they are faced with a problem that requires logic or some kind of rational decision to be made then they approach that problem in a rational way' (Design Engineer, company D).

'The real strength of engineers as managers is their ability to solve problems, because that's what engineering's all about. If you give an engineer a problem, it doesn't necessarily have to be a technical one, they will think very logically about how to get a solution. As an engineer they might be asked to save a certain amount of weight in part of an engine. And he would think through the solution and prioritise what they are going to do. He would do exactly the same thing if asked to solve a problem which had nothing to do with engineering, and I think that is a great strength' (Design Engineer, company A).

One engineer supported Barry et. al.'s (1997) belief that engineers tended not to be able to deal with problems which had no clear solution:

'I think one of their strengths is that they are analytical and are trained to understand problems, trained to analyse problems, whether it's an engineering or management problem. I think a weakness is that engineers in management positions are less able to handle fuzzy issues. Engineering issues tend to be hard edged. You make the right decision or you make the wrong decision. If you are handling non-engineering issues, they tend to be more woolly. Only part of the information you need to make the decision is available, and in any case the decision you need to make is not clear cut. I think sometimes engineers can't make the jump to handle the fuzzier issues, issues that are less clearly defined. That said, I don't think accountants are any better. They tend to be very clinical and want all the figures on front of them.' (Production Manager, company A).

Six respondents, all engineers, believed that engineers tended not to be good communicators. According to one respondent engineers tended not to have a particularly good grasp of the English language:

'Engineers as a breed seem to be able to handle the applied mathematics and technical issues that confront them but frequently they are unable to understand the basic mechanics of the English language and are unable to communicate positively and accurately' (Design Engineer, company B).

However, most respondents believed that engineers could communicate at least as effectively as any other professional group. According to one engineer communication skills tended to improve with age. This applied to people of all backgrounds:

'This [the ability to communicate effectively] is a thing I believe comes with age actually. Older guys will be better than younger guys and again every department is going to be like that... but I know certainly how I felt when I was younger... I just wanted to be sat down at a drawing board and be told what to do... as you get older you get more confident about expressing yourself' (Design Engineer, company D).

Respondents also debated whether particular types of professional expertise were more suitable for senior management than others. Most respondents felt that technical knowledge was not essential and that what was needed was a balance of people with both technical and non-technical backgrounds. The following responses are typical:

'I don't think you have to be an engineer to be a senior manager in an engineering company. You need to be able to understand what engineers are telling you which requires some product knowledge, but that's something that can be acquired. Our chief executive is an example of that. He was a psychologist originally but he's been working in engineering companies for years so he knows how to understand and calibrate the technical issues' (Management Accountant, company A).

'I think it's important for a significant proportion of board members to be engineers. And it's important for the people who are from a non-technical background to be supported by people who understand the technical issues. So there is nothing wrong with having a chief executive who isn't an engineer providing there are technical people advising him. So it's not essential, but I think that at any level in a company you need to have a good balance of technical and non-technical, engineering and non-engineering' (Production Engineer, company C).

However, almost all respondents, both engineers and non-engineers, believed that engineering provided a very good training for senior management. Although some respondents felt that some engineers tended not to be particularly aware of commercial issues, most felt that engineers understood them well or that they were able to learn them quite easily:

'An engineer in a senior position in a large company will have been involved in every engineering department in that company. He will also almost certainly have had some accountancy training and experience of looking after budgets. So I think that by the time an engineer does move into a senior position he is well aware of the financial needs of that company and how it operates' (Marketing Manager, company E).

'I would say that engineers are ideally suited to suited to senior management and understanding the commercial aspects of the business. Because you have to know everything about the product from the basic design to the cost of materials to the needs of the customer. Now who else would know that? An engineer has complete product knowledge' (Production Engineer, company C).

Engineers who had moved into marketing were also seen as ideally suited for senior positions. Around two thirds of respondents felt that accountants were also well suited:

'I think accounting gives you a very broad view of the business and when they've been through the training they know roughly what makes a business tick and they are much more portable because every business has a balance sheet and money and cash and sales and purchases. So everything is much more standard so they are much more mobile whereas engineers can tend to become product dominated, so I suppose accountants start off with an advantage' (Design engineer, company D).

Some engineers were unconvinced:

'It rather depends. I don't think technical knowledge is absolutely necessary. It depends on how good the individual is. It may be that a lot of accountants or financial directors who join a company that sells engineering products will take some time to learn about the products. If you are a company that manufactures nuts and bolts there is no reason why the financial director could not become the managing director. But if you are a company which is at the "cutting edge" so to speak, then it's more likely that a managing director would have to have some kind of product knowledge' (Production Engineer, company D).

'I think that in the most senior positions you really need to have some engineering knowledge... I mean if you work for an engineering company you need to know about the problems involved in the design and manufacture of the products you sell' (Design Engineer, company E).

Thus while some respondents felt that engineers had particular strengths and weaknesses compared with other groups and some engineer respondents felt that technical expertise was important for senior positions in manufacturing, most felt that people's effectiveness as managers depended on their qualities as individuals rather than on their professional training and that it was important to achieve a balance between technical and commercial expertise in senior positions.

The Collective Organization of Engineers

Although some writers have suggested engineers tend to join trade unions (Whalley, 1986; Meiksins and Smith, 1992; and Smith and Whalley, 1997), none of the twenty engineer respondents in the electrical and mechanical engineering companies in the study were trade union members. Indeed, when respondents were asked whether they belonged to trade unions, most of them seemed surprised and one or two even appeared a little insulted that they had been asked the question. Most appeared to associate trade unionism with semi-skilled and unskilled work. Glover and Kelly (1987) noted that engineers were management-level employees who found it natural to identify to varying degrees with the goals of their employing organizations. This appeared to be the case for most of my respondents, many of whom felt that trade unions were incompatible with their managerial identities. The following response was fairly typical:

'I know that some of the guys on the shop floor are in the union but I don't think any of the engineers are... I think you'll find that beyond supervisor level people don't join. I think we care too much about the job and we're also quite a conservative lot. We've got a lot of responsibilities and a lot of people depend on us... I certainly couldn't imagine myself going on strike' (Design Engineer, company A).

Five respondents felt that engineers were in such strong positions that they simply didn't need trade unions: they were well paid and did not usually have difficulties finding employment. According to one engineer:

'Engineers are in such high demand at the moment... when I came to work here I was able to negotiate my own pay and I even managed to get some guarantees about my research budget. There's no advantage for me in some sort of collective bargaining. I'd much prefer to negotiate my own terms and conditions thank you very much. Engineers negotiate their own salary levels and if they don't turn out successful they tend to move on' (Development Engineer, Company C).

Also, a significant minority of engineer respondents, about a third, gave the impression that they were quite hostile to trade unions and to what they represented. The following were typical of these responses:

'Trade unions don't feature much in industry now. A lot of the guys on the shop floor aren't even in trade unions any more and I think that's one of the reasons the economy's doing quite well at the minute' (Marketing Manager, company D).

'Professional engineers don't join trade unions, at least not as far as I'm aware... I don't think they ever have done really but maybe some of the more experienced guys would be better able to tell you about that... I think with all the problems British industry had in the 1970s we're better off without them' (Production engineer, company D).

Academic writers have tended to ignore the role of the engineering profession in the careers and lives of engineers, believing them to be more or less irrelevant (Whalley, 1986; Meiksins and Smith, 1992; Smith and Whalley, 1997). However, ten of the twenty engineer respondents from this sample were members of professional associations and most respondents had very strong views about the profession. Several respondents were angry and frustrated at the profession's apparent inability to promote the profession effectively to the general public and at the infighting which had characterised its history. The following quotation is a good example of this:

'The profession is just a distant group of institutions which are of little relevance to engineers... until we have a body like the British Medical Association we are still going to be seen as a fragmented group of voices. I think we need a British Association of Engineers or whatever you want to call it. I am not saying it would be easy to achieve but I think that is what we should be aiming for. I still think it is ridiculous for instance that someone like myself, who was a member of the Institution of Production Engineers when I first graduated, which then became the Institution of Manufacturing Engineers, which then got swallowed into the Institution of Electrical Engineers... people now think that I must have an electrical or electronics background and I object to that. I think there needs to be more merging together simply to reflect the way that engineering as a discipline has been heading and the way in which technology has driven it. A hundred years ago the mechanical engineer's area of expertise was easy to define, but nowadays there are very few manufactured products without some mechanical engineering. ATMs are a perfect example. It's got computer power in it, it's got software, it's got what you would loosely call mechatronics and it's got the hardware that presents the notes to customers... The institutions' determination to keep engineering compartmentalised is based on historical beliefs about the nature of engineering which are no longer relevant' (Production Engineer, Company C).

Five respondents criticised the institutions and the Engineering Council for being out of date and for not really being aware of the challenges facing engineers in the late twentieth century. A similar number were unhappy about an apparent lack of openness and democracy. One engineer, who had previously been actively involved in the Institution of Mechanical Engineers, painted a slightly sinister picture of the engineering profession. He claimed it was dominated by 'men in smoke filled rooms making decisions by committee with no attempt to incorporate the views of members'.

Seven respondents believed that the engineering profession had been relatively ineffective in raising the profile of the engineers and engineering in society. However, four engineers believed that the Engineering Council had worked hard with limited resources to do this. One of them was 'fed up' of the criticism which it had received. There was only so much that the profession could do. The rest, he believed, was up to individual engineers who had been, and continued to be, apathetic towards their profession. This was at the heart of its difficulties:

'One of our training officers here put out an e-mail outlining what the Year of Engineering Success was all about and effectively trying to open up the factory to school kids for a day. Another one came round a week later and from the tone of it she obviously received a very poor response. I have been involved in and supported these initiatives in the past and they tend to be very poorly supported. I'm not blaming people for that... people are really busy at work these days and they just don't have time to support these things. But there's no point in slagging the institutions if you're not willing to get involved' (Marketing Manager, company C).

Meiksins and Smith (1990) argued that chartered status for engineers had had little impact in UK industry. The findings reported in this chapter lend some credence to this view. Only eight of twenty respondents with engineering backgrounds were chartered. Another two had previously been chartered but felt that they did not have the time to participate in the seminars which engineers needed to attend each year in order to retain their chartered status. Two of the companies (A and C) actively encouraged their engineers to obtain chartered status by paying subscription fees and providing time off for seminars. However, even in these companies chartered status did not appear to be particularly attractive to engineers. According to respondents this was because being chartered offered no obvious advantages in career terms. One respondent said that his company had made significant savings when negotiating its product reliability insurance as a result of its employing chartered engineers. However, none of the respondents, even those who had become chartered, made mention of any advantages or potential advantages which chartered status might bring for individual engineers.

One engineer said that he wasn't willing to give up two or three weeks a year of his 'valuable time' to attend the seminars necessary for chartered status when he would not benefit financially. Another believed that chartered status tended to be a high priority for young graduates at the beginning of their careers, but that this soon faded when they discovered 'how pathetic the institutions are'. Four engineers believed that chartered status did not necessarily improve standards and that companies looked for more tangible evidence of an engineer's ability. According to one engineer:

'Nobody has ever paid attention to the fact I'm chartered. I think generally that companies are more interested in whether somebody is actually capable of doing the job rather than whether they can say they are a chartered engineer. It's certainly open to question how valid it is. I think if anything it is becoming less valid than in the past. Your ability to design and design quickly is more important than being able to hold up a chartered certificate' (Design engineer, company D).

Despite the fact that only half of the respondents were members of professional engineering associations and that most believed that chartered status offered no significant career advantages, engineers generally had strong views about the engineering profession. Most were critical of its organization and effectiveness. Respondents were even less enthusiastic about trade unions which they generally considered to be incompatible with their status as managers.

Engineering Education

Sixteen of the twenty respondents with engineering backgrounds were graduates in engineering. Six also had MBAs and one of them had a Diploma of Management Studies. Of the remaining four, all of which were over forty, three had HNCs and one had an HND. UK degree courses have been criticised for being too theoretical and for not containing enough practical elements (Francis and Winstanley, 1988; Campbell, Sorge and Warner, 1989). Respondents tended to agree with this. Fourteen of them expressed concern about what they saw as their overly scientific nature. In particular, they were concerned that many graduates had little or no working knowledge of machines or components when they left university. As a result they tended not to be well prepared when they started work. Eight engineers suggested that placements and/or sandwich courses were the best way to solve this problem. The following quotation is fairly typical of the views expressed by these respondents:

'I think you should be put out into industry during your degree. I was just left to go to the lectures and study the theory. It wouldn't have done me any harm if I had gone out and done a real job during the summer and learned the basics like turning, machining and assembly. When I got my first job I couldn't do these things. Often you don't see the relevance of things unless you do them in a real environment... The other thing about going out and doing 'real' work is that it gives you confidence to go from the quiet design office to the noisy, chaotic engineering environment' (Design Engineer, company D).

Although there appeared to be a consensus that engineering education was too theoretical, one respondent did add a note of caution. Engineering at university, he believed, should be largely about theory. He advocated a 'broadly based' engineering degree which gave students 'a very sound grasp of the fundamentals'. Teaching engineers how to use these was the role of employers. Sandwich courses were of little use because the skills that students learned from them were company-specific and probably not transferable to other settings. On the whole, however, respondents thought that it was important to strike a balance between practical and theoretical elements and that most university courses were currently too theoretical.

As was noted earlier in the chapter, most respondents believed that an understanding of subjects such as finance and marketing was very important for engineers at all levels. Thus it is not surprising that increases in the proportion of these subjects in engineering degrees were generally seen as positive. One senior project engineer told said that ninety per cent of his time was spent performing non-engineering tasks and that it was surely sensible to learn about the commercial and financial aspects of companies. Two engineers suggested that presentational, team building and/or communication skills ought to be included in degree programmes as these formed an extremely important part of engineers' roles. Another engineer said that engineers who graduated from 'old' universities tended to be more aware of non-technical issues than those who graduated from 'new' ones. This, he believed, was partly indicative of differences in the standard of graduates from different institutions: 'a graduate from Cambridge is of much higher calibre than a graduate from a former poly'. However, he was the only respondent who discussed this issue.

According to two respondents many of the academic staff who taught on engineering degrees lacked the commercial and technical experience which needed to be passed on to students. Both believed that lecturers should spend some time in industry before being allowed to teach undergraduates:

'I have contacts at our two local universities and I am quite happy to go and prepare an hour's talk on an area of specific interest or on something that they may find interesting. I know it's very difficult to find the time to do it but I think it's very important that engineers with experience should go back in because the lecturers themselves have limited experience of what engineering is about. Many of them go from school, do their degree, then do their PhD and then go straight into lecturing. So they don't see much of industry or have the experience of the big bad world where their "product" happens to be going' (Engineering Director, company E).

'What you find in the academic world is that if a guy is bright at university he might go on to do a PhD. After that he wouldn't go into industry to practice anything, he would become a lecturer and he would keep lecturing until he was sixty-five. And he's probably never seen a nut or a bolt or done any engineering as such. But this guy is training people, and he's never had any experience! I think that universities should be filled with people who have had at least ten or twelve years' experience in industry so they could pass that on to people rather than just pass on theory' (Design Engineer, Company C).

In chapter 5 it was noted that several writers had argued that formal qualifications and technical positions were weakly correlated in UK industry (Jones et. al., 1994, Whalley, 1986; Smith, 1987; Meiksins and Smith, 1992, 1993; Smith and Whalley, 1997). Non-graduate technical staff and even manual workers could apparently quite easily work their way 'through the grades' and it was normal for graduate engineers to 'share work conditions, status and responsibility with promoted manual workers' (Smith and Whalley, 1996: 29).

The situation at the six mechanical and electrical engineering companies in the study appeared to be very different to that outlined above. Respondents at four of the six companies stressed their view that only graduate and/or professional technical staff were termed engineers, although two of the six companies (B and D) used the term engineer to describe some of their non-graduate technical staff (employees whom the author would term technicians and who generally possessed a Higher National qualification). However, in all six cases it was made very clear that graduate and/or professional engineers were part of completely separate pay and grading structures and performed very different tasks to all other types of technical staff. All of the respondents at companies B and D said that employees in both technical and non-technical positions were generally able to distinguish between different types of technical staff, despite the fact that the term engineer was used more widely than in the other four companies. Also, graduate engineers were not associated with manual labour in any way in any of the mechanical and electrical companies in the study, and engineers were clearly considered to be management level employees. The following quotation was typical of what was said:

'There is quite a distinction between engineers and technicians. Engineers who would be degree-educated are part of what we call a technology structure. Technicians are part of a different grade and that division is very clear and well maintained and we are keen to keep that there because we recognise that once we call someone a professional engineer we expect certain things of them And they know that as a professional engineer you have certain responsibilities: you make certain decisions, you think for yourself, and you show initiative. That's not necessarily expected from a technician' (Chief Engineer, company A).

In five of the six companies it was not possible for non-graduate technical staff to be promoted into positions normally occupied by graduates unless they first studied for an engineering degree. The exception to this was company C. It had recently relaxed its rules to allow very experienced technicians to be employed on the same grading structure as graduate and/or professional-level engineers. However, this was apparently very unusual:

'We have a professional engineering structure and a technician structure. Different structures and grades have different job titles. The technician structure is broadly, normally, non-graduate and the technology structure has had until recently a total graduate entry requirement. We have relaxed that a little recently so that more senior and very experienced technicians who we feel can do a job for us can join the professional structure even though they don't formally have a degree. But yes, job titles and positions tell you whether they are a graduate or not' (Production Engineer, company C).

Thus formal qualifications and technical positions were very strongly correlated in the six mechanical and electrical engineering companies visited. It was simply not the case that former manual workers were often employed in similar roles to graduate engineers, or confused with them in any way.

The Social Place of Engineering

Of the twenty respondents with engineering backgrounds, thirteen believed that the social standing of engineering needed to be improved. Of these thirteen, almost all were very concerned about the vagueness of the term engineer. Several engineers, following the old saw, thought that the general public considered an engineer to be someone who fixed washing machines or wore boiler suits. Three engineers believed that the public's perception of engineers was different for different industries. Thus engineers who worked in electronics were more highly regarded than those who worked in shipbuilding. One respondent, a Cambridge graduate and a very senior design engineer at one of the world's most prestigious and advanced manufacturing companies, said that even his own mother didn't know what he did:

'I remember discussing with my mother of all people about engineers and their status in society. And we were once having a discussion about the effect of alcohol on people's performance in their job if they drank too much. And she was saying things like "if a surgeon had too much to drink his knife might slip and he'd kill someone. And then she said and your spanner might slip on a nut and you might tighten it up wrong". If my own mother doesn't realise what I do, what do other people think?' (Senior Design Engineer, company A).

This kind of misperception of engineering is very boring in repetition, but its persistence needs to be recorded. Fourteen of the twenty engineer respondents thought that the term 'engineer' should be licensed so that only registered professional engineers could use it. They believed that this was the best way to improve the profession's image and standing. One respondent who worked for a company which operated in the United States said that in order to open an office in Illinois it had to prove that it employed chartered engineers who were registered with the Board of Engineering Registration in the UK. Four of the engineer respondents believed that several other professions were held in higher esteem than engineers. Medicine, law and accountancy were most frequently mentioned. The following quotation was fairly typical of what was said:

'Traditionally it [engineering] has been seen as a second rate profession. If somebody said their son or daughter was going to become an accountant or a lawyer then people would say that's great. But if they said they were going to be an engineer they would wonder why they had chosen it' (Development Engineer, company A).

Three respondents felt that there were no problems with the social position of their profession and four said that they did not care whether it was low or not. One respondent believed that engineering was just one of a number of professions whose members believed that they were not high enough up the social pecking order.

Another thought that it tended to be younger engineers who were most concerned about their social status:

'My views have changed over time. When I was a young engineer I wanted to be recognised as having a certain status in society. I wanted my contribution to be recognised and to be regarded in the same esteem as lawyers and chartered accountants and so on. It's less of a concern for me now although I know it's very important for some people. Why does someone want to have status? When you're at work it doesn't matter what you are. You are rewarded and get promoted on your capabilities, your experience, and on your judgement' (Marketing Manager, company B).

Similarly, another engineer believed that the social standing of engineers was lower in the UK than in other countries but added that this was of no consequence, providing that the influence of engineers in companies was satisfactory:

'Personally I am not too worried as long as I've got what I view as adequate remuneration and the company car is satisfactory. But I know from visiting customers in the USA that the status of a professional engineer in the UK isn't as high and that engineering isn't considered as important as it is in the USA. American professional engineers have their certificates on the wall. And in Germany as well, the professional engineers are perceived to have a higher standing than is the case in the UK. If I say to someone that I am the Engineering Director of a company in the UK, it's no big deal. It's not perceived as being particularly important or wonderful and I don't expect that really. Some people don't like it and try to change it, but I just accept it' (Engineering Director, company E).

One respondent felt that the low social standing of the profession was partly due to the 'moaning' of its members. It was pointless for engineers to complain about their standing in society if they weren't willing to do anything about it. Individual engineers had to take some responsibility for improving their situation:

'It's no use engineers just sitting back moaning about their lot because that only creates a negative aura. I see it as being the responsibility of every professional engineer to do what ever they can. That's partly why over the years I've tried to be an active member of my professional institution, participate in local meetings and committees, organize events and generally try to do things that raise the general awareness of what goes on' (Marketing Manager, Company C).

Those engineers who were concerned about the standing of their profession tended to have very strong views about this issue. Restricting the use of the title engineer so that the public would have a clearer idea of what an engineer did was seen by many as the best way of addressing this. The author was left with the impression that while engineers were generally satisfied with their roles and careers in their employing organizations, most of them were very concerned about how general public perceived them, although the fact that some engineers think that their status in society is too low does not, of course, necessarily mean that it is.

Engineers and Pay

It was noted in chapter five that at least some of the available evidence suggested that UK engineers were paid well compared to other graduates or professionals. Statistics about the pay of engineers and other managers were not obtained from the companies in the study. However, respondents were asked what they thought about the pay of engineers. Almost all of them believed that engineers were paid about the same as or better than managers in other functions on the same levels. Of the twenty respondents with engineering backgrounds, only four thought that engineers were underpaid or deserved to be paid more: a contracts manager from company B, a production engineer from company C, a design engineer from company D and the engineering director from company E.

Conclusion

In this chapter the interviews conducted with respondents from the electrical and mechanical engineering companies in the study were reported. Engineers appeared to enjoy good working relationships with accountants and marketing and sales specialists and there was little evidence of the apparent dominance of accountants or the subordination of technical to financial objectives. The relationships between production engineers and design engineers appeared to be the most difficult ones in most of the companies that were visited. Some respondents expressed concern that designers did not take production issues into account when they were designing products.

Most engineers believed that engineering offered the best route to senior management, and there was little concern that engineers were under-represented in senior positions. Some respondents were concerned, however, that engineers were forced to become less involved in the technical aspects of their work if they were to advance their careers. Perhaps unsurprisingly, most respondents believed that people's competence as 'managers' was unrelated to their professional training. Respondents generally considered that engineering provided an excellent training for senior positions, although most respondents felt that marketing and sales and finance also provided a good preparation for senior management.

None of the engineers interviewed were trade union members and many were surprised that the question was even asked. Half (ten) of the respondents with engineering backgrounds were members of a professional engineering association, although the profession was generally thought of as ineffectual and poorly organised. Only eight engineer respondents had obtained chartered status and most engineers believed that it offered virtually no advantages in career terms.

Engineers appeared to have clear occupational identities and there were clear distinctions between different grades of technical worker. Most (sixteen from twenty) engineers were graduates but several respondents were critical of engineering degrees. In particular it was felt that they were often too technically oriented and too theoretical. However, their image in the eyes of the public was of most concern to many engineers. They believed that the public neither understood nor appreciated what they did. In the next chapter the interviews conducted with engineers and their colleagues in the chemicals companies in the study are reported.

CHAPTER 9

CHEMICALS

Introduction

Chapter 8 reported the interviews which were conducted with engineers and their colleagues in electrical and mechanical engineering companies. This chapter reports the interviews conducted in the chemicals companies that were visited. Chemicals (including rubber and plastic products) is the largest single industrial sector in the UK with an output of £22.4 billion (Office for National Statistics, 1997b). Over half of this is exported making it UK manufacturing's biggest exporter. Chemicals and related industries employ about 450,000 people (Office for National Statistics, 1998b). Traditionally, the UK has been a major manufacturer of basic industrial chemicals such as organic and inorganic chemicals, plastics and fertilisers and these products continue to account for about 40 per cent of output. However, the fastest growing markets in recent years have been speciality chemicals such as pharmaceuticals, essential oils and flavourings, adhesives and sealants, and explosives. Pharmaceuticals is a particularly successful UK sector. There are over 400 pharmaceutical manufacturing and research organizations based in the UK and they employ about 75,000 people. British companies developed five of the world's twenty best selling medicines and pharmaceutical companies account for one fifth of the total amount spent by UK companies on research and development (Office for National Statistics, 1998a).

The issues which were examined in the previous chapter will also be examined in this one: the influence and careers of engineers vis-à-vis members of other management-level occupational groups; the perceived managerial abilities of engineers and their colleagues; engineers' views about the professional associations and trade unions which represent many of them; the views of engineers concerning issues surrounding engineering education and the importance which employers place on formal engineering qualifications; and how engineers feel about the social standing of their profession and their levels of remuneration.

As was noted in the previous chapter, the aim was not to conduct a case by case analysis by examining the companies separately, but to build up a more general picture of the experiences and attitudes of engineers in the sector as a whole. However, as in the previous chapter, some relevant issues are also discussed in the context of individual companies. Twenty-eight interviews were conducted in five companies: eleven with mechanical engineers, eight with chemical engineers, three with chemists, four with accountants, one with a marketing specialist who had an engineering background and one with a personnel manager.

Company G was a leading manufacturer of products derived from silica and alumina, with significant global business in silicates, zeolites, silicas and catalysts. This company employed around 1,000 people on the site that was visited. Products were developed, manufactured and sold on this site. Six people were interviewed: two mechanical engineers, two chemical engineers, a marketing manager with an engineering background and a management accountant. Company H manufactured plastics and was a subsidiary of a large US multinational. The manufacturing plant that was visited employed around 250 people and was involved in the development, manufacture and selling of its products. Six interviews were conducted: two with chemists, two with mechanical engineers and two with chemical engineers.

Company I was a Dutch-owned leading producer of paints, finishes, stains, and synthetic resins. It employed around 200 people on the site that was visited. Again, the site consisted of a manufacturing plant which was not involved in product development. Four people were interviewed: three mechanical engineers and one accountant. Company J was a leading pharmaceutical multinational. The site that was visited was also a manufacturing plant which did not take part in product development and the company employed around 500 people on it. Six interviews were conducted: two with mechanical engineers, two with chemical engineers, one with a management accountant and one with a personnel manager.

Company K manufactured fertilisers. It employed about 300 employed on the site that was visited, where the development, manufacture and selling of products took place. Six interviews were conducted: two with mechanical engineers, two with chemical engineers one of whom was the engineering director, one with a chemist and one with a management accountant.

Engineers and their Colleagues

This chapter begins by examining how engineers feel about their roles and influence within companies. The sites that were visited at companies G, H and K were involved in product development while the other two, companies I and J, were purely manufacturing facilities. They produced chemicals which were sent to other factories and used in the manufacture of the products for sale. There were no marketing or sales people employed at these two sites. Also, as it is chemists rather than engineers who are mainly involved in product development in chemicals companies, engineers tended to have rather less contact with marketing and sales specialists than the mechanical and electrical engineering companies that were visited.

All of the companies claimed to use project teams. In the case of company I this consisted only of mechanical engineers and accountants. At company J project teams consisted of chemical engineers in addition to mechanical engineers and accountants. Project teams in companies G, H and K consisted of chemists, chemical engineers, mechanical engineers, marketing specialists and accountants.

Engineers and Accountants

As has already been noted, the relationship between engineers and accountants was one that particularly interested the author, mainly because of the latter's assumed dominance over engineers in the academic literature. In the mechanical and electrical engineering companies that were visited, the author found no evidence to support the notion that accountants dominated manufacturing companies, and engineers and accountants appeared to co-exist quite well. A similar situation appeared to exist in four of the five chemical companies that were visited. However, the engineers in company G all complained that accountants were more influential than they should be. One such engineer explained that the finance department was continually asking production to improve productivity on an increasingly tight budget. This, he believed, had made life very difficult for the engineers:

'I think we are a company run by accountants. At times it can be very frustrating in manufacturing because you are basically running a plant on a shoestring but being asked to deliver more and more of a higher quality product, and we have not been very good at saying no. We always try to do it and the problem is we always manage it. That's fine for a while, but it really wears you down after a time and that is the stage where I am at the moment, because, you want to do your best, but if there's no money and if you don't have the facilities to enable you to do the job, then it can be very disheartening' (Chemical Engineer, company G).

Another expressed a similar view. He believed that the arrival of a new Finance Director who did not have any experience of the chemicals industry was the reason for the above problems. As a result finance was expecting an unrealistic output given the resources available:

'Finance make things really difficult for us. Our Finance Director came from a consumer goods company and they obviously had a completely different pricing structure and asset base than we do. Chemical companies do have a large asset base of which capital expenditure is high due to the nature of the business, and what is a very good yield for a chemical company isn't a very good yield from a fast moving consumer goods company. And so you've then got a conflict because he doesn't really understand the nature of the business. Finance wants to see the yields increased, but they forget about the people that make the products. They just want us to deliver it at the bottom line. Unfortunately it comes all the way down and stops at me, and I have to make it work' (Chemical Engineer and Plant Manager, company G).

The management accountant interviewed agreed that finance was a very influential function in company G. This was, she felt, completely justified because of the importance of the work that they did. She also felt that the engineers tended to see the accountants as 'ogres' and that this was unfair because, after all, they were only doing their jobs to ensure the successful continuation of the business:

'At the end of the day, I suppose that without us the company wouldn't exist because legally the company is required to file its accounts and also we provide a lot of important information. I mean if the figures that come out of our accounting system say that there are problems on the engineering side then that is where we go in and we make the engineers understand the figures and how we can then control our costs... it's just a tool with which you manage the business so I don't think that we are the ogres, although the engineers probably wouldn't agree with that!' (Management Accountant, company G).

It appeared that the role of the finance department in this case was to monitor and control production in the way suggested by Armstrong (1984, 1985, 1987). Indeed the management accountant interviewed talked quite openly about engineers being 'judged' and 'monitored' by the finance department using mainly financial rather than technical criteria:

'We are the number crunchers. We take information and we produce the annual operating plan which is what their performance is judged against for the whole of the following year. This year we are monitoring progress against the annual operating plan for 1997... I think it's just unfortunate that we produce the final document and that is the bible that you are judged by and monitored by for the whole year' (Management Accountant, company G).

Inevitably, there was some friction between the two groups. One engineer felt that accountants did not understand what engineers did, and more significantly the importance of their work. Accountants and other non-technical people needed to be made more aware of this:

'Most engineers, graduate engineers that is, have perhaps a better understanding of other people's disciplines than other people do of engineering. We make money from manufacturing and selling products. But at times everything is driven by finance who don't understand the manufacturing side of things and I think there is a general feeling that people like your accountants and your marketers who, unless they have come from the engineering profession, in general don't ever appreciate the engineer's role. I think there needs to be more training in terms of understanding the role that we play and what we contribute, if only to improve team working' (Mechanical Engineer, company G).

The management accountant believed that most engineers tended to be sloppy when it came to administration. They didn't care about paperwork and were continually losing invoices and other important documents. Even worse they didn't take an interest in the financial implications of their work:

'Engineers don't ask you about tax or capital allowances or what the tax implications of doing something would be. They rarely pose the question... I think I have only been asked twice... you rarely hear the words pass their lips' (Management Accountant, company G).

The views of respondents in company G contrasted sharply with those in the other four companies visited. In each of these companies accountants were seen as supporting the engineers. None of the engineers in these four companies were concerned that accountants were too influential. The role of accountants was to report on costing or capital expenditure and in some cases to make money available for specific projects. It was certainly not their role to judge or monitor the behaviour or performance of engineers. One senior chemical engineer compared the role of accountants in chemicals to that of linesmen at a football match. Their role was to help the referees (the engineers):

'Financial guys, they have a very similar role to health and safety in that as a support function they are not actually manufacturing anything. What they are doing is keeping watch, a bit like the linesman at a football match. They help the referee, offering good suggestions along the way... they look for ways in which we can save money in particular areas, so they do make a contribution, they don't always stay on the line. A rather strange game of football but I think you know what I mean' (Chemical Engineer, company H).

As in the previous chapter, most engineers clearly felt that the role of accountants was to support them. The following response was fairly typical:

'Within our own organization they are a support function. They tell me how much money I am spending and so on. They give us advice. We say "we are short of money here and we need to get it". So they go and do their job and they don't interfere with me. It's up to them to go and find it. If they find it then we spend it. If they can't find, we'll have to work round it' (Mechanical Engineer, company H).

In chapter 8 it was also noted that several respondents who worked for the mechanical and electrical engineering companies that were visited, commented on the importance of accountants in manufacturing. That feeling was also evident here. There appeared to be a good relationship between engineers and accountants in each of the four companies. This was considered essential to the successful operation of their plants:

'Yes, accountants are very useful people. You have got to have somebody out there checking the dollar amount and the pound amount that you are spending and there needs to be somebody there to shut the gate because, you know, it's quite easy in this game just to go on pouring money at the project and then you sit back and say I've overspent on this and overspent on that. But if you've got somebody that's monitoring what you're spending over long periods and he jolts your memory about something like you've only got so much here, it makes life so much easier. Our plant accountant is really good at that and it doesn't upset me that I get an accountant calling me up and saying you have only got so much more to spend. That makes you look for value up front and makes sure that you have got your figures right so that you can get the job on time and within budget' (Mechanical Engineer, company H).

'We have a very good working relationship with our accountants here and that's because we treat them as part of the team. We involve them, they see the money being spent and how it's been spent, so everything is up-front. They help us and we help them' (Mechanical Engineer, company I).

While the author did not find any evidence of major conflict between engineers and accountants in any of the other companies, three engineers were concerned about accountants' attitudes towards costs. The head of engineering at company H said that he made sure accountants were never involved in purchasing decisions:

'Towards the end of last century there was an industrialist in Cumbria, a guy called John Ruskin who lived from 1819 to 1900. He was disenchanted with the way industry was being run at that point, too much wheeling and dealing. And he said in one of his many quotations "it is unwise to pay too much but it is worse to pay too little". When you pay too much you lose a little money, that's all. When you pay too little you lose everything because the thing you bought was incapable of doing the thing it was bought to do. You cannot pay a little and get a lot, it cannot be done. If you deal with the lowest bidder, it is well to add something for the risk you run, and if you do that you will have enough money to pay for something better… the accountant here is a good friend of mine out of work actually. I pull his leg, but not without a good deal of meaning in it: never let an accountant buy anything, because they buy the cheapest' (Chief Engineer, company H).

The management accountant for company H believed that it was important that accountants knew their place in manufacturing and that it was dangerous if they became too influential. Their role, he believed, was not to make strategic decisions but to provide engineers and other managers with accurate, up-to-date and relevant information about costs and markets. He also felt that, in any case, accountants were much less influential than was commonly believed:

'In the right place accountants are okay. In the big picture I don't believe that accountants have got the amount of power that people perceive them to have. The job of the accountant is to provide senior management with various facts so they can decide whether they should invest in shares and to advise on costs and they should also pay the employees the correct money and on time. They shouldn't run companies but they should advise on certain matters' (Management Accountant, company H).

The Engineering Director at company K expressed similar views. He also believed that, while accountants were important, they should not become too influential in manufacturing. In particular, strategy should be decided by people who were best qualified to do so. In companies which manufactured chemicals these were engineers and chemists:

'I think it is dangerous to let the accountants think that they can decide company strategy. Company strategy should be decided on business reasons to do with products and customers using a vision of where you want to go. It should not be determined by short term financial constraints. That said, we recognise that accountants have a very important role to play. If we don't get the finances right we don't have a future so we need to have the finances under careful control. But I believe they should have a role at the operational rather than the strategic level. We would never make strategic decisions about our future direction on accounting principles' (Engineering Director and former Chemical Engineer, company K).

Three of the four accountants interviewed believed that engineers tended to have an excellent understanding of the financial implications of their work:

'All of the project engineers can control their project costings and they know how to write a capital proposal and they know how to keep records of their spending, although some of them still do it manually rather than using a spreadsheet. They are also good at getting quotations organised with our buying department, so they know what they are doing' (Management Accountant, company J).

'Yes the engineers are all very competent when it comes to money. Sometimes politically they are constrained and sometimes they overspend slightly but that is the nature of the beast and we have safety margins built in... I mean we have quite a close relationship when it comes to things like budgetary control, but you have got to remember that the management team has been together for a very long time. I have been here thirteen years, the engineering manager twelve and the production manager about the same and the site director about seven or eight. So we have been together for at least seven or eight years and they get monthly reports and we meet regularly, so we work through any problems' (Management Accountant, company I).

'Certainly in this company engineers are heavily involved in the financial side of the business. Production budgets, fixed costs, variable costs, variances and all the financial analysis that goes with running the plant and running the business. We help them with any problems but they are actually very competent. I think it's a strength of theirs' (Management Accountant, company K).

Thus engineers and accountants appeared to enjoy a good working relationship in four of the five companies that were visited. Furthermore, with the exception of company G, the author did not find any evidence to support the hypothesis that accountants dominate manufacturing companies in this sector.

Engineers and Marketing and Sales Specialists

Although the author asked to speak with someone from marketing and sales in each of the companies that were visited, only company G provided a respondent employed in marketing. In the cases of companies I and J this was because there were no marketing or sales people employed at the sites which were visited. In the cases of companies H and K, the people who organized the interviews said that there were no marketing or sales people available on the day of the visit. Although chemical engineers are playing an increasingly influential role in product development, it is chemists who tend to be mainly involved with this in chemicals companies. As a result engineers had less contact with marketing and sales people. That said, production and marketing liased with each other in order to set production targets and to ensure that customers were satisfied with the quality of the product.

At company G there were apparently often quite intense negotiations between marketing specialists and engineers. This was due to a large extent to the highly specialised and complex nature of that company's processes and products. Customers required unusually high levels of consistency which were often very difficult to achieve. Because of the specialised nature of the chemicals being produced, only people with technical or scientific backgrounds were considered suitable for marketing positions and thus all of the marketing staff were either chemists or engineers. Clearly, marketing wanted to ensure that customers were satisfied with the product that they had bought. According to one process engineer:

'Say we have made a product once. The process looks stable but because you've only made it once you can't be certain because you don't really know that much about the process. You have got to go through the potential problem areas to ensure that the quality is right in terms of consistency. The problem is the customer may have a different set up from us and we might make something which we think is better, but it's not better for him. So it's really understanding what is required so we have to co-operate extensively with marketing because it is they who mainly interface with the customer' (Chemical Engineer, company G).

A marketing manager at the same company who had until recently worked in production said that the types of process which were being conducted on site worked much better if they had some stability. Marketing people were perhaps insensitive to this at times:

'Marketing want diversification, they want product flexibility. But the processes that we are involved in are very complex and difficult, and they need some sort of stability. But marketing want different grades and different yields every week and that's not what you want, because these processes run best when they are just left to run and run without any interference' (Marketing Manager, company G).

This problem did not appear to exist at companies H and K. This was probably because the manufacture of plastics and fertilisers tends to be a more straightforward process than the manufacture of Company G's specialist chemicals. All of the marketing specialists at company H were engineers or chemists. At company K, however, none of the marketing specialists had engineering or scientific backgrounds.

Respondents in all three companies believed that marketing people performed very important roles. However, engineers did not appear to feel threatened by them. One engineer believed that the importance of marketing was something that had increasingly been recognised by many British companies:

'I think that everybody in British industry has learned that you owe your existence to your customers and that one of the key things is to find out your customers' requirements and to have a focus about the company which says that our fundamental objective is to meet the customer's needs. Now that does not mean that it is all marketing because flowing back from meeting the customer's needs are the efficient manufacture of products and engineering things the right way and so forth' (Engineering Director, company K).

Another in the same company felt that, despite differences in emphasis, engineers and marketing people had tended always to work well together:

'There are always going to be differences of opinion and emphasis because it's only natural that you will think that your particular interest is the most important. Sure, an engineer might think that the most important thing is to have a well designed plant that is efficient and so forth. Whereas a marketing person may think, never mind all that, just give me the stuff and let me sell it. But I think that by working in teams in the end you reach an understanding that each part has its role to play. The marketing guy needs the soundly engineered, professionally run production side to be able to give him the right quality products in the right quantities and at the right time etc., and it's no good me saying this is wonderful stuff if nobody wants to buy it. So you have to have both ends... there are differences in emphasis but I don't think there are major problems. I think we have a good attitude here and that we work well together' (Chemical Engineer, company K).

A chemical engineer at company H said that the company that he worked for had always considered marketing to be a very important function. Rather than waiting for new markets to develop and then exploiting them, they would spend considerable time and money <u>making</u> new markets:

'I'll give you an example. About ten years ago we got a Renault 5 and we stripped it of its mechanical components. And we went through each part of the car and said "can we replace this with any engineering polymers?" And we managed to put it in places where you wouldn't normally see it. And now if you take any Ford car for example, there are huge quantities of engineering polymers in there because motor manufacturers want to combine minimum weight with maximum performance. So the bumpers, the seat shells as well as several bits under the bonnet are plastic. So that's one example of the importance we place on marketing and product development' (Chemical Engineer, company H).

Marketing seemed to have taken on an increasingly important role in these three companies. However, engineers did not appear to be concerned about this or their position more generally vis-à-vis marketing specialists. Rather, they accepted them as a group of people which performed a very important function and that companies needed to understand markets and customers if they were to be successful and profitable. Moreover, given that a large proportion of marketing people are engineers in any case, marketing was very much a possible career option for them.

Chemical Engineers, Mechanical Engineers and Chemists

In the previous chapter it was noted that engineers in design and production appeared to have rather uncomfortable relationships at times. The main types of engineer which work in chemicals are mechanical and chemical ones. Electrical and civil engineers are also sometimes employed, although in much smaller numbers. The relationships between chemists, chemical engineers and mechanical engineers and the relative influence of each type was much discussed by respondents.

In chemical companies it seems that it is mainly chemists who are involved in product development, although chemical engineers are also involved to a lesser extent. However, the main functions of engineers are to design, build and maintain the machinery which manufactures the chemicals which have been developed by the chemists. There is some overlap between the roles of mechanical and chemical engineers. Mechanical engineers are responsible for the maintenance of the plant as well as for the design of the parts of the plant in which chemicals are mixed to make the product. Chemical engineers are responsible for designing parts of the plant where a chemical reaction is required to make the product. Not all chemical companies employ chemical engineers because their expertise is not necessary for the manufacture of some products, such as paints, and this was the case at company I.

However, all respondents at this company had worked with chemical engineers in the past and were able to discuss the relationship between the two types of engineer. Chemists, chemical engineers and mechanical engineers work together as well as with accountants and marketing people, with the latter normally being chemists or engineers by training.

Slightly more than a half of these respondents believed that mechanical and chemical engineers and chemists tended to have quite strained relationships, or at the very least that some sort of professional rivalry existed between them. According to one chemical engineer:

'There will always be a competitive element between chemists, chemical engineers and mechanical engineers because each regards the other as a black magician – don't know how you do your job, don't really care as long as you do it' (Chemical Engineer, company J).

Mechanical engineers and chemists placed the blame for this situation squarely on the shoulders of chemical engineers. Four mechanical engineers and two chemists complained that chemical engineers tended to see themselves as 'superior' to them:

'A chemical engineer always thinks that he is specialised over and above any other engineer... they consider themselves to be an elite' (Mechanical Engineer, company I).

'From my experience there is always a slight conflict between chemists and chemical engineers. Chemical engineers regard themselves as the ultimate and think of development chemists as their servants. I was an analytical chemist in my last job and they tended to insist on things being done right away and were never able to put themselves in our position' (Chemist, company G).

However, a significant minority of respondents believed that the three groups enjoyed good working relationships. A chemical engineer in company G believed that chemists and chemical engineers were usually able to solve any difficulties by talking through any problems that they encountered:

'Chemists make chemicals in laboratories which is a little bit different to making it in full-scale production and there are various problems that you have to take into account. There is the old story that the chemist has made it in the laboratory satisfactorily, then you go to the main plant and find that in a reactor it goes solid on you. And you ask him how he got it out of the test tube and he says "I had to break it didn't I". It's getting beyond these simple things where you communicate right from the start and follow it all the way through and that's what usually happens' (Chemical Engineer, company G).

Company K tried to use the 'rivalry' between the three groups to their advantage, and in fact even encouraged it:

'It's basically friendly rivalry. We have a very healthy competitive spirit and it actually helps us very much. We encourage it. Each of us cannot develop a product on our own, it needs all of us. So if each group continually wants to prove its worth to the team then we all pull together... I think they all complement each other' (Engineering Director, company K).

A chemical engineer at company H said that there was no rivalry between the three professions in his company:

'I wouldn't say that we have a rivalry here because again we are very much working as multi-function teams where the problem may not be established as purely mechanical, chemical or chemistry. It may be a mixture of all three and you may choose to set up a particular team with particular people who have certain qualities. So I don't say I need a mechanical engineer or a chemist on this job, I say who do I know that has the skills that can fix it' (Chemical Engineer, company H).

The author was told that traditionally chemists were the dominant profession in chemicals at all levels. They were most likely to lead projects teams and most likely to achieve positions at and immediately below boardroom level. Mechanical engineers were an important but much less influential group. However the 'arrival' of chemical engineers, who had only appeared in large numbers relatively recently, had changed the existing order. Almost all respondents in companies G and J as well as two in company K and one in company H, expressed the view that chemical engineers were increasingly becoming the dominant force in many chemicals companies mainly at the expense of chemists, and also to a lesser extent of mechanical engineers, who had not been in a particularly strong position in any case. Indeed one respondent, who had a PhD in chemistry, was previously employed as a chemist with SmithKline Beecham, a leading pharmaceuticals company, but had changed companies because she wanted to be a chemical engineer. She felt that this was the best way to improve her career opportunities:

'I wasn't happy at SB and speaking from my experience of the pharmaceuticals industry most of the chemists weren't happy. They felt they were being overworked and not thoroughly appreciated. You have to bear in mind that there are an awful lot of chemists and not a lot of positions to move on to... I moved to this company because I wanted to be a chemical engineer because that was the only way I could see to improve my career prospects' (Chemical Engineer, company H).

A chemist at company G said that some chemists and mechanical engineers felt threatened by chemical engineers because they had both engineering and scientific expertise:

'I think you could take it as a triangle, and without blackening the chemical engineers too much, any problems will be between chemical engineers and chemists or chemical engineers and mechanical engineers, not between mechanical engineers and chemists. The crux of the issue is that people feel threatened and both chemists and mechanical engineers sometimes feel threatened by chemical engineers... because chemical engineers have the two skills and know about the engineering and the chemistry. They feel powerful because if any one is to be sacrificed then chances are it won't be them' (Chemist, company G).

Another respondent believed that chemical engineers were more influential than mechanical engineers because they had a fuller understanding of the production process:

'Chemical engineers have a wider spread of knowledge than mechanical engineers do... I mean if we are talking about the chemical industry then I think if you look at the people who are running the projects they will be chemical engineers... in general chemical engineers have been more successful than mechanical engineers, because I think the chemical engineer has more of an understanding about the production process and that tends to give you more of an understanding of the business as a whole' (Chemical Engineer, company J).

However, several respondents pointed out that while chemical engineers were becoming increasingly dominant in sophisticated chemicals industries such as pharmaceuticals which required complex chemistry and chemical reactions, many chemical products required only very simple chemistry. Products such as toothpaste and paint did not tend to require very elaborate chemical engineering expertise. Chemists were also employed in much fewer numbers. Mechanical engineers generally formed the largest group in the manufacture of such products and thus tended to be very influential:

'I think that it depends what industry you are talking about. We don't have any chemical engineers here because of the sort of processes we run. Mechanical engineers run this plant. We are in complete control... we don't have any interference from anybody' (Mechanical Engineer, company I).

Thus the role and influence of mechanical engineers appeared to vary by product and/or company and depended at least partly on the sophistication of the chemistry involved. Chemists, while still a very influential group, appeared to be losing their dominance to chemical engineers.

The Careers of Engineers

As with the mechanical and electrical engineering companies discussed in the previous chapter, the author wanted to know the occupational backgrounds of the executive directors of the chemicals companies that were visited. It was only possible to obtain this information for three of the five companies (I, J and K). Company I was Dutch-owned but the figures obtained were from its UK subsidiary. It had four executive directors: one accountant, two chemists and one (chemical) engineer. Company J had six executive directors: three chemists, one accountant, one lawyer and one with a background in general management. Company K also had six executive directors: three engineers (two chemical and one mechanical), a chemist, a marketing specialist, and an accountant. Thus of the total of sixteen executive directors in these three companies, six were chemists, four were engineers, three were accountants, one was a marketing specialist, one had a background in general management, and one was a lawyer.

Table 9.1 Occupational backgrounds of the executive directors of three of the five chemicals companies in the study

Engineers	Chemists	Accountants	Other Backgrounds
4	6	3	3

Thus among this group it was chemists rather than engineers who were the most numerous. However, as in the previous chapter, these figures do not support the view that accountants dominate manufacturing companies, although there appeared to be more of a 'balance' between technical and non-technical expertise than in the mechanical and electrical engineering companies that were visited.

In terms of promotion opportunities to the most senior positions, opinion was varied. Only three respondents believed that engineers were under-represented, but only in one company (company K) did respondents actually feel that engineers tended to have the best chance of becoming directors. Most other respondents felt that chemists tended to dominate senior positions, but several respondents noted that engineers, particularly chemical engineers, were increasingly achieving senior positions at their expense. Most respondents, with the exception of company G where respondents had complained about the influence of finance, were not concerned that accountants tended to dominate senior positions.

Thus although engineers did not appear to be overly concerned that they were underrepresented in senior positions, the author also wanted to know what engineers and their colleagues felt about their career prospects more generally. Although chemical engineers were apparently more likely to achieve senior positions and to manage projects than mechanical ones, both mechanical and chemical engineers in all five companies believed that considerable career opportunities were available in both engineering and non-engineering parts of their companies. The following responses were fairly typical:

'I think it all depends on what your objectives were when you started off. Mine have never been to be anything other than an engineer so if somebody offered me a job as a senior plant manager of some description I wouldn't be interested anyway... engineers do do other things. I'll have been here 23 years come September and because I am a chartered engineer and an official mentor of the Institution of Mechanical Engineers I have been a tutor to quite a number of the younger engineers, and virtually all of these people have changed their role as time has gone on. Most of them have tended to go into plant management rather than stick here in chemical or general engineering or even projects engineering, although one of them has gone into marketing' (Mechanical Engineer, company G).

'I think being an engineer gives you a tremendous advantage because, okay, if you are the accountant you can talk about the numbers in terms of profit and loss but you can't tell people how to make a thing better. Cheaper maybe, but not better. When I say an engineer I mean all of them, I am not singling out a particular branch. I think they have excellent skills which are in demand, and when used in the right way in terms of communication and presentation skills then every avenue is open to you and you can do really well' (Chemical Engineer, company G).

Only two of the five companies (H and J) operated dual career ladders which allowed engineers to remain as specialists within engineering while receiving increases in salary and grading which were equivalent to 'managerial' positions. In the case of company J they had only recently been introduced and their effects were unclear. Nevertheless, they were welcomed by respondents:

'Certainly previously there was no prospect for promotion in my previous job... the only way was sideways into business support groups. We are still formulating our structure at the moment but when we have finally done that I think we will see quite a lot of scope for career progression in there' (Chemical Engineer, company J).

'I think what we have done in the last six months or so is to recognise that there are broad bands that people can be fitted in to. They can be rewarded for their technical competence, for their managerial competence, or a combination of both. But their contribution to the business can be measured in what they can deliver to the business' (Mechanical Engineer, company J).

At company H the dual career ladder had been in existence for some time, apparently with a good deal of success. Respondents did not appear to feel pressured into moving into commercial positions, or into roles which involved less technical content. It was also felt that progressing along the technical path did not preclude moving to the 'managerial' one at a later stage:

'There are plenty of career opportunities for engineers in this company. You get moved around to various positions, both engineering and commercial... they keep the flow going and keep you moving. You can move away from engineering if that is what you want to do. They have a thing called a technical career path which can take you really far and you can advance yourself on and you can get recognised for the work that you do which is excellent. It really feels like, all right, I am still on the shop floor as an engineer but I am advancing in the eyes of the management of the company. They can see that I've got potential and if an opening does come on the managerial or commercial side that I'm interested in I know they'll be prepared to put me in that position' (Chemical Engineer, company H).

However, five engineers from the other companies felt that in order to further one's career it was necessary to move into a 'managerial' role either technical or non-technical, in order to be promoted. The following response was typical:

'What they need to do is pay the specialist as well or better than the general line manager. The general manager or line manager who has responsibility for a hundred people but who has a limited involvement technically is rewarded more highly than the person with the specialist knowledge and I don't think that's fair because one job is not more important than another, they are just different, so the specialist tends to get backed into a corner and if you want to get promoted you have to leave what you love doing' (Chemical Engineer, company G).

There was also a danger that, as an engineer became more specialised and the company became increasingly dependent on him or her, engineers tended to become trapped in particular roles:

'I think once you reach a certain level on the technical side you tend to get pigeon holed as a specialist and it then becomes very difficult to get out of that area because people rely on you being there and doing that job and being the main focal point for that area of expertise' (Marketing Manager, company G).

'It's never going to be 100 per cent fair but that's life... I think there is a feeling that it's more difficult for technical people to progress because in technical areas you tend to build up specialist knowledge which is of such value to the company that the company doesn't want to move you on, whereas that doesn't tend to be the case on the commercial side' (Chemical Engineer, company G).

However, three engineers said that they had no intention of moving into 'management', either technical or otherwise. They clearly enjoyed their work and felt no pressure to change tack:

'I've wanted to be an engineer since I was a kid. I think it's the sort of mind I've got. I love fixing things and making things work and making things work better... and I basically enjoy my work. I like the fact I don't have a sedentary job and I don't think I'd get the same enjoyment if I was sitting behind a desk all day' (Mechanical Engineer, company K).

Thus virtually none of the respondents appeared to believe that there was a shortage of career or promotion opportunities for engineers. However, some of them felt that it was necessary either to leave engineering or to take on more administrative responsibility in order to advance their careers.

The Position of Engineers in Chemicals

In the previous sections the views of engineers with regard to their influence and roles vis-à-vis other management level groups were discussed. The career prospects of engineers were also examined. Company G was the only company in which engineers were found to be concerned about their influence. The problem appeared to be that the finance department was responsible for setting production targets and monitoring productivity. The engineers interviewed felt that this was unfair because the accountants were not properly informed about the issues and problems of production. However, engineers were not concerned about the roles or influence of accountants in any of the other four companies and accountants were generally considered to be performing a support function. Their role was mainly to assist engineers about costing and budgets.

Only three of the five companies employed marketing people at the sites that were visited. At each of these, respondents reported that more emphasis had been placed on the importance of marketing. This did not mean that engineers had become less influential or that marketing people were considered more important than engineers. Indeed, given that many of the marketing people at these companies were engineers by qualification, particularly chemical engineers, this development could, if anything, be seen as raising their profile and influence.

Chemists and engineers form the largest groups of management level staff in chemical companies. While chemists probably remain the most influential professional group, particularly in speciality chemical companies, it appeared that chemical engineers, whose education had combined major features of those of chemists and mechanical engineers, were challenging for their place as the leading professional group. In speciality chemicals companies, mechanical engineers had tended to be less influential. However, in other companies in which the chemistry involved was less sophisticated than in others, mechanical engineers had always been and remained influential.

It was also noted that there were considerable opportunities for promotion both in engineering and in other parts of companies, although some respondents were concerned that it was necessary to become less involved in the technical aspects of their work in order to realise these opportunities. There was no concern that boardrooms might be dominated by accountants.

With the possible exception of those in company G, most of the engineers interviewed spoke with, both chemical and mechanical, painted very positive pictures of their lives as engineers. Although chemical engineers were generally thought to be more influential than mechanical ones, neither group expressed any real concerns about a lack of influence and they certainly did not appear to think that they were undervalued or that their views were ignored. The following response from a relatively junior engineer illustrates the level of responsibility which many engineers enjoyed and the sense of satisfaction which many of them felt about their work:

'I find my job rewarding and I think I am well suited to the job. I like the work I do. There are some things that I like better than others but as a whole I find it pretty rewarding because I am involved right the way through from design to costing to looking after the chaps on site, buying the stuff in, commissioning. I am not just pinned at the desk all the time. I am doing the whole shooting match and I really like that' (Mechanical Engineer, company H).

Engineers were influential partly because their role was crucial to the success of their companies:

'Companies like ourselves and BP, big companies like that, if you look at their annual balance sheets and look at where their increased profits came from you can be sure that at least 50 per cent of it came from productivity improvements and most of that is down to engineers, so they are an absolutely essential part of the organization' (Chemist, company H).

The following quotations probably sum up how engineers felt about their position:

'We are no longer the "grease monkeys" of industry. We have a definite role in its management. When I first came here I think engineers were subservient to the chemists and if anyone was going to be promoted into a key role it would have been a chemist. Now we find a lot of engineers in the key positions so I think it's changing' (Mechanical Engineer, company J).

'As soon as you walk through those gates you're in my plant. All of manufacturing and technology is run by engineers almost exclusively. It's not run by accountants, it's not run by personnel, it's not run by commercial. I have complete control of what goes on here. There is obviously a strong link between what we are producing and what someone wants to sell so there is a constant rapport with commercial. But engineers have control of everything in manufacturing' (Mechanical Engineer and Plant Manager, company K).

Management Abilities

In the previous chapter it was reported that many respondents believed that the education, the qualifications and the professional training of individuals were less important than their personal qualities in terms of being effective managers. Sixteen respondents in the chemicals companies that were visited expressed similar views. Nevertheless, some respondents felt that engineers had particular strengths and weaknesses. Seven respondents commented that engineers tended to approach problems in logical and rational ways:

'I think the skills an engineer has are analytical skills in getting to the root of the problem that he is trying to solve. Engineers are trained to analyse problems and come up with solutions and the arts graduate isn't trained to do that, so they have a definite advantage when it comes to management' (Personnel Manager company J).

'Managers who are or were engineers tend to be very pragmatic because they have a very practical, hands on background. They tend to visualise the problem three dimensionally. They are very good at picturing things because they have been drawing pictures all their lives as designers, and management in many respects is not much different' (Chemical Engineer, company J).

'Personally speaking I think that they are quite pragmatic, very factual, precise. The training I received as a chemical engineer teaches you to be quite pragmatic, it's numbers, figures, equations' (Chemical Engineer, company G).

Barry, Bosworth and Wilson (1997) also believed that engineers tended to be logical and rational in their thinking as expressed above. This made them very suited to middle management positions. However, these authors also wrote that engineers tended not to be particularly good at managing problems to which there were no right of wrong answers or which required that much open ended information be digested.

Five respondents expressed similar views. According to one respondent engineers often lacked decisiveness:

'It is not easy to give you an example but often engineers lack intuition, or vision. Sometimes it might be appropriate to take a risk but engineers would prefer to say we can take this step and then we can take that step as opposed to saying let's just go for it. They would prefer to do the calculations and they might have missed the boat' (Mechanical Engineer, company K)

Another believed that engineers tended not to think in a flexible way:

'I think to manage at the highest level you have got to be quite flexible in terms of outlook and attitude and I think with engineers, and I would include chemists as well, everything is black and white, things work or they don't work. And I think it's sometimes dangerous to see things like that when you are not dealing with engineering or chemistry' (Chemist, company K).

However, two respondents also added that this was a 'problem' that could be quite easily solved by training:

'Sometimes engineers can become a bit entrenched. They become blinkered, and I think every now and then you've got to push your chair back from your desk and look round the room and say, "right, what are the broader issues here that we need to think about". But that's something that people can learn to do. I went on a course last year which was called "a structural approach to getting things done". It was marvellous for me because it changed my approach to tackling problems. Why am I doing it, who am I doing it for, what have I got to achieve and how do I know when I've got there' (Chemical Engineer, company J).

'I think engineers can get too bogged down with detail, it's very difficult for us to have the overview that some other managers have because sometimes we don't have the breadth of knowledge. But having said that, that is something which we can learn either at work or at postgraduate level. I'm not advocating that we dilute the engineering content at degree level, because there's a lot to be said for the classical engineering education. Go and do an MBA. It's not difficult to pick up compared to the stuff we are used to learning' (Mechanical Engineer, company J).

Three engineers and one accountant believed that engineers tended not to be able to communicate effectively. The accountant said that:

'Engineers are good at communicating with engineers but I'm not so sure that they're good at putting over the technical stuff to people like me [an accountant]. There are times in meetings where I feel they presume that I know what they are talking about…

they don't seem to be able to explain clearly what they mean in layman's terms' (Management Accountant, company I).

However an engineer at company G made the point that communicating technical information to non-technical people was very difficult and that engineers were perhaps criticised unfairly in this respect:

'People say it's a weakness but if you need to communicate a technical problem then you have got to simplify it using non-technical words, but without being condescending. You have got to put it into terms that they understand and some engineers do have difficulty doing that, but it's a very difficult thing to do and I think it's a little unfair to say that engineers can't communicate... it comes down again to individual skills and appreciating and understanding where the other person is coming from' (Process Engineer, company G).

However, the majority of respondents, both engineers and non-engineers, believed that engineers were able to communicate as well or as badly as any other group:

'I don't think they're worse than anybody else. I think probably people pick on engineers in the sense that what they are doing impacts on the company much more. So it's much more important that engineers can articulate what they are doing, than say purchasing' (Mechanical Engineer, company H).

Respondents discussed the types of expertise which were most suited to senior management. As in the previous chapter, there was a consensus that a there should be a balance between technical people such as engineers and chemists and non-technical people such as accountants and marketing and sales people. The following quotations were fairly typical:

'I think in this industry [chemicals] you need a combination of people who understand the chemistry [chemists], people who understand the production [engineers] and people who understand the financial aspects of the industry [accountants]' (Chemist, company K).

'Yes technical knowledge is very important but you need to have a balance in actual fact. That is why companies like ICI have engineers, chemists, accountants and human relations people on their boards of directors' (Mechanical Engineer, company I).

Five respondents felt that senior managers needed to have some awareness of technical issues but that detailed knowledge was not essential. One respondent believed that it was quite easy for managers who were not engineers or chemists to obtain the necessary technical awareness:

'I think that senior managers need to have an awareness of technical issues rather than technical knowledge. Senior management don't need to get into detail with a lot of the equipment we have down here, and I don't think it's appropriate or desirable for them to have a detailed knowledge but I do think they have to be aware of the issues... and there are a number of technical courses that we run for non-technical managers' (Personnel Manager, company J).

Another believed that it was not the professional background of senior managers which was important. It was their knowledge of the industry in which a particular company was competing:

'I would certainly not subscribe to the idea that somebody who is a "professional manager" as opposed to an engineer or anything else, someone who is just a business manager, would be best placed to run, say a chemical factory if he didn't know anything about the chemical industry. He would have to gain huge insights into that business to be able to run it at its best, so it would be preferable if he had some engineering background, or at east some experience specific to the chemical industry' (Mechanical Engineer, company K).

Two respondents said that technical knowledge was not at all important for senior management. According to one engineer:

'I don't think it's important. Sometimes it can actually be a hindrance because if you were a specialist in a particular field you may be arguing from a point of view that is now a bit outdated and that can cause problems. A good manager is one that has no axe to grind on a subject and takes the views expressed by the specialist in his report at face value. It is fine if he understands the details but it is not essential... managers at all levels should rely on their team to feed them the information which enables them to make the decision. They shouldn't necessarily make a decision based on their own technical expertise'. (Chemical Engineer, company J).

The Collective Organization of Engineers

Some academic writers have argued that engineers tend to be unionised and uninterested in the professional engineering associations (Whalley, 1986; Meiksins and Smith, 1992; Smith and Whalley, 1997). In the previous chapter it was noted that none of the engineers who were interviewed were trade union members. In the chemicals companies that were visited, only one engineer was a trade union member. He had originally joined his company as an apprentice fitter and had been encouraged to join a trade union. Some years later he obtained a mechanical engineering degree through part-time study and was promoted to a managerial position. However he had decided to retain his trade union membership. None of the other respondents in chemicals felt that there was a need for professional engineers to join trade unions. As in the previous chapter the author got the impression that engineers felt that because engineers perceived themselves as managers or managerial level employees, trade unions were not appropriate. They argued that they were well rewarded and operated in a labour market in which their skills were in relatively short supply. This made it quite easy for them to change employers should they wish to do so. The following responses were fairly typical:

'I do not belong and have never belonged to a trade union. In the thirty years that I have been an engineer I have never thought about joining, even when the unions were strong. In our company, I have no reason whatsoever to join a trade union. The company has treated me well. I am well paid. I've got excellent employment conditions. I do not need defending by a union' (Mechanical Engineer, company K).

'Professional engineers don't join trade unions, partly because there isn't really a union that we can join. Technicians and fitters and so on have unions which represent them, but if you look at our pay bargaining, all engineers are on performance related pay and we are able to negotiate directly with our boss, so unions don't feature' (Chemical Engineer, company J).

'I'm very fortunate in that, as a chemical engineer, what we do is very specialised and if you've worked for a prestigious company like this you are in very high demand, so I don't need to join a union' (Chemical Engineer, company J).

Of the twenty respondents with engineering backgrounds, seventeen were members of professional engineering associations. Twelve of these had achieved chartered status and two were in the process of becoming chartered. In chapter 8 it was noted that most respondents with engineering backgrounds in the mechanical and electrical engineering companies in the study were sceptical about the benefits of chartered status, and only eight of twenty had obtained it. The views of engineers in chemicals contrasted sharply with this. Fifteen of the twenty respondents with engineering backgrounds believed that chartered status was advantageous in some way:

'It's becoming increasingly important to maintain your chartered status these days. You have got to prove that you are on a personal development plan and that you are taking responsibility for your own development. That hasn't happened in the past but it's happening now and I see that as fundamental. You have got to keep pace' (Chemical Engineer, company J).

One young respondent, a marketing manager qualified and experienced in engineering, had recently become chartered and clearly felt very proud of his achievement. He no longer felt able to work in the factory due to a traumatic accident at work in which he had lost part of his arm. As a result he had moved to the Marketing Department:

'I have just recently received my chartership... and that gave me a really good sense of achievement, you know... it was like I had really achieved something. I was a chemical engineer for five years and I eventually reached a level where I became chartered, a professional engineer. I like to think that I will be more respected now and that people will think, okay, he has got his chartership now, this guy must know his stuff. Okay he got a degree in Chemical Engineering, but now he is actually putting theory into practice' (Marketing Manager, company G).

One senior engineer believed that chartered status gave employers a benchmark with which they could use to judge engineers who had applied for a position in their companies. Chartered status gave employers a guarantee of technical ability:

'I think chartered status is helpful. It gives you an independent assessment of what someone has done. It's not just someone bringing out their CV and saying I've done this, I've done that. Maybe they got on really well with their previous manager and they got a great reference, but that may not reflect the standard of work they have done in their particular field. The key thing is that it's independent because it is awarded by the Engineering Council' (Mechanical Engineer, company H).

A senior engineer in company I said that he ensured that only chartered engineers designed or maintained parts of the plant which were subject to regulation and inspection. This, he believed, provided evidence of competence:

'Over recent years we have a had a lot of new legislation to deal with, things like chemical handling, systems regulation and a whole load of environment legislation. Usually, it is the engineer who is in charge of making sure the company is compliant with these regulations. We have a situation where we are continually getting inspectors round. Now I won't make anyone who isn't chartered responsible for part of the plant which is subject to inspection. It's my guarantee that these people are competent. Because if we are found not to comply with a piece of legislation we will be shut down, and that means we lose money' (Mechanical Engineer and Plant Manager, company I).

Another engineer felt that engineers were much more employable if they had chartered status:

'Companies use it as an advertisement, depending on the type of industry they're in. If you place an order with us, we'll produce what you want and we've got technical resources there to back that up should we have any difficulties with x, y and z... we've got chartered mechanical, electrical and civil engineers... and that indicates that you have expertise in different areas. They use it as a selling point. You might not get any particular benefits from the company, but they will value it and it will be in their PR literature that they give out to potential customers. It's more important to the companies than to the individual engineers and therefore it makes you much more employable' (Mechanical Engineer, company H).

Six respondents, however, were not convinced of the benefits. One, who had only recently graduated and who wanted to leave engineering and move into general management said that she did not see the benefits of chartered status:

'I am not particularly interested in becoming a chartered engineer, and that's probably because I don't perceive it as having a particularly high status. If I went home and said that I'm going to be a chartered engineer most of my friends who are lawyers and doctors and that sort of thing would say "oh, right". It wouldn't mean very much to them' (Chemical Engineer, company G).

Another thought that chartered status was less important in small companies:

'It's considered quite important in certain companies and in certain industries, particularly multi-national companies, but in smaller companies all it might do is get you an interview... if you have two candidates who are closely matched then in might help push things in your direction. Beyond that I don't think it serves a great deal of purpose' (Chemical Engineer, company G).

Nevertheless, a significant difference between the engineer respondents who worked in chemicals and those who worked in mechanical and electrical engineering was that most of the former believed that chartered status was beneficial to their employment prospects while most of the latter believed that it made little difference. It seems fair to conclude that this was one reason for the greater proportion of chartered engineers in chemicals. Another was that all five companies encouraged engineers to achieve chartered status whereas only two of the six mechanical and electrical engineering companies that were visited did so. Underlying this may be the relative newness of the chemicals industry and its long tradition of employing highly qualified chemists, some with doctorates, from respected university departments.

However, thirteen respondents were critical of the engineering profession more generally. Five respondents believed that the profession had been and would continue to be ineffective unless they were able to restrict certain engineering tasks to registered professional engineers:

'The problem with the Engineering Council is that they are not in control. Accountants, doctors, lawyers, vets and pharmacists all have a legal entitlement to operate, and the only way you can perform the functions of these professions is through the tall gates of membership. So the professional associations are able to control the supply and demand of a particular profession... so for example if you want your financial records certified for tax purposes the only person that can do that is a Chartered Accountant, nobody else is allowed to do it' (Chemical Engineer, company H).

You cannot be a doctor unless you have a medical qualification and if you act improperly you get thrown out the BMA and you can no longer practice. If you act unprofessionally as a lawyer you can get struck off the bar list. But if you are an engineer you don't have to belong to a professional association. Supposing for example you are a maintenance engineer and due to your negligence someone is killed. You have acted unprofessionally, and yet you can walk straight back into another job' (Mechanical Engineer, company I).

Four respondents believed that the profession had spent too much time fighting amongst itself rather performing its role, and one respondent believed that the profession was too distant from its members. One chemical engineer felt that individual institutions were partly to blame for the profession's ineffectiveness. They were too concerned with their own interests rather the interests of all types of engineer:

'They could do a better job. I think there is probably too much in-fighting. From my own experience they don't work together as much as they could do to promote the engineering profession in the widest sense. The Institute of Chemical Engineers is quite good at promoting chemical engineers, but it's very insular. As chemical engineers we have to deal with mechanical, electrical and civil engineers all the time, and yet there is no co-operation at the professional level. We must make progress in that area I believe' (Chemical Engineer, company G).

Eight engineers were also concerned that the profession had not been effective in promoting engineering to the general public. Although four engineers were supportive of the engineering profession's efforts, most engineers, as in the previous chapter, were quite cynical about them. However, some respondents were, superficially at least, partly contradicting themselves by on the one hand talking about the benefits of chartered status, and on the other criticising the profession for being ineffective.

The Education of Engineers

Eighteen of the twenty respondents with engineering backgrounds were graduates. The remaining two, who were both in their forties, had HNDs. Two respondents had MBA degrees and two were doctors of philosophy. With regard to the education of engineers, respondents focused on the balance between theoretical, practical and management elements in engineering degrees. Twelve respondents thought that degrees should be more practically oriented and 'hands-on':

‘I think engineering degrees need to be more practical because if that side is missing then I don’t see how you can appreciate how you design something or make something or maintain something if you haven’t actually seen what everything does’ (Mechanical Engineer, company G).

‘I think there is a need for universities to work closely with industrial partners to try to include a practical aspect, no practical is the wrong word, practical sounds like it involves spanners. It’s about being out in the wide world and seeing how things are actually done and realising the relevance of that to the course you are doing and vice versa’ (Mechanical Engineer, company J).

Almost all respondents agreed that the inclusion of management subjects such as accounting and marketing in the syllabus was positive. However, one respondent believed that such courses must not in any way dilute the technical content:

‘I did my degree twenty-odd years ago and it included a bit of marketing and a bit of business studies... I think that’s all to the good, but you can’t sacrifice the technical nitty gritty. I think that a chemical engineer or a mechanical engineer that comes out of university must be first and foremost one of those. But yes if he is given some management skills and communication skills and business skills along the way, fine. What you must do then of course is allow the time for it’ (Chemical Engineer, company J).

In a similar vein, three respondents believed that the purpose of an engineering degree was to ensure that graduates had a solid theoretical foundation. Companies could then build on this with their own training programmes. One engineer believed that it was not possible for degree courses to be particularly practical because of the huge range of tasks involved in engineering:

‘I think it would be very difficult to make engineering degrees more practical. With civil engineering for example, what part of civil engineering would you get experience in? I think they can only give you a very broad base, let you see some of the different machines, different tools, whatever. The practical side is really the responsibility of companies themselves, because to get chartered status, you don’t just need the basic work experience you also need to have had certain responsibilities for a certain amount of time and that can only happen once you’ve defined your own career path, so I don’t think it’s up to the universities. Management skills, again it’s something you need to learn to do at work, but doing a course at university would certainly help’ (Mechanical Engineer, company I).

Most engineers felt that engineering degrees should be more practically oriented and the introduction of management subjects was broadly welcomed. The following quote probably sums up the feelings of the majority of engineers:

'I think engineering courses have started to move in the right direction by combining both engineering and management courses... But I think that the universities could still do more to service the needs of industry rather than academia. The balance isn't right in terms of the practical elements of the degree' (Chemical Engineer, company G).

It was noted in chapter 5 and in the previous chapter that a number of writers believed that one of the problems which UK engineers faced was that employers tended not to distinguish between different grades of technical staff (Whalley, 1986; Smith, 1987; Meiksins and Smith, 1992, 1993; Jones et. al., 1994; and Smith and Whalley, 1996). Thus technicians and even semi-skilled technical workers usually performed similar tasks to graduate engineers and were often employed on the same pay and grading structures as them.

The author found little evidence to support the above views in the five chemicals companies that were visited. Three of them (H, I and K) only used the title engineer when referring to professional and/or graduate engineers. The word technician was used to refer to lower grades of technical staff. This distinction was apparently clear to all employees. As would be expected, different grading and pay structures were applied to the different groups. According to the Engineering Director of company K:

'There are clear distinctions. We don't call anyone an engineer unless he or she is technically qualified, and by technically qualified I mean that they are able to join one of the institutes and become chartered engineers. Therefore craftspeople will never be anything better than perhaps technicians unless they do further study... but if we see a technician who we believe has potential then we have no hesitation in putting him through university. Our design manager is an example of that. He was a young apprentice who started here when he was about 15, and he went through university and got a degree and then he stayed on to do a PhD... that's an extreme example but we encourage people to fulfil their potential' (Engineer Director, company K).

Companies G and J called all grades of technical staff engineers. Although different pay and grading structures were also applied in these companies and the distinction between different levels of technical staff were of course clear to those affected, two engineers at company G and one at company J felt that some non-technical people were unclear about the differences between the groups. Also, the management accountant at company G said that she considered all technical workers to be engineers. However other respondents at these two companies believed that non-engineering people were aware of such differences. Furthermore, in all five companies, with the exception of some older engineers, respondents made it very clear that professional-level engineers required an engineering degree. On balance it appeared that, to slightly varying degrees, there was a clear grading system for engineers in all five companies and that employers relied heavily on formal qualifications as a means of distinguishing between different grades of technical staff.

The Social Place of Engineering

Engineers employed in the five chemicals companies that were visited expressed very similar concerns about the general social standing of their profession to the ones expressed by engineers employed in electrical and mechanical engineering companies. Sixteen of the twenty respondents with engineering backgrounds believed that the social standing of engineers in the UK needed to be improved. Again, it was the vagueness of the term engineer that caused most concern, with most respondents apparently believing that the general public thought that engineers were skilled labourers rather than part of society's managerial stratum. Sixteen respondents wanted the title 'engineer' to be licensed, believing that this would help to resolve this 'problem' at least partly. The following quotations were fairly typical of what was said:

'I am hard pressed to think of any word in the English Language more maligned than "engineer". An engineer can be anything from the Managing Director of ICI to a grease monkey with dirty overalls. They are all engineers. Your washing machine breaks down at home. Who do you call out?' (Engineering Manager, company I).

'I think the problem goes back to Victorian times really when most engineers worked with spanners and dirty overalls. And I think that perception has remained, partly because engineers have not publicised their achievements to the extent they should have' (Engineering Director, company K).

'I would honestly say that a good proportion of the general public probably wouldn't know what the difference was between a chemical engineer, a mechanical engineer or a civil engineer. And if you asked them what a chemical engineer was, they would have no idea at all' (Chemical Engineer, company G).

Thus most engineers were very concerned about society's perceptions of their profession. However, a small number of them appeared excessively concerned, almost paranoid. One respondent felt that engineers had a 'complex' about their position, and there is perhaps some truth in this. The following quotation is from a mechanical engineer in company I. He felt that engineers were blamed for almost everything that went wrong in people's daily lives. He was very articulate and logical, and yet his response to a question about the social standing of engineers was not, in the author's view, entirely rational:

'I think that the public has long accepted that most of their woes have been caused by engineers. For example the water shortages that we've been having down here. That's not caused by Yorkshire Water, it's the fault of engineers who didn't build enough reservoirs. A plane gets delayed, it's not the airline's fault it's a maintenance problem. Anything that happens out there to Joe Public, 99 per cent of the time the engineer gets the blame' (Mechanical Engineer, company I).

On several occasions, when respondents were asked about the position of engineers in companies, the responses given concerned their social standing. However, four engineers were unconcerned about the image of engineers and engineering. One respondent compared the social place of engineers with that of accountants, referring to the professional model which some respondents wanted engineering to emulate:

'Most professions are like engineers. Take accountants, some engineers talk about accountants as if they were adored in the eyes of the public. If you are an accountant you are just Joe Bloggs the accountant, aren't you? And there are as many levels of accountants as there are levels of engineers. I'm sure there are people who are clerks in firms who call themselves accountants, just as there are people who are the bosses of major accountancy companies that will call themselves accountants, and Chief Executives of companies who call themselves accountants. So I really don't think it is something to get hung up about. What difference would it make anyway?' (Mechanical Engineer, company K).

Another engineer was even more scathing about the 'moaners' who were apparently too concerned about what other people thought rather than performing the work that they were employed to do:

'These people are going to have a miserable life and die unhappy, aren't they? They have a perspective that is different from reality. They want to be king of the castle. They would like to be the ones with the best looking curtains in the windows. I'm quite happy just to have curtains' (Mechanical Engineer, company K).

One of the engineers interviewed was French. She said that in France if a school pupil is good at maths then they are pushed towards engineering at a very young age. Even being considered to be potential engineering material was considered an accolade:

'If in primary school you are a good student and especially if you are good at maths and physics then the system pushes you towards academic study. Then later on [at secondary school] if you are at the top of the class then the system pushes you to an engineering school [university or grande école] because then you are considered to be "the stuff"' (Chemical Engineer, company H).

This contrasted sharply with the views of some British respondents who felt that schools in the UK tended, often unintentionally, to discourage young people from a career in engineering. One respondent said that teachers didn't do enough to promote engineering:

'If you haven't got good teachers who are able to encourage young people into engineering as a career then we have failed. It's like sport, it's too late for somebody in their teens to take up sport. If a teacher thinks it's just a dumb job then our children aren't going to be interested. It has got to start when kids are young and I feel that this is where the British education system has gone wrong in the past. If you want people in the future who are good at the maths and the sciences, you have got to change the way teachers behave because it is the teachers who nurture the spirit of engineering and can make it fun and enjoyable and something that people might want to do' (Engineering Director, company K).

Another, who left school less than a decade ago, said that he did not receive any careers advice at all at school:

'I didn't have any careers advice because there was no careers service at my school. I never sat down with a careers chap. I knew I liked maths and technical drawing so I decided myself that engineering would be the best thing for me. It's just something that I have followed out of my own interest really' (Mechanical Engineer, company I).

According to another of the engineers, part of the 'problem' was that teachers did not have enough industrial experience. He believed that professional engineers should be allowed to become teachers without studying for a teaching qualification. This was the best way to encourage experienced engineers into the classroom:

'I don't see enough people with industrial experience in the teaching profession. In England, until about the late 1970s anybody who was a graduate could teach. I think that they closed the doors at the end of the 1970s and you then needed a teaching certificate. I think that was a great shame, because it was a way of getting engineers into the classroom. And of course they tended to be very experienced because a lot of them did it in their later working years. But if you speak to a teacher now and ask him what experience he has of engineers, he won't have any. He'll have come straight from college and into the classroom. So maybe if you took some of the engineers who have been forced to take early retirement because they have been cast off by these multinationals, they could become part-time teachers' (Chemical Engineer, company H).

Thus, most respondents were concerned about the esteem in which engineering was held and wanted it to be improved. Indeed, many of the responses expressed by engineers who worked in chemicals were very similar to those in the previous chapter.

Engineers and Pay

Respondents said that the pay for engineers was the same or higher than other managers employed at the same level in all five companies that were visited. Only four of twenty engineer respondents thought that engineers were not paid as well as they ought to be: two mechanical engineers at company I, and a mechanical and a chemical engineer at company G. All of the others thought that they were at least adequately remunerated.

Conclusion

In this chapter the position of engineers in the five chemical companies in the study have been reported. Chemical engineers appeared to be more influential than mechanical ones in terms of the management of projects and promotion prospects, particularly with regard to the most senior positions. Chemists probably remained the most influential group but there was a consensus that chemical engineers were challenging them very closely in this regard. Accountants played an important role, but with the exception of company G, the author found little evidence to support the belief that they dominate and control chemicals manufacturing companies. Also, companies appeared to be placing an increasing emphasis on marketing and on understanding and meeting the requirements of markets and customers.

Although there were numerous career opportunities for engineers in different types of 'management' positions, both technical and non-technical, and engineers were not under-represented at board level, several respondents expressed concern that it was necessary to become less focused on the technical aspects of engineering if they were to progress in their careers. Most respondents felt that engineers and other groups made equally good and/or bad managers. However, a small number felt that they did not tend to be able to deal with large amounts of open-ended information.

Respondents were quite critical of the engineering profession but many believed that chartered status had provided real benefits. All but two respondents were graduates and there were relatively clear grading systems for distinguishing between different types of technical staff in all five companies. Many respondents felt that engineering degrees needed to focus more on 'hands-on' skills, by which they did not mean manual ones. Most were also very concerned about the social place of their profession and some felt that restricting the title 'engineer' to graduates or professional engineers was the best way to improve the situation. Taking this chapter and the previous one together, engineers in manufacturing, at least in the relatively successful companies that were visited, appear to enjoy a very significantly more influential and constructive position than some academic writers have indicated in the past, recent and not so recent. In the next chapter the interviews conducted with respondents in the construction companies in the study are reported.

CHAPTER 10

CONSTRUCTION

Introduction

The position of engineers in construction has been almost completely ignored in the academic literature on engineers, although their roles are often discussed by writers on construction. Given that many engineers are employed in construction and in view of the economic importance of the sector, the author felt that it was important to include it in this study. The UK construction industry employs around 895,000 people (Office for National Statistics, 1998b) and has an annual output of around £33.7 billion (Office for National Statistics, 1997b). There are around 165,000 construction firms in the UK, only 87 of which employ more than 600 people. However, these 87 companies are responsible for about 15 per cent of all UK construction work (Office for National Statistics, 1998a).

As was noted in chapter 4, the construction industry can be divided into three parts (Glover and Kelly, 1987): building, civil engineering and engineering construction. Building includes the construction of housing, factories, shopping centres, schools and hospitals. Civil engineering is mainly concerned with projects such as those which eventuate in roads, bridges, dams, and harbours, although it used to mean all or almost all engineering except military engineering. Engineering construction consists of projects such as power stations, process plants and railway electrification schemes, ones which generally produce the large structures within which other forms of engineering occur. In this chapter the focus is on building and civil engineering. However, and clearly, all three parts of the industry overlap.

The roles of the actors in the design and construction of projects have remained fairly consistent over time. However, there has been considerable competition, especially in the recent past, between the main construction professions for the overall co-ordination and control of projects. In this chapter the roles of engineers in the design, construction and management of projects in building and civil engineering will be examined. The views of respondents about the management abilities of different groups, the collective organization of engineers, the education of engineers and the importance which employers place on formal engineering qualifications, and the social standing and levels of remuneration of engineers, will also be reported and discussed.

An important difference between construction and manufacturing is that in construction competition for power and influence between occupations usually takes place between firms, rather than within them. Assessing the position of engineers in construction is quite difficult, not only because of the different types of engineer employed, each of which performs different roles, but also because the relative influence of the various professions depend on the type of product and the method of contracting chosen by clients. As noted in chapter 4, there are four main ways in which projects are organized in the UK construction industry: the 'traditional' model, design and build, management contracting and project management. The term project management, as well as being a form of contracting, also refers to the management of projects regardless of the form of contracting used. This can be confusing. Throughout the chapter the author has tried to make it clear what is meant when this term is used. Also, as noted in chapter 4, the phrases 'type or method of contracting' and 'type of project organization' are used interchangeably.

Twenty-seven interviews were conducted in thirteen companies: twenty with engineers, four with quantity surveyors, one of whom had an engineering background, and three with architects. Company L was a building contractor which employed about 350 people. Two people were interviewed: one civil engineer and one geotechnical engineer. Geotechnical engineers specialise in soils. Company M was also a building contractor and employed around 400 people. Two interviews were conducted with civil engineers. Company N was an electrical engineering contractor which employed around 40 people. Interviews were conducted with an electrical engineer who installed electrical equipment in buildings, another who designed electrical building services, and a quantity surveyor who was trained as an engineer. Company O was a structural engineering consultancy which was involved in both building and civil engineering projects. It employed seventeen people. Three structural engineers and a geotechnical engineer were interviewed. Interviews were also conducted with a structural engineer in each of Company P and company Q, which were very small structural engineering consultancies. Both respondents were self-employed and did not employ any other people. Company R was also a structural engineering consultancy. It employed fifteen people. One of its structural engineers was interviewed. Companies P, Q and R were only involved in building projects.

Companies S and T were architectural consultancies. Company S employed two architects and company T employed one. All three of them were interviewed. Company U was a quantity surveying consultancy which was involved in building projects and which employed six people. Two quantity surveyors were interviewed. Company V was a civil engineering and building contracting firm which employed 7,00 people. Three civil engineers from its civil engineering division were interviewed. Company W was a local authority which employed around 1,200 people. Interviews were conducted with two of its structural design engineers who worked on civil engineering projects, and one of its quantity surveyors who was involved in both civil engineering and building projects. Company X was a structural engineering consultancy which employed 28 people. Two structural engineers, both of whom worked on civil engineering projects, were interviewed.

Building

The Role of Design Engineers

A design team in building usually consists of architects, structural engineers, services engineers and quantity surveyors. Architects are responsible for how a building will look and for most aspects of its layout. Structural engineers design the structure of buildings. Mechanical and electrical services engineers, often called M and E engineers, have responsibility for the design of a building's services such as cabling, heating, lighting, and ventilation. Quantity surveyors are responsible for costing designs produced by architects and engineers. Often all of the professionals in such design teams are employed as independent consultants but they are also often employees of local authorities, large companies or contractors.

Regardless of the method of contracting used, architects normally led design teams and co-ordinated the efforts of their members. This was because their part in the design process was usually the largest. Clearly, when architects design buildings they have to take structural and mechanical and electrical considerations into account. Almost all of the design engineers interviewed felt that most architects had a good understanding of such considerations, although some had experienced relatively minor problems. However, these problems had always been worked through. There was no concern that engineers were not listened to or that their views were not acted upon. In the case of structural engineers this was partly because they used mathematical calculations to determine the kinds of structure needed to help ensure that buildings were safe. If their calculations indicated that drawings would need to be altered to ensure that structures were secure, the architect would have to change his or her drawings:

'Most architects I have been lucky enough to come across do have an understanding of structures and building. They realise that if you have a beam, something has got to hold it up, and you can't have a knitting needle spanning twenty metres. To be fair they appreciate that. There are one or two architects that I often find difficult because they are continually pressing for something to be reduced as far as possible. They don't realise that you must consider the service life of a building, not just the next few years... that if you make it that small it's going to sag, it's going to cause cracking' (Structural Engineer, Consultant, company Q).

'It's just a question of discussion really. I always come up with the, "well Peter if you want this to be so and so and it sags, don't blame me. Is your client willing to accept that?". And invariably he agrees to the changes and he has to go and do the changes. I mean that's only happened once or twice. The vast majority of architects and clients for that matter accept that if a structural engineer says the beam's got to be this and the column's got to be that, they accept it. That's what we're paid for' (Structural Engineer, Consultant, company P).

Clearly, however, making changes to drawings to overcome these problems costs money. The question of who would pay for any changes was more difficult to resolve:

'The other problem you will get is where somebody [one of the consultants in the design team] changes something and then everybody else has to change their drawings... what happens now is that everyone is so ruthless about money and fees that they only want to draw things once. If anyone makes a mistake they are looking for somebody else to pay for the changes. So there's a lot of discussion goes on and there is a potential conflict between the design engineers and the architects' (Structural Engineer, Consultant, company O).

The increasing sophistication of modern buildings meant that building services were an increasingly important element of many buildings and accounted for a much higher proportion of the costs:

'Say twenty-five years ago, in a typical office block for example, the services section of the whole cost would have been about twelve per cent. That's an average figure. Now it's fifty per cent. Because you don't build a building nowadays unless there is air conditioning plus all the sophisticated wiring for the building management system which includes telecommunications and things like that' (Civil Engineer, Contractor, company M).

Services design engineers worked very closely with architects to ensure that the design of a building's services was compatible with the way in which the rest of the building was designed. This was a very important part of the design process. There were health and safety requirements to be considered and it was often very expensive to rectify errors after the building had been erected:

'I think there seems to be a lot more thought going into the services of buildings, especially with big contracts like offices... there is normally a services co-ordinator now who works with the architect when he is designing the building. Before the architect would go off and design the building and forget about the services, but they've improved a lot in that respect. It was even worse for mechanical stuff because they're even bigger items... In this building here for example you'll maybe need six inches above the ceiling for a light fitting and you'll maybe have a bit of trunking up there as well which might be ten inches. So you need space. And the architect might just show a gap of three inches. But how do you get ten inches into three inches? It doesn't go. So the obvious solution is to drop the ceiling down. But there are complications there too because there are minimum regulations for ceiling height. But these things are all thought about at the design stage. They've got to be because by the time the building's up it's too late... It's the same with shopping centres. A lot of these buildings are concrete. They pour the concrete and you can't change the concrete once it's there. So there has to be a lot of thought goes in before they pour the concrete. They leave holes in the concrete for services and things passing through, so it all has to be very closely co-ordinated' (Electrical Design Engineer, Contractor, company N).

The role and position of design engineers were normally not affected to any great extent by the type of contracting used. When the traditional method of contracting was used, it was normally the case that the architect was both leader of the design team and the project manager for the whole project, i.e. the design and construction of the building. Thus design engineers were normally working for teams which had been assembled by and led by an architect. However, when other types of project organization were used, such as project management, design and build, and management contracting, it sometimes became unclear who the design engineers were answerable to. Both the design engineers and the architect were ultimately accountable to the specialist project manager, main contractor, or in some cases, the management contractor. However, the architect usually retained his or her position as leader of the design team and co-ordinator of all design activity, with the main contractor, specialist project manager, or sometimes the management contractor keeping a watchful eye. That said, and as will be discussed later in this chapter, with design and build, contractors tended to interfere in the design process to a greater degree than was the case with the other two methods. Thus although it was sometimes unclear who the design engineers were accountable to, the services that they provided remained the same. Their role and influence also remained the same unless they were chosen by the client to be the project manager, which was very unusual. According to respondents, despite becoming less common, the traditional method of contracting was still the preferred type of project organization for a significant minority of clients. Of the eight design engineers in the study who worked on building projects five said that they preferred this method of contracting with the architect performing the role of project manager because they felt more comfortable with a project manager who was a designer and who understood the design process.

Respondents had little experience of management contracting, but almost all said that design and build was the most common form of contracting and that an increasing proportion of projects were organized in this way. This is in accord with the conclusions of a study by Franks (1992) who estimated that forty-five per cent of projects in the UK were design and build. He also claimed that it was the fastest growing procurement system in the UK and that by 2000 over half of the construction workload in the UK would be procured through design and build. Project management was also becoming a more popular form of project organization. As clients were becoming more cost-conscious they were increasingly employing quantity surveyors as specialist project managers. As will be noted later some engineers felt that this was a role that they were unable to perform.

Respondents agreed that design engineers were not influential in terms of their dealings with clients and the management of projects. According to one of the architects:

'... [design] engineers have quite a happy role in that they are able to calculate something, show that calculation to a client and the client will say "yes we need that". But having said that I don't really think they have all that much influence because they are only involved in a small part of the project... the structural engineers have left the site long before the project is finished' (Architect, Consultant, company T).

Services engineers never led design teams and were never involved in the management of projects. In cases where there was a large structural engineering input into the design process, structural engineers were occasionally chosen as design team leaders and/or project managers. However this was unusual. Four of the structural engineering consultants interviewed were concerned that they rarely had opportunities to manage projects and that their profession had not jumped on the project management bandwagon as quantity surveyors had done:

'We don't get the opportunity to be project managers often enough and I think that's because it's becoming a much more specialist line. There are lots of people who are just specialist project managers which means we've kind of been sidelined' (Structural Engineer, Consultant, company O).

Another explained that with the increasing number of quantity surveyors employed as project managers, the pecking order between architects, engineers and surveyors had changed:

'In a traditional design team you had architects and engineers with the QS [quantity surveyor] as tail-end Charlies. Sometimes now it's QSs at the top, then architects and then the engineers as tail-end Charlies' (Structural Engineer, Consultant, company O).

Three structural engineers felt that their profession had been slow to grasp the changing nature of their industry. Structural engineers had not responded to the changing methods of project organization which clients were increasingly choosing. Contractors, and to a lesser extent quantity surveyors, were increasingly becoming the most influential group in the management of building projects, mainly at the expense of architects, but also of structural engineers. Another structural engineer pointed out, however, that in building the engineering input was often relatively small and that structural design engineers often had very little experience of costing. It was not surprising, therefore, that they had tended not to become involved in project management:

'In building terms then the engineer's role is to a degree secondary and a lot of projects have a relatively limited input. If you go back enough in history you would have scarcely required engineers in most building projects. They wouldn't have involved a significant engineering content at all... Also you have to distinguish the building side from the civil engineering side because civil engineering consultants tend to take the lead role and tend also to have a greater involvement in costing. Within building we are much more sheltered from that. You have a quantity surveyor who deals with all the costs and there is a tendency to gain very little experience of costing. And if you start becoming project manager and dealing directly with the client and reporting to him, you soon realise how important that omission is' (Structural Engineer, Consultant, company O).

It appeared that engineers were an important element of design teams but with limited influence over the management of projects. Despite concerns about their lack of influence with clients and in the management of projects, most design engineers felt that they performed an important role and that this was appreciated by other people in the industry. The following quotation is indicative of this:

'I can't think of any project where I haven't been given the respect that's due... if I say something on the site they'll go and do it. Or if they don't they know they'll be in trouble. They're certainly aware of the importance and significance of engineering, albeit a lower key part than architects' (Structural Engineer, Consultant, company P).

The Role of Contractors

As was noted in chapter 4, building and civil engineering contractoring companies of any size are staffed at management level mainly by engineers. They also employ quantity surveyors to advise on costs, and they are increasingly employing design professionals so that they can offer 'package deals' to clients. Nevertheless, it is normally engineers who supervise construction on site and who are involved in the management of projects should the contractor assume this role.

Unlike design engineers, contractors were increasingly involved in the management of projects and their role and influence largely depended on the method of contracting adopted by the client. In building projects contractors build the designs produced by design teams. They are responsible for choosing the materials to be used and for deciding how buildings are to be put together. Respondents agreed that the balance of power in the building industry had shifted away from architects and towards contractors and, to a lesser extent, quantity surveyors. This was because clients were increasingly adopting different forms of project organization.

Contractors, architects and quantity surveyors were often in conflict. Although ultimately the aim of each group was the same, namely to produce a building to the client's satisfaction on time and within budget, each of the parties had different priorities. Contractors wanted to erect the building as cheaply and as quickly as possible in order to maximise profits. Architects wanted to ensure that the building was as aesthetically pleasing as possible and were inevitably less concerned about the practicalities of its construction. Quantity surveyors wanted value for money for their clients. However, they were considered to be bit part players unless they were involved as project managers. The relationship between contractors and architects was considered crucial because of the perhaps inevitable conflict between aesthetics and 'buildability'. The reason that the control of projects, and thus the method of project organization used, was so important, was that it made it easier for whoever was in control to prioritise their own objectives:

'Very often an inexperienced architect can design something that is pretty well impractical to build. Not all the time and in general not, but sometimes. In a sense the reason you get conflict is that we have different objectives in mind. Of course the object is to finish the building for the client but each group is coming at it from a different angle. The quantity surveyor wants to get the best deal for the client he can possibly get. The architect has his idea that he wants the contractor to build and the contractor's objective is to make money, to make a profit so he wants to build it as quickly and as practically as possible' (Civil Engineer, Contractor, company M).

When the traditional method of contracting was used architects retained their dominant role. As was noted earlier, and although a significant minority of projects continued to be organized in this way, it was undoubtedly becoming less common. In this situation architects were usually employed directly by the client to lead the design team. The client entered into a separate contract with a 'main' contractor for the construction of the building. The contractor carried out some of the work itself but subcontractors were increasingly employed. Despite this, it was usually the case that the architect oversaw the construction of the building on behalf of the client and was responsible for the overall planning, control and co-ordination of all parts of the project. Thus the architect performed the role of project manager. In effect, the contractor was answerable to the architect. Also, because the designs were normally already completed by the time the contracting company was awarded a contract, it did not have the opportunity to encourage the architect to consider the buildability of their design.

When clients chose project management, a specialist project manager co-ordinated and supervised the design and the construction of a project on behalf of the client. The project manager could be a member of the client's team or someone from another company which offered a project management service. When clients opted for this form of organization it was usually the case that a quantity surveyor assumed the role of project manager (Bresnen, 1996). However, architects, structural engineers, or even contractors themselves could also be employed in this role.

Contractors preferred to be involved in projects which used design and build and, to a lesser extent, management contracting, because of the greater levels of control that they obtained. However, the type of project organization used for any project was the choice of the client. If the client thought that a method of project organization in which contractors did not hold the reigns of power was more suitable, they had little choice but to accept this:

'At the end of the day you're stuck with whatever project you're working with. Say you're in a traditional contract and it's the architect that holds the reigns of power i.e. the money. Then you've just got to go with the flow if he's the guy that's got the cash' (Civil Engineer, Contractor, company L).

With management contracting, contractors were considered on a more or less equal footing with architects, with the management contractor and the architect both part of the client's team. The role of the architect was to lead the design team and the role of the management contractor was to manage the construction of the project. The management contractor did not contribute directly to the design of the building or in its construction. Their role was purely a managerial one. The contractors that in the study had little experience of management contracting. According to respondents it was only used on prestige projects such as the Scottish National Art Gallery in Glasgow and the Royal Museum of Scotland in Edinburgh. With this type of project organization contractors tended to have more control over designs and the management of projects than in project management or the traditional type of contracting, but less than in the case of design and build. However, this varied between projects:

'In management contracting sometimes the client would ask us to supply a job architect. The job architect doesn't so much design himself as overlooks what the client's architect has designed to make sure it's buildable. But that doesn't always happen' (Civil Engineer, Contractor, company M).

According to Torrance (1992) and Bresnen (1996) this type of project organization was often problematic because the roles and responsibilities of the different groups tended to be unclear. Nevertheless, the contractor played a much more important role than with the traditional method of contracting. The architect was expected to work with the management contracting firm rather than through it. This was a situation to which, according to Bresnen (1996), architects had found very difficult to adjust.

The engineers who were employed by contractors had clear preferences for design and build. This put them in complete control of whole projects. One of the advantages of design and build was that it provided a single point of responsibility for projects. That single point of responsibility was the contractor. Because the architect was working in effect for the contractor, any drawings needed their approval. Contractors could ensure that the design of the building was not impractical from the point of view of a building's construction. Architects were instructed to consider this when they were designing a building:

'From the design point of view, i.e. the architect's point of view, he will now ask us "have you got any better solutions about how to do this?" So he may say "I'm thinking about putting in such and such a window, what do you think of that?" And we'll say "well, we've used that in the past and it's useless" or whatever. So yes, there's a lot more questioning now. We're not just given a drawing and asked to go out and build it. Because with design and build the client is looking for value for money and we are now questioning "well why have you selected that brick? Why did you not choose one more local? Why did you use concrete instead of steel?"' (Civil Engineer, Contractor, company M).

According to respondents, design and build was the most common form of contracting in the UK, and this would increasingly be the case in the future. Again, this view is in accord with that of Franks (1992), discussed in the previous section.

According to one of the architects interviewed, one of the disadvantages with design and build was that it often resulted in mediocre designs because of the tendency of contractors to focus of profits and buildability:

'I know that some clients don't like design and build because you find that contractors don't really have the client's interests at heart. They want to make as much money as possible... it's fine for repeated work or something which has a lower budget or is a very simple building. But on prestige, very complex, expensive buildings I don't think it's in clients' best interests' (Architect, Consultant, company S).

There had clearly been a major reconfiguration of the roles of architect, quantity surveyor and contractor. The three architects interviewed were philosophical. They accepted that they had lost their pre-eminence. This had partly been due to complacency, particularly from the 1950s until around 1980. However, they also believed that clients were being short-sighted in many ways because architects possessed expertise which other groups were unable to offer them. Yet the situation was 'not set in stone'. If architects were to reassert themselves they had to be more proactive and articulate to clients about ways in which they could improve the quality of life for those who worked and lived in the buildings which they designed:

'I think that we have to aim at particular issues where we could possibly bring more experience to the party than other people. We can make buildings more attractive places to work which is more efficient for employers. And we can actually improve buildings in terms of their layout so that it's more efficient in terms of actual staff hours... We can also make buildings energy efficient and more user friendly in terms of the finishings within them because there are an awful lot of building materials which are mildly toxic. If we can actually make something that looks good and address all of these issues, then I think we will improve our position because I don't think there are too many people who can offer or want to offer those issues to clients' (Architect, Consultant, company S).

In contrast, the engineers who worked for contractors clearly enjoyed the increased power and influence that they had obtained with design and build and management contracting:

'When it comes to the crunch whoever is holding the purse strings is the guy that's got the power. If you upset him and you do it deliberately then you're stupid. About ten years ago everybody thought it would be the consultant engineers who would run the jobs at the expense of the architects but that's not happening. It's the contractors that are doing that' (Civil Engineer, Contractor, company M).

The quantity surveyors who were interviewed also appeared quite pleased with the way in which their role was evolving, although they were less bullish about their increased influence than contractors. They were creating a new identity for themselves and no longer felt inferior to architects and engineers:

'Traditionally as a QS, I've always been regarded as an architect's clerk. Traditionally we always worked for the architect. But today we go out and sell ourselves more as independent cost consultants rather than working purely for an architect. So maybe in a particular project you'd have an architect heading the design team and then a QS as project manager and then a QS performing the traditional QS role and then the various engineering disciplines. So I think QSs are having much more of a say than in the past' (Quantity Surveyor, Consultant, company S).

Civil Engineering

Most of the academic literature on construction focuses on building and rather neglects civil engineering. See, for example, NEDO (1976), Ball (1988) and Bresnen (1996). Four of the respondents in this study were design engineers who worked solely on civil engineering projects, and three respondents worked for a civil engineering contractor. Also, the four design consultants that were interviewed at company O were involved in civil engineering as well as building projects, as was the quantity surveyor at the local authority that was visited. Earlier in this chapter it was noted that in building, architects usually led the design of projects and were assisted by engineers. The roles of architect and engineer were reversed in the design of civil engineering projects. Civil or structural engineers led the design with some input from architects. Indeed, it was often the case that architects are not involved at all. When architects were involved, for example with the design of some bridges, they worked in a team led by engineers:

'I have never worked on a project where architects were dominant. It has always been the other way round... I am not aware of anybody having that type of problem when they are working with architects' (Structural Engineer, Consultant, company X).

Traditionally in civil engineering, quantity surveyors have not been involved in the design process and engineers have carried out their own cost planning and measurement (NEDO, 1976). However, according to respondents, quantity surveyors were now playing more influential roles. Clients and contractors often insisted that quantity surveyors were used, and quantity surveyors were increasingly becoming involved in project management. Consultants had failed to offer value for money in the past and the increasing influence of quantity surveyors was partly due to clients' greater focus on cost:

'I don't think we were in the real world in the 70s and 80s. It was all very cosy, but now we've got to keep the client much happier than we used to... we didn't respond to clients requirements and we didn't offer value for money so we've lost control [of costing] to a degree' (Structural Engineer, Consultant, company X).

Earlier in this chapter it was reported that architects had lost much of their influence because of the different types of project organization that were being used. A similar situation existed in civil engineering with design engineers becoming less involved in the management of projects. Design and build was the most often used type of project organization in building, and, according to respondents, it was also the most often used in civil engineering. This placed the control of projects in the hands of contractors:

'I suppose we have slipped down the ladder because a lot of our work is design and build so we are actually working for a contractor. Whereas in the traditional contract we were working directly for the client so the contract would be between us and the client... and we did his design and put it out to tender whereas now the contract's between the client and the contractor and we work for the contractor. So our role has certainly diminished from that point of view' (Structural Engineer, Consultant, company X).

With this type of contracting, design engineers were employed by contractors who were extremely focused on costs. Because of this they were forced to consider the financial implications of their work to a much greater extent than was the case previously. Indeed, according to one design consultant it was increasingly the case that cost was prioritised over technical excellence. Designs were often compromised technically because of the fierce competition for work which now existed between design consultants. This made mistakes more likely:

'It's much harder to make sure that you deliver a quality product working for a contractor because you have a lot more commercial pressures on you... before you maybe used to have engineering as your top priority and money second, slightly in the background. Now you have got contractual pressure on you from the guy building it saying "we don't have that money"... there is more danger of somebody in the profession making a mistake basically, but that's the sort of environment we're in' (Structural Engineer, Consultant, company O).

In building, building contractors had become very influential in the management of projects at the expense of architects. Similarly, in civil engineering, civil engineering contractors had become very influential at the expense of design engineers. The engineers who worked for the civil engineering contractor in the study commented on their increased control over designers with design and build contracts, and the benefits for contractors which resulted from this:

'We've become sucked into everything. With design and build we have more of a say in the whole project... we offer the whole service and totally control the project. The consultant might have an idea about how it would look but we actually dictate to him the raw materials etc, etc.' (Civil Engineer, Consultant, company V).

'The advantage for us is that we are influencing our own profit at the end of the day. If we can find a more economic way of doing the build, which means shortening the build and as a result shortening the contract, we increase profit' (Civil Engineer, Contractor, company V).

However, one of them did point out that with this increased responsibility came increased risk to the contractor:

'We carry a lot more of the risk than we did at one time so to say that we have been the winner or benefited the most, I'm not so sure. That's a tough one, the client has dumped the risk on the contractor. So if something goes wrong enough times then we've not benefited' (Civil Engineer, Contractor, company V).

This apparently could result in conflict between clients and contractors when projects did not go according to plan:

'Sometimes we have difficulty with a project and the client sees the responsibility for the difficulty lying in one area and we see it lying in another area... and we certainly have discussions on the rights and wrongs of any particular situation. Generally we are talking engineering judgements here on what we might reasonably have foreseen, what we might reasonably have expected or anticipated when we agreed to enter a contract' (Civil Engineer, Contractor, company V).

According to respondents, as in building, management contracting was not particularly common in civil engineering. This is probably because the lines of communication are even more blurred than with traditional methods of contracting, and thus it creates as many problems as it solves. The traditional method of contracting continued to be used quite widely. Project management was also quite common. Although quantity surveyors often assumed this role, design engineers were also often used in this capacity:

'With civil projects I have never seen an architect as project manager. Quantity surveyors are sometimes used when cost control is very important, costs can run away very quickly in civil projects. But clients are often going for [design] engineers because they have a better understanding of what the whole thing is about' (Structural Engineer, Local Authority, company W).

'From the client's point of view cost control is very important... it depends what the client wants at the end of the day and what he is prepared to pay for. If he just wants something simple and isn't worried about what it looks like at the end of the day or what it looks like in years to come a QS is probably the best person. If he wants something a bit better, he'll probably go for an engineer' (Structural Engineer, Consultant, company X).

Thus despite having undoubtedly lost much of their influence over the management of projects to contractors and to a lesser extent quantity surveyors, the design engineers interviewed appeared relatively upbeat about their situations. One design engineer said that he expected clients to move away from design and build and back towards more traditional approaches to project organization. In his view, contractors were cutting too many corners in order to maximise their profits and clients were becoming dissatisfied with the quality of the final product:

'I wouldn't be surprised if in ten years time the industry reverted back to a degree. We created a lot of our own problems and a lot of it was our own fault because consultants were cosy and they got work too easily... but I think that things have gone too far the other way now and I think the balance [of power between contractors and designers] will redress itself over the next ten to fifteen years' (Civil Engineer, Consultant, company X).

Quantity surveyors were becoming increasingly influential in civil engineering. That said, they still appeared the least influential of the main groups and they appeared to be less influential than they were in building. Nevertheless, according to the quantity surveyor at the local authority in the study, his profession would continue to grow in influence as long as cost remained a priority for clients:

'Cost has become very emotive. Like everything else there are few projects that go ahead with a budget where there is scope for significant overspend. Cost has become such an issue. Everyone is trying to get value for money out of their building project and so for whatever reason the balance has changed a little bit. As I say I still see a number of [design] engineers fulfilling that role [project management] and I wouldn't anticipate that would change. I suspect that historically surveyors would have been at the bottom of the pile, but in my view that's changing' (Quantity Surveyor, Local Authority, company W).

Explaining Changes in Project Organization

In chapter 4 it was noted that three reasons had been put forward for the increased use of alternative forms of project organization. All of them were discussed by respondents to varying extents. The move away from the traditional method of contracting gathered pace in the mid-1980s when the proportion of work carried out in the private sector increased dramatically (Bresnen, 1996). Private investors as well as local authorities faced with shrinking budgets sought more cost-effective ways of managing projects. Architects and engineering consultants were not considered to be offering value for money. This led some clients to consider contractors and quantity surveyors as more suitable candidates to manage projects:

'Things were very different ten or fifteen years ago when the government was our main client. And what happened basically was that they had their approved consultants that they worked with and they dished out work around those consultants. Every consultant was guaranteed so much work more or less and that was it. Whereas in the last ten of fifteen years we've all had to compete with each other for work. We're given nothing now. Everything is done on a competitive basis' (Structural Engineer, Consultant, company X).

Under the traditional method of contracting design and construction were treated as separate tasks. This led to problems of communication and integration and resulted in projects running over budget and over time. Clients were becoming increasingly intolerant of this (Young, Torrance and Egbu, 1996). Other methods of contracting were introduced partly to clarify the roles and responsibilities of the parties involved in an attempt to co-ordinate the two parts of the process better. It was hoped that this would result in a greater proportion of projects completed on time and within budget (Bresnen, 1996). According to respondents, this was another explanation for why clients were increasingly choosing alternative forms of project organization, particularly design and build which offered very clear lines of responsibility:

'With design and build the contractor will give the client what he wants within a particular budget. So if the client turns round to us and says okay, I've got seven million pounds to spend and I won't give you a penny more. Then it's to our advantage to build it for five or six million or whatever we can get away with along as we can provide what the client asked for within the specifications. This is happening more and more whereas before the architect was the guy that was responsible for the money and the contractors would push the price up. They would start off at seven million and say "but the architect's changed this, the architect wants pink bricks now. That's going to cost you another £100,000"' (Civil Engineer, Contractor, company M).

In building, the increasing complexity of many projects led to criticism that architects tended not to possess all of the relevant skills needed to manage some projects (Bresnen, 1996). Some respondents concurred with this, although unsurprisingly, and as was discussed earlier, architects expressed different views. The following response was typical:

'The power of architects is waning and they are becoming technical organizations now. They are obviously very worried about this. The industry is changing and they are not. They're finding it very difficult to adapt. They don't possess all the relevant skills to run a project and they're nervous about taking advice from others about those skills because then they'll be seen to be inadequate. Rather than being open and saying "we don't understand how to do piling or how to construct a roof", they try and hide behind the mystique of being an architect and that no longer wears really, because at the end of the day the client's paying the bill, and he can't afford that any longer. So contractors have taken on the baton if you like and we're running with it' (Geotechnical Engineer, Contractor, company L).

However, the introduction of alternative methods of project organization does not appear to have resulted in an improvement in the performance of the construction industry (Proverbs, Holt and Olomolaiye, 1999) or in increased client satisfaction (Bresnen and Haslam, 1991). The data also suggest that it has not improved the relationship between designers and contractors and that conflict continues to be a major feature of the construction industry.

The Position of Engineers in Construction

The role of project manager has been seen as the ultimate goal of the main professional groups in construction. As a result of changing methods of project organization there has been a weakening of the power of architects in building and of design engineers in civil engineering. Contractors have been the main beneficiaries. Design and build has become the most popular method of project organization and this has placed contractors in control of projects. Quantity surveyors have also increased their influence. They appear to have altered clients' perceptions of them from that of bean counter to project manager. Services engineers, both consultants and contractors, have not shown any willingness to become involved in project management. Their work is very specialised and it unlikely that clients would consider them as suitable for project management. Some of the structural engineers interviewed who worked in building were disappointed that they were rarely considered to be suitable candidates for controlling projects. Again, their work is rather specialised and clients may also doubt their suitability.

The author's view is that the construction industry is in a state of flux. While it is unlikely that architects and design engineers will ever re-establish their previous dominance in building and civil engineering respectively, it is quite likely that they will develop their own strategies for at least regaining some of the lost ground. There is also some hope for structural engineers in building. While it is true that their role is more limited in many respects than other professionals groups, there is no reason for them to continue to be excluded from the 'holy grail' of project management. In view of their comments discussed earlier in this chapter, it appears that this is something which they would indeed like to become involved in.

It should also be borne in mind that while respondents as well as writers on the construction industry (Ball, 1986; Bresnen, 1996) have focused on the increased power and influence of contractors relative to other groups, there is only one contractor who can run a project. Thus in any given project, there will be a number of sub-contractors with no more power than they have had in the past. This includes, of course, services contractors who will surely never be involved in the management of whole projects.

Management Abilities

There were a number of different views concerning the suitability of different types of professionals for managing projects. Respondents tended to focus on the advantages provided by particular types of expertise (usually their own). Earlier in this chapter it was pointed out that some architects and design engineers felt that contractors compromised innovative designs because of their desire to maximise profits. It was also noted that some engineers who worked for contractors felt that at times architects produced designs which were impractical to build, and that some respondents had expressed some doubts with regard to how much architects understood what was involved in the erection of buildings.

Five engineers of various types were annoyed about the increased use of quantity surveyors as project managers. This was a role which they felt surveyors were not qualified to perform. The following response was quite typical of this point of view:

'I do find that quantity surveyors have great difficulty dealing with complex geotechnical problems. It's fine when it's straightforward but when you get into difficult areas it's quite difficult for them to follow the logic of what you are saying. Quantity surveyors want exact figures and numbers. But a lot of the decisions we make are almost rule of thumb and they don't like that' (Geotechnical Engineer, Consultant, company O).

Another engineer said that clients were being short-sighted by employing quantity surveyors in this way:

'If you're extremely cost conscious then the surveyor's the man for you. He'll save you money. He'll create a lot of problems but he'll save you money initially. And often they [clients] can't see the problems these surveyors create. You've got to remember that they're not designers and sometimes there are flaws in their designs' (Structural Engineer, Consultant, company P).

Perhaps unsurprisingly, the quantity surveyors interviewed did not agree with this point of view. When the author put it to one of the quantity surveyors in the study that perhaps members of his profession lacked the technical knowledge needed for project management, the respondent said in no uncertain terms that this was not the case:

'This is another fallacy you know. The quantity surveyor actually has a lot of technical skill. Because apart from the financial side of things one of our main functions is actually the construction and services of a building. We probably know more about how a building is put together than an architect... a surveyor does have technical knowledge. It's nuts and bolts, belts and braces. It's not fancy but yes we do have building skills. It's one of our examinable subjects. So yes, we might not actually know how to design these things but we know how to put it up. You must be able when you're reading a drawing to say "no, that won't work". So that's a fallacy' (Quantity Surveyor, Consultant, company U).

Two structural engineers thought that quantity surveyors made the best project managers because of their knowledge about all the different elements involved in a project:

'As much as I generally have a low opinion of quantity surveyors I think they do make good project managers because they have a bit of knowledge about everything and they are probably more familiar with contracts than engineers' (Structural Engineer, Consultant, company Q).

'As a structural engineer I don't need to have any knowledge of the means by which water is kept out of the building in terms of cladding systems. Equally I don't need to know about the building services. All I need to know is that there's a hole in the floor... whereas the quantity surveyor, he has got to have a knowledge of the building services, he needs to know about ground conditions and he needs to know about what sort of building envelope the architect's looking for, so quantity surveyors are evolving as project managers because they have to be knowledgeable of all the other diciplines' (Structural Engineer, Consultant, company R).

Two design engineers and two architects felt that it was best to have a designer as project manager, as contractors and quantity surveyors often did not understand the design process. The following response was typical:

'I'm a great believer in the traditional process where things are simple and where there is a client, an architect, an engineer and a quantity surveyor. And if they all work together and do their job properly there should be no need for them to be managed. I think that other methods have crept in where the traditional process has maybe fallen down or [been] perceived to have fallen down... I believe that project managers should be designers as opposed to cost control professionals' (Structural Engineer, Consultant, company O).

One of the engineers who worked for contractors felt that they were most suited to project management:

'We have an advantage in that have to deal with lots of different people. Architects and quantity surveyors don't have to meet as many different groups as we do in the day to day running of a contract. We deal with people who are not in the same field as us. We have to deal with architects, services engineers and all different branches of engineering. Whereas quantity surveyors meet other quantity surveyors and they would all read from a bill of quantities and they are dealing with the exact same people as themselves' (Civil Engineer, Contractor, company M).

However, about half of the respondents (thirteen) felt that the professional expertise of project managers was inconsequential. The personal attributes of individuals were much more important. In particular project managers needed good interpersonal and planning skills. This was not connected to a person's professional training:

'The best project manager is neither an architect, surveyor or engineer. It depends on the individual. I don't think by nature architects or quantity surveyors make the best ones. It's down to individuals. You will get very good project managers who are architects and you will get very awful project managers who are architects' (Architect, Consultant, company T).

'It's down to individuals. There's no doubt about it. I don't think that any of the institutions particularly train their members better than others. At this moment in time I don't think that one discipline prepares you better than any other. I think it's people rather than process' (Quantity Surveyor, Consultant, company U).

'I think project management comes down to individual skills rather than professional skill. It doesn't really matter about your professional background, as long as you've got experience of the type of project you're managing. It's more about dealing with people and setting targets and sticking to them than being an engineer or a QS' (Civil Engineer, Contractor, company V).

Many respondents in the previous two chapters expressed similar views about the management of manufacturing companies. Bresnen (1996) noted that in a 1988 publication the Chartered Institution of Building made clear that in its view no professional group were best suited to perform the role of project manager:

'The discipline from which the Project Manager comes is not significant since all disciplines can produce good Project Managers. A basic training in the industry with an understanding of financial and legal background is important but personal qualities are of considerable importance in producing a Project Manager of the right calibre and with the ability to lead the building team' (CIOB, 1988: 12).

The implication of this is that anyone who has experience of the construction industry, regardless of their occupation and providing they have the personal attributes, is suitable to manage projects. Unlike respondents in the previous chapters, nobody suggested that engineers tended to think in more logical ways that other managers and nobody suggested that engineers tended to not to be able to deal with problems which did not have a clear solution. The following response was very typical:

'It's very much an individual thing. Personality is crucially important. Their ability to manage people isn't something that comes out of detailed knowledge of engineering... You get hopeless architects, hopeless quantity surveyors or whatever, and you can have really excellent ones who make outstanding managers. It really depends on the individual' (Structural Engineer, Consultant, company O).

Only two respondents, both of whom were engineers, thought that engineers tended not to be particularly good communicators. All of the others either thought that engineers were at least as good as architects or quantity surveyors or that they were better. However, the issue of communication between the different professions in construction more generally was much discussed by most respondents. Many of them felt that while engineers, architects and quantity surveyors communicated well with each other, many had difficulty explaining technical information to people out with their own profession. One respondent believed that this was partly because the relevant professional associations did not work together and partly because university courses did not teach their students about other disciplines:

'I think that the problem lies with the professional institutions, they need to talk more to one another instead of considering each other as rivals. And I think there needs to be more interaction between students when they are studying because the professionals in construction don't know enough about each other. I know that at one of the building colleges in Glasgow that the first year is common to all the building disciplines – building surveying, quantity surveying, civil engineering, whatever. And I think that's very important psychologically. The students get a taste of all parts of the construction industry and you can choose to specialise as a civil engineer or whatever, but the students are aware that everyone is part of one team and that it's not a competition between the different parties involved' (Quantity Surveyor, company W).

The Collective Organization of Engineers

In both of the previous chapters it was noted that trade unions were not prominent in the lives of engineers. Only two of the twenty engineer respondents in construction were trade union members. Each worked for a local authority and each was a member of UNISON. They said that this was because they were employed in local government rather because they felt that as engineers they ought to join trade unions. Later in this chapter it is noted how engineers in construction appeared to be very concerned about how much they earned and in particular about the very low fee levels that they obtained due to increased competition in the construction industry. Despite this, only one respondent suggested that a trade union might help engineers to increase their fee levels. Contractors were particularly hostile towards trade unions. They often depended on tradespeople and labourers working very long hours to ensure that projects were completed on time, and some respondents believed that trade unions were an unnecessary obstruction. One engineer who worked for a contractor said that that trade unions did not feature at all in the construction industry, not even among the labourers:

'the work force has no sympathy for trade unions either... if you talk to any of my labourers they certainly wouldn't man a picket line... workers in construction are very cynical about trade unions because they want to make as much money as they can... they see unions as a disadvantage because they only want them to work about eight hours a day. My guys work eleven hours a day and they'd work sixteen if I'd let them. At the end of the day they are away from home for long periods of time and they want to make as much cash as they can' (Geotechnical Engineer, Contractor, company L).

Several engineers suggested that trade unionism was not compatible with their 'professional' status, and in general the author got the impression that engineers in construction had stronger professional identities than those in manufacturing. According to one engineering consultant:

'Nobody in the company says that you shall not be a member of a trade union but what is the purpose of it? The point of a trade union is to give people who are very similar a collective voice, isn't it? But we're not all the same, especially in a consultancy. We're professionals. If I want more money I go to the boss and I argue it out there. If he refuses then I have two options. I either go to another employer or stick with the job I've got. You are very much arguing your own case' (Civil Engineer, Consultant, company X).

Another respondent believed that trade union members were often 'trouble makers' and that engineers were too conservative to belong to them:

'Engineers are more concerned with things being right. We're more concerned with people's welfare in a general sense than workers rights and that sort of thing. We want houses to be safe and liveable and we don't want to stir up trouble which unions have done in the past. You know, trouble makers – let's get in there and cause some bother. I think that engineers just quietly want things to be right for people' (Structural Engineer, Consultant, company P).

Eighteen of the twenty-one engineer respondents in construction were members of professional associations. Sixteen had obtained chartered status and two were in the process of obtaining it. Two of the three engineers who were not chartered engineers or not in the process of becoming chartered engineers worked for the electrical engineering contractor that was visited. As will be discussed later in this chapter, some building services engineers who work for contractors are not graduates. This was the case for two of the three services engineers who were interviewed. They were therefore not eligible for chartered status. The third engineer worked for a building contractor. He said that most civil and structural engineers in construction were chartered and that he regretted not being chartered himself, but that this had probably not affected his career adversely as there was no legal requirement for him to be. However, other engineers who worked for contractors said that chartered status was very important because some local authorities only allowed contractors who employ chartered engineers to tender for contracts. In the case of structural design engineers, there is a legal requirement for them to be chartered. As one consultant engineer explained:

'When you design a structure you have to apply to the council for a building warrant... there is a requirement that the person who signs the piece of paper to say the design is completed and has been thoroughly checked is a chartered engineer, so it's very important' (Consultant Engineer, Consultant, company O).

Thus virtually all consultant civil and structural engineers and engineers who work for local authorities are chartered. Most engineers who work for contractors are also chartered, although, as noted above, there is no legal requirement for this to be the case. Almost all respondents believed that chartered status was extremely beneficial to engineers' careers and almost all also thought that chartered status was a very positive achievement:

'But just from a personal point of view, a business development point of view, you want to become chartered. I mean, once you've graduated it's your next goal and anyway if you want to achieve something in your career, if you want to become an associate director of a company or whether you want to run your own business, you're going to need it' (Structural Engineer, Consultant, company R).

Despite this, almost all respondents were critical of the engineering profession. Only one engineer talked about the profession in a positive way. The rest were critical to varying degrees. There was a strong feeling of resentment towards the profession among many respondents, even more so than in chemicals or in mechanical and electrical engineering, and some respondents became quite obviously agitated when they were discussing the subject. Perhaps this was because a much higher proportion of engineers in construction were members of the profession and therefore had more contact with it. The most common complaints were that it was too focused on London and the south-east, that it was an 'old boys club', and that it had done little to promote the profession to the general public.

It is very interesting that respondents had such views about the profession considering that almost all of them spoke positively about chartered status, something that was introduced by the Engineering Council. Nevertheless, the views of respondents were very clear. One engineer said that he resented paying his subscription fee to the Engineering Council when he was getting 'nothing' in return:

PT: 'Do you think the Engineering Council is doing a good job?

Respondent: 'I think they're bloody useless. The Institution of Civil of Engineers is just a con for getting money out of us.

PT: 'What do you think they should be doing?'

Respondent: 'They shouldn't be charging us £150 for getting a magazine. It's a social club for them down in London so they can get cheap meals and things like that. It's bugger all use to us up here. What do they do for us? They do nothing for us. It's like joining a trade union when you're in the same trade union as your boss' (Civil Engineer, Contractor, company M).

Another engineer expressed similar views:

'I can't be doing with all this slapping people on the back, saying what a nice guy Fred is and all that sort of stuff because at the end of the day they do absolutely nothing for us. Absolutely nothing. They are very poor. They send you mail all the time, vote for Fred Bloggs our seasoned campaigner who's done so much for engineers... That's my biased opinion, I have to say that. But it's also a view reflected by nine out of ten engineers I know. It's an old boys club' (Structural Engineer, Consultant, company O).

Several engineers said that the profession was very insular and that it did little to promote the profession to the public:

'They should really be lobbying the public which they don't seem to be doing... the ICE might have a meeting at a University about some major development in civil engineering. But it's all so technical, they don't make it accessible to people who aren't engineers. You're not going to get a member of the public turning up to hear about mathematical calculations' (Structural Engineer, Consultant, company O).

Slightly over half of respondents knew about the changes which had taken place to the Engineering Council in 1995 but almost all believed that they would have little effect on the lives of engineers:

'The changes to the Engineering Council won't have any impact on the practice of engineering. It's just so remote, so distant from what we do. We pay our fees but that's about it and I don't see how these changes are going to change anything. They are so wrapped up in themselves and they don't seem capable of promoting themselves in the right way' (Structural Engineer, consultant, company R).

Another engineer believed that the changes did not address the underlying problem of the fragmentation of the profession:

'I think there are still too many institutes. There has never seemed to be a logical reason for having the Institution of Structural Engineers and the Institution of Civil Engineers. It's always struck me as silly. I can see no rational reason for it. They are very insular and have lost site of what they are doing and having that division doesn't help, it just reduces the effectiveness of each of them' (Structural Engineer, Consultant, company O).

Thus despite the importance of chartered engineering status to the careers of engineers in construction, most engineer respondents felt very strongly that their profession was letting engineers down.

Engineering Education

Only two engineers were not graduates. Of the rest, one had a masters degree in the design of buildings and another was a Doctor of Philosophy. The two engineers who were not graduates both worked for the electrical engineering contracting company. This company operated an apprenticeship scheme which provided most of its engineers. It is not unusual for building services engineers who work for contractors to be formed in this old-fashioned way. However, in general most consultant services engineers are graduates. All of the other engineers interviewed were graduates and several respondents said that virtually all engineers under the age of forty who worked for contractors, consultants or local authorities were graduates.

Engineering technicians are used extensively in the construction industry in consultancies, contractors and local authorities. Technicians were considered to perform very important roles, as one engineer explained:

'There is a very large technician content who probably have a Higher National qualification. Technicians make up about fifty per cent of your workforce. They are very important. In a consultants they do all the donkey work and work out how the things actually go together' (Civil Engineer, Contractor, company M).

The position and responsibilities of technicians were clear. Technicians were called technicians and there appeared to be no confusion within the industry about this. One engineer said that 'there was no possibility of overlap between the two [engineers and technicians]'. Another engineer was formerly employed as a technician, but decided to go to university because he felt that the levels of responsibility that he obtained were too low:

'I used to be a technician. I started off as a technician many years ago and then decided to go to university to do a degree and then I did a PhD. I knew that I would never get any great status as a technician. I think what happens is that you probably do as much or more work than chartered engineers. A lot is expected of you, but the responsibility that you get is an awful lot less than a chartered engineer. So your status within the industry is an awful lot less than a chartered engineer' (Structural Engineer, Consultant, company P).

Thus very clear divisions existed between engineers and technicians in construction, perhaps even more so than in chemicals and electrical and mechanical engineering. The exception to this was again the electrical engineering contracting company (company N). It called all of its senior technical staff engineers.

Respondents' views on engineering education broadly mirrored those reported in the previous two chapters. Again, respondents focused on the balance between theoretical, practical and management elements in engineering degrees. Three respondents believed that engineers were there to provide the theory and employers the practical experience and that the balance was about right at present. However, fourteen respondents felt that engineering degrees needed to be more practically based. An engineer who was involved in the teaching of engineering degrees at Glasgow University said that much of the material taught there was of little use to graduates once they became civil engineers, particularly on postgraduate courses:

'The postgraduate courses at Glasgow University are far too academic. They teach stuff which is really quite mind-blowing. It goes beyond engineering and becomes science. In soils, on the geotechnical side, they are testing soils way beyond the capability they are ever going to need as a civil engineer' (Civil engineer, Contractor, company L).

Another engineer believed that, because graduates have such little practical experience, his company had to assume that new graduates knew virtually nothing about civil engineering when they were first recruited:

'At the moment it's very clear cut. University gives them an academic training and it's up to industry to train them practically. The fact that they have a degree only tells us that they have a certain level of intelligence and that theoretically they know about certain things. When they arrive here we treat them as if they know nothing and we start from scratch' (Civil Engineer, Contractor, company V).

The increased management content in engineering degrees was welcomed by virtually all respondents, although some felt that it was difficult to teach students about 'management' in an academic environment:

'I suspect that in an academic course it would be really difficult to address the sort of commercial decisions and business aspects of being a civil engineer. People learn that in their first years in industry... I think it comes with real life' (Civil Engineer, Contractor, company V).

The Social Place of Engineers

In the two previous chapters it was noted that most engineers were concerned about the social standing of engineering. The views of respondents who worked in construction on this matter were very similar to the views of respondents in the previous two chapters. Sixteen of the twenty-one respondents with an engineering background felt that the social position of engineers needed to be improved. The following quotation was very typical:

'I think society doesn't know what an engineer is basically. You've got the concept of a guy in overalls with a spanner in his pockets and that's an engineer. You don't have that concept abroad. In France and Germany their professional engineers are highly regarded. In America too. But in this country we're treated like... well nobody knows what we are' (Civil Engineer, Consultant, company M).

Seventeen wanted the title engineer to be restricted to graduates and/or professional engineers. According to one engineer:

'I mean, you don't call yourself an engineer in France unless you are a qualified engineer. Below that you call yourself a clerk or a technician. They've got different terms in Germany and France. You can't call yourself an engineer there unless you're a fully qualified engineer. It's a sacred term. It doesn't mean anything in Britain' (Structural Engineer, Consultant, Company P).

The author got the sense that engineers in construction were very proud of their work and of what they had achieved, perhaps even more so than the engineers in manufacturing. It was clearly the case that the engineers employed in construction felt that they were performing very valuable roles in society and that they were contributing significantly to the quality of life of the inhabitants of the UK, but that this was not appreciated by the general public. However, there was also some evidence of the mild paranoia about the social standing of engineers that was mentioned in the previous chapter. One respondent believed that people in Britain took their infrastructure for granted, until, that is, something went wrong:

'People are used to having running water and they get used to having roads and bridges. If you go to a less developed country, such as when I went to South America, they're not used to that. When I was in Venezuela, which is a moderately developed country, but their lights still go out and their water still goes off and their sewerage doesn't work very well, engineers are looked on in a totally different way. In Western Europe and North America people have got used to having their infrastructure and it's only when something goes wrong, maybe a fire in the Channel Tunnel, or a sewer collapses, or there is a pretty major problem, then suddenly people are looking for someone to blame, and the engineer is at the top of the list' (Geotechnical Engineer, Contractor, company L).

Another engineer said that the profile of engineering would not be raised until there was a major engineering disaster. Incredibly, this engineer appeared to be almost hoping for one. Although aspects of the following quotation may seem a little disturbing, perhaps it illustrates the depth of feeling of many engineers. This respondent believed that the greater number of engineering disasters in the United States was perhaps part of the reason for the higher social place of engineers in that country:

'It's the old adage. Doctors only kill in ones. I know that's pretty brutal and the Institutions and the Engineering Council may not like it but it is something as blunt as that that you need to get over to the general public. When a civil or a mechanical engineer does something wrong a lot of people could be killed. A doctor can only operate on one person at time. It may take something as brutal as that or it may take some sort of major disaster in this country which we haven't really had, OK there was the Herald of Free Enterprise, but that was more human error... you need something where a lot of people are killed and they understand that it matters what civil engineers do. America has had more disasters and maybe that's partly why their engineers are still held in fairly high esteem' (Civil Engineer, Contractor, company V).

Four engineers also offered the media's apparently limited coverage of civil engineering as another reason for the low social standing of engineering. This was interesting because this issue was not raised by respondents in chemicals and electrical and mechanical engineering. According to one engineer:

'My wife is a producer at the BBC and she'll never have an engineer on her programmes because they come across as very boring. But that's because whenever broadcasting organizations want a spokesman for something they get an academic rather than the more flamboyant practitioners. If they want to talk about the Channel Tunnel, you suddenly get this stuffy guy on television, probably from Imperial College. They don't get the project manager from Tarmac or Wimpey, the guy who actually built the thing who's probably quite gregarious and would give a different emphasis' (Geotechnical Engineer, Consultant, company L).

However, as in chemicals and electrical and mechanical engineering, a significant minority of engineers (five) were unconcerned about the social standing of their profession:

PT: 'Do you think that the status of engineering in society needs to be improved?'

Respondent: 'I don't see how it's going to benefit us any. That's my view. You can't take the respect of the general public and buy anything when it's all said and done, respect is something in the mind really. It's what you take home at the end of the month that really counts… engineers seem to think that they are not highly thought of in society but what do they want? I mean people think oh the minister's a great guy but the fact is that they pay him six thousand a year. Do you want to be called a great guy and get six thousand a year?' (Civil Engineer, Contractor, company M).

Nevertheless, as with respondents in the previous two chapters, most respondents were concerned about the standing of their profession and thought that it needed to be improved. In the next section engineers' views about their remuneration are discussed. The views of engineers in construction differed considerably from those of engineers in chemicals and electrical and mechanical engineering on this topic.

Engineers and Pay

Pay was not an issue for most of the engineers in electrical and mechanical engineering and chemicals. Respondents appeared satisfied with their levels of remuneration and had very little to say on the subject. The views of respondents in construction were very different. According to the Office for National Statistics (1997) civil and structural engineers are paid significantly less than electrical and electronic engineers, but about the same as mechanical engineers and significantly more than management accountants, surveyors and architects. However, eighteen of the twenty-one engineers were concerned about how much they were paid. The following response was very typical:

'A young graduate in civil engineering will probably start on twelve or thirteen thousand pounds. You can go into the City with a degree in economics or politics and probably earn twice or three times that amount. And that deficit stays there throughout their careers. Engineering is looked on as something which is vocational. It's almost at the stage where it's like going into nursing. You do it because you're interested in it, not because you're going to make a great living out of it. Most engineers, even in senior positions such as managing directors of sub-engineering companies, will be lucky if they earn £100,000 a year. If you go into an equivalent profession like IT or law and you become a managing director, you would probably earn double that amount. The gap never closes up' (Geotechncial Engineer, company L).

Respondents also discussed the reasons for the apparently low salaries of engineers in construction in some detail. Almost all respondents agreed that the 'problem' was due to the fee levels which engineering consultants and contractors were able to achieve. In the past fee levels were approximately the same and companies tended to compete on quality rather than on cost. Since the 1980s, however, partly due to a decline in the amount of new construction projects, partly because of the increasing proportion of work carried out by the private sector, and partly because of the greater emphasis which clients have placed on value for money that was mentioned earlier in this chapter (Bresnen, 1996), the construction industry had become increasingly competitive. As a result fees had continued to spiral downwards. In some ways this had made the industry more efficient. For example, one respondent said that contractors often deliberately used expensive materials so that their fees would increase (five per cent of a £2,000,000 contract is obviously substantially more - £20,000 - than five percent of a £1,500,000 contract). However, the situation appeared to have gone too far. According to one engineering consultant:

'I think there is a crisis just now in engineering in that fees are at a low ebb and people are taking big jobs at half a per cent and things like that. It's just crazy. I don't ever go below one per cent myself, but I mean, you hear about these tales and if you take a job at that level you've got to take all kinds of shortcuts and the dangers are inherent. Flipping heck, an extra one per cent here and there and the job would be done right. If they make drastic cuts in their fees it means they put a drastically poor service out. And you see drawings sometimes that are from a fellow engineer and you shake your head and say "how can you possibly think that's good enough?"' (Structural Engineer, Consultant, company P).

Furthermore, engineers were increasingly asked to do more work for projects but fees were not being increased to compensate for this:

'Liability is much higher now than it was and they keep throwing new things at us. We've got to look out for health and safety now. We've been dragged into that side quite dramatically. We've also got to look out for contamination issues, environmental issues. I'm not objecting to all these things, but nobody's ever put more fees on the table for doing them. It's just something else you've got to do for the same fee. It's very, very competitive' (Structural Engineer, Consultant, company Q).

Conclusion

Traditionally, architects led design teams for building projects. They also supervised the construction of their designs and managed budgets on behalf of clients. While generally retaining control over the design of buildings, architects were found to have become much less involved in the management of projects. In civil engineering, design engineers had traditionally performed a similar role to that of architects in building. However, they were also much less involved in the management of projects than was the case previously. In both cases contractors, and to a lesser extent quantity surveyors, had assumed this role. These changes were largely due to the adoption of alternative methods of contracting by clients, which was discussed in chapter 5.

The role of 'project manager' was seen as the ultimate goal by respondents. Although some respondents felt that their professional specialism made them more suitable than other groups to assume this role, about half of respondents felt that personal qualities were far more important than professional training. Only two engineers were trade union members and trade unions did not appear to feature in the lives of engineers in construction. Chartered status was considered almost a pre-requisite for employment in the construction industry and virtually all engineers were graduates. Despite the success of chartered status, respondents took a more negative stance towards the engineering profession than was the case in chemicals or mechanical and electrical engineering. Respondents' views on engineering education and the social standing of the profession broadly reflected the views of respondents reported in the previous two chapters. Also, engineering technicians were used widely in the construction industry and they were differentiated clearly from professional engineers. However, engineer respondents were very dissatisfied with their levels of remuneration.

This is the fourth and final results chapter. Having now reported all of the data that were collected, in the next chapter the position of engineers in electrical and mechanical engineering, chemicals, and construction will be compared and contrasted. Also, the findings will be related to some of the wider issues concerning engineers and management in the UK.

CHAPTER 11

DISCUSSION: SURVIVAL AND REVIVAL OF ENGINEERS AND INDUSTRY?

Introduction

Different views and issues emerged from each of the three sectors in the study and this alone probably justifies the decision to explore the views of engineers in different settings, although this is not, of course, the only or main reason for doing so. In this chapter the views of respondents from the different sectors are compared and contrasted both with each other and with those of others who have written about engineers. In doing this the author is concerned with the main issues addressed in this thesis: the influence and careers of engineers, the perceived managerial abilities of different professional and functional groups in management, the collective organization of engineers, engineering education and the role of formal qualifications in the employment of engineers, and the social standing and remuneration of engineers. The final part of the chapter discusses what the study has to say about UK management and the prospects for the UK economy more generally.

Influence and Career

Manufacturing

The main objective of this research was to explore the influence and careers of engineers in UK manufacturing and construction. Although different issues and views emerged from each of the three sectors, there were a number of common themes, particularly between the two manufacturing ones. In chapter four, for example, it was noted that many writers had assumed that accountants were the dominant group in UK manufacturing (Glover and Kelly, 1987; Lee and Smith, 1991;

Canainn, 1995; Alexeichenko, 1996; Smith and Whalley, 1996). It has been argued that accountants are the most numerous group in senior positions at the expense mainly of engineers and that financial expertise is considered to be the dominant kind in companies at all levels. The main arguments which have been put forward to explain this tend to have been concerned with aspects of the UK's financial system which apparently force companies to consider financial matters as being more crucial to the success of companies than technical ones, and thus leading to the prioritising of the expertise of accountants over and above that of engineers (Fligstein, 1990; Higgins and Clegg, 1988; Hutton, 1996). Three features of the financial system have been identified as being at least partly responsible for the above situation. These were discussed in detail in chapter 4.

As was noted earlier in the thesis, it is not an aim of this study to examine the strengths and weaknesses of the financial system. The study is concerned, however, with the influence of engineers and how they feel about their position vis-à-vis accountants. Thus the author was keen to learn whether there was any substance to the notion that accountants use strict financial and budgetary controls to monitor engineers. Of the eleven manufacturing companies that were visited, only one (Company G, a chemicals company), provided evidence to support this view. In this company engineers complained that the finance department expected unrealistic yields from production because its members did not understand the products and processes involved in their manufacture. The recently appointed finance director had previously been employed in a consumer goods company and, according to one respondent, did not appreciate that capital expenditure was higher in relation to the value of goods produced in chemicals companies than in consumer goods ones.

Engineers were subjected to strict financial controls and the management accountant that was interviewed talked quite openly about this. Indeed she referred to the set of ratios that the finance department used to assess and measure production performance with as 'the bible'. Unsurprisingly there was a good deal of friction between the two groups and engineers felt that accountants did not understand the problems which they faced.

However, this was the only manufacturing company in the study in which engineers appeared to be subordinated to accountants. Indeed the author only found evidence of any friction between engineers and accountants in one other company that was visited (company E). However, in this case engineers were not concerned about their position and there was no suggestion that engineers were subordinated to accountants in any way. Company E was a small mechanical engineering company which employed around 300 people. It only employed two accountants. The management accountant felt that the natural spending tendencies of engineers needed to be curbed. The engineers, on the other hand, felt that the accountants were too focused on costs. In all of the other nine manufacturing companies engineers and accountants appeared to co-exist rather well. Some respondents in both manufacturing sectors felt that some friction over spending had existed in the past between accountants and engineers. However, almost all respondents believed that accountants and engineers were now able to work together to good effect. Respondents tended to emphasise that engineers were relied upon and trusted to minimise costs wherever possible. In most cases accountants lacked the technical knowledge to be able to advise on how to make major savings. This was because major savings came mainly from improvements in the design of products or the processes involved in their production.

Two accountants actually believed that engineers had become too cost-conscious and that this was in danger of stifling their creativity. Most of the engineers were very conscious of their responsibilities in terms of costs and stressed the importance of minimising them while also obtaining the necessary standards of quality. With the exception of respondents from the two companies discussed above, very few of the engineers interviewed expressed concern about the influence of accountants, or felt that accountants were more influential than engineers, or felt that financial performance and financial concerns more generally were considered to be more important than engineering performance or other technical issues. Indeed, the opposite was usually the case. On the whole, the role of accountants was not to set budgets, but to monitor them. The author was left with the impression, from both accountants and engineers, that accountants largely operated to support engineers. One respondent who worked for a chemicals company used the analogy of a football match to describe the roles and influence of engineers and accountants, with engineers as the referee and accountants as the linesmen, with the former in charge and the latter giving them information and advice from time to time. Also, and as will be noted later, it was felt that technical knowledge was an advantage for promotion to senior positions, rather than a disadvantage as suggested by Armstrong (1987a).

Engineers generally spoke in positive terms about the roles of accountants. Engineers appeared to acknowledge that they possessed a valuable and legitimate body of expertise which was important to corporate success. This is all a far cry from the conflictual and controversial attitudes of the 1970s reported by Glover and Kelly (1987), that 'some engineers seem to think that water runs in the veins of accountants and accountants sometimes believe that engineers are self-indulgent spendthrifts' (p.144). Perhaps this apparent change is an indication of improvements in UK manufacturing management which may have taken place since the 1970s and the first half of the 1980s. Certainly the arguments discussed above that technical issues appear to be subordinated to financial ones in much of UK manufacturing, because of the UK's financial system or otherwise, no longer appear valid. It does not necessarily follow that the UK's financial system is problem-free or that it could not be improved. However, it does perhaps indicate that some of the criticisms which have been made of it in relation to engineers and industry may be unfair, out of date, or both.

Although some writers have suggested that marketing and sales specialists tend to be more influential than engineers in manufacturing as well as being more likely to be found in senior positions (Glover and Kelly, 1987; Lee and Smith, 1991; Alexeichenko, 1996), there has been little analysis of their position (Glover, 1999). This is perhaps related to the fact that much of the attention of the more critical management and sociological researchers has been focused on accountants and their relationship with engineers than on marketing and sales specialists, in spite of the numerical dominance of the latter across the whole of the UK's economy.

However some writers have discussed the position of marketing in a more general sense. Whittington and Whip (1991) believed that because marketing was a 'flexible' skill which could theoretically be developed and deployed by people of any professional background, the challenge for marketing specialists was to monopolise their 'ideological resource' (p.56), and Whittington (1991) believed that marketing and sales in manufacturing tended to be performed by engineers and scientists because marketing specialists were often not considered credible by clients or staff. Writing in 1993 Bathie (1999) argued that the marketing profession should encourage people in other functions to adopt marketing as a philosophy rather than become preoccupied with the power and influence of those who practised it. Pitt and Morris (1995) believed that this had often already happened and that in many respects marketing was the victim of its own success. They argued that the distinction between marketing and strategy had become blurred. Marketing was increasingly a general management responsibility to be carried out by all functions.

The author was interested in how engineers felt about their positions in relation to those of marketing and sales specialists. My data generally supported much of the above views and most engineers welcomed the greater emphasis which had been placed on marketing in their companies. However, there was little evidence to suggest that marketing and sales were considered to be more influential than engineers and engineering as was suggested by Glover and Kelly (1987), Lee and Smith (1991) and Alexeichenko (1996). All of the marketing and sales specialists in the electrical and mechanical engineering companies in the study were engineers, and most of them in chemicals were either engineers or chemists. Several respondents said that non-technical people would almost certainly not be able to perform marketing and sales roles to good effect in their companies. They worked closely with engineers, particularly design engineers, and technical expertise was considered to be crucial. Only one of the manufacturing companies (company K) employed non-technical people as marketing or sales specialists. It produced fertilisers which my respondents said are quite simple to manufacture and thus technical expertise was apparently not considered to be necessary in marketing and sales.

Webb (1992) reported that in the medium sized electronics company which was the focus of her study there was considerable conflict between design and marketing and to a much smaller extent, between design and production. The design department staff apparently felt that marketing managers interfered with their work by setting design parameters and controlling design timetables. Similarly, Lam (1994, 1996) reported that marketing staff often tended not to communicate effectively with design and production in the companies which participated in her study, and that this affected product development adversely.

Although some conflict between engineers and marketing and sales was reported in the companies in this study, the relevant staff generally appeared to enjoy relatively constructive relationships. As might be expected, some engineers felt that marketing and sales sometimes did not consider fully the implications of the product diversification and product flexibility which they tended to want. Engineers were very aware of their roles in terms of meeting the requirements of customers, and the author certainly got the impression that there had been more emphasis placed on marketing as a philosophy in virtually all of the manufacturing companies that were visited, as suggested by Pitt and Morris (1995). Despite this, and while marketing and sales were clearly considered to be very important activities, none of the engineer respondents expressed any concern about their influence. Perhaps this was because marketing was in many respects considered to be an extension of engineering in general, and of design and development in particular. It was viewed very much as a technical, rather than as a non-technical function. Also, engineers appeared to appreciate the importance of understanding markets and customers.

Something that the author had not considered to be likely to be of great significance before the interviews were conducted, but which emerged as quite important from the data, was that different kinds of engineer might be in conflict with each other. Webb (1992) reported that the relationship between design and production was problematic in the company in her study. In particular, design engineers apparently resented being asked to help with production issues and problems. Respondents did not discuss this specifically in any of the companies in this study, but there were other problems, including the more general one reported by Webb. Indeed engineers with different responsibilities reported more problems with each other than with accountants or marketing and sales people. In the mechanical and electrical engineering companies that were visited the relationships between design and production often appeared to be quite strained, particularly in companies C and D. In particular some production engineers felt that design engineers tended not to consider fully how the products that they had designed were to be manufactured.

In the chemicals companies there was evidence of some friction between mechanical engineers, chemical engineers and chemists. Slightly more than half of respondents felt that there was some degree of rivalry between them. Several respondents said that chemists were traditionally the most influential group both in senior positions and in product development in chemicals. However, there was strong agreement that chemical engineers were increasingly challenging them very strongly in both areas. One of the respondents, who had a doctorate in chemistry, had started her career as a chemist but decided to switch to chemical engineering because she felt that it was the best way to advance her career. Some chemists and mechanical engineers complained that chemical engineers considered themselves to be 'superior'. However several respondents also said that chemical engineers were not employed in the manufacture of products which required less complex chemistry, and that chemists were also employed in smaller numbers under these circumstances. Thus in companies which manufactured, for example, products such as paint or toothpaste where chemicals were simply mixed rather than reacted together to produce the final product, mechanical engineers tended to be much more influential at all levels.

The careers of engineers in manufacturing were also examined. Earlier in this chapter it was noted that many writers had implied that accountants were the most numerous group in the most senior positions in manufacturing companies and that this was not the case in companies in other more successful countries (Glover and Kelly, 1987; Lee and Smith, 1991; Alexeichenko, 1996; Smith and Whalley, 1996). The author tried to obtain information about the professional and functional backgrounds of the executive directors of all of the manufacturing companies in the study. It was provided by five of the six mechanical and electrical engineering ones and three of the five chemicals ones. Of the twenty-six executive directors in the five electrical and mechanical companies, sixteen were engineers, six were accountants, three had backgrounds in general management and one was a psychology graduate who had spent much of his career in banking. Of the sixteen executive directors in the three chemicals companies, six were chemists, four were engineers, three were accountants, one was a marketing specialist, one had a background in general management, and one was a lawyer.

Taking these figures together, of the forty-two executive directors from the eight companies discussed above, twenty were engineers, nine were accountants and thirteen had other backgrounds. Thus there were more than twice as many engineers as accountants. Barry, Bosworth and Wilson (1997) believed that engineers outnumbered accountants by three to one. However, their figure also included scientists. If the engineers and chemists in the sample are taken together, the total is twenty-six engineers and scientists to nine accountants, which is almost the same as Barry et. al.'s statistic. It should be noted, however, that Barry et. al. only included chief executives in their study, whereas this study included all executive directors.

The very small size of the sample means that it is very difficult to generalise to a wider population. However, the views of respondents were broadly consistent in most of the companies that were visited. Most respondents in mechanical and electrical engineering felt that a career in engineering, either design or production, offered the most expeditious route to the top, while most respondents in chemicals felt that a background in chemistry was most likely to result in a boardroom position. That said, and as was noted earlier, many respondents believed that chemical engineers were becoming increasingly influential in the chemicals industry at all levels.

Table 11.1 Occupational backgrounds of executive directors of eight of the eleven manufacturing companies in the study

	Mechanical and Electrical engineering	Chemicals	Mechanical & Electrical engineering and Chemicals
Engineers	16	4	20
Accountants	6	3	9
Other Backgrounds	4	9	13

As was noted in chapters 8 and 9 the vast majority of engineers will, of course, never serve on the boards of companies. Therefore the study was concerned with what engineers felt about their careers more generally. In chapter 5 it was noted that, in general terms, engineers had three kinds of career orientation (Causer and Jones, 1993). Some wanted to remain as technical specialists. Others wanted to move into 'management' positions, either technical or general. A third group wanted to move to other functions such as marketing and sales or personnel. There was a consensus in the literature that engineers tended to be unable to advance their careers should they remain as technical specialists and that a career in 'management' was often considered to be the only or best route for a successful career (Bailyn and Lynch, 1983; Dopson and Stewart, 1990; Lee and Smith, 1992). Armstrong (1987a) went further and suggested that engineers could 'only demonstrate their eligibility for senior positions by renouncing any claim which they might make on their distinctive expertise as engineers' (p.427). Other authors noted that some companies had introduced dual career ladders in an attempt to solve this problem, but most agreed that power and status was often unequally distributed in favour of the latter, between the professional ladder and the managerial one (Armstrong, 1984; Raelin, 1987; Burgower, 1990; Badawy, 1995).

The data collected in this study supported some of the views discussed above. Only three of the manufacturing companies that were visited operated dual career ladders: one in mechanical and electrical engineering (company A), although company C was in the process of developing one, and two in chemicals (companies H and J). The one at company J had only very recently been introduced and it was not clear whether it had been helpful or not. The one in company H was generally thought to have been successful in allowing engineers who wanted to remain as technical specialists to be rewarded for their achievements. However at company A there were concerns that it was easier to move up the 'management' ladder than the 'professional' one and that too many engineers were choosing to follow non-technical careers. In the other companies some engineers were concerned that 'management' positions were considered to have a higher status than technical ones, and some felt pressured into moving into non-technical roles in order to advance their careers. Others, however, felt that engineers had the 'best of both worlds' and that engineers had a wider range of career opportunities than any other group (with the possible exception of chemists in chemicals). On the whole, and as was noted in chapters 8 and 9, the 'problem' was not a shortage of career opportunities but a feeling that engineers needed to become less involved in the technical aspects of their work to advance their careers.

In chapter 3 it was noted that managerialism had been identified as a feature of UK management. This term refers to the self-interested tendency on the part of those claiming to be managers to consider 'management' as a generalisable competence which is intellectually, morally and technically superior to specialist tasks and expertise (Glover, 1979; also see Child, 1969, Bendix, 1974, and Enteman, 1993). It valorises the management <u>of</u> specialist work rather than management <u>in</u> it (Glover and Hughes, 1996; Glover and Tracey, 1997). Considering 'management' positions as superior to technical specialist ones, as appeared to be the case in some of the companies in this study, is, of course, a form of managerialism.

It was also noted that professionalism had been identified as a characteristic of UK management (Glover, 1979). It had apparently encouraged segmentation and differentiation between groups in management (Reed and Anthony, 1992). In chapter 4 it was noted that there had been an assumption made by some authors that different groups in management were in competition with each other for power and resources. Clegg (1975) compared the interaction between groups in organizations to a game of chess with each group trying to gain control over as many 'pieces' as possible. Similarly, Crozier and Friedberg (1980) considered organizations as political arenas with different groups devising strategies for increased influence. Hickson (1987) believed that there was a dual rationality within organizations. Any decisions which were made were considered in terms of what was best for the individuals making them, the group or function to which they belonged, and the organization as a whole.

These views seem eminently sensible and reasonable, and to apply to all types of organization. Manufacturing companies are, of course, no exception. However, what impressed the author when the interviews were being conducted was the way in which respondents talked about co-operation with other groups and the importance of working together. It certainly appeared that respondents in manufacturing enjoyed fairly constructive relationships. Where professional rivalry did exist it appeared to be between different types of engineer or between engineers and chemists, rather than between engineers and accountants or engineers and marketing and sales. Even then, there seemed to be a basic appreciation of the need to work together. Of course, there is no way of knowing whether this happened in practice and there may have been an element of propaganda in the responses that were given, but the fact that the respondents appeared to appreciate the importance of it is significant given the criticism of UK manufacturing in this respect (for example Child et. al., 1983; Reed and Anthony, 1992).

Further evidence for this point of view came from the interviews reported in chapter 7. Representatives of the main professional groups in manufacturing also talked of the need for co-operation and the need to work together, suggesting that perhaps the penny has finally dropped. The increased use of project teams is presumably at least partly responsible for this apparent change in behaviour, although the author got the sense that there may have been a more fundamental change in attitudes. As was noted in chapter 2, the Finniston Committee (1980) believed that much of UK manufacturing had neglected the centrally important 'engineering dimension'. This term was used to 'convey the interaction of engineering with non-engineering factors in determining manufacturing performance and to emphasise the importance of considering the whole manufacturing system and not just aspects of it' (p.22). The author believes that UK manufacturing, of at least some of it, has become much more aware of these issues and that there is a significantly greater focus on the 'engineering dimension' than at the time of the Finniston Report's publication.

Armstrong (1984, 1985) argued that the main professions in manufacturing were engaged in a competition to become the most important group in the 'global function of capital' (Carchedi, 1977), meaning the combination of activities performed by senior managers in companies which used to be performed by the individual capitalist. They did this by developing control strategies which relied on their own professional expertise. There appears to be a good deal of truth in this argument. Where the author would disagree with Armstrong is that it is engineers and not accountants who have become the most important group in the 'global function of capital' in manufacturing. It is difficult to judge whether engineers have developed a conscious strategy in order to achieve this position. Their dominance is partly because they are the most numerous management level group. However, they have also managed to promote technical expertise successfully as being relevant for senior positions in companies. Financial knowledge has by no means been squeezed out completely. Accountants are a very influential and important minority. However, the findings reported in this thesis indicate that it is wrong to suggest that they, or their expertise, dominate UK manufacturing. Although marketing and sales had become increasingly important in the companies in the study, marketing and sales specialists did not feature to a great extent in them, with these functions generally being performed by engineers or chemists. Thus marketing and sales were considered to be technical rather than non-technical specialisms.

The work of Abbott (1988) is also relevant here. He described a 'system' of professions which were competing for a mixture of distinct and overlapping jurisdictions. The term 'professional jurisdiction' was used to conceptualise the ways in which the control of skills and knowledge were continually called into question. Access to the most senior positions in manufacturing companies might be considered to be a jurisdiction which is contested by different groups. As noted above it is engineers and not accountants who appear to have successfully achieved a dominant position, at least in the companies in this study.

Construction

It was noted in chapter 4 that traditionally the design and construction phases of projects were considered as separate tasks to be performed independently of each other, and that a number of authors had noted the problems of co-ordinating them (Higgin and Jessop, 1965; NEDO, 1976; Ball, 1988; Bresnen, 1990; Bresnen, 1996). The relationships between clients, design teams and contractors (who construct the design) depended on the method of contracting (or project organization) chosen by clients. The four main types were identified and described: 'traditional' contracting, design and build, management contracting, and project management (Ball, 1988; Young, Torrance and Egbu, 1996). It was also noted that many authors believed that clients were increasingly moving away from the traditional form of contracting towards alternative ones, and to design and build in particular (Ball, 1988; Bresnen, 1996; Franks, 1990, 1992, Torrance, 1992). This had resulted in architects in building and design engineers in civil engineering becoming less involved in the management of projects, the responsibility for which increasingly lay with contracting companies (which are dominated at management level by engineers) and quantity surveyors (NEDO, 1976; Ball, 1988; Bresnen, 1996). However the extent to which these newer forms are used is unclear. Bresnen and Haslam (1991) believed that traditional methods continued to be dominant while Franks (1992) estimated that forty-five per cent of projects were design and build and that this would increase to over fifty per cent by 2000.

There is undoubtedly a shortage of empirical evidence in construction on the influence and roles of the main professions, and the author is not aware of any researchers who have looked at the situation of engineers specifically. Also, most writers have tended to focus on building and to rather neglect civil engineering (Ball, 1988; Bresnen, 1990, 1996). The construction industry can be split into three parts: building, civil engineering and engineering construction, although there is some overlap between them (Glover and Kelly, 1987). This study examined the positions of engineers in building and civil engineering. This was quite difficult, mainly because there are several different types of engineer who work in construction, each of which performs different roles. Also, their influence changes with different types of project organization. What came across very clearly when the interviews were being conducted was that the management of projects is the holy grail for the professions in the construction industry and this issue dominated the interview discussions.

In building, the effects of different types of project organization on the roles of structural engineering consultants and services engineers were negligible. Regardless of the type of project organization used, architects almost always led design teams and structural engineers rarely had opportunities to project manage building projects. Services engineers were never given this opportunity. Some structural engineers were concerned about this and felt that they had 'missed the boat'. The building services engineers interviewed did not express any desire to become involved in the management of projects.

However the influence of architects in building, design engineers in civil engineering and contractors in both depended to a large extent on the type of project organization used. With the traditional method of project organization contractors were usually accountable to the design team leader, who would normally be an architect in building projects and a design engineer in civil engineering ones, and who was also responsible for the overall management of the project. When project management was used the contractor and the design team leader were accountable to the project manager, who was often a quantity surveyor but who could come from any background. With management contracting the contractor tended to have a more or less equal relationship with the design team leader and was responsible for co-ordinating the design and construction of the project, although it was directly involved in neither. In this instance the contractor was clearly more influential than with the traditional form of project organization or with project management. However, it was when design and build was used that contractors had the most power. With this type of contracting the contractor was responsible for the management of the whole project, including its design, on behalf of the client. Indeed the designers were actually employed by the contractor on behalf of the client.

Most respondents believed that design and build was the most common method of contracting. They also believed that project management was increasingly popular, but that the traditional method of contracting remained quite widespread. However, management contracting was apparently used only rarely, usually for prestige projects. This had clearly resulted in contractors, and to a smaller extent quantity surveyors, becoming more influential, mainly at the expense of architects in building and design engineers in civil engineering. Thus the results of this study were generally consistent with the views of the authors discussed above.

Respondents who worked for contractors were very pleased about the way in which their roles had developed, although one respondent did point out that along with contractors' increased responsibility, came much greater financial risk. Also, one of the architect respondents believed that design and build led to designs which tended not to be aesthetically pleasing and to problems of quality. Furthermore, it should be noted that the roles and influence of smaller specialist sub-contractors, such as services contractors, did not change very much regardless of the type of project organization.

The career orientations of engineers in construction have not been discussed specifically by researchers. Unlike in manufacturing, where engineers sometimes move into marketing and sales or personnel, engineers in construction apparently do not move into other functional areas. Services engineers are a possible exception to this. They tend to cost their own work rather than to employ quantity surveyors and some of them therefore take on aspects of a quantity surveying type of role. Another major difference between manufacturing and construction was that in construction none of the engineer respondents discussed moving into non-technical management. In the case of those who worked as consultants this was probably because all engineers, regardless of their place in their company hierarchies, were involved in technical work. Engineering consultancies tend to be too small to be support people who are employed purely as business managers.

However, even respondents who worked for contractors, and where senior managers were not involved in technical work, did not express any desire to become involved in the management of their companies or even to discuss the issue in any way. This was not something which the author was conscious of while conducting the interviews and it only became apparent upon analysing the data. Project management was seen as the ultimate goal for most respondents and it had a very high status. Most engineers aspired to it, with the exception of those who worked for the services contractor that was visited. Dual career ladders do not appear to exist, at least formally, in construction. However those engineers who were involved in project management might be considered to have access to the ultimate dual career ladder: they were project managers for some projects and technical specialists for others. In a more general sense the engineers in construction were all involved in management largely because they were (part of) the management.

The data indicate that disputes between designers and contractors remain a feature of the construction industry, and that quantity surveyors tend to be unpopular with both. Thus the main professions in construction appeared to enjoy less constructive relationships than those in manufacturing. Part of the reason for this is that they have long been engaged in competition for the role of project manager. The work of Abbott (1998) is clearly relevant here. The management of projects is a jurisdiction which is currently being contested fiercely in the UK's construction industry.

However, the above problems, and the relatively poor performance of the UK construction industry more generally, have been attributed to a very large extent to the industry's staffing and organization (Latham, 1994; Barlow, Cohen, Jashapara and Simpson, 1997). In the UK, as in most countries, the construction industry is very fragmented with large numbers of firms performing diverse activities for clients of different types (Ball, 1988). However, the industry in the UK operates in a particularly adversarial environment with clients, consultants and designers often in dispute, partly because of the very low fees which contractors and consultants have been forced to accept (Latham, 1994). Thus Hickson's (1987) notion of dual rationality in decision making is surely even more relevant in construction than in manufacturing. Clearly the main groups involved in projects want to see projects finished on time, within budget and without defects. However, because they belong to different companies the way in which they try to achieve these objectives may differ, as may the emphasis they place on them. For example, architects tend to focus on the aesthetic qualities of buildings, while contractors tend to focus on minimising costs.

Alternative forms of project organization were introduced mainly because they were believed to help solve the problems inherent in co-ordinating the design and construction phases of projects, discussed above (Bresnen and Fowler, 1996). Interestingly, however, they do not appear to have significantly improved the performance of the construction industry which, as far as can be established given the limited evidence, appears to continue to have lower levels of productivity than its counterparts across much of Continental Europe (Lynton, 1993; Stewart, 1994; Proverbs, Holt and Olomolaiye, 1999).

Bresnen and Haslam (1991) noted that 'the last several years have seen a burgeoning of interest in alternatives to traditional contracting and managerial arrangements. The age of regarding them as panaceas to the industry's problems has now well passed... there is no great weight to the argument that that any one method will help guarantee improved performance or greater satisfaction' (p.340).

Concerns about the adversarial relationships between the main parties in construction led to the establishment of a review, commissioned partly by Government and partly by members of the industry, into the industry's procurement and contractual arrangements. The Latham Report, which was published in July 1994, made recommendations which the Report's author hoped would lead to a 'healthier atmosphere' (p.v) and to greater co-operation between the main parties. It suggested that one of the main reasons for the adversarial environment was the nature of the contracts (the legal document which states the roles and responsibilities of each party) used in the industry. Most work in the building industry takes place under contracts produced by the Joint Contracts Tribunal (JCT), while most contracts for civil engineering projects are produced by the Conditions of Contract Standing Joint Committee (CCSJC). Latham criticised these contracts for being insufficiently clear, encouraging conflict and/or litigation, and creating high levels of mistrust. He believed that a new type of contract was needed which, among other things, defined the roles and responsibilities of the parties more clearly, encouraged teamwork by introducing shared financial motivation, and appointed a pre-determined impartial adjudicator in order to resolve disputes should they arise.

The Latham Report suggested that the New Engineering Contract (NEC), which was developed by the Institution of Civil Engineers in 1993, addressed most of the above issues and argued that the Contract should become a national standard across all parts of the construction industry. However, although the NEC appears to be used quite widely (Hughes, 1999), the results of this study suggest that it does not appear to have improved the situation significantly. Nevertheless, the search for ways to improve co-operation between the main actors has continued. Partnering is the latest idea designed to achieve this. It is a concept which is relatively new to the UK construction industry, having first appeared around the mid-1990s. The extent to which it is used is not entirely apparent. The author was not aware of it until after the data had been collected and it was not mentioned by any of the respondents when the interviews were conducted in 1997.

According to Barlow et. al. (1997) 'partnering is simply a generic term for a range of practices to promote greater co-operation between organizations' (p.58). It encourages all of the groups involved in a project to work together by adopting shared interests and goals, and by open dialogue. It is hoped that by understanding each others' expectations and values, the parties involved will be able to trust each other and to work together to solve any problems. Partnering can be used alongside any method of contracting. Often a 'partnering charter' is drawn up by the participants. This is separate from the legal contract and outlines the goals of team members and a framework to resolve any disputes should they arise. Barlow et. al. examined five case studies in which partnering arrangements had been used and concluded that 'in each case the... partnering processes helped to build mutual trust and achieve dramatic improvements in performance' (p.58). However, according to Watson (1999) contractors and clients often enter into partnering agreements half-heartedly: 'contractors desperate to win repeat business are taking on the tough task of cutting costs for clients with no net reward other than the wink and promise of additional work. Many on both sides of the contractual fence are failing to get to grips with key aspects of partnering – which means that rewards are likely to be disappointing' (p.14). She also reported that there was concern in the industry that subcontractors were being excluded from partnering arrangements and that consultants tended not to be committed to working in partnership with contractors, preferring to criticise them in order to demonstrate their expertise and worth to clients.

A survey of clients conducted in 1999 by the Construction Clients' Forum (CCF) provided further evidence of the continuing poor performance of the UK construction industry. It found that 58 per cent of clients reported that their projects were late, 32 per cent said that they were over budget and 90 per cent reported defects of varying seriousness (Ridout, 1999). According to the Contract Journal (1999) a government report due out later in 1999 will also show that more than a half of all projects are indeed completed late.

Other Points

In the selection of sectors and types of engineer, the author chose to ignore information technology and those who specialise in it. According to contacts made by the author's supervisor with the British Computer Society (BCS) in 1998, there are about 500,000 information technology/ information systems specialists in the UK. The BCS is a constituent institution of the Engineering Council and its fully qualified individual members are chartered engineers. The BCS told him that its members and student members total a mere 35,000 from the aforementioned 500,000. There is a huge literature, most of it produced since about 1980, on the work and employment of IS specialists (for example, Currie, 1995, 1999; Currie and Galliers, 1999). This vastly outweighs the equivalent literature on 'traditional' engineers. 'Engineering old and information technology new' appears to sum up a great deal about the attitudes of management and social researchers in this area.

Information systems specialists are employed across most economic sectors and are often seen to be detached, especially when outsourced, or semi-detached from management hierarchies and to suffer many of the problems discussed above regarding the apparently marginal situations of engineers in UK manufacturing in the past. The author suspects that this is because most are currently employed, along with most other UK employees, in services, such as banking, education, insurance, health care, retailing and so on, where senior managements have rarely if ever had engineering or other technical backgrounds, meaning that the old gentleman-player syndrome which appears on the basis of this research to be dying out in manufacturing is being experienced anew (Currie and Glover, 1999). However it appears likely that information specialists will in the long run be absorbed into management hierarchies and teams as fully as any other specialist kind of employee (Ackroyd, Glover, Currie and Bull, 1999).

Management Abilities

Some writers have argued that engineers tend not to make good managers (Barry, Bosworth and Wilson, 1997). Others have used this to explain their apparently poor career prospects. Rosenbaum (1990), for example, suggested that engineers tended to lack the interpersonal skills needed for more senior positions and that managers with non-technical qualifications were more suitable for such posts because they tended to be more able in this respect. Beuret and Webb (1983) also concluded that engineers had poor communication skills, both written and oral. This had apparently resulted in their partial exclusion from the decision-making process. The authors of the Finniston Report (1980) suggested that some engineers tended to lack the drive and flair needed for more senior positions. They believed that improving the education system could help to resolve these problems. However, others have argued that such deficiencies are innate (see, for example, books by Hudson (1966) and Barry, Bosworth and Wilson (1997), and an article in Professional Engineering on the 8th of May 1994, all of which were discussed in chapter 5).

Clearly, it was not an aim of this research to assess the management abilities of different professional groups. This type of study could not possibly achieve that, particularly given that most of my respondents were engineers. However, the author wanted know what management-level people who worked in UK industry thought about these issues. The views of respondents in the three sectors were quite consistent. Fifteen of twenty-seven respondents in electrical and mechanical engineering thought that people's professional backgrounds had little or nothing to do with their ability to be effective managers. The figures for chemicals and construction were sixteen from twenty-eight and thirteen from twenty-seven respectively. Thus of the eighty-two respondents, forty-four, over half, felt that there was no difference between the management abilities of different groups. However other respondents felt that engineers had various strengths and some weaknesses compared to other groups. Some respondents in manufacturing, but not in construction, agreed with Barry, Bosworth and Wilson's (1997) point that engineers tended not to be able to think as creatively as managers with non-technical backgrounds, while others felt that the logical thinking of engineers was a major strength or that engineering was, as the world itself suggests, a very creative activity. Respondents were asked to compare the ability of engineers to communicate with that of other groups. Only twelve of the eighty-two respondents (six engineers in mechanical and electrical engineering, three engineers and one accountant in chemicals, and two engineers in construction) believed that engineers were less proficient than other groups in this respect. The overwhelming consensus was that there was no difference between engineers and anyone else. A number of respondents in construction, however, did suggest that while all the professional groups were able to communicate effectively with each other, communication between them was nonetheless sometimes poor and needed to be improved. Unfortunately or otherwise the notion of communication is a rather vague one and too much should not be read into these arguments and findings.

Some respondents, both in manufacturing and construction, had quite strong views on the suitability of different types of expertise for the management of companies and projects. They argued that a particular kind of expertise (usually their own), for example in engineering or quantity surveying, provided people with a more suitable training than others for management positions. In construction five engineers were concerned about the increasing numbers of quantity surveyors who were involved in the management of projects. They believed that quantity surveyors did not know enough about the design process or about how buildings and structures were put together. However most respondents thought that the personal qualities of individuals were more important than their professional training. In manufacturing most respondents believed that technical knowledge was not essential for senior positions. What was needed was a balance between technical and non-technical expertise. However, most also believed that the rigour and practicality of engineering provided a very good training for senior management, just as the somewhat different demands of marketing and accounting did.

Although the views of the respondents are interesting, they of course tell us little about the managerial abilities of different groups. The author very strongly doubts that there are innate differences between engineers and members of other professional groups in terms of their ability to manage effectively and found little or no evidence to support a different view. Certainly, German, Japanese, and other engineers overseas appear to have managed their countries' manufacturing companies rather well. It does not seem particularly helpful to explain the 'problems' of UK management, and of manufacturing management in particular, in this kind of way. Nurture rather than nature is surely a more constructive basis for examining the strengths and weaknesses of UK management. Surely because most engineers never rise above middle management level posts and therefore do not need to be strategic divergers does not mean that they could not become so if they were employed in top management posts. Clearly, however, much more empirical work on this issue, if indeed it merits that term, is needed before more substantial conclusions can be reached.

The Collective Organization of Engineers

Whalley (1986) believed that while most engineers were favourably disposed to trade unions, they were concerned that they would be seen as untrustworthy by their employers should they join them. A decade later Smith and Whalley (1996) argued that engineering unions and the professional institutions had been competing with one another to 'capture engineers' identity and mobilize their grievances' (p.49). This was, they believed, a battle in which trade unions had gained the upper hand. Although these authors are alone in arguing for the importance of trade unions in the lives of engineers, their views are important because their work has been influential in the debate about engineers in the UK, particularly given the relatively small numbers of researchers in this field and the use of their work to support the notion of the 'low status' of engineers in the UK. Other writers have noted that engineers have been reluctant to join trade unions (Finniston, 1980; Causer and Jones, 1996). Glover and Kelly (1987) pointed out that very few engineers employed in the private sector were trade union members, but that engineers employed in the public sector, along with other management level employees, were quite likely to join them.

There appears to be more agreement among most of the above authors that the engineering profession has not tended to be influential in the lives of most engineers. It has been criticised heavily for being fragmented and ineffectively organised and led (Finniston, 1980). It is often claimed that the engineering institutions are more concerned with competing with each other and furthering their own interests than working together in the best interests of their members (Jordan, 1992). A number of attempts have been made to reorganize the profession into a more coherent whole, the most notable of which was that undertaken by those who established and who have run the Engineering Council since 1983, following the arguments put forward by the Finniston Committee of Inquiry in 1980. Despite such attempts the engineering profession has continued to be criticised for being fragmented and for failing to be able to influence employers and to lobby government and other relevant bodies as effectively as it might (Jordan, 1992).

Only three of the engineer respondents in this study were members of trade unions: two in construction and one in chemicals. The two in construction worked for a local authority. They explained that they were trade union members because they were public sector employees rather than because they were engineers. The respondent in chemicals had first joined a union when he began his career as an apprentice fitter. Although he later obtained a mechanical engineering degree through part-time study and achieved a managerial position, he had decided to retain his union membership. In all three sectors engineers appeared to be ideologically opposed to trade unions. In the two manufacturing ones respondents appeared to feel that they did not need trade unions because they were generally in a strong position in terms of their pay and conditions. Although most engineers in construction were concerned about their levels of remuneration, only one suggested that trade unions might be useful in addressing this. Respondents in all three sectors were generally quite hostile to trade unions and to what they represented and some of them appeared to feel that they were incompatible with their status as managers and/or professionals. Although generally salaried employees, engineers are not 'workers' in the sense of being, in Marxian terms, a class for themselves and thus they perceived there to be a very clear distinction between themselves and technicians as well as between themselves and semi-skilled and unskilled manual workers. Unionism appeared to represent non-managerial status in the eyes of some engineers.

The situation as regards membership of the engineering profession was more varied between the three sectors. Ten of twenty engineer respondents in mechanical and electrical engineering were members (50%), and eight of these had obtained chartered status. In chemicals seventeen of twenty engineer respondents (85%) were members of the profession and fourteen of these were chartered or in the process of becoming chartered. In construction eighteen of the twenty-one respondents with engineering backgrounds (86%) were members. All of these were either chartered or in the process of becoming chartered.

Attitudes towards chartered status also varied between sectors. Respondents in mechanical and electrical engineering, even those who were chartered themselves, believed that it offered few or no career advantages. As a result many respondents felt that it was not worth the effort. In chemicals however, most respondents believed that it offered significant advantages in career terms, although it was still possible to be successful without it. In construction it was considered to be more or less essential. Most contracts required that both designers and contractors were chartered, partly for insurance purposes and partly because it was seen by clients as an indication of competence. Thus in construction the engineering profession appears to have achieved a credential-based exclusionary strategy which does not seem to exist in much of manufacturing. Many respondents in both chemicals and construction expressed a sense of pride in being chartered. This was generally not the case in mechanical and electrical engineering.

It is perhaps the case that the greater proportion of chartered engineers in chemicals than mechanical and electrical engineering is partly attributable to the fact that engineers in chemicals have tended to live in the shadow of chemists to some degree (although, as was noted earlier, this is changing) many of whom held doctorates. Thus chartered status perhaps helped them to assert themselves. Similarly in building, and even in some parts of civil engineering and engineering construction, professional architects have tended to dominate the management of projects until relatively recently. Engineers, especially in construction, may have used chartered status as a way of legitimising their expertise in the eyes of clients and other professional groups. However, engineers in mechanical and electrical engineering work mainly alongside other types of engineer and therefore their technical expertise has perhaps not been questioned, or their professional jurisdiction threatened, by other groups.

However, almost all respondents believed that their profession was poorly organised. The issue of fragmentation was addressed directly by a number of respondents, many of whom could not see the sense in having, for example, an Institution of Civil Engineers, an Institution of Structural Engineers, and an Institution of Building

Services Engineers. All of these types of engineer work in the construction industry and many respondents believed that, quite correctly in the author's view, it would be more sensible to have one institution for all engineers in construction. Many became visibly angry and/or agitated when they were discussing their profession. They felt that it had let them down. The employment of engineers was discussed earlier in this chapter. With the exception of the views of engineers in construction about their levels of remuneration, most engineers felt reasonably satisfied with their employment conditions. They did not feel that the engineering profession should be doing more in this respect. However, many blamed their profession for not doing enough to promote engineering to the general public and for being relatively ineffective in providing a voice to represent their views about issues which affected them. Thus their anger and frustration towards the profession appeared to be linked partly to their concern about the social standing of engineering, as well to the apparently self-indulgent behaviour of the institutions, discussed above.

Ill-feeling towards the profession was particularly strong in construction. This is perhaps surprising given its apparent success in developing an at least partial system of occupational closure in that sector. These respondents appeared to have a greater sense of their professional identities than those in manufacturing. The latter, even some of those with very technically specialised and sophisticated roles, tended to talk more in terms of corporate objectives than the former. Some engineers in construction, although not so much those who were employed by contractors, while forced by the increasingly competitive environment in which they worked to recognise their responsibilities in terms of minimising cost, appeared to place more emphasis on 'technical' and professional excellence and on providing a service to their clients. This is probably, of course, because many engineers in construction are employed as, or have had some experience of working as, independent consultants. This form of employment is more closely aligned with the 'traditional' model of independent fee-taking professionalism in the UK.

Engineering Education

For some time most writers have been agreed that virtually all professional engineers are now graduates (Glover and Kelly, 1987; McCormick, 1988; Smith and Whalley, 1996). The qualifications of all respondents were recorded. In mechanical and electrical engineering sixteen of the twenty respondents with engineering backgrounds were graduates. The figures for chemicals and construction were eighteen from twenty and nineteen from twenty-one respectively. Thus fifty-three of the sixty-one engineer respondents (87%) were graduates. In construction the two engineers who were not graduates worked for the electrical engineering contractor that was visited. The only engineers who tend not to be graduates in construction appear to be those who work for building services contractors. Most of these companies tend to train their engineers themselves, and this was the case with the electrical engineering contractor which featured in the study. The respondents in manufacturing who were not graduates all had Higher National qualifications and all of them were over forty. The author was assured by several respondents that all professional engineers who were beginning their careers in manufacturing were graduates.

Thirteen (21%) of the sixty-one engineers in the study had postgraduate qualifications. In mechanical and electrical engineering six engineer respondents had MBA degrees and one had a Diploma of Management Studies (DMS). In chemicals two were Doctors of Philosophy and two had MBA degrees. In construction one engineer was a Doctor of Philosophy and another had a Masters degree in the design of buildings. The respondents who had MBAs and the one who had a DMS had studied for them on a part-time basis and had been sponsored by their employers. The three who were Doctors of Philosophy and the one who had a Masters degree had obtained these qualifications immediately following their first degrees. The relatively small number of respondents with postgraduate qualifications perhaps indicates that most graduate engineers do not experience many problems in finding relevant employment.

According to some writers one of the problems which contributes to the supposedly low status of engineers is the weak correlation between qualifications and technical positions in companies (Jones et. al., 1994; Whalley, 1986; Smith, 1987; Meiksins and Smith, 1992, 1993; Smith and Whalley, 1996; Carter and Crowther, 1997). These authors have argued that graduate and non-graduate technical workers were often employed together and that employers made little or no distinction between them. Thus all 'technical workers' were incorporated under the generic title engineer which was no more than a 'hazily defined set of positions at a particular point in the company hierarchy' (Whalley, 1986: 187) and thus engineers were readily and closely associated with manual labour (Lee and Smith, 1992). Furthermore, Smith and Whalley (1996) believed, despite the fact that most engineers were now graduates, that elements of the traditional craft system of training engineers continued to affect the employment of UK engineers. By this they meant that skilled and semi-skilled non-graduate technical staff were sometimes promoted to the same level as graduate engineers. However, in a study conducted by McGovern (1996), discussed in chapter

5, the author found that there were clear distinctions between junior and senior technical staff and that employers relied heavily on formal qualifications as a means of achieving this. The results of this study indicate that the situation in all three sectors is similar to that outlined by McGovern.

Seven of the eleven manufacturing companies made clear distinctions between technicians and engineers both in terms of formal job titles as well as in terms of pay and grading structures. In the other four companies (B, D, G and J) clear distinctions existed between engineers and other types of technical worker in terms of pay and grading structures, but the term engineer was used generically. Despite this, in two of these companies (B and D) respondents believed that both technical and non-technical staff understood the differences between graduate engineers and other types of technical staff. However, in the other two (G and J) some respondents were concerned that some non-technical staff were not aware of them. In construction the distinction between engineers and technicians was even more marked. Engineering technicians are employed in large numbers in the construction industry. They are considered to form a separate occupational grouping and the division of labour between them and engineers is defined very clearly. It was also made clear by virtually all respondents in both manufacturing and construction that although it was possible for a technician to become an engineer, they would normally be required to study for a degree in order for this to happen. One exception to this was company C which had recently relaxed its rules to allow very senior and experienced technicians to be employed in positions which normally required graduates.

A number of criticisms which have been made of UK engineering education were outlined in chapter 5. First, it has often been argued that degree courses are too technically oriented with insufficient time devoted to presentational skills and to non-technical subjects such as marketing and accounting and finance (Beuret and Webb, 1983; Bolton and Spanyol, 1984). This, it is suggested, leaves engineers insufficiently prepared for 'management' positions. However, and as was noted in chapter 5, almost all degree courses now contain these and other subjects. Second, it has often been argued that degree courses are too scientific or theoretical, that they contain few or no practical elements, and that there is insufficient co-operation and co-ordination between industry and the universities (Finniston, 1980; Francis and Winstanley, 1988; Fowler, 1996; Whitworth, 1998). This point continues to be debated within the engineering profession and the higher education system. Third, it has been argued that significant variations in standards exist between both degree courses and the graduates that they produce, with the differences being linked to the varied academic status of different universities (Dunn, 1995; Patel, 1996).

Most respondents focused on their belief that engineering degrees were too theoretical and that they needed to include more practical aspects. Some of them believed that the 'problem' was caused or at least exacerbated by the fact that many academics had little or no experience of industry. Others suggested that more sandwich courses would help, although it was only suggested by a few respondents that industry was partly to blame in the sense that it has tended to be unwilling to become involved in higher education. A minority of the respondents believed that the present balance was about right. The role of the universities, they argued, was to teach students about theory. It was the role of employers to teach them how to apply it.

Subjects such as marketing and accounting and finance now feature in virtually all engineering degrees. Almost all respondents viewed this positively. As was noted above these subjects are part of and integral to engineering. In construction, some respondents pointed out that some of the 'management' issues which engineers faced are very difficult to teach on academic courses and that many of them needed to be learned, through experience, 'on the job'.

The notion of variations in standards between graduates of different institutions did not appear to be an issue that most engineers were concerned about. Indeed only one respondent (in electrical and mechanical engineering) mentioned it. He said that he had noticed that the ability of graduates of traditional universities such as Oxford and Cambridge was higher than those at the 'new' ones.

The Social Place of Engineering

The apparently low social standing of engineering as an occupation has been the subject of three government reports since the Second World War: the Annual Report of the Advisory Committee on Scientific Policy (1964), the Finniston Report (1980), and the Report of the Council of Presidents Steering Group (1993). Academic writers have also expressed the view that engineering is less highly regarded in the UK than other countries such as France, Germany, Japan, Canada, the USA and those of Scandinavia (Glover and Kelly, 1987; Lee and Smith, 1992).

The views of engineers in each of the three sectors on the social place of engineering were consistent. In mechanical and electrical engineering thirteen of twenty respondents (65%) with engineering backgrounds thought that the social standing of engineering needed to be improved. In chemicals the figure was sixteen from twenty (80%), while in construction the figure was sixteen from twenty-one (76%). Thus forty-five engineer respondents out of sixty-one (74%) were concerned about society's perception of their profession. The vagueness of the term engineer was of most concern in all three sectors. Many respondents felt that lay people did not know what they did. Others felt that engineers tended to be considered as little more than skilled or semi-skilled manual workers with few or no formal qualifications. Forty-seven (77%) of the sixty-one respondents with an engineering background wanted to see the title engineer restricted to graduates and/or professionally qualified people.

The social place of engineering was the main issue for many of the engineer respondents. On many occasions the author asked questions about the role and influence of engineers in UK industry and respondents replied with their views about the general social standing of the profession. Some respondents appeared not to be considering this issue in a completely rational way. One respondent in construction seemed to be almost hoping for a major engineering disaster. This, he felt, was the best way to raise the profile of the profession into the consciousness of the general public because it would help them to understand the importance of the roles which engineers played.

It was noted above that most respondents wanted the term engineer to be restricted to people who are graduates and/or professionally qualified. Also, and as discussed earlier in this chapter, many respondents felt that the engineering profession should be doing more to promote the profession to the general public. However, and despite their obvious concerns about this issue, most did not offer other suggestions with regard to improving the social standing of their profession. One respondent suggested that allowing engineering graduates to become secondary school teachers in the later parts of their careers might help. This would allow engineers with industrial experience to educate young people about the importance of engineering and the career opportunities that it offered. Others felt that British schools tended to discourage pupils, perhaps unintentionally, from pursuing careers in engineering. Four engineers felt that the ways in which engineers were portrayed in the mass media were partly to blame. One of them said that the broadcasting media and the press ought to approach engineering practitioners, who tended to be quite flamboyant characters, rather than engineering academics, who tended to be more staid, when they were reporting on engineering issues. However, a significant minority of engineers (sixteen) believed that there was no problem with the social standing of the profession or did not care whether it was low or not. Some of these suggested that part of the problem might be that engineers spent so much time 'moaning' about their social position that it had become something of a self-fulfilling prophecy.

Engineers and Pay

Most of the engineers in manufacturing appeared unconcerned about their remuneration and had little to say about it. Indeed only eight of them felt that they should be paid more (four in electrical and mechanical engineering and four in chemicals). Engineers in construction, however, were much more concerned about this. Remarkably, perhaps, eighteen of the twenty-one engineer respondents interviewed felt that engineers were underpaid. These respondents suggested that the increasing proportion of contracts awarded by private sector companies, increased competition within the construction industry, and a greater focus by clients on cost more generally, had led to fees and thus salaries being forced down.

The Engineering Council's statistics on pay, which claimed in 1997 that on average engineers earned £40,131 per year, do not differentiate between different types of engineer or between different sectors. Figures produced by the Office of National Statistics (1997) were outlined in chapter five. They suggest, like this study, that engineers in manufacturing are generally quite well paid compared to members of other professional and managerial occupations. However, they do not suggest that civil and structural engineers are poorly paid. Rather, they indicate that civil and structural engineers are the most highly paid of the main professions in construction, earning significantly more than architects and quantity surveyors. They also suggest that civil and structural engineers earn more than management accountants, production engineers, and design and development engineers, although less than mechanical engineers, chartered accountants and chemists. According to these figures electrical and electronic engineers are the most highly paid types of engineer, earning slightly less than solicitors and significantly less than doctors. A figure for chemical engineers is not included. However, according to a publication by the Engineering Council (1996b), chemical engineers are the highest paid type of engineer, although no amount is given and the source of this information is not referenced.

Engineers, Management and Economic Life

The position of engineers in construction corresponded quite closely with the picture painted in the literature in terms of influence and career, although there has been virtually nothing written about other aspects of the lives of engineers who work in construction, such as their collective organization, education and managerial abilities and roles.

However the findings of this study differed in several key respects to those of other studies which have fed into much of the literature on engineers in manufacturing, which paints a mixed but generally bleak picture of their position. One view or model of the lives of engineers, based mainly on the work of Smith, Whalley and Armstrong discussed in chapters 4 and 5, might be as follows. Engineers are marginalised in management hierarchies which are dominated by accountants and to a lesser extent by members of other non-technical functions such as marketing and sales (Armstrong, 1984, 1985, 1987, 1992; Glover and Kelly, 1987; Cannain, 1995; Lee and Smith, 1992). This is symptomatic of the subordination of technical to financial and other non-technical objectives. Furthermore, engineers at all levels are closely monitored and evaluated using financial criteria and engineers and accountants enjoy uncomfortable relationships. They are technical specialists with only limited possibilities in terms of reaching senior non-technical positions (Lee and Smith, 1992; Canainn, 1995; Lam, 1994, 1996) and they must sever their association with technical work should they have any hope of meaningful career advancement (Armstrong, 1987a; Dobson and Stewart, 1990; Roberts and Biddle, 1994). They are trusted by 'management' in the sense that they perform complex work which requires autonomy (Whalley, 1986), but are not trusted in the sense that they are not considered suitable to become part of it (Armstrong, 1987a). Indeed technical expertise has become a disqualification for senior positions.

They tend to be regarded as lacking the 'personal qualities' needed for 'management' positions in terms of their ability to communicate effectively (Rausenbaum, 1990) and their ability to solve problems to which there are no well-defined solutions (Barry, Bosworth and Wilson, 1997). Also, engineers are usually unionised and their professional associations have been ineffective. This has helped to reinforced their status as workers rather than managers (Lee and Smith, 1992; Meiksins and Smith, 1992). Although engineers are usually graduates, they sometimes perform the same roles as technicians and semi-skilled workers (Meiksins and Smith, 1992). This is partly because non-graduate technical staff can work 'through the grades' and reach more senior positions which are normally performed by graduates (Whalley, 1986). Thus all types of technical staff are grouped under the generic title of engineer and there is little distinction drawn between them by 'management' (Whalley, 1986; Meiksins and Smith, 1992; Smith and Whalley, 1996). They have a low social status which is partly because of their weak position in companies and partly the reason for it (Meiksins and Smith, 1992). Finally, engineers are poorly paid (Lee and Smith, 1992).

The author would like to propose an alternative model of the position of engineers in UK manufacturing. Although there is some overlap in some respects with the position outlined above, there are fundamental differences. Thus, although an influential group, accountants are employed in relatively small numbers in senior positions. In the case of electrical and mechanical engineering companies, engineers tend to dominate management positions and the formulation and execution of strategy at all levels. In chemicals companies chemists tend to dominate senior positions but engineers, and particularly chemical engineers, are an increasingly influential group.

In both sectors finance and accounting are support functions. The role of accountants is mainly to monitor budgets and advise on costing and other accounting and financial issues. It tends not to include the monitoring or evaluation of engineers, and engineers and accountants often enjoy constructive relationships. Far from being disqualified from senior positions, engineers enjoy the greatest career opportunities of all the more senior occupational or professional groups in manufacturing (with the exception of chemists in chemical companies, although they, while qualified as scientists are of course actually working as engineers of a kind to contribute to the production of useful material artefacts for sale). Furthermore, engineers are managerial-level employees who are not confused or associated with manual workers in companies in any way. During their careers significant proportions of them spill out into such non-technical functions as marketing and sales and human resource/personnel management. In some companies, however, engineers feel that they are required to become much less involved with the technical aspects of their work in order to advance their careers, and that technical specialists are sometimes less valued than they should be, while in others engineers feel that they have the best of both worlds and unrivalled career opportunities.

There is virtually no serious evidence to suggest that engineers are any better or worse at managing people and/or companies than the members of any other professional grouping and to suggest otherwise is little more than speculation. Engineers consider trade unions to be largely unnecessary for themselves and not in keeping with their professional or managerial identities. Thus it is unusual for engineers to be trade union members, especially in the private sector. The profession is considered by many of its members to have been ineffectual in promoting engineering to the general public and in lobbying employers and government about issues which affect engineers. It is fragmented and its constituent institutions often appear to be more concerned with furthering their own interests than with representing those of their members. In electrical and mechanical engineering chartered status is usually not considered to be particularly important for career advancement. In chemicals chartered status is considered to be beneficial in career terms, but not essential. In neither case has the engineering profession been successful in developing a system of professional closure.

However, virtually all engineers are graduates. Employers rely heavily on formal qualifications to distinguish between different types of technical employee, and technicians and other types of non-graduate technical worker who wish to become engineers are almost always required to study for degrees in engineering. Technicians and engineers have separate pay and grading structures. In some cases the word engineer is used to describe all types of technical employee, but in most cases they have different job titles. In both instances there are very clear distinctions between engineers and non-graduate technical workers in terms of pay, the nature of the tasks that they perform, and their career paths. Engineers are very concerned about their social position and feel that they are not given the recognition that they deserve. In particular they believe that most people in the UK do not understand the nature or importance of their work. Finally, engineers in manufacturing, and indeed construction although to a smaller extent, are generally well paid.

The findings of this study offer a different picture of some aspects of the lives of engineers to the work of Chris Smith, Peter Whalley and Peter Armstrong, who along with Ian Glover, have been the most influential writers on UK engineers. One explanation for this is that much of their writing is either quite old, or based on data which are quite old. Armstrong did not do any empirical work as such but is a former graduate engineer and his views presumably are at least partly based his own experiences in industry. However, the latter are now around thirty years old. The work of Smith is based mainly on a case study that he conducted in the late 1970s, while the work of Whalley is based on two case studies that he conducted, also in the late 1970s. The book by Glover and Kelly (1987) draws mainly on evidence of the decades leading up to the mid 1980s when in the opinion of Glover and (in conversation) senior members of the Engineering Council, UK engineers and engineering were first starting to emerge from the doldrums which they had experienced for the best part of twenty years. The nature, organization and management of British industry has changed considerably since then. This study might reflect the fact that engineers have reasserted themselves and that many companies have learned that success depends on technical excellence as well as careful financial management.

During the 1980s and 1990s the UK attracted large amounts of foreign direct investment and a larger percentage of UK industry is now foreign-owned as well as more foreign-influenced with commerce and manufacturing being more international than in the past (Nicholaides, 1991; Barrell, 1997). The sample probably reflects this (five of the eleven manufacturing companies are foreign-owned). Companies from the European Union and countries such as Japan and the USA, where the status of engineers is apparently higher than in the UK, have brought new practices and ideas, many of which have been adopted by UK companies (Pickard, 1997). The way in which these companies employ engineers may have influenced the position of engineers in the UK's indigenous companies. The author certainly did not notice any particular differences between the positions of engineers in the companies in my study which were British-owned and those which were foreign-owned. The author finds both of these first two points credible.

A third point, also useful for explanation, is that the position of engineers was never as weak as was claimed and that engineers have always been a relatively influential group. A strong case can be made for this view. Engineers have always been the largest professional group in manufacturing management and there has never been overwhelming empirical evidence to suggest that all or even most engineers suffered greatly from 'low status' (Acton Society Trust, 1956; Clark, 1966). However, given the considerable concern about the position of engineers in the 1970s which led to the Finniston Inquiry and its report, it is likely that engineers tended not to be a particularly influential group at and immediately below the boardroom level from the later 1960s and through to the early to mid-1980s. Nevertheless, any discussion of the 'low status' of engineers must be considered in the context of the central importance of the tasks which they perform to the operation and profitability of companies. Thus it might be argued that engineers could never really have 'low status', even if they were under-represented or acting in overly diffident ways in the more senior positions in the managerial hierarchies in their companies.

A fourth point is that the relatively small size and the in some ways self-selected nature of my sample is not fully representative of UK manufacturing with the companies in the study probably being from its 'better-performing half'. It is true that all of the manufacturing companies that were visited appeared to be relatively successful. Also, when the author wrote to companies to ask for their help, it was made very clear to them that the focus of the study was the influence and position of engineers. It may have been the case that those companies where engineers tended not to be influential were less willing to participate. There is probably a good deal of substance to this point. There are probably many examples of manufacturing companies which are dominated in many respects by accountants and by financial controls more generally and in which all or almost all of the engineers in them tend to be confined to pursuing careers as technical specialists with little or no influence over strategy. Nevertheless, despite these probable limitations of the sample, it appears to be the case that engineers in manufacturing are more influential on the whole than they appeared to be in the 1970s. The author suspects that many researchers have taken the alleged 'low status' of engineers for granted (particularly Chris Smith, Peter Armstrong and Peter Whalley). Thus they have tended to look for new ways to explain why engineers were apparently not influential in companies and failed to consider that the underlying situation might be changing.

Given that the debate about UK engineers has been considered largely in the context of economic performance, what do these data suggest about the UK's economic prospects? As far as can be established, and as was noted earlier in this chapter, the productivity of the UK construction industry appears to have remained inferior to that of much of its counterparts in Continental Europe (Lynton, 1993; Stewart, 1994; Proverbs, Holt and Olomolaiye, 1999). A large proportion of UK-based projects appear to be late, over budget, and of a poor quality (Ridout, 1999). Barlow et. al. (1997) noted that despite relatively low labour costs, overall UK construction costs are among the highest in Europe. Moreover, the data indicate that designers and contractors continue to have problems working together. It is probably fair to conclude that construction continues to be a weakness of the UK economy. There is also plenty of evidence to support the notion that there continue to be weaknesses in at least some parts of UK manufacturing. In particular UK companies tend to invest less than their counterparts in competitor countries (Bond and Jenkinson, 1996), although UK companies do not appear to have been disadvantaged in terms of access to long-term sources of capital compared to them (Mayer and Alexander, 1990; Mayer, 1997). Also, there has been an apparent unwillingness or failure to adopt and/or to implement successfully management techniques such as flexible specialisation, lean production and total quality management to the same extent and standard as companies in other countries (Delbridge and Lowe, 1998; Ackroyd and Proctor, 1998). Ackroyd and Proctor (1998) painted a picture of UK manufacturing in which companies adopted low-technology and low-training approaches to flexible specialisation.

Delbridge and Lowe (1998) argued that the UK's financial system was central to the 'problem' of UK manufacturing. These authors implied that Britain might very usefully adopt aspects of the Japanese and German systems of corporate financing, governance and control. However, the problems of the Japanese economy, which were evident before their book's publication, appear to have been closely associated with weaknesses in these respects. Also, given the current pre-eminence of the US economy which has a financial system that is very similar to the UK's, the notion that the UK's financial system is to a large extent responsible for the 'problems' of British industry perhaps needs to be re-evaluated by those who continue to espouse it. It is not being suggesting that it could not be improved, but simply that it is perhaps being used as a scapegoat for apparent weaknesses in the UK economy or for the short-term and arms'-length behaviour of managers or other relevant factors.

Glover, Tracey and Currie (1998) pointed out that the performance of UK manufacturing and related industries appears to be very varied, with much of what remains after the 'shake-outs' and 'downsizings' of UK companies since the 1970s being of good to outstanding quality, while some sectors continue to perform poorly by almost any standards: 'Relevant macro and microeconomic data and management research offer evidence of consistently or recently very strong performance in several sectors, of considerable improvement and/or striving in others, and in pockets across the whole system, of the persistence and even development of old bad habits of short-termist and arms'-length management' (p.204). The author believes this to be a reasonably balanced view of the situation.

Despite the pessimism of many researchers, there appear to be at least some good reasons for considering the UK's economic prospects, including those for manufacturing, more favourably than has become traditional since the 1950s. In chapter 2 it was noted that the UK's economy had performed poorly compared to its main economic rivals from around 1945 to the late 1970s. However, during much of the 1980s and 1990s its relative performance in terms of productivity and general economic growth has been better than them. It was also noted in chapter two that after-tax incomes in the UK were now on a par with those in Germany and Sweden, but below those in Japan, the USA and some other European countries (O'Mahony and Wagner, 1995, O'Mahony and Wagner with Poulson, 1995). Manufacturing productivity (measured by output per hour worked) is slightly lower than in Germany, slightly higher than France, but significantly lower than in the USA (Oulton, 1994).

Other points raised earlier are also relevant here. The quality of UK management measured in terms of educational attainment, relevance of qualifications, and commitment and effort, appears to have improved significantly during the 1980s and 1990s (Glover and Hughes, 1996; Storey et. al., 1997; Glover, 1999) although little is known about the precise recent or current levels and types of formal qualification held by British managers. There have clearly been a number of major and pertinent developments in higher education in the UK. In chapter 3 it was noted that Glover and Hughes (1996) believed that a professional-managerial class of senior job holders has been taking shape. By this they meant that professionals and managers were increasingly likely to hold a combination of vocational and non-vocational, technical, scientific, commercial, professional and managerial and other qualifications, including many kinds of first, second and other degree. Many of the relevant developments have been both imaginative and hard-nosed. Glover (1999) suggested that a person with, for example, a first degree in biology, a masters degree in technology management and a professional chartered accountancy qualification, a combination possessed by someone of his acquaintance, would be at least a match for, for example, a broadly educated German Diploma Engineer, or an American manager with a first degree in history and a Masters degree in Business Administration.

Ackroyd and Lawrenson (1996), discussing the UK vehicles industry, noted that during the 1950s and 1960s engineers were replaced on the boards of companies by accountants and general managers with largely non-technical backgrounds because of their apparent inability to solve recurring cash flow problems. According to the authors, this had had serious and long-lasting negative implications: 'Accountancy – and financial expertise generally – was defined as the antidote to the failure of management based on engineering, promoting the view that accountancy rather than engineering was a more reliable basis for executive decisions. Hence, engineering considerations were increasingly not addressed when the future of companies was considered, and strategic decisions were taken on considerations of the likely rate of return on assets already committed to production… it is doubtful whether the general management that typically emerged in vehicle manufacturing companies was really qualified to diagnose the basic problems of the industry, and to make appropriate decisions as what needed to be done… accountancy is not (without qualification and addition) an adequate basis for insightful strategic management' (p.187). The authors believed that both types of expertise were necessary for the vehicles industry to have prospered. The findings of this study indicate that this type of balance is perhaps increasingly being achieved in at least some parts of UK manufacturing, although power appears to be weighted towards engineers. Engineers or scientists working as a kind of engineer were the dominant group in most of the companies that were visited and there appeared to be an appreciation of the importance of technical expertise in decision making at all levels, including the most senior ones. Simply by being present in relatively large numbers on the boards of companies probably (although not certainly) means that technical issues are taken into account in strategic decision making. However, it also appeared that commercial and financial expertise were considered as vital to corporate success and accountants were not under-represented in senior positions.

The author's belief that engineers are the most influential professional group in manufacturing and in much of construction, that in general it is they and not accountants who run British industry, that many engineers are not themselves of the view that there is a subordination of technical to financial objectives in companies, and that the main functional groups in manufacturing management appear to enjoy relatively constructive relationships, are at least fairly encouraging indicators for the prospects of the UK economy. In particular, the fact that one of the main criticisms of UK manufacturing management, that most engineers have 'low status', no longer appears valid, is also encouraging. Taken together with some of the developments discussed above, it appears to add weight to the suggestion that the UK can look to the next century with greater confidence than might have been expected in the 1980s and that the loss of national impetus and the confusion about national identity which may have affected the inhabitants of the UK in the generation or so from the mid-1950s onwards and which were discussed in chapter 2, are perhaps beginning to be overcome.

Conclusion

The main finding of the study was that engineers in manufacturing appeared to be much more influential than is generally believed. It was they, and not accountants, who were the most influential group at all levels, including the most senior ones. Engineers were also generally influential or very influential in much of the construction industry. In manufacturing, but not in construction, the main professional groups appeared to enjoy relatively constructive relationships and the penny regarding criticisms made in and since the 1970s appeared to have dropped in this respect.

The author found no evidence to support the view that engineers are superior or inferior to other professional groups in terms of their 'management' abilities, although the latter are clearly very difficult to measure. Only three of sixty-one engineer respondents were trade union members and most engineers appeared to believe that trade union membership was incompatible with their professional and/or managerial identities. About half of the engineers in the sample were members of professional engineering associations but this varied between sectors, as did the importance attached by respondents and their employers to chartered status. The engineer respondents tended to believe that their profession was poorly organised and ineffectual.

Although employers appeared to rely heavily on formal qualifications to distinguish between different grades of technical staff, most respondents felt that engineering degrees needed to more practically oriented. The social standing of engineers and engineering was generally considered to be low. Many engineers believed that the general public neither understood nor appreciated fully what they did. However, engineers in the manufacturing companies in the study were generally satisfied with their levels of remuneration, although most respondents in construction felt that they were underpaid. The chapter concludes by arguing that when taken together with other evidence, particularly the many useful developments in education for management, the results suggest that the prospects for the UK economy might be considered to be improving, and certainly better than they were during the 1970s and 1980s.

The following chapter is the concluding one. In it the contents of all foregoing material are briefly summarised and the policy and research implications of the study discussed.

CHAPTER 12

CONCLUSION

Introduction

In the preceding chapter it was explained that the results of this study indicated that the position of engineers was different in some key respects to that outlined by other writers, particularly in the context of manufacturing. Earlier in the thesis it was noted that there was relatively little recent or other empirical evidence about UK engineers. It was argued that as wide-ranging a study as possible, within the limits of the available resources, was needed to try to evaluate their influence and to constructively describe other aspects of their careers and lives in the late twentieth century. Hopefully, this study has at least partly filled this gap. In this cocluding chapter some of the policy implications of the findings are discussed and a few suggestions for further research are outlined. Before that, however, the main points of each chapter and of the thesis as a whole are summarised.

The first chapter was the introductory one. In it current and conventional thinking about UK engineers in management and social scientific research was discussed. It was noted that there has been surprisingly little empirical work about UK engineers. Also, writers have focused on their roles in manufacturing and have almost completely ignored their roles out with it, notably in construction.

In chapter 2 the UK's economic and industrial performance were discussed. For much of this century and until quite recently the UK has performed poorly compared to its main competitors (Musson, 1978; Alford, 1996). A number of the explanations which have been offered to explain this situation were examined. Some writers have argued that the apparent decrease in the economic importance of manufacturing in developed economies is a desirable phenomenon (Rubinstein, 1993). However, manufacturing and services are increasingly interrelated so as to be often indistinguishable and it is likely that arguments about the relative importance of different types of economic activity, such as manufacturing or services, are at best pointless (Glover, Tracey and Currie, 1998).

In chapter 3 the rather limited available evidence about the backgrounds and character of UK management was examined. A number of trends appear to be emerging: managers and professionals are increasingly likely to be qualified to degree level or higher (Handy et. al., 1988; Barry, Bosworth and Wilson, 1997), qualifications are becoming more relevant to the work that their holders will do (Glover, 1999; UCAS, 1999), business and management qualifications are the fastest growing kinds of qualification (Glover and Hughes, 1996; Storey, et. al. 1997), qualifications are more varied as well as more vocational than they have been in the past (Glover and Hughes, 1996; Storey, et. al. 1997), and more specifically in relation to the concerns of this thesis, increasing numbers of engineers are graduates (McCormick, 1988; Smith and Whalley, 1996; Wyman, 1998).

Chapter 4 was about the influence, the relative positions of, and the relationships between the main occupational groups in manufacturing and construction. In manufacturing most authors have assumed that specialists in accounting and finance, and to a lesser extent other non-technical specialisms, dominate the management of manufacturing, especially in the most senior positions (Armstrong, 1987a; Glover and Kelly, 1987; Fligstein, 1990; Lee and Smith, 1992; Smith and Whalley, 1996). The most commonly used explanation for this is that aspects of the financial system tend to make the expertise of accountants more suitable than that of engineers for the management of companies (Armstrong, 1984, 1985, 1987a; Higgins and Clegg, 1988; Lane, 1995). In construction it was noted that the position of engineers apparently depended to a large extent on the method of contracting adopted by clients (NEDO, 1976; Ball, 1988; Bresnen, 1990, 1996). There appeared to have been a move away from the traditional form towards other (newer) ones. According to some researchers this has resulted in contractors and quantity surveyors becoming more influential than designers in the management of many projects (Naphiet and Naphiet, 1985; Bresnen, 1990, 1996).

In chapter 5 the literature on UK engineers was reviewed. Many writers believed that, rather than being content to remain as technical specialists, engineers feel pressured into taking 'management' positions in order to advance their careers (Bailyn and Lynch, 1983; Roberts and Biddle, 1994). Also, some writers have argued that engineers tend not to make good managers, either because of deficiencies in their formation or because of certain innate characteristics (Rosenbaum, 1990; Barry, Bosworth and Wilson, 1997). The presumed low pay, social standing and promotion prospects of engineers have apparently provided an ideal breeding ground for union membership, but the professional institutions have apparently been largely rejected by engineers (Glover and Kelly, 1987; Meiksins and Smith, 1992; Lee and Smith, 1992, Smith and Whalley, 1996). Engineering education has been criticised for being too scientifically and technically oriented with insufficient emphasis on 'management' subjects (Beuret and Webb, 1983; Bolton and Spanyol, 1984). Also, it is often argued that it is too theoretical and that it fails to provide students with an understanding of some of the practical skills needed for work in industry (Finniston, 1980; Francis and Winstanley, 1988; Fowler, 1996). Of even greater concern has been the extent to which employers rely on formal qualifications. Indeed some writers believe that engineers are quite closely associated with manual workers in companies (Whalley, 1986; Lee and Smith, 1992; Meiksins and Smith, 1992; Smith and Whalley, 1996). Furthermore, there is almost complete agreement that professional engineering has a relatively low social standing and some writers have argued that engineers are poorly paid, something which is not supported by the available evidence (Whalley, 1986; Lee and Smith, 1992).

The aims and rationale of the study were outlined in chapter 6. A qualitative approach was adopted as the author believed that this was the most suitable methodology to obtain the kind of descriptive and experiential data that was sought. Eighty-two interviews were conducted with engineers and their colleagues in three industrial sectors: mechanical and electrical engineering, chemicals, and construction.

In chapter 7 the interviews conducted with representatives of the engineering and other mainly organizational professions, management and employers' associations, economic and political interests and a small number of academic researchers were reported. A number of contentious and other issues concerning engineering education, collective organization and the social place of engineering were discussed. Also, although views about the position and influence of engineers in manufacturing were varied, it was generally suggested that the situation was more positive than that outlined in much of the literature.

Chapters 8, 9 and 10 reported, respectively, the interviews that were conducted with respondents in the electrical and mechanical engineering, chemicals and construction companies in the study. In most of the manufacturing companies, both mechanical and electrical engineering and chemicals, the author found little evidence of the apparent subordination of technical to financial expertise. Although accountants tended to perform very important and influential roles, they were employed in relatively small numbers and were generally considered to be performing a support function.

In mechanical and electrical engineering engineers clearly dominated senior positions. In chemicals chemists were the most numerous group in senior positions followed by engineers, although there was a feeling that engineers, and chemical engineers in particular, were increasingly likely to achieve boardroom positions in both manufacturing sectors. Accountants were employed in relatively small numbers in boardrooms. However, some respondents believed that engineers needed to become less involved in the technical aspects of their work if they were to advance their careers.

In construction the situation with the regard to the position of engineers depended to a very large extent on the methods of contracting adopted by clients. In both civil engineering and building there had been a move away from the traditional method of contracting towards design and build. The result was that contractors, and to a lesser extent quantity surveyors, had become more influential in the management of projects mainly at the expense of architects in building and design engineers in civil engineering.

The views of respondents from all three sectors about the management abilities of engineers and their colleagues were quite consistent with each other. A little over half of them believed that the level of competence of engineers as managers was no different to that of any other group. Other respondents felt that engineers had particular strengths and weaknesses. There was some disagreement about the suitability of different kinds of expertise for senior positions and for the management of projects, but most agreed that the personal qualities of individuals were more important than their professional training.

Only three engineer respondents (two in construction and one in chemicals) were trade union members and it appeared that many were ideologically opposed to them. Around half of respondents were members of relevant engineering professional associations in electrical and mechanical engineering, but most engineers in chemicals and construction were belonged to the profession. Chartered status was considered to be relatively unimportant for career prospects in electrical and mechanical engineering, very important in chemicals and more or less essential in construction. However most respondents in all three sectors felt that the profession was poorly organised, self-interested and ineffective in promoting the profession to the general public.

Most (87%) of engineer respondents were graduates and engineering is now more or less an all graduate profession. There were clear differences between professional and/or graduate engineers and other kinds of technical employee in terms of job titles and grading and pay structures, but in some manufacturing, but not construction, companies the term engineer was used to describe all types of technical employee.

With regard to the content of engineering degrees, many respondents focused critically on their still apparently relatively theoretical nature.

Forty-five of sixty-one engineer respondents believed that the social standing of their profession needed to be improved. Many were angry, obsessed even, about this issue and felt that the public did not understand the nature and importance of their work. Most respondents in manufacturing appeared to be relatively happy with their levels of remuneration. In construction, however, almost all respondents believed that engineers were poorly paid.

Chapter 11 was the discussion chapter. In it the beliefs and views of respondents from the different sectors were compared and contrasted both with each other and with those of past researchers on UK engineers. The results of this study were generally supportive of the views of other researchers who had written about the construction industry, but varied considerably from many of those who had written about the role of engineers in manufacturing (particularly, Chris Smith, Peter Whalley and Peter Armstrong). Despite the continuing problems of the construction industry, discussed above, the author concluded by suggesting that there are reasons for considering the UK's economic prospects, including those for manufacturing, relatively favourably.

Policy and Research Implications

Any research project must attempt to find a balance between the range of issues addressed and the detail in which they are studied. In attempting to offer a fairly wide-ranging analysis and discussion of the issues which are relevant to engineers in three settings, some of them inevitably had to be investigated less extensively than the author would have liked. Nevertheless, the author felt that it was important to approach the subject in a broad way, particularly given the relatively limited available evidence. Also, all of the issues examined are interrelated to varying extents and hopefully the research has at least shown that the experiences of engineers who work in different industries or sectors are indeed different.

The findings must be considered in the context of the size of the sample from which the data were collected. Given the relatively small number of interviews that were conducted and that the companies which participated may well have been from UK industry's 'better-performing half', the conclusions arrived at can by no means be considered conclusive, although the arguments and research of Barry, Bosworth and Wilson (1997) clearly provide support for the author's view that engineers tend to be the most numerous group in senior positions in manufacturing. Nevertheless, further work using larger samples would clearly be helpful. As a follow up study it might be useful to distribute questionnaires to a much larger sample of engineers and other managers in order to explore some of the points which emerged from the data.

In particular, very little is known about the educational and occupational backgrounds of UK managers. All of the surveys which have been conducted to date have been regionally-biased, biased by being restricted to members of professional and management associations, or restricted to senior and top managers. The only exception to this was a study conducted by Rosemary Stewart in the early 1950s and published by the Acton Society Trust in 1955. There is therefore a very clear gap in our knowledge which needs to be filled.

This research has suggested that manufacturing managements were not purely focused on financial matters and that technical expertise was considered to be very important for decision-making at all levels. It also suggested that perhaps the UK's financial system did not necessarily encourage short-term behaviour. It was pointed out that the USA, currently perhaps the world's most successful large economy, has a financial system which is very similar to, indeed based on in many respects, that of the UK. A study which looked specifically at the factors which influence senior managers when they consider financial, marketing, technical and other matters in the process of formulating and implementing corporate strategy would perhaps shed useful light on this issue.

This study suggests that at least some manufacturing companies in the UK have learned (or re-learned) the crucial importance of members of different professional and organizational groups working together in order to design and manufacture products efficiently and in ways which satisfy the requirements of customers. Thus many companies appear to be realising the significance of the 'engineering dimension' (Finniston, 1980). Also, there appears to be a consensus that a balance is needed between technical and financial and other commercial expertise in senior positions in manufacturing companies. The author feels that it is important that this belief becomes widespread across all sectors of the UK's economy. Also, some employers could and should be doing more to ensure that engineers who wish to remain as technical specialists and who are successful as such are rewarded very well for doing so. Indeed, it might be the case that they should be rewarded more highly than their counterparts who choose non-technical careers. However, the author also believes that most engineers should increasingly be educated and trained and employed to be capable of being both generalists and specialists.

Unlike in manufacturing, companies in construction appear to continue to operate in an adversarial environment and the traditional split between designers and contractors continues to trouble the industry. This is partly because several firms are usually employed on projects each of which has different aims and objectives. As noted earlier in the thesis, there have been several attempts to improve this situation, but these have apparently generally been unsuccessful. The low levels of fees which consultants and contractors are forced to accept seem to be close to the heart of problem (Barlow et. al, 1997). These low fees usually result in narrow profit margins and lead, almost inevitably, to short cuts being taken and to the quality of the final product suffering. It also appears to discourage openness and encourages a blame culture in which individuals and companies refuse to accept responsibility for many of the problems or difficulties which sometimes arise. Under these circumstances any measures which are used to help solve these problems, such as partnering or the New Engineering Contract, will probably prove futile. It is the author's view that clients have a responsibility to consider these issues when they consider tenders. While it must be appreciated that clients themselves, particularly public sector ones, often face considerable monetary pressures, it may well be short-sighted, as well as more expensive in the longer term, for them to consider tenders purely on the basis of cost. Clients should ask themselves questions about the extent and character of interprofessional and other co-operation in and between the construction companies and consultants with whom they interact.

The construction industry is sometimes called backward in terms of the local nature of many of its activities and roots and in terms of its fragmented and therefore rather archaic divisions of labour (Morrell, 1987). In discussion with colleagues, friends, relatives and mature students with relevant experience and knowledge the author occasionally heard the term 'time warp' regarding the industry and its professions and trades. However, this may be unfair in many respects, partly because of the very obvious (to the author) very high levels of ability of most of the construction industry respondents but more importantly because it seems wrong to criticise one kind of sector or activity using the standards of others. Also, just because construction is a very old, indeed ancient, sector does not mean that it is sensible to try to 'modernize' it. It has its own specific characteristics and needs. That said, it is hard to avoid the impression that the nature of markets and production processes in construction sustains the historically fragmented organization of education and training and permits a great deal of chaotic and dubious activity in this nonetheless very often exciting and interesting sector. The divisions of labour between those responsible for design, construction and cost have, in the author's opinion, been taken for granted for far too long. In other words the formation of the construction industry's professionals probably needs a fundamental overhaul. Domestically if not abroad, and compared with manufacturing, the industry has probably suffered from a lack of foreign competition and examples. There is at least some evidence to support the view that the relatively chaotic occupational and management structures of the industry permit considerable abuse of consumers as well as unfair competition between producers (Morrell, 1987; Glover, 1995, Appendix).

The notion that some occupational groups are more effective managers than others is clearly very difficult to study. As was noted in the previous chapter, people's ability to manage people and/or resources is probably related to their qualities as individuals rather than to their professional education and training and the author is unconvinced that most engineers tend to be 'convergent' thinkers who find it difficult to tackle problems with no clear solution. It may be useful for further work to be conducted about this issue in order to at least help clarify the situation. However, this may not be a particularly constructive use of time and resources. A better approach might be to consider people as individuals and not only as members of groups who may or may not share a set of homogeneous characteristics. The stereotyping of different professional groups such as accountants as cold-hearted penny-pinchers, engineers as inveterate spenders or glorified clerks, or marketing and sales as the 'gin and tonic brigade', may tell us more about exceptions proving rules and about the authors of the relevant stereotypes, than anything really useful about the victims.

The engineering profession was widely criticised by respondents for being ineffective and many appeared angry and frustrated when they were discussing it. However, a distinction should perhaps be drawn between the Engineering Council and some of its constituent institutions, something which was not done by most of the respondents. While many of the criticisms of the latter are perhaps fair, the author believes that the Engineering Council has done quite well in difficult circumstances, particularly with regard to developing chartered status. That said, fundamental problems of the profession's organization remain. The kind of Engineering Authority which the Finniston Committee had originally wanted to establish was quite different from the Engineering Council (Jordan, 1992). The Finniston Committee had sought an

Authority which had statutory powers and which was government-funded. Crucially, this Authority would be independent of the institutions, and the registration and licensing of engineers would be transferred from them to it. The institutions would still exist, but their role would be to advise and to assist the new authority rather than to run it (Jordan, 1992). As was noted in chapter 5, the institutions were horrified at the prospect of this blatant dilution of their power and lobbied powerfully against the proposals. The Engineering Council, set up in 1981, was not a statutory body but an independent public one established with a Royal Charter. Registration and licensing were transferred to it from the institutions but engineers who members of it were still required to be members of an institution (Jordan, 1992).

Concerns about infighting between the institutions and the Engineering Council led to a further inquiry into the organization of the profession. The Council of Presidents' Steering Group, chaired by Sir John Fairclough, was set up in January 1992 and reported in April 1993. Fairclough, like Finniston before him, thought that a powerful single body was needed. It was hoped that this would help to solve the infighting discussed above as well as provide a more powerful voice with which to represent the profession's interests. However, again the institutions lobbied powerfully against the proposals. Indeed, the influence of the institutions in the 'new' Engineering Council, which emerged in 1996 as a result of the inquiry, is greater than it was before as twenty-four of the Council's fifty-four members are elected directly by the institutions. Another twenty-four are now elected by members of the profession and the other six are Privy Council appointees. Previously the institutions and their individual members had little control over who was appointed to run the Engineering Council. (See chapter 5 for a more detailed account of these and other related issues).

However, the problems of fragmentation and co-ordination between institutions appear to remain. Under the present system the Engineering Council can only do so much to help solve these problems. It is surely quite ridiculous that there should be 39 professional associations for engineers. The author believes that the Finniston Committee and the Fairclough Steering Group were right in their belief that a single body provided the best way for the profession to serve its members. However, the institutions, particularly the 'big three' – the Institutions of Civil, Electrical, and Mechanical Engineering, remain powerful and appear to be as protective of their individual identities as ever. As a compromise it might be possible to reduce the number of institutions to four or five organized around four or five major branches of engineering, such as construction and extraction, chemicals, mechanical and electrical engineering, information technology and software engineering, and transport. This might be more palatable to the institutions and would reduce much of the duplication and overlap which currently exists between them. However, it would surely be sensible to consult with the profession's members before any radical changes of this sort were made. Further proposals which sought to curb the power of the institutions would surely be blocked by them again unless they were seen to have the support of a majority of their members.

As was noted in chapter 5, most engineering degree courses now include 'management' subjects such as finance and accounting and marketing and sales. This development was broadly welcomed by respondents. There was concern, as ever in the UK, that many degree courses were still too theoretical with insufficient emphasis placed on practical elements. The latter are often deemed to be the responsibility of employers (Fores, Glover and Lawrence, 1991). Given that engineering is a practical art this would appear problematic. The author is of the view that sandwich courses which provide students with the opportunity to spend at least one term or semester, but preferably a whole year, on placements are very desirable. This would clearly require many universities and industry to co-operate more closely than is presently the case. The author accepts the argument that much of the training which engineers receive needs to be company- and not only sector-specific, and that therefore some of the knowledge and skills which students learn on their placements may not be used in their future employment. Nevertheless, the experience of working in the 'real world' would surely be valuable to them. It should be pointed out, however, that UK universities are generally successful as educators of engineers. UK engineering degree courses remain popular with students from overseas and the best UK engineering graduates are considered by many employers to be among the best in the world (Henry, 1996).

The engineers in the study were clearly very concerned about the social standing of their profession. In chapter 3 the notion of scientism, which has been identified as a feature of Anglo-Saxon societies (Glover, 1987a), was discussed. It refers to the tendency to value the role of science rather than engineering in technical development, and in wealth creation more generally. In the UK science is considered to be central to the process of technical development. Scientific data, theories, principles and laws are developed by the natural scientist and they are then apparently translated into new processes and products by the engineer. Thus engineering is viewed as the application of scientific principles. As was noted in chapter 3, this British view of technical change has been called the science leads to technology leads to hardware view (Sorge and Hartmann, 1980). Yet, as far as can be established, science is rarely the source of technical change (Lawrence, 1980). Technical change is cumulative and usually builds on, and is dependent on, previous technical change. It occurs in response to perceived technical and commercial opportunities and problems and consists of gradual improvement, not relatively dramatic 'scientific' or other 'breakthroughs' (Jewkes, Sawers and Sillerman, 1969; Langrish et. al, 1972; Sorge and Hartmann, 1980). The output of science is knowledge, while the output of engineering is three dimensional artefacts (Lawrence, 1980). The notion of engineering as applied science implies a congruence between science and engineering, with the latter playing a supporting role.

Also, technology is not an appropriate word to describe the output of engineers and engineering. It implies that engineers have a body of knowledge which they use in their work. However, as Glover and Kelly (1987) pointed out, 'Engineers are not hired primarily because they have read 'the book', or because they own a copy of 'the book' and can understand what its author(s) say(s); rather they are used, and valued, because of their ability to work out solutions on matters for which 'the book' says little or nothing. This is the core of the engineering task. It is the meaning which the engineer ascribes to this task that to a large degree determines the nature and experience of engineering' (p.182).

The views discussed above are fostered and encouraged by the UK's education system and in its media. In education, engineering has long been described using the terms 'applied science' and 'technology', and in professional education and training many kinds of 'theory' are inaccurately projected as being more challenging than practice (Fores, Glover and Lawrence, 1991). Glover and Kelly (1993) used the popular British television series Dr. Who as a metaphor for the British view of technical change 'in which lazy English aristocratic scientific genius habitually, at one minute to midnight, saves Creation from the remorseless/ soulless/ mechanical depredations of such culturally stereotypical creatures as the Daleks (German engineers?)' (p.81).

In the author's view it is unlikely that the social standing of engineers and engineering in the UK will reach levels similar to that of, for example France, Germany and Japan, unless the inhabitants of the UK understand the role of engineers in technical change more adequately, or more mischievously, unless the standing of engineers in those countries comes down to meet ours coming up! The engineering profession should surely be acting more imaginatively and forcefully to assert the identity of engineering. Education clearly has a responsibility in this regard. Educators as well as those whom they teach need to be encouraged to think about the nature of engineering as a discipline in its own right, separate from and in most cases much more important than science in terms of technical change and wealth creation. Education should not, as is presently the case, encourage people to consider engineering as an –ology (technology) or 'merely' as the application of scientific principles.

The author believes that the position of engineers must also be seen in the context of an erosion of the esteem in which the public holds professionals in general. This is partly the result of the much higher proportion of people who attend university. A paediatrician of the author's acquaintance regularly complains that doctors are not 'respected the way they used to be' and that the parents of his patients are quite often unwilling to accept his professional judgement, something which he believes is a relatively recent phenomenon. It would surely be useful to conduct a research project which examined the public perception of several or most types of professional occupation, partly in order to compare how the public perceive engineers compared to other occupational groups.

Furthermore, the author believes that engineers should have protected titles. Most engineers have considerable responsibilities, and the consequences of them not performing their tasks correctly are very serious and may involve considerable danger to human life. Many of the respondents believed that a protected title was the most effective way to improve their social standing. This could be done either by restricting the title engineer to adequately experienced engineering graduates and/or to those who have obtained chartered status.

Conclusion

Conventional wisdom in management and sociological research suggests that engineers tend not to be an influential group in UK manufacturing. This thesis argues against this view. Given the limitations inherent in this type of study, it would not of course be judicious to dismiss entirely the work of other academics in this field. However, the author believes that this study has at least shown that the picture is somewhat more complex than is commonly believed, and thus represents a contribution to our knowledge. In this chapter a number of suggestions about future research have been made. However, the position of engineers in the UK appears to be regarded as passé by many social scientists. This is probably at least partly due to the present preoccupation with IT professionals and the 'information revolution' more generally in social and management research. While these are undoubtedly issues which are of massive importance to our society, it would be unfortunate if the situation of engineers was neglected entirely. However, the more general concerns of the thesis (the performance of the UK economy) will surely be the source of much debate for the foreseeable future. As has already been noted, the author's view is that the loss of national impetus and the confusion which may have affected the inhabitants of the UK from around the 1950s onwards, and which was discussed in chapter 2, are probably beginning to be left behind.

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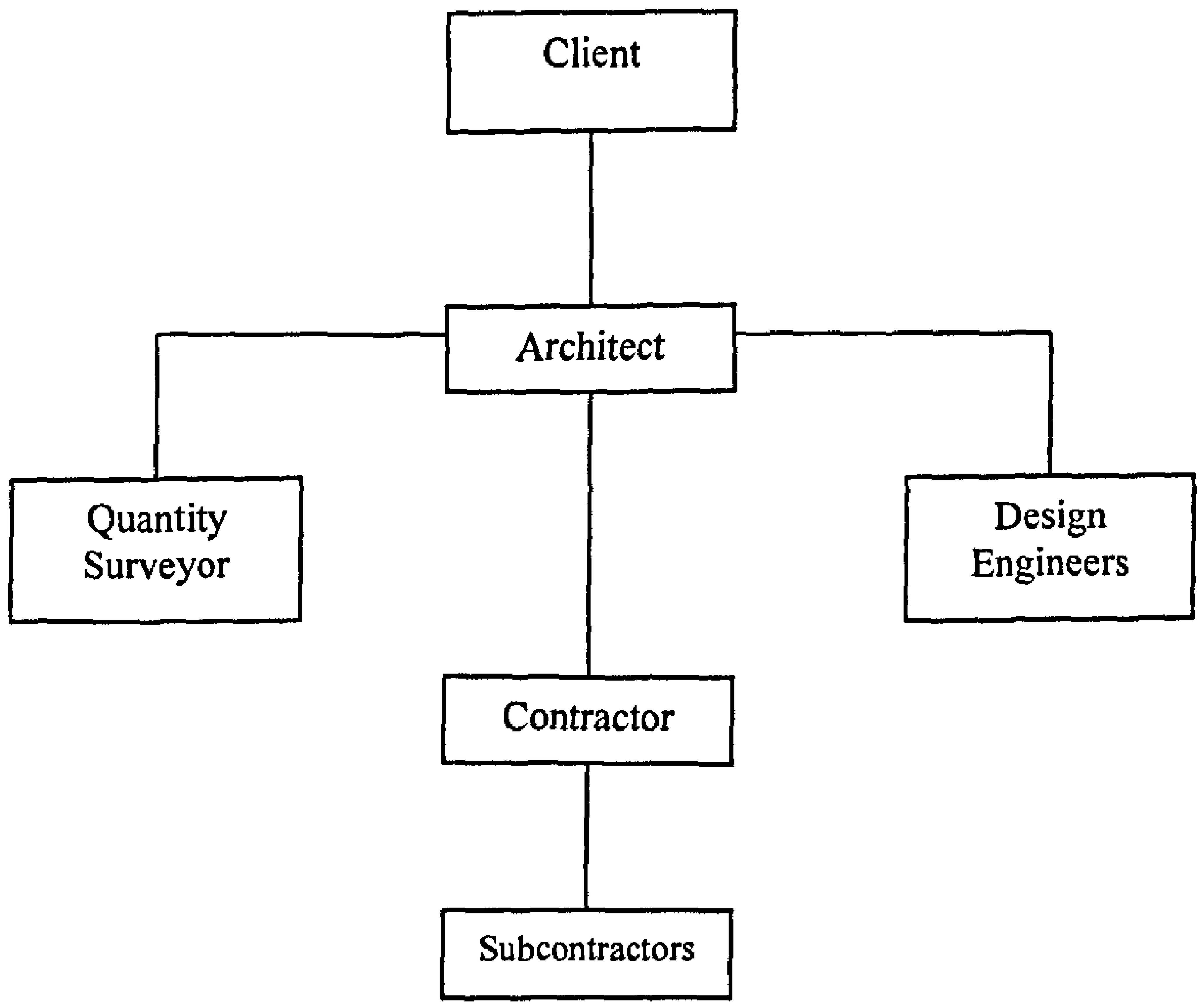
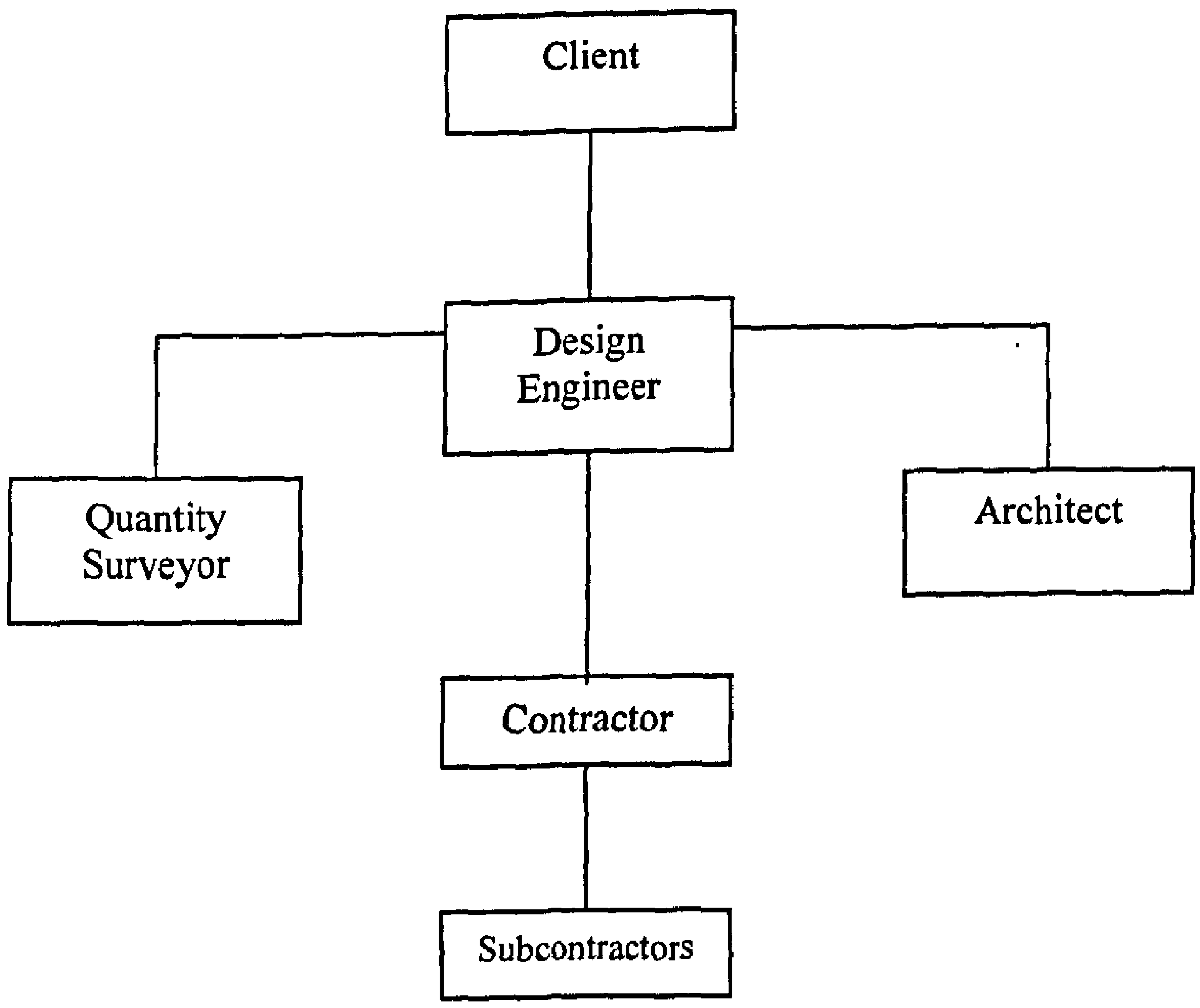
APPENDIX 1(A)

Traditional form of project organization in building projects



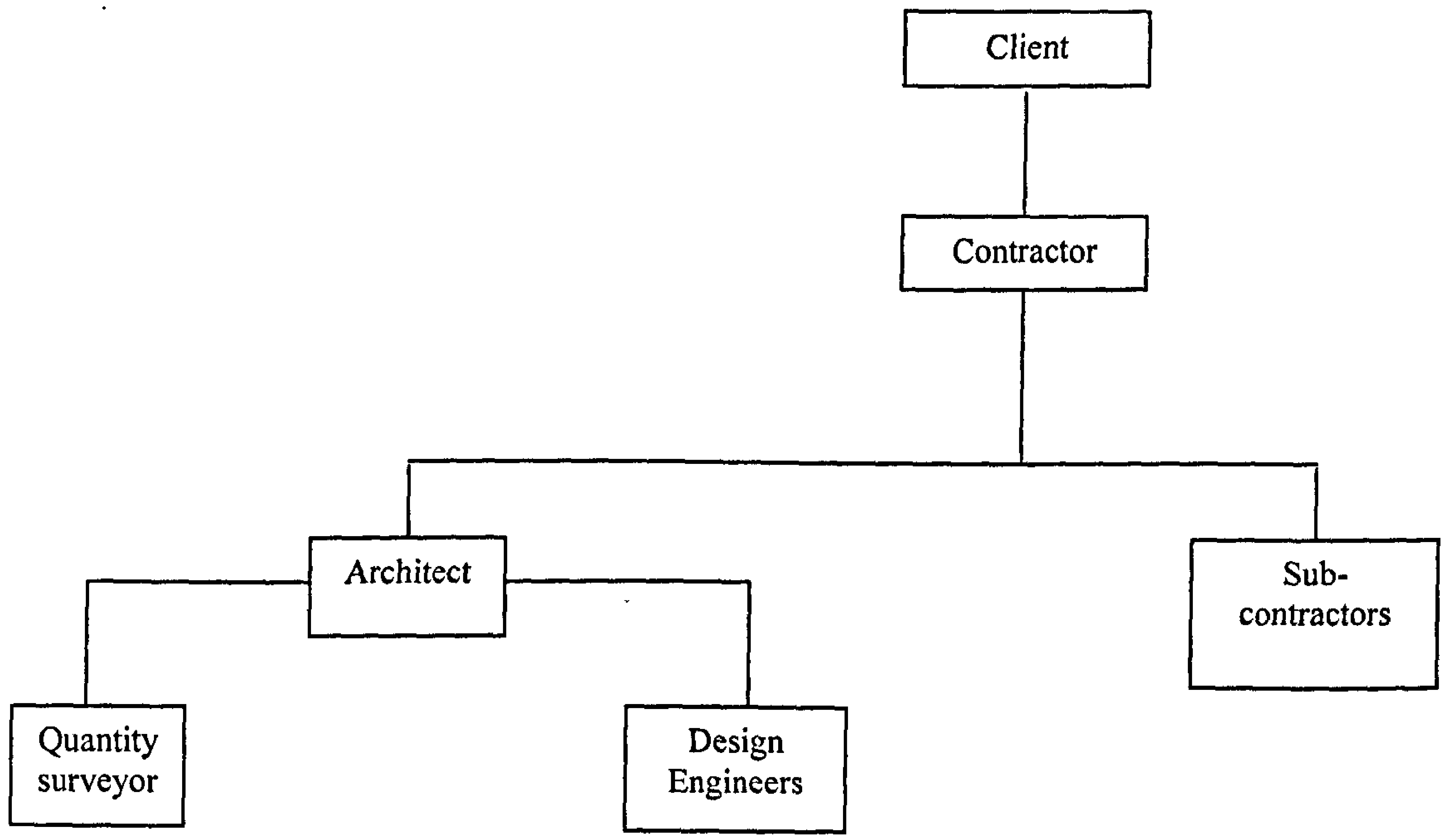
APPENDIX 1(B)

Traditional form of project organization in civil engineering projects



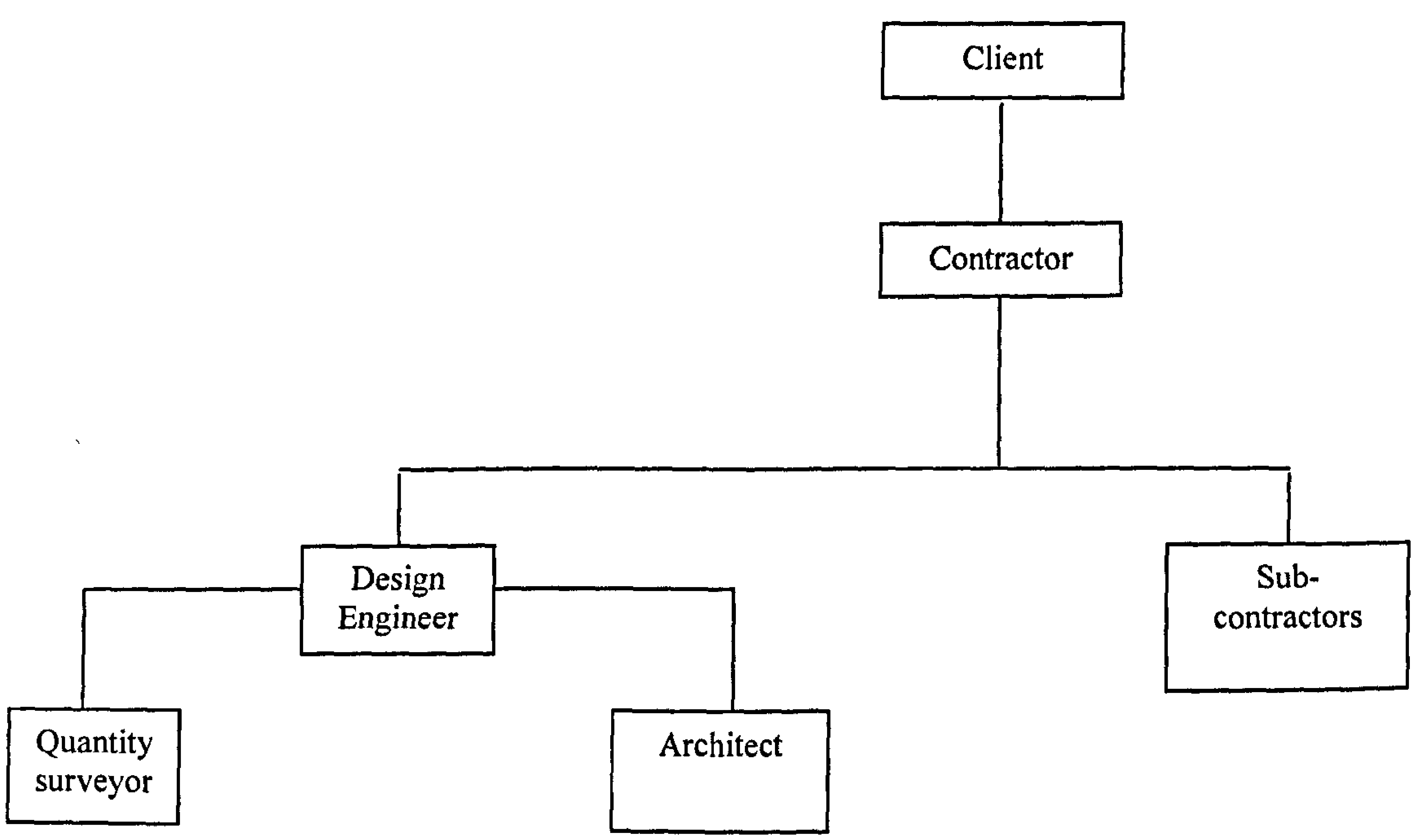
APPENDIX 2(A)

Design and build form of project organization in building projects



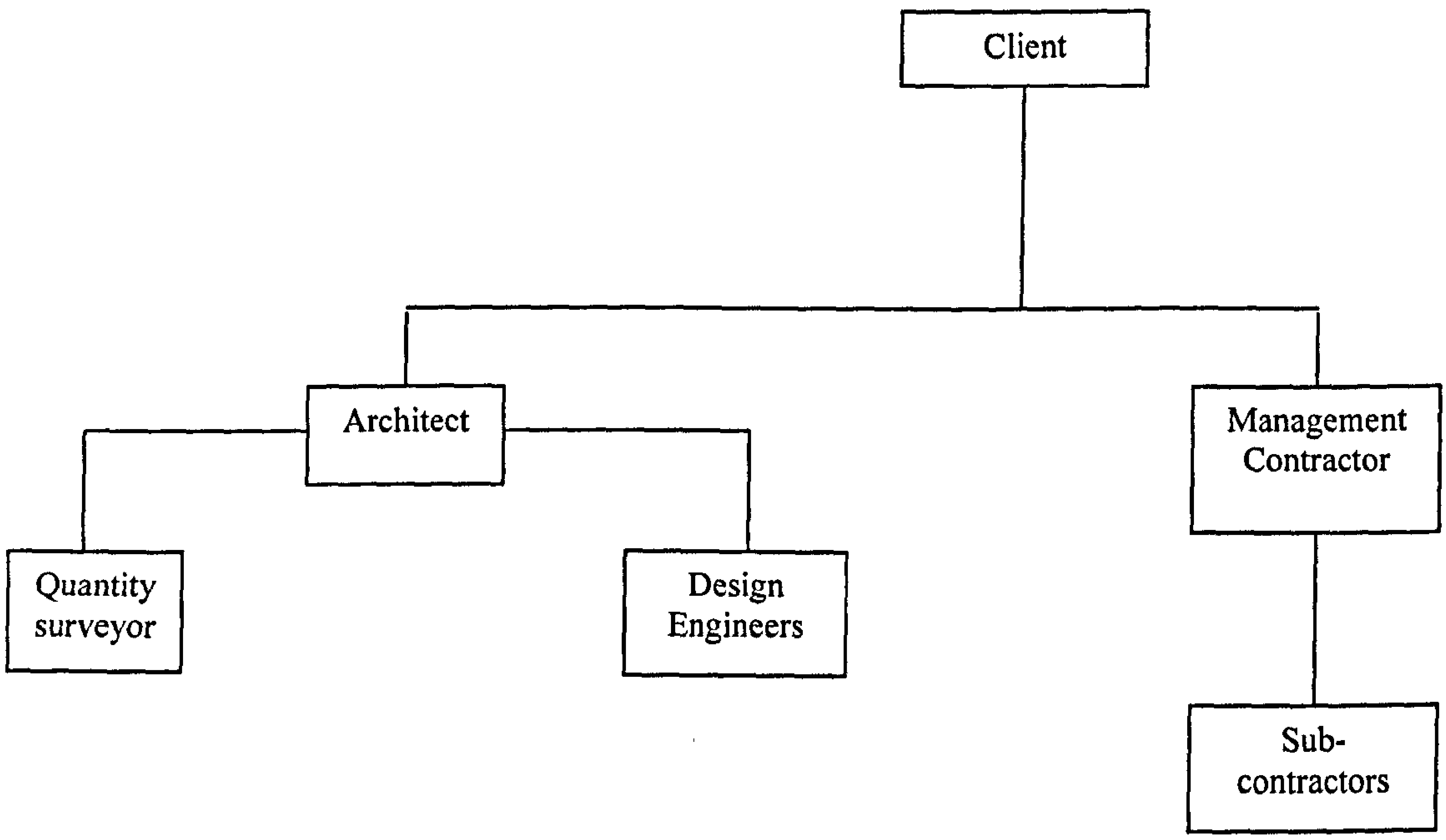
APPENDIX 2(B)

Design and build form of project organization in civil engineering projects



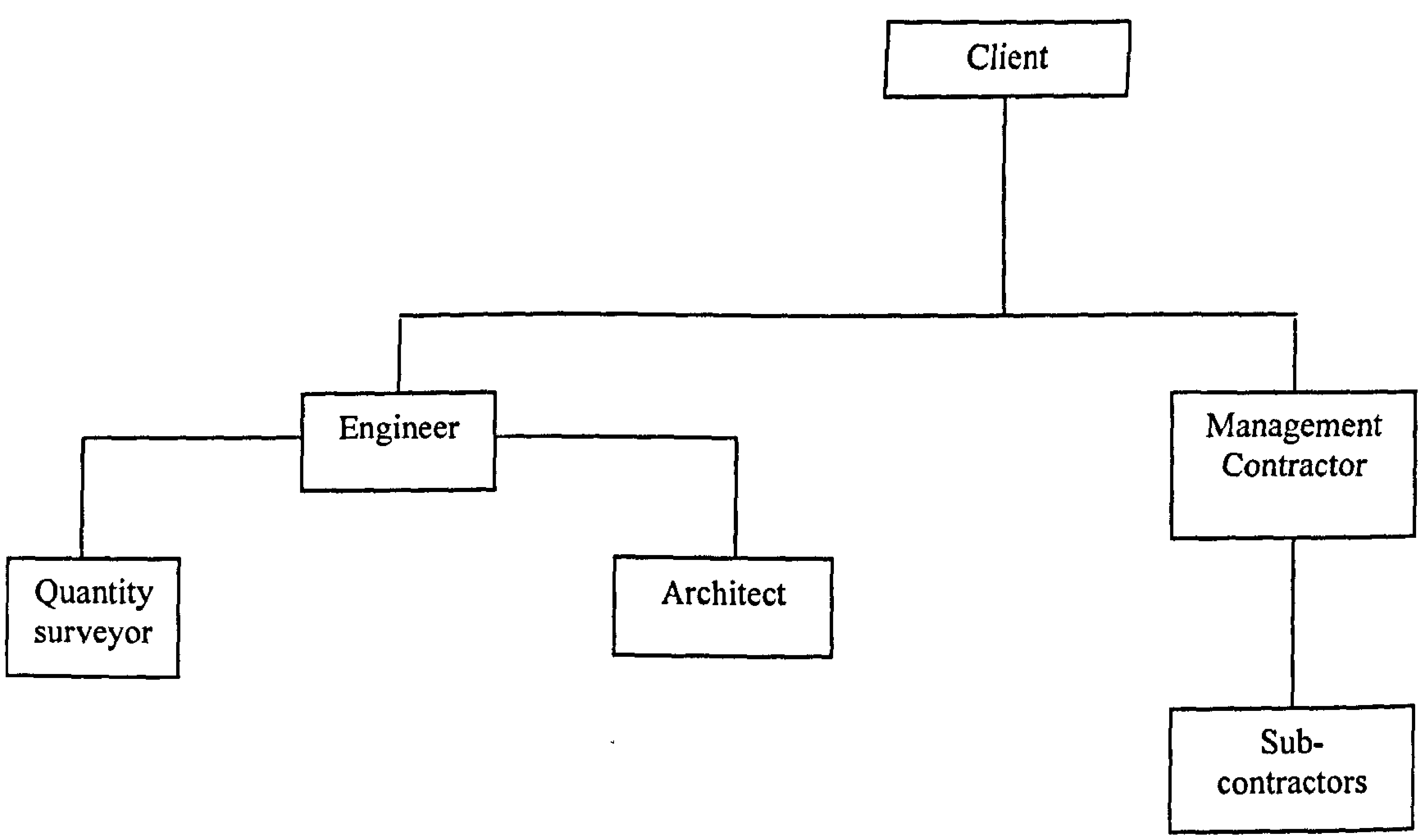
APPENDIX 3(A)

Management contracting form of project organization in building projects



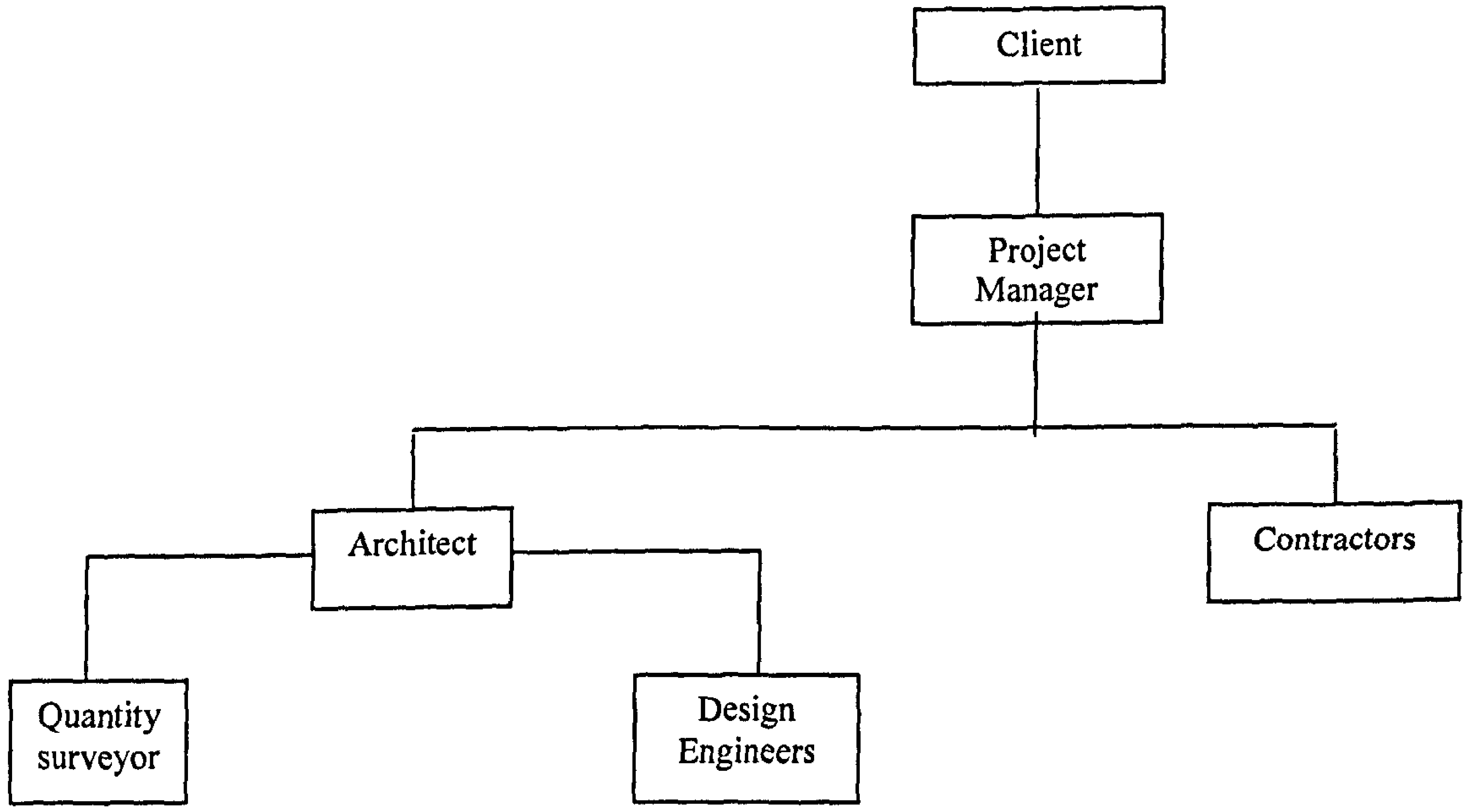
APPENDIX 3(B)

Management contracting form of project organization in civil engineering projects



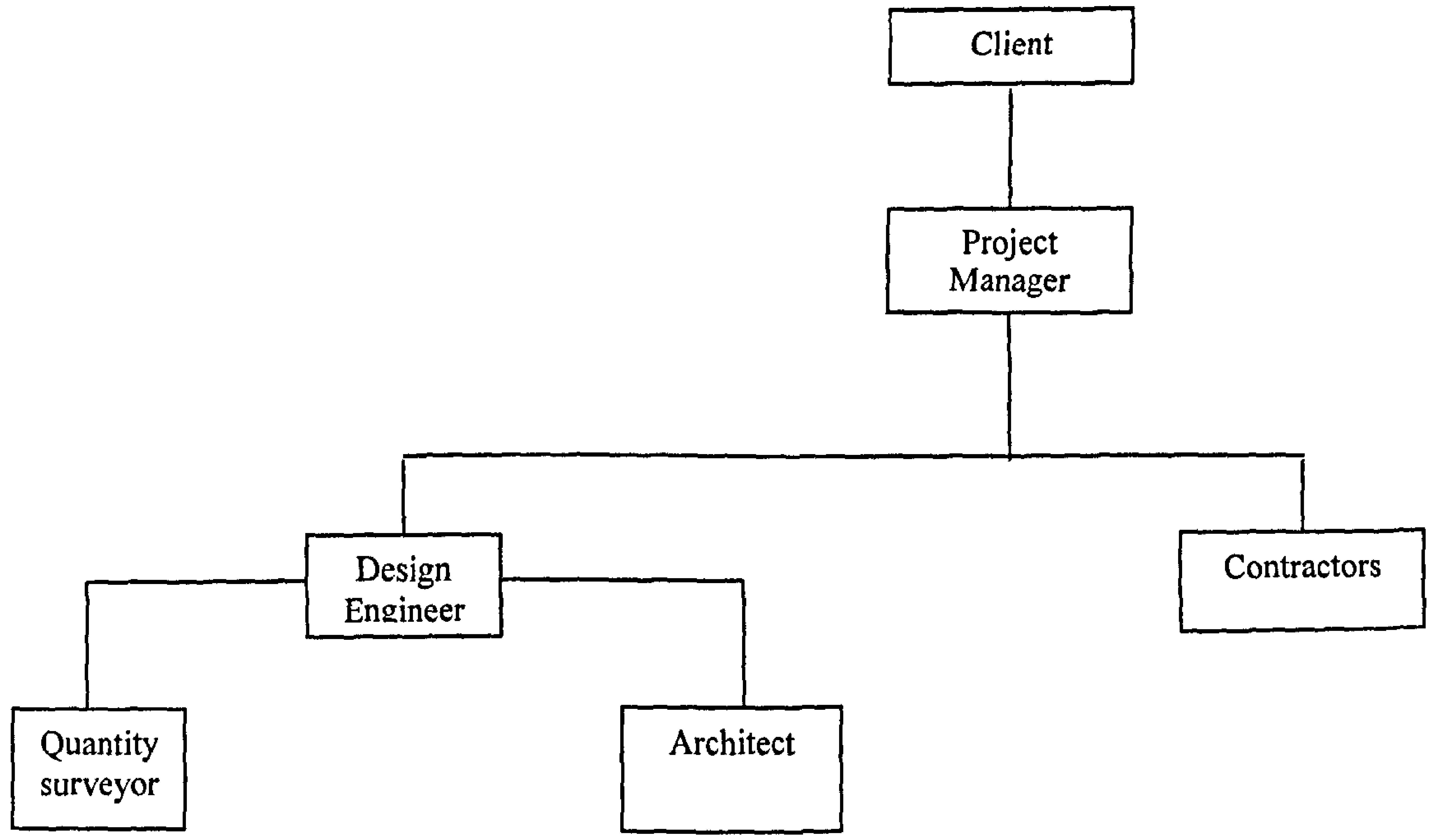
APPENDIX 4(A)

Project management form of project organization in building projects



APPENDIX 4(B)

Project management form of project organization in civil engineering projects



APPENDIX 5

Interview schedule used for respondents employed in the manufacturing companies that I visited.

The Work and Role of Engineers
Can you tell me about your company?

Approximately how many people does your company employ?

At what levels do engineers operate?

In which divisions or departments (whatever) are they?

How do engineers and the division/departments that they work in fit into the company's structure?
(Functional, product or matrix structure?)

Are engineers and technicians clearly differentiated from each other?
(If yes, in what way? Pay? Career?)

How easy or common is it for lower level technical staff to be promoted into roles normally performed by graduate/professional-level engineers?
(What qualifications do professional-level engineers and technicians normally have?)

The Influence and Careers of Engineers
How much contact do engineers have with accountants /marketing and sales specialists/ chemists/ personnel specialists/ other kinds of engineer?
(Ask separately. Teamworking? Functional flexibility?)

How would you describe your relationship with them?
(Ask separately)

Is there any conflict or jostling for power and influence between any of the groups?

If so, what are the sources of any conflict and what is each group trying to achieve?
(Resources/rewards/values/interests?)

How determined is each group in pursuing its own interests and which groups tend to be more able to persuade or force other groups to accept that their opinions and solutions are preferable?
(Why? How?)

How are conflicts resolved?
(Confrontation? Compromise? Informal mediation? Third party involvement? Formally? Informally? Which groups or individuals tend to have the final say in any conflict? Why? How?)

How would you assess the influence of engineers in manufacturing?

What about accountants? Marketing and sales specialists? Chemists? Personnel specialists?

Do you think that engineers are concerned about issues of power and status?
(Do they lack influence? Are other people aware that this is the case? What about accountants? Marketing and sales specialists? Chemists? Personnel specialists?)

In your company, is the emphasis on strategy commercial, financial or technical?
(What about your industry as a whole?)

Which group is most likely be promoted to senior management in your company?

What about in your industry as a whole, which group (if any) dominates senior management positions?
(Why? What effect does this have on the ways in which companies are run?)

Do you think that engineers are under-represented in senior positions?
(If this is the case, why?)

What do you think about the career prospects of engineers?
(How does this compare to other groups?)

Does your company use dual career ladders?

Is engineering a rewarding career?
(Does it offer high job satisfaction, autonomy, responsibility, influence, opportunity?)

What do you think about the pay of engineers?
(Should they be paid more? Less? About right?)

How does the pay of engineers compare to other management-level groups?
(Watch for level)

Do you think that anything needs to be done by employees and managers to improve the position of engineers in companies?

The Abilities of Engineers

In your experience, do engineers have enough expertise of the following kinds?

the processes of employing people and human resource management
finance and accounting
marketing and sales

(Do they need these kinds of expertise?)

What about other groups? Do they tend to have enough expertise of different kinds?
(Particularly technical skill).

How do engineers compare to accountants, marketing and sales people, chemists and personnel/HRM specialists in terms of their ability to be commercially and strategically aware?

How do engineers compare to accountants, marketing and sales people, chemists and personnel/HRM specialists in terms of their ability to communicate and get on with people?

How do engineers compare to accountants, marketing and sales people, chemists and personnel/HRM specialists in terms of leadership and motivation skills?

In your experience, what are the strengths and weaknesses of engineers as managers and senior managers?

In general, how do other groups compare to engineers as managers and senior managers?

In your opinion, is a certain amount of technical knowledge an important requirement for senior management?
(What about more junior levels of management?)

In your company, is technical knowledge regarded as an important requirement for senior management?
(What about more junior levels of management?)

Wider Issues
Are you a trade union member?

Do engineers in construction tend to be trade union members?

Do you think that trade unions have an important role to play in your industry?

What do you think about engineering education in the UK?

There have been a lot of changes to the education of engineers for over twenty years e.g. the introduction of so-called management subjects like marketing and accounting and the development of B Eng degrees. What do you think about these?
(Are more or different changes needed?)

Do you think there is a shortage of good quality engineers in this country?

Are you a member of one of the professional institutions?

Do you think that the Engineering Council and the institutions represent engineers effectively?

There have been many changes to the professional organization of engineers for the past twenty years e.g. amalgamations between professional engineering institutions

and the setting up of the Engineering Council and its reorganization early in 1996. What do you think about these?
(Are more or different changes needed?)

Are you a Chartered Engineer?

Does your company reward/encourage engineers to achieve chartered status?

Do you consider chartered status to be useful?

Do people in industry take an interest in issues such as engineering education or professional organization?

What do you think about the status of engineers, engineering and manufacturing in UK society?

(If there is a problem) what needs to be done to improve the social status of engineers?
(How can people's underlying attitudes be changed? Do you think that the contribution of engineers to society needs to be clearly articulated to the general public?)

Do you think that the term 'engineer' should be licensed?
(Do you that that the term engineer is too vague? Is this part of the problem (if respondent thinks that there is one))

How important do you think engineers, engineering and manufacturing are for the long-term future of our (or indeed any) economy and society?

Personal Details
Would you mind if I ask you your age?

20-25	26-30	31-35	36-40	41-45
46-50	51-55	56-60	61-65	65 plus

Job title and brief description of role:
(Make sure role fully explained)

Please list your main subject(s) of study and the type(s) of qualification(s) (e.g. B.A., M.Sc., etc.) obtained at college or university:

What type of secondary school did you attend and what qualifications did you obtain?

Please can you tell me about any professional qualification(s) which you hold:
(When was it/were they obtained?)

Please can you give a general picture of your experience and career.
(Always an engineer/accountant etc.? Always in this sector/company? If not, where? General outline of background, experience, career needed).

APPENDIX 6

Interview schedule used for respondents employed in the construction companies that I visited.

The Work and Role of Engineers
Can you tell me about your company?

Approximately how many people does your company employ?

At what levels do engineers operate?

In which divisions or departments (whatever) are they?

How do engineers and the division/departments that they work in fit into the company's structure?

Are engineers and technicians clearly differentiated from each other?
(If yes, in what way? Pay? Career?)

How easy or common is it for lower level technical staff to be promoted into roles normally performed by graduate/professional-level engineers?
(What qualifications do professional-level engineers and technicians normally have?)

The Influence and Careers of Engineers
How much contact do engineers have with quantity surveyors and architects?
(Ask separately. Teamworking? Functional flexibility?)

How would you describe your relationship with them?
(Ask separately)

Is there any conflict or jostling for power and influence between any of the groups?

If so, what are the sources of any conflict and what is each group trying to achieve?
(Resources/rewards/values/interests?)

How determined is each group in pursuing its own interests and which groups tend to be more able to persuade or force other groups to accept that their opinions and solutions are preferable?
(Why? How?)

How are conflicts resolved?
(Confrontation? Compromise? Informal mediation? Third party involvement? Formally? Informally? Which groups or individuals tend to have the final say in any conflict? Why? How?).

Which group is most likely to project manage a project?
(Why? Are engineers considered as suitable as anyone else for project management?)

How much experience do you have of the main methods of contracting?
(Traditional, design and build, management contracting, project management? How often do you use each of them?)

How does the position of engineers change when different methods of contracting are used?
(What about architects? Quantity surveyors?)

How would you assess the influence of engineers in construction?

What about architects? Quantity surveyors?

Do you think that engineers are concerned about issues of power and status?
(Do they lack influence? Are other people aware that this is the case? What about architects? Quantity surveyors?)

In your company, is the emphasis on strategy commercial, financial or technical?
(What about your industry as a whole?)

To what extent are accountants, marketing/sales people and personnel/HRM people involved in the construction industry?
(How much contact do engineers have with them?)

Which group is most likely be promoted to senior management in your company?

What about in your sector as a whole, which group (if any) dominates senior management positions?
(Why? What effect does this have on the ways in which companies are run?)

Do you think that engineers are under-represented in senior positions?
(If this is the case, why?)

What do you think about the career prospects of engineers?
(How does this compare to other groups?)

Is engineering a rewarding career?
(Does it offer high job satisfaction, autonomy, responsibility, influence, opportunity?)

What do you think about the pay of engineers?
(Should they be paid more? Less? About right?)

How does the pay of engineers compare to quantity surveyors and architects?
(Watch for level)

Do you think that anything needs to be done by employees and managers to improve the position of engineers in companies?

The Abilities of Engineers

In your experience, do engineers have enough expertise of the following kinds?

the processes of employing people and human resource management
finance and accounting
marketing and sales

(Do they need these kinds of expertise?)

What about architects and quantity surveyors? Do they tend to have enough expertise of different kinds?
(Particularly technical skill).

How do engineers compare to architects and quantity surveyors in terms of their ability to be commercially and strategically aware?

How do engineers compare to architects and quantity surveyors in terms of their ability to communicate and get on with people?

How do engineers compare to architects and quantity surveyors in terms of leadership and motivation skills?

In your experience, what are the strengths and weaknesses of engineers as managers and project managers?

In general, how do architects and quantity surveyors compare to engineers as managers and project managers?

Which group makes the best project managers?
(Ask for discussion/reasons)

In your opinion, is a certain amount of engineering knowledge an important requirement for project management?
(What about more junior levels of management?)

In your company, is engineering knowledge regarded as an important requirement for project management?
(What about more junior levels of management?)

Wider Issues

Are you a trade union member?

Do engineers in construction tend to be trade union members?

Do you think that trade unions have an important role to play in construction?

What do you think about engineering education in the UK?

There have been changes to the education of engineers over the past twenty years e.g. the introduction of so-called management subjects like marketing and accounting and the development of B Eng degrees. What do you think about these?
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Do you think there is a shortage of good quality engineers in this country?

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What do you think about the status of engineers, engineering and construction in UK society?

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Do you think that the term 'engineer' should be licensed?
(Do you that that the term engineer is too vague? Is this part of the problem (if respondent thinks that there is one))

How important do you think engineers, engineering and construction are for the long-term future of our (or indeed any) economy and society?

Personal Details
Would you mind if I ask you your age?

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