Capabilities, Strategy and Environment: Organizational Change in the UK's Defence Industrial Base, 1989-95

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Authorship Declaration and Acknowledgments

It is acknowledged that this thesis is the sole work of the author and has been composed by himself alone.

However I would like to acknowledge a number of people, who have all provided important support and guidance throughout the production of this thesis. Firstly, thanks are necessary to my supervisors Donald MacKenzie and Jan Webb, who both gave invaluable advice and guidance. Secondly, I would like to thank Alex Law for both the friendship he provided and for the many long hours of discussions that we had, which helped shape my thoughts tremendously. Finally, I would like to acknowledge the support of my partner, Catriona, who provided constant support and encouragement to me throughout the production of this work.

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ABSTRACT

This thesis examines how a range of companies from the UK’s defence industrial base were affected by and responded to the end of the Cold War. Specifically it examines the relationship between an organization’s capabilities and behaviour on the one hand, and the character of its operating environment on the other. The thesis considers both how organizational capabilities are shaped by the operating environment and the extent to which organizational strategy is shaped and constrained by environmental factors. The research draws on both evolutionary economics and contingency theory, which both consider a firm’s operating environment to be central in shaping its behaviour. To represent the heterogeneity of the defence industrial base the aerospace, electronics and vehicles sectors were examined, with a range of companies from prime contractors to component suppliers being examined within each sector.

The research found that the capabilities of the companies examined were shaped by the character of their operating environment. However the character of the operating environment varied substantially across the defence industrial base, resulting in the capabilities of companies also varying greatly. For example, the market and technological character of the operating environment for the prime contractors was substantially different from that of the component suppliers, resulting in them possessing very different organizational capabilities. The capabilities of the companies examined were also found to be specific and cumulative in nature, limiting their relevance to other market environments, thus making profound organizational change difficult to accomplish. One of the most noticeable findings was the similarity in the strategies adopted by most of the companies examined. The strategies adopted did not involve diversifying out of defence markets, instead companies concentrated on modifying their organizational structures and operating practices in response to the changes in their defence markets. While the strategic autonomy of companies was
constrained by environmental factors, such as the particular policies of the UK government towards its defence industrial base, their behaviour was not totally determined by environmental factors. Thus the companies examined still possessed an element of 'strategic choice' to shape and control their strategy. However, the level of strategic choice was found to vary substantially between the divisional and corporate level.
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CHAPTER 1

INTRODUCTION

The collapse of the Berlin Wall in November 1989 following the revolution in East Germany provided the most symbolic marker of the end of the Cold War. Within the space of a few short months around this time the political map of Eastern and Central Europe had been totally transformed. From Poland on the Baltic to Romania on the Black Sea, in almost every one of the USSR's former European client states, similar internal revolutions occurred, resulting in the disintegration of the Soviet Bloc. The swiftness and profundity of these changes was particularly shocking as for almost 50 years the geo-political character of the Cold War had been relatively stable, fixed in the bi-polar antagonism between the 'communist' East and 'capitalist' West. This collapse of the Soviet Bloc brought into question the whole ideology of Cold War defence policies, which in Western Europe and the USA had been built on the assumption that the Communist Bloc, dominated by the USSR, represented the main enemy and military threat. Thus the collapse of the Soviet Bloc brought these defence policies into question, particularly in countries like the USA, UK and France, where relatively large amounts had been devoted to weapons development and production. Therefore since 1989 the defence industrial base in almost every country involved in arms development and production has gone through a period of profound restructuring as defence policies were adjusted to the new post Cold War world. While the events outlined above brought about enormous political, social and economic change, particularly in Eastern Europe, the focus of this research will be on the UK's defence industrial base and how the companies operating in it were affected by and responded to these events. Specifically the research examines the relationship between the character of the operating environment in the UK's defence markets and the nature of the
capabilities possessed by organizations competing in these markets. The next section will outline the scale and character of the changes which occurred in defence equipment markets during this period, before the research question is defined in more detail.
1.1 Defence Markets and the End of the Cold War

1.1.1 Global Changes

The political significance of the end of the Cold War was apparent from the fact that it produced the most profound and sustained decline in global arms expenditure since the end of the Second World War (Wulf 1993a; p3). From 1987, when global arms spending peaked at $1,000bn, until the early 1990's, global arms expenditure declined by over 15% (Ball et al 1994). While expenditure on weapons development in the USA, USSR, France and the UK did vary during the Cold War, the changes in spending levels which followed the end of the Cold War were more significant and abrupt than any other variation during this period. In the USA, for example, following the Vietnam war defence spending declined by one third, however this reduction occurred over an extended period with relatively little effect on the military spending of other nations (Gansler 1984; p12). However, the USA's level of spending on defence equipment was such that even after this reduction it was still one of the industrialized world's highest proportional spenders on defence. Thus during the approximate 45 years that the Cold War lasted these nations devoted consistently high levels of spending to weapons development and production. It has only been following the end of the Cold War that global defence expenditure has been reduced so significantly. The figures for defence expenditure in Western Europe show a similar pattern of decline, which has also had a substantial impact on employment levels. For example, between 1988-90 employment in Western Europe's defence industrial base declined by over 300,000 (Anthony & Wulf 1992).

1.1.2 UK Changes

Throughout the Cold War, as will be shown in chapter 3, the UK government was consistently one of the highest spenders on the development and
production of defence equipment (Coates 1994, Dunne & Willett 1992). This may therefore partly explain why defence spending in the UK declined by more than the global average following the end of the Cold War. In the UK the reduction in government defence expenditure predated the end of the Cold War by a few years, beginning in the mid 1980's (Dunne 1993; p95). Whether considering the proportion of GDP spent on weapons or the absolute size of the defence budget, it is apparent that there has been a large reduction in defence expenditure since this time. In terms of GDP, the proportion spent on defence declined from 5.6% in the mid-1980's to 3.6% in 1993/94 (Cm 2501, Cm 2801). Similarly, using prices fixed at 1994/195 levels, the UK's total defence budget declined from £28.8bn in 1985/86 to £22.5bn in 1994/95, a reduction of almost 22% (DS 1996, Table 1.2). Employment in the UK's defence industrial base also declined substantially dropping from 550,000 in 1990/91 to 360,000 in 1994/95, a reduction of approximately 35% (DS 1996, Table 1.10). Thus large numbers of workers have directly experienced the negative effects of these events.

Defence spending in the UK began declining in the mid-1980's as it was then that the UK government changed its equipment procurement system. These changes, termed the Levene Reforms, were introduced primarily in response to spiralling increases in the cost of defence equipment (Laurent 1991). While the absolute level of the UK's defence budget was reduced the main focus of these changes was to make the equipment procurement system more economically efficient through placing a greater emphasis on cost control. This was achieved by a number of measures: passing greater cost and technical risk to industry through changing the contract system: increasing the level of competition for equipment programmes by allowing foreign companies to bid for UK contracts: increasing the number of collaborative projects: and encouraging UK's defence equipment manufacturers to increase their level of exports (Lovering 1995, Taylor 1992, Gummett & Walker 1989). While these changes predated the end of the Cold
War by a few years, the shrinkage in defence spending that occurred in the early 1990's made these changes extremely pertinent. Thus the period following 1985 has been one of substantial change in the UK's defence equipment markets.

Unsurprisingly, therefore, the defence industrial base of the UK changed dramatically, with most defence equipment manufacturers responding to these events by introducing some substantial changes. These have been wide ranging and included: large redundancy programmes, where employment levels were reduced drastically; internal restructuring programmes, where new operating practices were introduced; mergers, acquisitions and the formation of strategic alliances with other companies; and the refocusing of business through increasing exports (Wulf 1993c, Brzoska & Lock 1992).

However, one strategy which none of the UK's largest defence equipment suppliers have pursued has been to diversify organically through adapting their capabilities or products to non-defence markets. Given the level by which defence spending declined, and the massive level of uncertainty which followed the end of the Cold War it is somewhat surprising that no UK companies have even attempted such a strategy. This research was initially intended to examine the process of diversification, as it was expected that some of the UK's defence equipment manufacturers would have attempted to diversify, but as this was not found to be the case the focus of the research changed.

The research was stimulated by my own personal experiences at the old Ferranti company in Edinburgh, where I worked as an engineer designing defence equipment for four years, in the period from 1988 until late 1992. Thus I witnessed and experienced in an extremely direct way how the end of the Cold War could affect defence equipment manufacturers and their
workers. Following the end of the Cold War, Ferranti, which by this time had become a part of GEC, experienced the uncertainty and reduction in spending which this period produced, and the company made a significant proportion of its workforce redundant. In response to these job losses the local trade unions began a campaign to encourage the company to diversify. While the campaign raised diversification as an issue it was unsuccessful in persuading the local management to invest to any significant extent in diversification efforts. Thus when I decided to begin a PhD in 1993 I was interested to compare the response of Ferranti's management in Edinburgh to that of other companies which had also been negatively affected by the end of the Cold War.

Following initial searches aimed at identifying relevant companies it became apparent that none of the UK's major defence equipment manufacturers had attempted to diversify, therefore the focus of the research shifted to consider what strategies they had pursued. Implicit in the design of the research is therefore the issue of why diversification was not pursued. The lack of attempts to diversify raised the question of whether it really was a feasible or realistic strategy for the companies examined to pursue. A common answer to this question is no, it is not feasible, primarily because the character of defence markets results in the capabilities of defence equipment manufacturers not being relevant or transferable to other market environments. Therefore, the focus of the research became the relationship between the defence market environment and organizational capabilities and behaviour. The following outlines the focus of the research in more detail, showing why the theories considered were relevant to the subject considered.
1.2 Organizational and Environmental Change

The main focus of this research was to examine the relationship between organizations and their operating environment, looking at how they mutually influenced each other. The research considered how the character of an organization's operating environment shaped its operating practices, structures and capabilities, and the extent to which organizations could shape their environment. Thus the relationship was not assumed to be unidirectional with companies simply reacting to environmental changes, but with companies seen to be active elements in their operating environment possessing the ability to influence its structure and character.

The UK's defence markets in the period immediately following the end of the Cold War provided an excellent environment to study this due to the significance of the environmental changes which have occurred. As is apparent from the above figures, the decade from 1985-95 was one of very significant change in defence markets. In the UK not only did the absolute level of demand decline significantly, but the government also introduced large changes to the way it managed its defence equipment procurement system. Therefore this provided an ideal opportunity to study the relationship between environmental change and organizational behaviour.

However, there was another equally significant reason why defence markets were relevant for studying the relationship between organizations and their operating environment. It is often argued that during the Cold war the operating environment in defence markets was highly distinctive, with very different characteristics from other non-defence markets. For example, it was argued that in defence markets there was much less emphasis on controlling equipment costs, that effective competition was limited and that the relationship between government and industry was untypical of customer supplier relations in other markets. It has further been argued that these
environmental characteristics shaped the capabilities and operating practices of companies in particular ways which made these companies unsuited to operating in other market environments (Berkovitz 1994, Dunne & Willett 1992, Maddock 1983). The research therefore also provided an opportunity to examine these assumptions. The relatively static character of the institutional structures and operating priorities in defence markets, which predominated almost unchanged for the whole of the Cold War provides a stark contrast to the rapidity and extent of change which has occurred in these markets since the late 1980's. The relationship between the organizations examined and their operating environment was therefore considered both during the relative stability of the Cold War and the turbulence of this later period.

The two main theories of organizational behaviour examined are evolutionary economics and contingency theory. The relevance of these theories is that for both the relationship between a firm and its operating environment is considered to be a central factor shaping the firm's behaviour, structures and capabilities. The heterogeneity of the defence market environment has meant that there was a large comparative element to the research with a wide range of companies from different parts of the defence industrial base being examined. To achieve this a two dimensional comparison was undertaken. Firstly, companies from three separate product sectors were examined, with the aerospace, electronics and vehicle sectors being examined. Secondly, a further comparison was made within each sector, looking at the different tiers which exist, comparing the large prime contractors, responsible for the design of complete equipment systems, to small component suppliers, responsible only for the design or manufacture of distinct components.
1.3 Evolutionary Economics - What's Examined and What's Found

Evolutionary economics, as developed by Nelson & Winter (1982), considers the relationship between an organization and its operating environment to be central in shaping its capabilities, structures and behaviour. One of the main elements of the research was therefore to examine these ideas within the context of the UK's defence markets, with the research supporting many of the arguments made, both in relation to the importance of the operating environment in shaping organizational capabilities and the specificity of organizational capabilities. The research showed that many of the arguments concerning the distinctiveness of the defence market environment during the Cold War were true and that the capabilities of the companies examined had been shaped in very particular ways as a result. Firstly, for example, the manufacturing systems in many of the companies considered had developed during the Cold War without being constrained by any strict cost imperative, which had resulted in them taking very particular forms and their cost efficiency being low. Similarly, the sales and marketing capabilities of the largest companies examined were also shaped by the very particular customer relations which predominated within these markets.

Secondly, the sectoral and sub-sectoral comparison highlighted the heterogeneity of the defence operating environment, as substantial differences in its character were found, shaping the capabilities of the companies examined in different ways. As suggested by Pavitt (1984), sectoral patterns of technical change were found, with the source of technical change, the technical trajectory being pursued and the relations between military and non-military technological developments varying greatly between sectors. While in the electronics sector the boundary between military and non-military technology was relatively indistinct, with similar trajectories being pursued in the military and non-military sectors, this was different from the aerospace and vehicle sectors. In these sectors military
and civil technical developments were more distinct, with noticeably different technological trajectories. Important sub-sectoral differences in the operating environment of the organizations examined also shaped their capabilities in different ways. For example, while the operating environment at the level of the prime contractors was extremely distinct, displaying characteristics specific to defence markets alone this was not found to be the case for the component suppliers examined. For them the character of their military customers were not significantly different from those of their non-military ones, thus for companies operating at this level there was little distinction between military and non-military markets.
1.4 Contingency Theory - What's Examined and What's Found

Contingency theory was used in the research to examine the relationship between organizational strategy and the operating environment. Contingency theory, like evolutionary economics, argues that a firm's operating environment will be an important factor shaping and constraining the strategies they pursue. Specifically the research examined the extent to which organizational strategy was shaped by environmental factors and the extent to which organizations could control their strategy independently of these constraints. The debate was largely focused around the issue of 'strategic choice' (Child 1972), with this research concluding that while environmental factors can place significant constraints on organizational autonomy, organizations still possess an element of freedom to control/shape their strategy. However, the level of autonomy possessed was found to vary greatly dependent upon which part of the organization was examined.

The degree of strategic autonomy possessed by the companies examined was found to vary significantly, dependent upon whether the corporate or divisional level was being examined. As most of the companies examined were divisions of larger corporations this was an important issue. It was found that most strategic autonomy existed at the corporate level, as it was there that the broad strategy of multi-divisional corporations was decided. However, at the divisional level, which was where the research was primarily focused, there was considerably less strategic autonomy. At this level management autonomy was constrained by the requirement to implement corporate level policies. Thus, at divisional level, strategic autonomy was limited to controlling the particular methods by which corporate level policies was implemented. For example, in GEC, the policies adopted by the two defence divisions examined, were substantially constrained by the policy
decisions which were passed down from the corporate level, which was typical for virtually all the companies examined.

Unsurprisingly perhaps, the UK government played the most significant role in these markets, with the particular policies and priorities pursued having a significant effect on the strategies adopted by the companies examined. The policies adopted by the UK government were to encourage market led solutions to defence industry restructuring while simultaneously supporting and encouraging the export efforts of the UK's largest defence companies. This led to the vast majority of the UK's major defence manufacturers undertaking some form of organizational restructuring. In comparison with France, where there has been greater government support to retain defence industry jobs, the level of industrial restructuring in defence has been substantially lower than in the UK.

One of the most noticeable aspects of the defence industry restructuring which occurred in the UK was the remarkable similarity in the strategies pursued by virtually all of the companies examined. The main elements of their restructuring programmes were to: undertake large redundancy programmes, where workforce levels were substantially reduced; remain focused on defence markets and not diversify out of defence markets to any significant extent (except at the corporate level through acquisitions); and to implement internal restructuring programmes where operating practices were modified. The similarity in strategies could be interpreted as suggesting that environmental factors were significant in shaping the strategies pursued and that the level of strategic autonomy possessed was limited. However, while it was recognized that, to a large extent this was the case, there were also other factors at play which helped explain the similarity in organizational behaviour. Using Child's concept of 'sectoral recipes' (1987), the similarity in behaviour examined is explained by the ways in which organizations competing in the same sector interact and share information, resulting in the
development of similar perceptions concerning their environment. Thus the similarity in strategy that was observed was not explained solely in terms of the constraints imposed on the company's by environmental contingencies.
1.5 Thesis Structure

The final section of the introduction outlines the structure of the thesis, showing how the argument is developed within each chapter.

Chapter two of the thesis, as indicated by its title, has two focuses, developing both the theoretical questions considered and the research methodology adopted. Firstly it provides a more detailed outline of the specific questions addressed, relating them to both of the main theories examined. Therefore this section of the methodology chapter considers the theoretical foundation on which the research is based. Secondly the research methods used are outlined before consideration is given to their potential limitations. In chapter three the focus shifts substantially, examining the history of the UK's defence industries during the Cold War. This chapter therefore details the particular character of the operating environment in these markets during the period of the Cold War, outlining both how the UK government acted to retain and develop a broad base of industrial capabilities and the priority attached to pursuing a technological trajectory based on the incremental improvement of equipment performance. This chapter finishes by outlining the character of the Levene reforms, showing how they produced a substantial change in the character of the UK's defence markets.

In chapters four, five and six the main empirical evidence on the post-Cold War experiences of the companies examined is provided. Thus these three chapters provide the empirical core of the thesis. The chapters are divided sectorally, as this is one of the main dimensions of the comparison undertaken, thus the aerospace, vehicle and electronics sectors are examined separately. The internal structure and subject focus of these chapters is very similar in order to make cross sectoral comparisons straightforward. The subject focus within these chapters is as follows. Firstly
they outline how the end of the Cold War affected both the level and character of demand. Secondly, they show how the companies examined were affected by these changes, comparing these experiences with those of the general sectoral responses of a much wider range of companies, both domestic and international. Thirdly, these chapters provide details on the strategic responses of the companies examined, where the similarity in the strategies pursued becomes apparent. Finally, these chapters examine the character of the capabilities possessed by the organizations examined, relating them to the specific character of their operating environment.

In chapter seven the findings from the empirical chapters are analyzed in relation to the theories outlined considering the capabilities and strategies of the organizations examined separately. One of the main focuses is to consider the ideas proposed by evolutionary economics with these ideas generally being supported by the empirical evidence, with the capabilities of the organizations examined being shaped by the character of their operating environment. Further, as outlined above, the sectoral and sub-sectoral comparisons undertaken further supported these arguments as it was shown that the differing character of the defence operating environment did shape the capabilities of organizations in different ways. In general it was concluded that the specific nature of the capabilities possessed by the organizations examined would make radical changes in market difficult to successfully achieve. In another major section of the analysis chapter the factors shaping the strategies of the companies examined were considered, with it being found that, again there were significant environmental constraints on organizational behaviour. However it was concluded that the organizations examined did possess an element of autonomy in shaping their strategy as the inherent uncertainty of organizational information means that a degree of interpretation is required by companies, introducing a significant element of subjectivity to organizational decision making.
CHAPTER 2

THEORY, METHODS AND RESEARCH DESIGN

2.1. Introduction

The purpose of this chapter is firstly to outline the central questions of the research, relating them to the two main theories examined and to secondly discuss the methodological questions raised by the research methods used. In section 2.2 the main questions examined and their relationship to the relevant theories will be considered. Following this section 2.3 will then show why the heterogeneous nature of the defence industrial base makes a comparative study important. Finally section 2.4 outlines the research methods used, considering both the methods for selecting companies and the main data collection methods.
2.2. Research Questions and Theory

The central issue examined by the research is the relationship between the capabilities and strategy of organizations and the character of their operating environment. The context of the study being the UK's defence industrial base in the period following the end of the Cold War. As outlined in chapter 1 (see section 1.2) this period and market environment provided a good opportunity to examine these issues. In this section the two main theories utilized during the research, evolutionary economics and contingency theory will be examined separately, where their relevance to the focus of the research will be outlined.

2.2.1 Organizational Capabilities and the Selection Environment - The Relevance of Evolutionary Economics

One of the main issues examined is the way in which the capabilities of the organizations examined were shaped by the characteristics of their immediate operating environment. Given the significance of the environmental changes which have occurred this will be done dynamically, examining how organizations were affected by and responded to the changes in their operating environment following the end of the Cold War. The relevance of evolutionary economics to this research is that one of its central tenets is that organizational capabilities and behaviour evolve through organizations interacting with and interpreting their selection environment (Blauwhof 1995; p102). Thus the relationship between the selection environment and the character of an organization's capabilities is assumed to be close.

Evolutionary economics developed as a challenge to neo-classical economics, which is believed to be based on a number of inaccurate assumptions (Dosi et al 1988). One of the fundamental differences between
neo-classical and evolutionary economics is in the way that organizational and technical change are characterized. In neo-classical economics technical change within organizations is considered to be instantaneous and straightforward (Coombs et al. 1987, Clark 1985; ch5). Organizations are assumed to be rational, profit-maximizing actors, selecting the optimum production technology, with the optimum changing automatically as the production function and factor costs change. Thus change within organizations, even substantial change is assumed to be unproblematic (Elster 1983, ch4). Evolutionary economics challenges the 'unrealistic' nature of these assumptions in a number of ways (Coombs et al. 1992). Rather than firms being profit maximizers, endlessly searching for methods of improving their efficiency, firms were seen as 'satisficing', following patterns and routines and being content with an adequate level of performance (Nelson & Winter 1982, Coombs et al. 1987). The satisficing nature of firm behaviour also means that organizational searches (for ways to improve organizational performance) tend to be localized and limited in nature (Mackenzie 1992; p26-30). This type of behaviour is related to the nature of organizational knowledge, which is often constrained and local (Coombs et al. 1992; p6), specific (Metcalf & Boden 1992) and cumulative in character (Pavitt 1987, 1991). Uncertainty is therefore a normal part of organizational decision making. Firms cannot change technological and organizational behaviour instantaneously and easily in response to environmental changes, and technological change has a 'path dependent' nature (Rosenberg 1994). Thus what firms can do in the future is assumed to be very much constrained by what they have done in the past.

The central focus of the research is on the relationship between organizations and their environment, and therefore this is the aspect of evolutionary economics which will be examined. The importance of the selection environment in shaping the capabilities of organizations is that it is through competition within a market type selection environment that
organizations evolve (Metcalfe & Boden 1992). Thus one of the main ways in which the selection environment influences organizational capabilities and behaviour is through the particular character of competition. This refers not only to the intensity of competition, but also to the type of competition (the definition of 'worth' (Nelson & Winter, 1982; p266)). The research examines the market and technological components of the selection environment, as for the industries examined they represent its most important elements. The research therefore examines both the character of organizational and technical change and the nature of the relationship between organizations and their environment, factors which are closely linked.

The relevance of studying the relationship between organizational capabilities and an organization's selection environment in the context considered is related to assertions that the distinctive character of the UK's Cold War defence market environment had a significant impact on the capabilities of companies competing within these markets. In the UK's defence markets during the Cold War, as will be shown, greater priority was attached to improving equipment performance than controlling or reducing equipment costs (Kaldor 1983), which meant that these markets were not governed by any strict cost control mechanism (Lock 1995). The impact of these priorities on companies operating within the UK's defence equipment markets, combined with the other distinctive features of these markets (see below) has been argued to be substantial and wide ranging. For example, this is argued to have resulted in: companies placing a greater emphasis on product rather than process innovation (Dunne & Willett 1992; p16); the rate and direction of technical change in these markets being extremely specific with little relevance to non-military markets (Harbor 1991); the development of large administrative functions (Berkovitz 1994); and the development of very particular sales and marketing practices. Examining these assumptions therefore constitutes a significant element of the research.
The reforms made to the UK's defence equipment procurement system from the mid-1980's onwards, combined with the decline in levels of demand for arms which followed the end of the Cold War significantly changed the character of the UK's defence market environment. Therefore this is the main period under consideration and the majority of the data collected is related to the period from 1989 to 1995. A large part of the empirical focus is on the way in which the organizational capabilities of the companies considered have been adapted in response to these changes, viewing organizational capabilities as malleable rather than fixed entities. Considering how organizations modify their capabilities in response to environmental change relates issues of strategy to those of organizational capabilities. The way a firm interprets its environment will shape the way it behaves and responds to environmental change. Therefore firm strategy is an important mediating element in the relationship between organizations and their environment.

2.2.2 Organizational Strategy - Environmental Determinism versus Strategic Choice

The research also examines the extent to which organizational strategy and behaviour is constrained and shaped by environmental factors, considering how the strategies pursued since 1989 were related to changes within the firms' selection environment. Contingency theory represents the most relevant theoretical focus for this as it is centrally concerned with the relationship between organizational behaviour and environmental contingencies, and constitutes one of the most extensive bodies of research in this area (Brown 1992).

Contingency theory in its strongest form has very deterministic overtones (See Donaldson 1985, 1988), suggesting that needs or imperatives within
the selection environment of a firm determine the most suitable form of organizational structure (Thompson & McHugh 1995; p69). These ideas are based on the 'one best way' logic, where for any organizational environment there is assumed to be a single most suitable way in which to organize and structure organizations. Thus, on the basis of these assumptions the design of 'efficient' organizations is a technical operation where a firm's structures and operating practices are adjusted to the particular character of the operating environment (Hinings 1988). The questioning of these ideas began in the 1970's and built into a significant debate, in which many of the foundational assumptions of contingency theory were brought into question (Reed 1992).

One important article by Child (1972) challenged the over-determinism of most contingency theory research by arguing that firms possess a significant degree of strategic choice, in relation to environmental constraints, to pursue a range of possible strategies. While it is still acknowledged that there are 'objective conditions' within any market which constrain organizational behaviour, firms never-the-less possess a significant element of strategic choice to define and control their organizational structures and strategic priorities (Child & Smith 1987). Thus the research considers the extent, origin and character of the environmental factors which constrain and shape the organizational strategy.

In chapter 7 the focus is largely on the constraints imposed on organizations from central government and on the relationship between individual divisions of corporations and the corporate centre. The focus on government is due to the significance of its role in defining and shaping both the market and technological environment in which companies producing defence equipment operate. The research therefore examines the ways in which the UK government, through its multiple role in these markets, constrains and
shapes the behaviour of the companies examined. Examining the relationship between individual companies and their corporate owners allows consideration of how the corporate centre constrains divisional autonomy and how control over strategy and decision making varies greatly at different levels within a corporation. As the vast majority of the companies examined were divisions of larger corporate groups this was an important factor shaping the strategy of divisions examined.

2.2.3 The Selection Environment

In the broadest terms the selection environment of any organization includes all external factors which impinge on, shape or constrain it. While this definition is extremely general, providing a more precise definition is difficult due to the wide range of heterogeneous factors which can be included. For work organizations the most obvious component of their environment is their immediate product market, the characteristics of which significantly shape organizational behaviour. A more complete definition of any organization's environment, however, should include elements such as technological factors, labour market characteristics, labour relations, geographical factors, as well as the broad legal, regulatory and political framework within which organizations operate (Thompson & McHugh 1995; p62). In this research the market and technological components of the selection environment are examined as they represent the most significant environmental factors impinging on the organizations considered.

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1 As well as being one of the most important and powerful customers to the UK's defence equipment manufacturers the UK government influences these markets in other ways. Firstly, it controls the procurement system, which defines the character of competition and the type of contractual relationship which is used. Secondly, through more general industrial policies the government can also exert and influence over these markets, for example through supporting (or not) the export of defence equipment and encouraging (or discouraging) defence equipment manufacturers to diversify.
The importance of technological factors in shaping the capabilities and behaviour of companies designing and producing defence equipment is because, as outlined in chapter 3, one of the main priorities of defence policy in the UK throughout the Cold War was the attempt to retain technological parity with the USA and USSR in military equipment. This not only resulted in a trajectory of technological development which produced incremental improvements in successive generations of defence equipment, but was also a significant factor shaping both the structure of the industrial base and the internal operation of organizations. The importance of market factors, as outlined above, is due both to the very particular characteristics of defence markets and the dramatic changes which have occurred in them since the mid-1980's. These changes have been the fundamental stimulus driving the changes in the organization of defence equipment production.

Both environmental factors considered are sub-divided into a number of separate elements to allow for a more detailed examination of their influence on the organizations studied. Thus the range of market factors include the market structure (on the supply and demand side), the level and character of competition and the character of market demand. Similarly, the technological environment can be sub-divided to consider the range and type of technologies required to design products, the source, direction and rate of technical change and the volume of production and type of manufacturing systems required. The research compares companies from three different product sectors and three different levels within each sector as the character of both the market and technological environment of the defence industrial base is not homogeneous (see following section).

While primarily considering how the character of a firm's environment impacts on its behaviour and structures it is acknowledged that this relationship is not uni-directional, and that organizations also have the ability to partially control and shape their environment (Dawson 1992; p96-102).
The power of large organizations to exert some control over their environment was an idea made popular by Galbraith (1972), which has been supported by a substantial amount of evidence from a wide range of industries. Thus the research will also consider the ability of organizations to influence their environment e.g. by lobbying customers to increase their spending levels or changing the structure of their markets through acquiring their competitors.
2.3 The Heterogeneity of the Defence Environment

This section outlines the heterogeneous nature of the defence industrial base, showing that, in order to examine it fully it is necessary to consider its different elements. This is achieved by firstly defining the character and boundaries of the defence industrial base before outlining the element of it that is examined in this research. Following this the rest of this section will show why the comparison examines both sectoral and sub-sectoral differences in the defence industrial base. While the research considers only one part of the defence industrial base, focusing on companies involved in the design and production of specific military equipment, this part is itself large and heterogeneous: the character of the market, the type of company and range of products developed and manufactured is highly varied. This requires the examination of a range of different product sectors, comparing how the differences in the character of the operating environment affect organizational behaviour and structures. The research not only examines the differences which exist between product sectors, but also the differences within product sectors, as the available data suggests that for both of these dimensions substantial differences in the character of the operating environment exist. This section therefore starts by defining the element of the defence industrial base examined before outlining the sectoral and sub-sectoral differences which exist in the defence industrial base.

2.3.1 Characteristics of the Defence Industrial Base

In the broadest terms the UK’s defence industrial base is extremely large, including all companies which supply equipment and services to the ministry of defence (MoD) (Taylor & Hayward 1989; p1). This is apparent from the fact that in 1991 over 11,000 companies were registered MoD suppliers (Cm 1559, 1991), and that in 1993-94 almost 400,000 people were employed in it (DS 1996, table 1.10). Defining the exact boundaries of the defence
industrial base however is problematic, and in reality difficult to achieve (Dunne 1995). For example, do companies which supply a missile manufacturer with furniture, raw materials such as sheet metal or guidance systems all constitute elements of the defence industrial base? For the purposes of this research the extreme boundary of the defence industrial base is defined to include companies directly involved in designing and supplying specific components of military equipment platforms, but not those who supply raw materials or equipment and components which are not a direct part of the system being designed. Therefore the company supplying guidance systems to the missile manufacturer is considered an essential part of the defence industrial base while the other two are not.

There are a number of ways in which this large and extremely heterogeneous range of companies can be classified, for example by their level of defence dependency, by whether the equipment being supplied is for lethal or non-lethal purposes or by the extent to which equipment is specific to military requirements (Hartley & Hooper 1995; p5-13). One of the clearest, simplest and most useful classification systems, and the one used in this research, was developed by Thorsson (1984). This system is based on the extent to which products are designed for specifically military applications, producing three broad categories of company. Firstly there are companies supplying products with no specific military characteristics. This category of products, which includes items such as food or stationery, are supplied to both commercial and military customers, with the military customer acquiring them in a totally unmodified form. The second category of company includes those who supply commercial products which have been modified to some extent for military usage. A good example of a company in this category is Land Rover, who supply their military customers with commercial vehicles which have been modified to meet a number of specific military requirements such as armour protection. The third and final category of company are
those who supply products which has been designed specifically for military purposes, and which therefore have little or no relevance in other markets.

Using this system the element of the defence industrial base examined was that which included category three companies, i.e. companies involved in the design and manufacture of specific military equipment. This constitutes the majority of the defence industrial base and is an extremely significant component of it. For example, spending on this category of equipment accounted for over £9bn of the 1995/96 defence budget (which totalled £21.7bn) (DS 1996, table 1.2). The main reason for focusing on only this element of the UK’s defence industrial base was that it is this part which is most strongly influenced by the character and imperatives of the defence operating environment, and which is therefore the most relevant part for examining the relationship between organizational behaviour and the defence operating environment.

As outlined above the supply base of companies involved in the design and manufacture of specific military equipment is extremely large and heterogeneous involving over 10,000 (extremely different) companies in a wide range of very different tasks. The rest of this section will therefore outline the main sectoral and sub-sectoral differences in the character of the defence environment to show the relevance of using these factors as the main dimensions of the comparison.

(a) Sectoral Differences
Comparing product sectors shows that significant differences exist in both the market and technological environment of the defence equipment supply base. Gansler (1984, 1991), based on research in the USA, found significant differences in both the demand side structure of defence markets and the level and type of competition which exists in different product sectors. Therefore, whether considering aircraft, missile or ship production the
defence market environment is likely to vary considerably. Important sectoral
differences also exist in the character of the technological environment,
further suggesting that this an important variable to examine. For example,
both Gummett (1990) and Dussauge (1987) argue that the relationship
between developments in military and civil technologies can vary significantly
between sectors. This suggests that the character of technical innovation
may show sectoral differences, which is an argument also made by Pavitt
(1984). The research therefore considers the significance of these sectoral
difference by examining companies from the aerospace, electronics and
vehicles sectors.

These three sectors were chosen for two main reasons. Firstly they
represent three of the largest and most important sectors of the defence
industrial base. This is especially true for the aerospace and electronics
sectors which, according to one source received over 50% of the UK’s
defence equipment expenditure in 1987-88 (Wulf 1993b; p150). While official
government figures from the mid 1990's (Table 2.1 below) do not show these
sectors receiving such a high proportion of the defence equipment budget
they were still the largest sectors in terms of funding levels, receiving a
combined 36% of the equipment budget. While the vehicle sector was only
the fifth largest sector in terms of funding levels it is also still one of the most
significant sectors of the UK’s defence industrial base. The second reason
for selecting these three sectors was that there were significant differences
in the character of both their market and technological environment, making
an effective comparison of environmental characteristics possible.
### Table 2.1 UK Defence Equipment Expenditure 1994 (Source DS 1995)

<table>
<thead>
<tr>
<th>Sub-sector</th>
<th>Absolute Expenditure (£m)</th>
<th>Proportion of Equipment Spending (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>2,427</td>
<td>23</td>
</tr>
<tr>
<td>Electronics</td>
<td>1,309</td>
<td>13</td>
</tr>
<tr>
<td>Construction</td>
<td>1,208</td>
<td>12</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>1,020</td>
<td>11</td>
</tr>
<tr>
<td>Vehicles</td>
<td>423</td>
<td>4</td>
</tr>
<tr>
<td>Ordnance</td>
<td>318</td>
<td>4</td>
</tr>
<tr>
<td>other</td>
<td>3,650</td>
<td>33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,355</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

(b) Sub-Sectoral Differences - the Pyramidal Product Hierarchy

There is an adequate body of evidence to suggest that there are important sub-sectoral differences in the character of the defence market and technological environment. Modern weapons systems have reached such a level of technical sophistication that they constitute extremely complex technological systems, made up of thousands of components and sub-systems. The technical demands of designing, manufacturing and integrating these systems is such that the structure of the industrial base required to produce these systems is primarily shaped by these requirements (Walker et al 1988, Gummett 1990). The industrial base of companies involved in the production of specialized defence systems is structured into a pyramidal hierarchy consisting of a number of distinct tiers (Walker et al 1988). For the purposes of this research, as with Gansler (1991; p239-40), a hierarchy of three tiers was used. At the apex of the pyramid, occupying the top tier, is the prime contractor, the company responsible for the design, manufacture and integration of the complete weapon system. The second tier consists of

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2 Walker et al (1988) developed a hierarchy with seven different tiers, however this was too difficult to operationalize as the differences between many of these categories was so small that placing the products of the companies examined into them was extremely difficult.
companies producing major sub-systems. In the aerospace sector, for example, a company producing radar, navigation or communication systems would be placed in the second tier. Finally, the third tier is made up of companies supplying individual components to the first and second tier companies.

At each tier significant differences were found in both the market and technical environment. As the hierarchy of tiers is descended the complexity and the technological character of the products changes (Walker et al 1988). While the prime contractors at the top tier are involved in the integration of complex technological systems (Schofield 1992), companies at the third tier in general produce more simple, discrete components. The pyramidal structure of defence markets is also related to the differing market characteristics at each tier. At the top two tiers the market structure tends to be oligopolistic, with only a limited range of companies competing against each other. At the third tier however a much larger number of companies are involved in the production of the vast number of components required in contemporary military equipment. Therefore at this tier there tends to be a greater number of competitors. For example, in a study of companies involved in the Eurofighter project over 500 companies were identified as being involved at the third tier (HC 563). Thus many of the market characteristics identified as being particular to defence markets, such as specialized customer relations (Gummett & Reppy 1990) and limited numbers of competitors (Markusen & Yudken 1992) are typical only of the top tiers of defence markets. These ideas are further supported by empirical research which has examined the circumstances of companies operating in the lower tiers of defence markets (for example, Oden et al 1993, Hankinson 1993). The character of the market at each tier was so distinct that the methods required to identify and select companies varied greatly, which is the issue examined in the following section.
Thus, to summarize, the research will provide a two dimensional comparison of different parts of the defence industrial base involved in the production of specialized military equipment. Undertaking such a comparison allows an examination of how the organization-environment relationship varies between parts of the defence industrial base with different environmental characteristics. The defence industrial base was separated into distinct product sectors, and at the sub-sectoral level into different tiers. Three different product sectors were to be compared, with the aerospace, electronics and vehicles sectors being the three selected. Each sector was then sub-divided into either two or three distinct tiers. A comparison was therefore made at both the sectoral and sub-sectoral levels.
2.4. Research Methods

This section will outline the research methods used. This will be done in two main sections with section 2.4.1 outlining the methods used to select the companies which were examined and section 2.4.2 detailing the data collection methods used.

2.4.1 Methods for Selecting Companies

The differences in the character of the market environment between the three tiers examined meant that the selection methods used to both identify and select companies for participation varied greatly. Therefore this section will be divided into two parts, examining separately the methods used to select companies from the upper and lower tiers of the product hierarchy.

(a) Identifying and selecting first and second tier companies

Due to both the high levels of concentration at the top tiers of defence markets (Smith 1989, Taylor & Hayward 1989) and the relatively large size of the companies which operate at these positions identifying the total population of relevant companies was not a problem. Thus from a wide range of public sources (see Appendix 1) it was relatively straightforward to produce a list of the most relevant companies. For the aerospace and electronics sectors approximately 20 separate businesses were identified as operating in the top two tiers of each sector, while in the vehicle sector five companies were identified as being prime contractors operating in the top tier (see Appendix 2). Companies were classified into tiers based on their customer relationship. If they dealt directly with the MoD and had

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3 This list of aerospace companies was produced at the end of 1994, with the vehicle and electronics sector lists being produced in the middle of 1995, and are accurate at these dates. Since then a number of corporate changes have occurred, for example with Dowty's defence divisions being restructured following the company's acquisition by the TI group.
responsibility for managing complete equipment projects they were classified
as prime contractors and were considered to be first tier companies. On the
other hand, if they were predominantly sub-contractors who dealt directly
with the prime contractors they were considered to be second tier
companies. For the second tier companies, due to the fact that many of them
were multi-product companies operating in a range markets, classifying them
into either the aerospace or electronics sectors was also difficult. The way
this was achieved in the end was on the basis of their main product market.
For example, GEC Sensors produced both specialized avionics equipment
and other non-avionics equipment, but they were classified as being in the
aerospace sector as the vast majority of their business was in aerospace
markets. While avionics equipment can be considered as constituting a
specialist sub-sector of the electronics sector it was decided to distinguish
between companies producing avionics and non-avionics equipment. The
reasons for making such a distinction were both technical and market based.
The technical distinction between avionics and non-avionics equipment was
due to the greater technical demands placed on avionics equipment due to
the hostility of the environment this equipment is required to operate in,
which, in general, is more severe than for non aerospace applications.4 The
market distinction between the aerospace and electronics sectors is that the
prime contractors in each sector are different, therefore the relationship
between prime contractors and second tier companies may also be
significantly different.

While it was possible to examine all the major companies in the vehicles
sector and at the top tier of the aerospace and electronics sectors the
number of companies in the second tier of both the aerospace and vehicles
sectors was too large to allow all companies to be examined. Therefore at

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4 The increased technical demands are due to a number of factors. Firstly the vibration levels avionics
equipment must withstand are usually more severe than equipment designed for non aerospace
requirements. The aerospace environment also places very specific weight and space limitations on
avionics equipment.
the second tier it was necessary to select a representative range of companies to examine. It was decided that three companies at the second tier of each sector would be examined as this was both a practical number in terms of the time available to conduct the research and because this number of companies allowed a typical range to be examined. While over 20 companies were identified as operating in the second tier of both the aerospace and electronics sectors it was possible to divide them into two distinct categories (Taylor & Hayward 1989; p49).\(^5\) One category consisted of the dominant companies which received the largest proportion of the UK’s defence equipment contracts, while the other consisted of significantly smaller organizations which operated in narrow specialist niches, and which therefore receive a much smaller proportion of UK defence sales. It was decided to focus primarily on companies from the first category, as these companies received the largest proportion of the UK’s defence equipment budget and also because they were the largest, most economically significant. This made the process of selecting companies easier as the first category consisted of a small range of large companies. Those corporations categorized as being in this category include BAe, GEC, RACAL, Smiths Industries, Lucas Industries, Siemens Plessey and Northern Telecom (formerly STC).

To select a range of companies to examine all were approached, firstly by telephone calls, and then by letter. The companies were telephoned first in order to identify a relevant contact for correspondence. The most relevant contact was usually a senior manager with strategy or sales and marketing responsibilities.\(^6\) The advantage of identifying a specific individual was that this made following up enquiries much easier. Once an initial contact had been made in each of the companies they were all written to with more

\(^{5}\) Taylor & Hayward used the terms first and second tier companies to distinguish between the two categories they described.

\(^{6}\) This approach was used as initial postal approaches to non-specific company representatives had produced a very low return rate.
details of the research and the level of participation required from them. While this method of approaching companies was relatively successful, producing a positive response rate of over 50%, access was denied by a number of companies at this stage. The most significant corporations to which access was denied were Lucas Aerospace and Dowty Aerospace. In both cases the reason for not granting access was the same: they were in the process of restructuring their defence businesses when they were approached and were thus reluctant to grant access at that point in time.

This process therefore reduced the number of companies from which to select the three to be examined. The bounded nature of private companies means that negotiating access is an unavoidable concern (Bulmer 1988; p151), with the denial of access by some companies being a relatively uncontrollable factor (Buchanan et al 1988). The final selection process, where three companies from each sector were chosen from those agreeing to provide access was based on two main criteria. Firstly, as outlined there was a bias towards the largest companies, because they received the largest proportion of equipment spending and secondly, the selection was done to allow for a range of companies with different products to be examined. In the aerospace sector the second tier companies examined were GEC Marconi Navigation Systems, GEC Sensors and Smiths Industries Aerospace division. In the electronics sector only two second tier companies were examined, these being Cossor Electronics and Racal Radar.

The vehicle sector, unlike the aerospace and electronics sectors, was divided into two rather than three tiers. The reason for this was that in the vehicle sector there was not an adequate middle tier of large sub-system companies. While there are electronic sub-systems on military vehicles they were not of the same scale or level of technical sophistication as those in the other two sectors. For example, while military vehicles have electronic sub-systems such as communication systems, fire control computers and weapons sighting systems, these systems are substantially less
sophisticated than the sub-systems such as navigation systems and radars which exist in the aerospace and electronics sectors. The result of this was that there wasn't a distinct middle tier of companies operating in this sector. The vehicle sector was therefore divided into only two tiers, with the first tier containing the vehicle prime contractors and the second tier containing the complete supply base of companies involved in the design and production of components and sub-systems.

(b) Identifying and selecting third tier companies

As indicated above, the character of the defence industrial base at the level of component suppliers was very different from the top tiers, as the number of companies involved was significantly larger, and, in general, the companies were substantially smaller. This made it extremely difficult to identify the population of companies involved at this level from public sources. Therefore the methods used to identify and select these companies were very different from those used at the higher tiers. The problems involved in defining the boundaries of the defence industrial base at this level of defence markets (see section 2.3.1) meant that identifying the complete population of companies involved was problematic. This methodological difficulty resulted in this part of the defence industrial base being under-researched, with research on defence industries usually focusing on the larger companies operating at the top tiers (Schofield et al 1992). The definitional difficulties outlined above mean that the range of companies considered to operate at this level will vary significantly dependent upon the definition of the defence industrial base used (Sandler & Hartley 1995; p182-5). As the defence industrial base in this research is considered to consist of companies directly involved in the production of specialized defence equipment the best method of identifying a population of representative third tier companies was through gaining access to supplier lists of some of the larger companies examined.
In each sector the supply list from one of the major companies examined was used to provide a typical sample of companies. Using these lists a two stage approach was then used, with postal surveys initially being sent to a large number of companies while the second stage consisting of more detailed case studies involving between three to five companies in each sector. The case studies primarily involved site visits and interviews with senior management representatives. This method of identifying third tier companies is obviously dependent on the co-operation of one company in each sector to provide a list of suppliers, which was achieved in the vehicle and electronics sectors, but not the aerospace sector. Thus for the aerospace sector another method was required to identify an element of the supply base to survey. A suitable list of companies was found in a report produced by Lancashire County Council (LCC, undated). This report provided a list of aerospace suppliers in the Lancashire area in the early 1990's. From this list 45 relevant companies were identified, which was used as the sample population of suppliers for the aerospace sector. Table 2.2 (below) shows the number of companies surveyed in each sector, and the response rate achieved.

<table>
<thead>
<tr>
<th>Number of Companies surveyed</th>
<th>Aerospace</th>
<th>Electronics</th>
<th>Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45</td>
<td>85</td>
<td>125</td>
</tr>
<tr>
<td>Number of Usable Replies</td>
<td>19</td>
<td>26</td>
<td>56</td>
</tr>
<tr>
<td>Response Rate</td>
<td>42%</td>
<td>30%</td>
<td>45%</td>
</tr>
</tbody>
</table>

Table 2.2 Supply Base Survey Details

In the vehicle and electronics sectors not all the suppliers identified were included in the survey population as in both cases the complete population of suppliers extended to many hundreds of companies. These lists were reduced to the sizes indicated above by concentrating on suppliers who were
directly involved in the design and production of specialized defence equipment (ignoring companies supplying standard items such as stationary and office equipment etc) and who in the previous 2 years had received regular orders. The intention of the survey was to provide a brief insight into both the range of companies involved at this level of the defence industry and also consider how they had been affected by the changing level in demand in defence markets in the early 1990's. It was recognized that one of the problems with postal surveys was a potentially low response rate (Hall & Hall 1996; p100, Bailey 1978; p136). With this in mind the questionnaire was designed to be relatively short, simple and straightforward to complete (Fowler 1984; p53-55, see appendix 3). This was the main method used to optimize the response rate as there were inadequate time and financial resources to pursue extensive follow up procedures.

The second stage of the fieldwork was to conduct more detailed case studies with between three and five of the companies surveyed from each sector. The main factor shaping the number of case studies conducted was time, as this was the most significant constraint. As with the larger companies examined the case studies consisted of a single day site visit during which senior management personnel were interviewed, and, wherever possible, a tour of the company's facilities was done. From the surveys it was found that there were large differences between companies in terms of both their product types and their level of defence dependency. This diversity was such that by examining only three to five companies in each sector it was not possible to examine the full diversity of company types. As detailed in each of the empirical chapters, the surveys showed that at this level in defence markets a large number of companies had only a relatively small dependence on defence work. As the thesis is primarily concerned with

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7 In the full supply lists provided for both sectors there were a large number of companies considered to be active, current suppliers, but who had received very small or very irregular orders. In order to reduce the survey population to a manageable size these companies were not considered.

8 This was primarily achieved by using multiple choice questions as much as possible.
examining the effects of the defence operating environment on companies it was decided to focus the case studies on those companies which had the most significant levels of defence work. Thus in the vehicle sector, for example, while over 75% of the companies surveyed had less than 40% of their turnover dedicated to defence related work the emphasis in the case studies was not on these companies. Of the five suppliers examined in this sector only two had less than 50% of their turnover dedicated to defence related work.

2.4.2 Data Collection Methods

While the methods used to identify companies varied between tiers the data collection methods in all companies were identical. This section will detail the methods used while also considering their limitations. The data on companies was collected by two main methods: semi-structured interviews with senior management personnel and secondary documentary sources such as government reports and newspaper articles. Each of these methods will be examined separately before the section is concluded by considering the general limitations of the data that was collected.

(a) Interviews

The use of interviews as the main method of data collection was because this was the most effective method of establishing the type of information required. Interviews provided the best method of establishing both the details of how companies had been affected by the end of the Cold War (examining both strategy changes and changes in organizational structures) and attitudinal information on senior management (Allen 1991). The rationale for interviewing senior management personnel was that they possessed the relevant broad overview of their own companies that was required. They
were also likely to have some level of insight into the strategies pursued by their organizations.

Semi-structured interviews were used as this provided the most flexible format, with the potential for the interviews to develop in areas felt to be relevant by the interviewees (Brenner 1985). The intention was to make the interviews open enough that issues unforeseen by myself could be introduced and developed. For each interview a detailed schedule of issues and questions was prepared, however the interviews were conducted in a flexible way, allowing the interviewees adequate opportunities to pursue the issues they perceived to be relevant. The result of this was that there were significant differences in how each interview developed. This format was deemed to be successful as, while the character of each interview varied, I was still able to pursue all the questions and issues perceived to be important, making the interview data gathered comparable. In the largest companies examined interviews were conducted with a range of personnel from different functions or with different responsibilities, with between three to five people being the average number interviewed. The benefit of doing this was that it allowed for some triangulation to be done between interviews, reducing the reliance on the opinions of any single person.

One concern with interviewing only senior management personnel was that the information collected did not represent the full range of opinions within the companies examined and that the information collected may therefore have been biased towards senior management perceptions. However, this was not considered to be a major concern as the purpose of interviewing senior management personnel was, as outline above, precisely to establish attitudinal information on their perceptions and opinions. The importance of their perceptions and opinions is related to their involvement in controlling and shaping organizational strategy and behaviour. Thus when examining the relationship between an organization and its environment management
perceptions provide an important filter which is likely to influence organizational decision making processes (Child & Smith 1987). The research was also not centrally concerned with examining the internal processes through which organizational changes are negotiated, agreed (or challenged) and implemented. This research was more concerned to examine the outcome of these processes than with the details of how these processes occurred. However, to provide an insight into these processes one company, BAe’s Military Aircraft Division, was examined in more detail with a wider range of people being interviewed, which did reveal the internal processes though which change was negotiated and fought over by different functions.

As Kahn and Cannell argue (1957), when conducting interviews it is important to reflect on the motivation of the interviewee as this may influence the information provided. It was recognized that senior management may be motivated to present a certain viewpoint, for example that there has been little internal resistance to any change. While it was not always possible to verify the accuracy of all data, a number of methods were available to do some checks. As outlined for example, interviewing a range of personnel was one way in which the data collected was triangulated. The other method used was to prepare for each site visit by examining newspaper and journal articles to establish the most significant recent events affecting companies and to provide a good general background on the companies concerned. This allowed the interviews to cover these issues but it also provided a method by which some of the interview material could be cross checked.

Prior to undertaking the main part of the fieldwork a pilot study was conducted, where two local (Edinburgh) companies involved in defence work were examined. This provided an opportunity to test the interview schedule developed and gave time to reflect on the data collected. The research design was not altered drastically following these pilot interviews as they
were generally found to be successful, with the interviews conducted providing data which was more than adequate for the research.

(b) Documentary Sources

A wide range of documentary sources were used to provide information on the companies examined. While this information provided a method of triangulating and cross checking some of the interview data it was also a rich source of original data itself, providing a wide range of information which could not have been collected from interviews alone. Examples of the sort of information collected from these sources include: contractual details on equipment orders (both domestic and export); levels of government spending on defence equipment; changes in the ownership of companies; and changes in governmental procurement rules. The range of sources used was extremely diverse and included: newspaper articles, with the Financial Times in particular providing a good source of information; local government reports into regional dependence on defence spending, for example (WCC 1992); trade union reports (Schofield & Davis 1995); specialized journals such as Jane's Defence Weekly, Aviation Week & Space Technology and Defence Industry Digest; parliamentary reports on defence related issues; and specialized government reports into defence matters (ACOST 1989, POST 1991).

As with interview data, consideration is required of the potential biasses which may occur with secondary documentary data (Scott 1990). These biasses can be related to the use of reports to support particular viewpoints or present particular arguments. For example, local authorities may use data to emphasize the extent of their region's dependence on defence work in order to win defence restructuring grants, or central government may distort figures on levels of defence spending to play down the actual spending levels. Therefore all documentary data must be used carefully. When using
documentary data care is required to establish the assumptions and definitions used in the presentation of data, as with different assumptions or definitions large disparities appear to exist in data. For example, when attempting to establish the levels of government spending of defence related R&D (see Buck & Hartley 1993) or on the value of the UK's defence equipment exports (see HC 333), large discrepancies were found, dependent upon which source was used. The reason for the differences found were related primarily to differing definitions. This does not mean that documentary data should not be used, but simply that care is required to consider the motivation of the authors and the assumptions made by them to support their arguments.

(c) Reflections on the Data gathered

It is recognized that the data gathered was not as complete as it could have been, thus the purpose of this final section is to briefly reflect on this. It will be shown however that the data gathered was more than adequate to support the arguments being made and that the limitations which exist in it are not fundamentally problematic.

There were a number of minor gaps in the statistical data collected. Due to reasons of company confidentiality or government secrecy it was not possible to obtain complete empirical figures on all companies. For example, most companies were unwilling to provide a detailed breakdown on the financial details of their defence businesses, therefore there was a reliance on documentary sources for this data, for example from company annual reports or newspaper articles. This data however was often not disaggregated to the level that was required. Therefore, some of the financial data used is general in nature, providing only a broad indication of the character of the changes that the companies experienced. Similarly, obtaining detailed figures on the value of export contracts to individual
companies or the level of government financial support given to export contracts was also difficult. However, having precise details of these figures was not essential given the focus of the research. For the purposes of this project general data was more than adequate. It was not necessary for the arguments that were being made that exact financial details were used. For example, in terms of the level by which any companies business had changed over the period examined it was only necessary to have general figures. The research was more concerned with establishing the character of organizational capabilities, the strategic response of companies to their changing circumstances and the changing character of their operating environment. Thus the general nature of the financial data collected was not a significant weakness, with the data used being more than adequate to support the arguments made.
3.1 Introduction

As was outlined in chapter 2, the primary aim of this research is to examine the relationship between the capabilities, strategy and behaviour of companies operating within defence markets to the character of their operating environment. The main period considered is that immediately following the end of the Cold War (1989-95), as during this time a number of dramatic changes occurred within defence markets, with the level of demand for equipment declining significantly. This therefore provides the opportunity to examine how companies are affected by and respond to extensive changes within their immediate operating environment. Central to the research is the issue of the extent to which the character of the UK's defence markets changed during this period. To establish this it is necessary to describe the character of defence markets during the Cold War to provide a contextual background for the empirical chapters which follow.

In many ways the character of the UK's defence markets remained relatively stable throughout the whole period of the Cold War. This was partly due to the relatively stable character of international relations during this period, but was also due to the fact that the UK government also consistently pursued the same priorities in relation to its defence industries. The main priority of the UK government was to retain a wide range of indigenous capabilities for the design and production of defence equipment. This resulted in the government spending
large amounts on defence, with many companies operating within relatively protected markets receiving continuous orders for work. The other main priority of the UK government during this period was to attempt to maintain parity with the USA and USSR in the technical performance of its defence equipment. To achieve this it prioritized issues of technical performance above those of equipment costs in the development and production of defence equipment.

The chapter begins in section 3.2 by briefly outlining the importance that military strategy and research has placed on technological developments, especially in the last two centuries. This is followed by two sections on the policies adopted by the UK during the Cold War. Firstly, in section 3.3 the general policies of the UK government towards its defence industries are examined and secondly, in section 3.4 the specific policies implemented to achieve them are outlined, showing the importance of technological development to military strategy during the Cold War. Following this the impact of these policies on the technological trajectory of weapons development and the evolving structure of industry is examined. These sections both reveal the extent of the influence that the UK government possessed to define the character of its domestic defence markets. This chapter does not consider the impact of these market characteristics on the internal structures and behaviour of the companies examined, as this will be done within the substantive empirical chapters.
3.2 Technology and the Military

Throughout modern history war and technology have had significant influences over each other, technology has transformed war as much as war has transformed technology. Since the early 1800's in particular the conduct of war has been fundamentally altered through a wide range of technological developments (Fuller 1992, van Creveld 1991, McNeil 1983). The rate of technological innovation in this sphere has been so rapid that the character of inter-state warfare from the 19th to the 20th centuries has been radically transformed. This was not due solely to developments in weapons systems such as the tank or the attack aircraft, but also due to innovations in technologies less specific to military applications such as communications and transport. Thus, for example, in Prussia in the mid-19th century, the construction and routing of the railway network was partly shaped by the needs of the military (Giddens 1985; p224). The growing awareness during this period of the potential power gained from possessing superior weapons systems and related technologies resulted in significant investments being made by most industrial states to develop and improve technology for military purposes. An obvious example of this was the naval arms race between Britain and Germany which was a precursor to the First World War (Kaldor 1963; ch2)

Investing in technology therefore has been a ubiquitous feature of military planning throughout the twentieth century, which has resulted in military technological innovations occurring at a phenomenal rate. Between World War Two and the late 1980's international relations and the defence strategies of the industrialized world were dominated by the dynamics of the bipolar Cold War (Kennedy 1991),9 which shaped the relationship between military strategy and technological change in particular ways. As the dominant military doctrine of the

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9 See Hobsbawm (1994) and Walker (1994) for more detailed studies and analysis of the Cold War period.
major powers during this period was based primarily on policies of technological superiority, investment in science and technology for military purposes became a constant feature of the Cold War. These investments were such that this period represents the first in history when military R&D became permanently institutionalized on a large scale during peacetime (Smit 1995; p599). This stimulated an arms race in both nuclear and conventional weapons which was another permanent feature of the Cold War world, with the UK government attempting to maintain a position of parity with the USA and USSR in terms of its conventional weapons. Military strategy during the Cold War, particularly in the USA and USSR, was dominated by the development of nuclear weapons, with innovations in these systems being largely responsible for the approximate billionfold increase in the lethality of weapons in the century between 1870-1970 (Mann 1984). This research however will focus on conventional weapons alone, which have themselves evolved substantially during the period of the Cold War.

The next section will outline the general policies adopted by the UK government towards defence spending and it’s defence industrial base during this period followed, in section 3.4 by an examination of the specific procurement policies used to achieve these aims.
3.3 UK Government Policies Towards Defence: 1945-89

The UK emerged from World War Two substantially less powerful, in relative terms, than when it entered it, however this was also true for both France and Germany, the two other major European powers of the time. With the USA and USSR in the long term emerging from the war with more advantageous economic situations it can be seen that the balance of international power had altered substantially. Britain's reduced position was such that it was unable to maintain its pre-war imperial commitments, however the defence policies of successive UK governments in the post war years reflect attempts to retain the countries position as one of the most significant international powers (Coates 1984, French 1980). That the UK's economic situation did not fit with it's global aspirations and imperial commitments resulted in the Cold War being a period of forced, but reluctant retreat from its previous global commitments (Chalmers 1985). Walker (1994; p47) encapsulated this attitude in the phrase, 'too poor to hang on, but too proud to let go, Britain had clung by its fingertips to the traditional status and commitments of a great imperial power.' This retreat from empire was brought into focus by events such as the Suez crisis in the mid-1950's and the currency devaluation of the late 1960's, which forced the withdrawal of UK forces from the Middle East.

While physically retreating from its extensive overseas empire the UK government attempted to maintain its position as a significant world power through committing itself to retain a broad range of indigenous defence industrial capabilities and having technologically advanced weaponry. This policy required high levels of defence spending, and throughout the whole period of the Cold War the UK's expenditure on defence, in terms of GDP, in comparison to other Western Industrial nations, was only exceeded by that of the USA (See Table 3.1).
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Table 3.1 Military Expenditure as a percentage of GDP

Source - Coates 1994; p194

As well as maintaining a broad range of indigenous industrial capabilities the UK attempted to maintain relative parity with the USA and USSR in terms of the technical capabilities of its conventional weapons. With the technological complexity of weapons systems increasing substantially the amount of research and development required to produce weapons systems increased dramatically following the end of the Second World War. For example, between 1945-50 there was an approximate 50% increase in spending on defence R&D in the UK, even before the increase in spending caused by the Korean conflict (Rose & Rose 1970; p76). The UK government's commitment to military R&D is illustrated both by its high levels of defence spending and by the fact that throughout virtually the whole period of the Cold War it spent approximately 50% of its total R&D budget on defence research (Webster 1991, Gummett 1984). This proportion of government R&D spent on defence was substantially higher than that of other European nations such as France, Germany or Italy (ACOST 1989; p13-14, Edgerton 1993; p11), further illustrating the UK's commitment to maintaining the most advanced defence industrial capabilities. While approximately 25% of this investment was made in government research

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10 Even in the early 1990's, following the end of the Cold War, military research absorbed nearly 45% of the government's total R&D budget (Annual Review of Government Funded R&D 1993).
establishments such as the Royal Aircraft Establishment at Farnborough (Gummett 1984; p59), with a further, relatively small proportion being given to universities, industry was undoubtedly the major benefactor of this commitment to defence research and development.

The emergence of the Korean conflict in 1950 provided a good illustration of Britain's commitment to both remain one of the dominant international powers and to support its defence industrial base (Dockrill 1988). This conflict was one of the early defining moments of the Cold War as it was argued by the US and UK governments to represent Soviet expansionism, making a commitment to support South Korea necessary to contain this (Walker 1994; ch3). Under pressure from the USA, and with its own motives of remaining a significant world power, the UK government committed itself to a massive increase in defence spending (Burnham 1995, Plowden 1989: Ch's 10-11). This resulted in defence spending increasing by over 50% between 1949 and 1952, raising it to approximately 10% of GNP (Greenwood 1977). Given the fragile condition of the UK's economy at this time this represented a very substantial commitment. This increase in defence spending provided an extremely significant boost to most sectors of the UK's defence industrial base, which prior to this had been suffering from declining levels of business following the end of the Second World War. The sectors which benefited most from this investment were the aircraft, vehicle and shipbuilding sectors and the emerging electronics sector (Burnham 1995, Geiger 1991). Therefore all three sectors being examined in this research benefited significantly from this increase in defence spending. In the aircraft sector the number of military aircraft produced increased substantially (Geiger 1991: p102-5). The fact that all the major electronics and avionics companies expanded very quickly in the early 1950's can also be largely attributed to the Korean arms build up (Edgerton 1991a; Ch5). Finally, the vehicle sector also received a large increase in investment, with the
government committing itself to build a large stockpile of tanks (Burnham 1995), which largely explains why the order book at Vickers tank factory trebled between 1946-52 (Scott 1962; p357-9). This investment therefore provided the funding necessary to support a wide range of indigenous defence industrial capabilities and illustrates the UK's commitment to investing in defence.

While government spending on defence declined in the UK following the end of the Korean conflict table 3.1 shows how Britain continued to spend proportionally more on defence than all Western industrialized countries apart from the USA. One 'peculiarity' of this support was the disproportionate bias in favour of both the aircraft and electronics sectors (Fine & Harris 1985; p238-9, Peck 1968; p452, Wilkie 1991; p43). The privileged status accorded to these sectors, as will be seen below, resulted in the companies involved in them being able to maintain a high rate of investment in technological innovation. In terms of the aircraft industry, the high costs of this policy were accepted as being necessary to allow the retention of indigenous design and manufacturing capabilities in an industry believed to be of key strategic importance (Edgerton 1991a, Lovering 1988). For the electronics sector the degree of government support was apparent not only from the high level of defence spending provided, but also from both the central role government played in its early development (Gordon 1981, McCalman 1988) and the protection it accorded to companies operating within the defence electronics sector (Morgan & Sayer 1988; p126). The following section will show in more detail the specific procurement practices adopted by the government to achieve the general policy aims outlined.

As outlined above, throughout the Cold War the general aims of Britain's defence policies were consistent, being concerned with the retention of a wide range of technologically advanced defence industrial capabilities. This was achieved by a clear 'buy British' policy, where domestic defence equipment markets were protected and the companies operating within them were supported with enough work to allow them to operate effectively. Another factor which remained constant was the low priority placed on keeping equipment costs down, which was deemed less important than either maintaining a wide range of domestic industrial capabilities or producing equipment to particular technical standards. While these priorities were not always contradictory, it will be shown that whenever they did come into conflict containing equipment costs was usually not the decisive factor in procurement decisions. The particular procurement policies adopted to achieve the above goals have varied considerably, with changes in policy usually following reviews, of which there have been a significant number since 1950 (Hennessy 1990; p415). The rest of this section will be developed chronologically to illustrate the evolutions in procurement policy which have occurred.

In the 1950's all sectors of the defence industrial base were fragmented, consisting of a significant number of small companies, therefore it was possible to maintain competition for both the design and production of defence equipment. Competition was argued by government to be the best method of encouraging technological development, with the penalty of high equipment costs that this produced being accepted as necessary (Edgerton 1991a). This policy can be illustrated using the example of the aircraft industry, where the government supported the 'ring' or 'family' of approximately 20 companies (Gardner 1981, Hayward 1989; ch2), ensuring that there was always
competition for the design of prototype aircraft. The most obvious example of this was provided by the procurement of the RAF's V-bomber fleet. For this project funding was provided for the development and production of three separate aircraft,\(^{11}\) which resulted in the cost of these aircraft being exceedingly high. The costs of this policy were significant because there was both a duplication of design effort which required to be government funded and also because the production volumes of aircraft actually manufactured were low, preventing economies of scale being achieved.\(^{12}\) For the V-bombers only approximately 100 aircraft of each type were produced (Kaldor 1980; p106-7). This size of production run was actually typical for the period, as between 1945-55 23 different aircraft were produced in numbers of less than 100 (Hayward 1989; p65). However, as outlined, the costs of this policy were accepted as being necessary to allow Britain to retain the most advanced industrial capabilities (Edgerton 1991a).

Towards the end of the 1950's it was becoming apparent that this policy was unsustainable. Firstly, the rapid growth in the complexity of defence equipment during this decade (see below) made it increasingly more difficult for very small companies to be able to undertake this work. Secondly, and related to this, the government did not have the financial resources to sustain such extensive design competition due to the increasing costs of the design process. Therefore, by the 1960's the procurement policies of the UK government had moved away from maintaining such extensive domestic competition to supporting the rationalization of the defence industrial base and then providing support for the remaining enterprises.

\(^{11}\) The three V-bombers were the Vickers Valiant, the Avro Vulcan and the Handley Page Victor.

\(^{12}\) Wood (1975) provides a detailed account of the large number of aircraft projects from the 1950's which were funded for development, but which never went into production.
The Labour governments of the 1960's pursued more interventionist policies than all previous post war Conservative administrations, with the expectation that it was possible for them to plan the economic development of their countries through creating and supporting large industrial enterprises (Young & Lowe 1974). These policies were applied not only to the defence industries, but to all sectors of industry predicted to be potentially important such as computing and electronics. Both the aircraft and electronics sectors received extensive support during this period as they were both deemed to be crucial components of the country's defence industrial base. Even though a significant number of high profile defence programmes (such as the TSR2 aircraft and Blue Streak missile) were cancelled virtually all sectors of the UK's defence industrial base still received adequate funding to allow the retention of domestic capabilities.13

While Denis Healey undertook two defence reviews during the 1960's the priorities and operation of the procurement system were not fundamentally altered, with these reviews being more concerned with: the cancellation of various equipment programmes; reducing and rebalancing force levels within the military; and modifying the countries international military commitments (Hartley 1996; p213-4). In terms of defence procurement the most significant change was the move towards collaborative military projects as recommended by the Plowden report, with the Jaguar and Tornado aircraft being two of the first large collaborative European projects begun in the 1960's (Taylor & Hayward 1989; p100-2).

The 1970's saw the continuation of extensive, direct government intervention in the defence industries, with the rationalization of industry which began in the late 1950's being extended. The changes undertaken in the 1970's also had a

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13 The cancellation of the Blue Streak missile meant that Britain did not have independent capabilities to design ballistic nuclear missiles. The main reasons for the cancellation of this and other projects were the technical problems which resulted in development cost increasing and the general fiscal crisis that the UK found itself in due to its commitments to maintain an extensive overseas military presence.
new dimension to them, as large parts of Britain's defence industrial base were taken into government ownership (Fleming 1980). Thus when restructuring of the aircraft industry was completed in the mid 1970's by the forced merger of Hawker Sidley and the British Aircraft Corporation, British Aerospace Engineering (BAe), the newly created company was simultaneously nationalized. Also, when Rolls Royce and Ferranti got into financial difficulties their survival was guaranteed by the UK government nationalizing them (Todd 1990; p147, Young & Lowe 1974; p151-2). In both cases the companies were saved by the government due to the strategic importance of their industrial capabilities; Rolls Royce was the UK's sole producer of aircraft engines while Ferranti had important capabilities in the military electronics field. Thus, while the means of supporting the countries defence industrial base had changed between 1950-75, the goal of retaining a broad range of defence industrial capabilities had remained constant.

Under the Conservative administrations of the 1980's the methods by which the defence industrial base was supported were transformed. This can be characterized by a retreat from directly interventionist policies towards more liberal, monetarist policies, which were applied to all sectors of industry, defence and commercial. In terms of defence industries the most obvious indicator of this change was the privatization of all the defence equipment manufacturers which had been nationalized in the 1970's (Taylor 1992). Following this the next significant change in the governments defence procurement policies came in the mid-1980's with the implementation of the Levene Reforms. These reforms were concerned with improving the cost efficiency of the MOD procurement system (Levene 1989) and were partly stimulated by procurement problems with

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14 These reforms were named after Peter Levene, their instigator, who was appointed as the chief of defence procurement by Michael Heseltine with the specific remit of commercializing Britain's defence equipment procurement system (Hennessy 1990; p416)
a number of programmes then under development,\textsuperscript{15} but which also fitted with the government's ideological commitment to market liberalization (Walker & Gummett 1989; p421). These changes represented the most fundamental reforms of the procurement system since 1950, as all other defence reviews had been more focused on other areas such as force levels or the immediate cancellation of specific equipment programmes. It is therefore necessary to examine these changes in some detail.

The two main components of the reforms were to firstly improve the competitiveness of procurement system by awarding more contracts competitively and encouraging a greater number of competitors to bid for work (Dunne & Smith 1992) and secondly to pass cost and technical risks to industry through using a greater proportion of strict fixed price contracts (Laurent 1991; p99). Prior to these reforms virtually all development contracts were awarded on a cost plus basis, where contractors were always guaranteed a certain percentage profit above their costs (Hartley 1996; p223). While approximately only 20\% of all MoD contracts (development and production) in the 1970's were awarded on this basis, less than 15\% of contracts (by value) were awarded competitively (Hartley 1996). Thus while the proportion of contracts awarded on a cost plus basis was low, the vast majority of all contracts were awarded non competitively, with loosely defined conditions, where little priority was given to, or incentives provided for, reducing equipment costs. Following the Levene reforms the number of cost-plus contracts reduced to 4\%, while the number of contracts awarded competitively increased to over 60\% in 1985-86 (Dunne 1993; p96). Table 3.2, below, illustrates the extent of these changes, where it is shown that by the end of the 1980's the number of contracts awarded on a cost plus basis had been reduced massively.

\textsuperscript{15} In the early 1980's a number of equipment development programmes (for example the Nimrod advance early warning system, the Upholder submarines and the Warrior armoured vehicles) experienced technical problems which resulted in large cost over-runs and significant time delays (Laurent 1991; p97-98).
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Table 3.2 Percentage of MoD contracts by total share of value
Source - DS 1994; table 1.14

However, even following the Levene reforms evidence suggests that in the allocation of large development and production contracts value for money considerations were not the most decisive factors in deciding the award of contracts, with the retention of domestic capabilities being given priority in some decisions. Consider for example the award of the CASOM cruise missile contract, for which seven separate bids were received (Gray 1996b). This gives the impression that the level of competition for the contract was high. However, at the time of the competition the European missile sector was extremely fragmented (Covault 1996, Morrocco 1996b) and the award of this contract had significant implications for the future structure of the industry. In the end the contract was awarded to the BAe-Matra bid even though it was not the cheapest (Financial Times, 26th July 1996; p7). This decision virtually guaranteed the maintenance of missile capabilities within Britain and France, which appears to have been the main factor deciding the award. Similar priorities were also important in the decision to award the Challenger 2 tank contract to Vickers, with the retention of domestic capabilities being one of the most decisive factors (Dunne 1993, Adams 1990; ch's 9-11). But even given these findings there has still been a substantial increase in the emphasis placed on cost management for all MoD contracts, which has been achieved by two main methods. Firstly, the greater number of bidders competing for large contracts has resulted in greater
cost competition occurring even though British based bids have tended to be favoured. Secondly, the implementation of stricter cost controls has succeeded in passing substantially greater cost and technical risk onto industry. For example, both Shorts Missile Systems (Financial Times, 6th March 1996; p8) and Vickers Defence Systems (Tusa 1996) had to accept the financial burden of cost overruns caused by technical problems in contracts as they were being managed on a fixed price basis. Thus the Levene reforms represent a substantial change in the character of Britain's defence equipment markets.

The previous two sections have shown both the general commitment of the UK government throughout the Cold War to maintain a broad base of defence industrial capabilities and to support the development of technologically advanced weapons systems as well as outlining in more detail the specific procurement practices it used. The following two sections will outline the impact of these policies on the structure of the countries defence industrial base, the behaviour of companies competing in these markets and the evolving technological trends in weapons systems.
3.5 Technological Trends

Since 1945, a trajectory of incremental technological improvement has been pursued in the development of every type of military equipment in the UK. This trajectory has been focused around incrementally improving the technical performance of successive generations of defence equipment, while the basic architecture of weapons systems has remained relatively constant (Kaldor 1980, 1983). During the period of the Cold War this resulted in all major weapons systems such as tanks or aircraft evolving through three or four successive generations. While the basic characteristics and functions of these platforms remained unchanged, due to the trajectory of technical improvement the technical performance of current generations of equipment far exceeds that of comparable systems from the 1950's, which will be illustrated for all three sectors examined. This trend of incremental technological improvement was the result of deliberate government policies intended to allow the retention of industrial capabilities within the UK to design and manufacture the most technologically advanced defence equipment. This policy of 'technological militarism' (Edgerton 1991b) was adopted by successive UK governments as it was perceived as providing the most effective method of allowing the UK to remain a significant military power.16

Two significant impacts of this trajectory were the massive increase in the complexity of defence equipment and the equally large escalation in equipment costs. The rise in the complexity of weapons systems can be seen in a number of ways: the increase in the number of component parts within weapons

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16 Due to the small physical size of the UK it was impossible to compete with larger nations in terms of absolute force levels, therefore possessing technologically advanced weapons was seen as overcoming this weakness.
platforms and sub-systems\textsuperscript{17}; the greater range of operational functions; and from the increasing dependence on and importance of electronic systems (Todd 1990; ch8). The rising cost of equipment which has also been a constant feature of this trajectory is closely related to the increasing complexity of equipment (Grin 1992; p221-3). While the rate at which the cost of successive generations of equipment has increased has been extremely significant, quantifying this is extremely difficult, however Smith (1988) approximated the increase in the unit cost of successive generations of equipment to be four. This trajectory has resulted in the cost of contemporary military equipment being very high. For example, the total cost to the UK of designing and purchasing 250 Eurofighter aircraft is approximately £15bn (Financial Times, 2nd September 1996; p1), with the approximate cost of each aircraft being approximately $46m (Elzen et al 1990).\textsuperscript{18} However, from the consistency of both the UK’s high level of defence spending and from the government’s commitment to invest in defence R&D illustrated above, this is a cost the UK government appears prepared to accept.

In each of the sectors examined this technological trajectory will be illustrated with reference to particular examples, where, in all cases, innovations have been focused on incremental improvements in particular performance parameters with the basic character of weapons systems remaining relatively constant. In the case of the electronics sector, where there is greater comparability between military and commercial products, the technical priorities and trajectory of development, until the early 1980’s at least (see chapter 6) will be shown to have differed greatly between military and commercial markets.

\textsuperscript{17} As the processing power of computers and micro-electronic components has developed the number of discrete components within military electronics systems has decreased, with an increasing number of functions being incorporated within individual components and sub-systems. However the increase in the complexity of these systems has shifted to being a software issue, with the amount of code required to programme successive generations of electronics systems increasing massively (Grin 1992; p221-223).

\textsuperscript{18} In the USA the latest generation of fighter aircraft, the F22, is even more expensive costing approximately $100m per aircraft (Callahan 1992).
For military aircraft the technical parameters which define the military effectiveness of technical systems vary greatly depending upon the type of aircraft examined. For transport aircraft carrying capacity, range and fuel efficiency are the most important technical parameters, whereas for fighter aircraft speed, acceleration and agility are more important (Grin 1992; p230-3).

Using data available on British fighter aircraft (Table 3.3) the increase in the maximum speed of successive generations of aircraft is illustrated, which provides a crude but accurate indicator of the trajectory of technological development pursued.19

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Manufacturer</th>
<th>Max Speed (mph)</th>
<th>Began Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spitfire</td>
<td>Supermarine</td>
<td>~400</td>
<td>1934</td>
</tr>
<tr>
<td>Hunter</td>
<td>Hawker</td>
<td>715</td>
<td>1954</td>
</tr>
<tr>
<td>Jaguar</td>
<td>Sepcat</td>
<td>820</td>
<td>1972</td>
</tr>
<tr>
<td>Tornado</td>
<td>Panavia</td>
<td>1,000</td>
<td>1979</td>
</tr>
</tbody>
</table>

Table 3.3 Selective British Fighter Aircraft since 1945
Source; Kaldor 1980; p106-7

In the vehicle sector, using the example of main battle tanks, a trajectory of incremental technical development is also discernible. Since World War Two tanks have evolved through three or four generations while their basic architecture has remained relatively constant (Ischebeck and Spitzer 1992; p181).20 For tanks military effectiveness cannot be measured by reference to one parameter alone, but is balanced between their firepower, their level of

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19 Trilling (1988; p157-9) provides evidence of a similar trajectory with American and Russian fighter aircraft.

20 The basic architecture of a tank consists of a front compartment containing a driver, which is one of the most heavily armoured sections, a centre section covered by a rotating gun turret and a rear section containing the engine.
protection and their mobility (Ischebeck and Spitzer 1992; p179) with inter-generational technical developments being focused on improving all three of these characteristics. In the UK there have been three generations of tank since World War Two beginning with the Chieftain, which was replaced by the Challenger 1 in the early 1980's, which itself is being replaced by the Challenger 2. Through these three generations of tank an incremental trajectory of improved technical performance is visible.

In the electronics sector the trajectory of incremental technological development is apparent from the massive increase in the functional capabilities of all military electronics systems, whether referring to missiles, communications systems or ground radar. These developments have both increased the range of functions conducted by these systems while simultaneously improving the technical parameters which characterize their military effectiveness. The particular technical parameters which shape the military effectiveness of electronics systems vary greatly, depending upon the type of system being considered. For battlefield command and control systems, for example, the critical technical parameters include the ability to obtain the necessary information (data collection) and the speed of data processing (Grin 1990; p25-6). In the development of successive generations of command and control systems these functions have been the main focus of technological developments. The replacement of the UK army's battlefield communication system Ptarmigan by the new BOWMAN system (to be in service 1997-98) represents a continuation of this trajectory. The evolution of 'serial products', where successive generations of equipment represent incremental technical improvements of previous systems, is also visible in other sub-sectors of the military electronics sector. In Short's Missile Systems, which is focused on short range missile defence systems, a range of serial products have been developed, beginning with Sea-cat in the 1960's and evolving through the Tiger-cat, Blowpipe and

74
Javelin systems to the current generation of Starstreak and Starburst systems (Interview Source). Through the development of these products a continuous trajectory of incremental technological development has been pursued.

The priorities which have shaped the development of military electronics systems, with the focus being on improving the technical performance of equipment, are significantly different from those which have shaped the development of commercial systems, where a greater emphasis was generally placed on equipment costs. This difference in priorities has been significant in influencing the directions in which the technical development of military and commercial electronics has occurred, which becomes apparent from the example of micro-electronic components. Technological developments in the military sphere, due to the focus on product innovation, has resulted in the cost of micro-electronics components increasing. In the development of commercial micro-electronic components unit costs have, in general, been decreasing as there has been as much focus on process as product innovation (Blunden 1989, Sayer & Morgan 1988; p126-7).
3.6 Industrial Trends

The defence policies adopted by the UK government have also had a significant effect on the structure of the UK’s defence industrial base. However, the changes which have occurred have varied greatly between sectors, therefore, each of the three sectors examined in the research will be considered separately.

In the aerospace sector, at the level of prime contracting, the Cold War was a period of intense concentration. Since the end of the Second World War the number of airframe designers in the UK decreased from 23 to one, while the number of companies designing and manufacturing engines shrank from eight to one (Gardner 1981). This concentration occurred primarily during two main periods, in the late 1950’s and mid 1970’s, with the UK government being the initiator of change on both occasions. By 1958-59 a number of structural problems had emerged in the aircraft industry with there being a large overcapacity in both design and manufacturing and with the companies being too small to cope with the growing complexity of aircraft design. This resulted in a large number of these companies experiencing severe financial difficulties and with technical problems emerging in development contracts which resulted in extensive delays (Hayward 1989; ch2). However, due to the fiercely independent and competitive nature of the companies in the industry there was resistance to any form of voluntary restructuring. The restructuring which was undertaken, with the number of airframe designers being reduced to three, was achieved by the government, through controlling the terms under which development programmes were allocated. Two main airframe companies, the British Aircraft Corporation (BAC) and Hawker Sidley Aircraft (HSA), dominated the industry, with Handley Page remaining independent from the mergers which

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21 A similar process of concentration also occurred in the USA’s aircraft industry (Economist 1994).
were occurring. However, by the late 1960's Handley Page had to close due to lack of orders (Hayward 1989). The second period of concentration in 1976-77, when Hawker Sidley and the British Aircraft Corporation were nationalized and merged to form British Aerospace, occurred in a very similar fashion (Hayward 1989; ch4), as the merger was achieved by the government against the resistance of both companies (Benn 1989). The final change of significance in this area was the privatization of British Aerospace which was finally completed in 1985 (Taylor 1992).

In the defence electronics sector, in contrast with the aerospace sector, the Cold War was a period in which there was an expansion in the number of companies competing, which indicated the increasing importance of electronics as the technological complexity of weapons systems grew. The high level of government investment in defence electronics, which was shown to be a constant feature of the Cold War, has been such that this sector represents one of the strongest sub-sectors of the UK's domestically owned electronics industry (Charles 1987; p185-6; Sayer & Morgan 1988; p126). The expansion in both the number of companies competing in the defence electronics sector, and in the absolute size of defence electronics companies occurred primarily in the 1950's and early 1960's. Between then and the late 1980's the structure of this sector remained remarkably constant, with virtually no new companies of any

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22 Due to the liberal non-interventionist policies of the governments of the early 1960's the exact form of the restructuring was left to industry. Because of this, many of the inefficiencies which existed in the late 1950's were not addressed full by BAC or HSA, with both retaining virtually all of the sites they inherited during their formation (Hayward 1989).

23 The avionics companies considered to be part of the aerospace sector in the empirical chapters are here included in the electronics sector. This is because in technical terms their products are primarily electronics systems, therefore their development is inextricably linked with that of the electronics sector in general. In the empirical chapters they are considered part of the aerospace sector due to the fact that they compete in this sector and have organizational relations with the aerospace prime contractors.

24 It is argued by some (see Kaldor 1983, Chalmers 1985, for example) that the decline in the competitiveness of much of the UK's commercial manufacturing industry which has occurred since the end of World War Two was primarily due to the retreat of domestic companies to the safety of protected government markets such as defence, telecommunications and power generation.
significance entering the UK's defence electronics markets (Sayer & Morgan 1988; p128). The growth and expansion of the electronics sector which occurred will be illustrated by examining the situation of a selection of the most significant companies, all of which grew substantially in the 30 years following the end of the Second World War.

For Smiths Industries the period from 1950-80 was one of almost uninterrupted growth as markets for both military and commercial aircraft instruments and displays expanded substantially. While no financial figures are available for this period the scale of the companies growth can be seen its employment levels, which increased from 10,000 in 1947 to reach 25,000 in 1965 (Ellis 1990). During this period there was also a substantial growth in the technological complexity of the company's products. In the immediate post war period the company was producing individual cockpit instruments such as fuel gauges, altimeters and speedometers. By the 1960's these individual instruments had been replaced by integrated display panels. The last major jump in the evolution of display systems came between the late 1970's/early 1980's when mechanical counters were replaced with LCD's (Ellis 1990).

While the Marconi company began operating substantially earlier than Smiths Industries, their patterns of growth were still very similar as Marconi only grew to a significant size during and immediately after the Second World War. While Marconi designed and manufactured a wide range of military and commercial products including avionics equipment such as radios and navigation aids, ground radar equipment and naval sonar and radar (Baker 1970; p310), there were two common characteristics to the markets it operated in. Firstly, the company only operated in markets requiring very high quality, technically

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25 The expansion of the company was not due solely to growing defence markets, with similar patterns of expansion occurring in the company's commercial product markets.
sophisticated products and secondly the company competed predominantly in markets where there were only a small number of large customers (Baker 1970; p329). While Marconi were involved in very different sub-sectors of the defence electronics market from Smiths, similar to them the first half of the Cold War was a period of substantial growth (Baker 1970).

The final example used is that of Ferranti who like Marconi and Smiths grew substantially on the back of wartime production orders and who continued to grow during the first half of the Cold War. In the first thirty years after the company moved to Edinburgh (1943) it grew continuously until it occupied seven major sites within the city and had substantially broadened its business into four separate product divisions (Ferranti 1993, Law 1995; p132).

In contrast to the two sectors outlined above the industrial structure of the military vehicle sector in the UK remained remarkably constant throughout the whole period of the Cold War. During this time the same companies have been involved in the production of armoured vehicles. The most significant change which occurred was the privatization of Royal Ordnance in the 1980’s, when the government’s tank design factory in Leeds was sold to Vickers, giving them a domestic monopoly in the design and production of main battle tanks (Taylor & Hayward 1989; p26). Vickers have been involved in the design and manufacture of tanks since the First World War, but it was only during the Second World War and in the build up for Korea that it received large orders from the UK government (Scott 1962). Therefore, following this Vickers was largely dependent on export orders for a large proportion of its business (see chapter 5). Alvis and Land Rover also occupied the same niches in the military vehicle sector since the Second World War, with Alvis being the main domestic supplier of reconnaissance vehicles (Foss 1996c) and Land Rover the main supplier of light armoured cross country vehicles. As with many of the companies examined
the production of military vehicles at Alvis first expanded during the Second World War, but it continued to receive business from the UK government during the Cold War with the company winning a number of successive contracts for a range of vehicles beginning with contracts for the Saracen and Saladin vehicles in the 1950's and continuing with the contract to develop the Scorpion light reconnaissance vehicle in the late 1960's (Day 1981).

While the industrial structure of the three sectors examined evolved differently during the Cold War, what was constant in all three sectors was the dominant role of the UK government as the main factor shaping their structure.
3.7 Conclusion

During the period examined the single largest factor which shaped the market and technological environment under which the UK's defence industries operated was that of domestic government, as the major priorities pursued and the most significant changes in industry structure which occurred were as a result of its policies. Throughout the period of the Cold War, the policies of the government towards its domestic defence industrial base were remarkably consistent, being primarily concerned with the retention of a broad range of technologically advanced indigenous capabilities for the design and production of defence equipment. This resulted in the UK committing relatively high levels of spending on the development and production of defence equipment. In general a 'buy British' policy was pursued with the vast majority of companies operating in relatively protected markets with the MOD supporting companies with 'key' industrial and technological capabilities. In all three sectors examined, this was shown to be the case, where the existence of the most important of the large companies was virtually guaranteed through either being supported with work, or as happened in the 1970's, by the government rescuing them from financial crises.

Another of the main characteristics of the UK governments policies towards its defence industries was the policy of 'technological militarism' adopted, whose purpose was to allow UK industry to retain the most advanced technological design capabilities. For companies designing and producing weapons systems the implications of this policy were significant as this resulted in an emphasis being placed on achieving demanding technical performance specifications rather than reducing equipment costs. However, the effect of these priorities on the internal structures and behaviour of companies will be examined in the empirical chapters. The Levene reforms introduced in the mid-1980's did
represent a significant change to the management of the defence equipment procurement process as they resulted in substantially greater levels of technical and cost risk being passed to industry.
CHAPTER 4

THE RESTRUCTURING OF BRITAIN'S MILITARY AEROSPACE INDUSTRY: 1989-95

4.1. Introduction

The aerospace sector has been significant to the UK economy since at least the Second World War (see chapter 3). Illustrating this in current terms, in 1992 the aerospace industry accounted for 4% of the UK's manufactured output and 9% of manufactured exports (HC 563, volume II; p1). In the same year the industry's balance of trade was £2.5bn, of which £1.2bn was in the military sector (HC 563, volume 1). Finally, in terms of employment, in 1995 there were approximately 135,000 direct workers in the aerospace industry (HC 333: p14), which was down from its mid 1980's figure of approximately 200,000 (HC 563). This reduction in employment, while partly attributable to the recession in the civil aerospace sector, provides an indication of the level of reduction in spending which has occurred in the aerospace sector of the UK's defence industry.

This chapter will describe and analyze the restructuring which occurred in the UK's military aircraft industry following the end of the Cold War, from 1989 to the present. During this period virtually every company in the sector experienced a reduction in turnover due to these events. However substantial differences were found between companies in terms of degree. The dominant company response to this decline in military business was not

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26 Data from this chapter will be published in 'Capabilities, Strategy and Environment: The Adaptation of the UK Military Aircraft Industry to the Post-Cold War Environment' Technology Analysis and Strategic Management vol 9(1) p3-18.

27 Unless stated, these statistics are for the military and civil sectors combined.
to diversify, but to restructure internally and downsize while remaining within the defence sector.

Firstly section 4.2 outlines the broad characteristics of the military aerospace sector in Western Europe and the USA. This shows that while there has been a significant amount of change in both regions since 1989 that this restructuring has been achieved by substantially different methods. This section will provide a contextual background against which the experiences of the case study companies will be compared. Sections 4.3 and 4.4 and 4.5 then detail the experiences of the UK companies which were examined, with the three tiers of the aerospace sector being examined separately. These sections will show both how the companies have been affected by the changes in defence priorities which have occurred since 1989 and also how the companies have responded to these changes.

Following this section 4.6 then considers how the capabilities possessed by the organizations examined were related to the character of their immediate market environment. For all three tiers it was apparent that the capabilities and skills of the companies examined were to a large extent shaped by the requirements of their market environment, limiting their general relevance to other markets. However it was only at the level of the prime contractors that capabilities were particularly limited to military markets. The products of the prime contractors were very specific to military markets, having limited relevance to any commercial market, whereas the capabilities of the suppliers were, broadly, more generic, having wider applicability outside of defence markets. The prime contractors also had a much greater dependence on defence markets than most of the suppliers. The survey showed that the vast majority of suppliers had only a small proportion of business in defence markets, therefore the influence of defence markets on their organizations was not as extensive as that experienced by the prime contractors. While the suppliers operated without difficulty in both defence
and commercial markets, diversification into commercial markets would therefore be more difficult for the prime contractors. For example, their sales and marketing capabilities were very specifically focused around the particular character of defence markets.
4.2. Military Aerospace Market Changes and Sectoral Characteristics: Western Europe and the USA, 1989-95

Military aircraft and avionics markets in Western Europe and the USA have, since approximately the mid-1970's, been relatively concentrated, being dominated by a small number of large companies such as McDonnell Douglas, Boeing and Lockheed in the USA and BAe, Dassault and Aerospatiale in Europe (Economist 1994). However, since the end of the Cold War the level of concentration has increased dramatically in virtually all product sectors. This process of concentration was stimulated primarily by the demand sided changes which occurred in these markets in the early 1990's. As well as there being a significant reduction in spending levels, resulting in the cancellation or scaling down of many aerospace projects there was also a lot of uncertainty in these markets as governments everywhere were reconsidering their defence policies. Thus, for example, both the Eurofighter (Gray 1994b) and Future Large Aircraft programmes (Gray 1995d) in Europe faced an uncertain future with possible funding reductions threatening the cancellation of both.28 This uncertainty in aircraft projects also had a trickle down effect on sub-system programmes, with avionics companies also finding the early 1990's to be a period of large uncertainties (Warwick 1994).

On the supply side of military aerospace markets the response by industry was very similar in all product sectors, with the level of concentration in these industries increasing substantially. However there were significant differences between the USA and Europe in the way restructuring occurred. In the USA restructuring occurred more through permanent mergers and acquisitions, while in Europe there were fewer permanent mergers, with companies undertaking more short term joint ventures and project alliances.

28 On Eurofighter Germany was threatening to withdraw from the production phase, and on the FLA programme the UK governments commitment was uncertain.
In the USA's military aircraft sector merger activity in the early 1990's was such that by 1995 it was dominated by three enormous corporations: Lockheed Martin, Northrop-Grumman and McDonnell Douglas. The most active players in this process were the Lockheed and Martin Corporations (Dickson 1993), who themselves joined together in a 'megamerger', creating the world's largest defence corporation (Velocci 1994). The merger between Northrop and Grumman was also very significant (Boatman et al 1995). A similar process of concentration was also occurring in the missile sector, with Hughes acquiring a number of companies, with the result that it and Raytheon dominated the air launched missile sector (White 1993).

The restructuring of Europe's aerospace companies proceeded at a much slower pace, and, as outlined, took a different form. The main factors which prevented restructuring on a scale and pace comparable to the USA were the political sensitivities of European nations such as the UK, France and Germany, who were all attempting to retain indigenous aerospace capabilities (O'Toole 1994, Gray 1994a). Restructuring therefore tended to occur through international collaborative project alliances such as the Eurofighter or Future Large Aircraft projects as this allowed France, the UK and Germany to all retain an extensive range of defence industrial capabilities. In the missile sector the pattern of restructuring was similar, with there being far fewer European mergers than were occurring in the USA (Gray 1994c). In Europe the only large scale merger in the missile sector in the early 1990's occurred between BAe Dynamics and Matra's missile division (see section 4.3.2 below). The level of concentration in European avionics markets is also high as they are dominated by two large companies, Thomson-CSF and GEC, who in 1991 were both four times

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29 Before the merged they both actively bought up the aircraft businesses of companies exiting defence markets, with Lockheed buying General Dynamics aircraft division and Martin acquiring GE's.

30 This process of concentration has continued with the merger of Boeing and McDonnell Douglas in late 1996 (Financial Times 16th December 1996; p1).
larger than the third largest company in the defence electronics sector (Wulf 1993b). In Europe's avionics equipment markets substantially more mergers occurred than in its missile or aircraft sectors. This was partly because spending levels in these markets had declined significantly (Nordwell 1996), but also because both Thomson and GEC were very active in acquiring a large number of smaller European avionics companies (Skons 1993).

Thus the early 1990's saw spending levels in military aircraft markets declining significantly, stimulating a period of profound restructuring. This resulted in these markets becoming even more concentrated than they had been previously. The rest of this chapter will concentrate on examining the experiences and responses of a number of UK companies involved in this sector. The intention of this section is to provide a contextual background against which the experiences of the companies examined could be compared and contrasted, which will be done at various points throughout the chapter.

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31 This data is based on their absolute level of arms sales in 1991, with Alcatel Alsthom of France being the next largest company at this time.
32 GEC, for example, acquired half of Plessey (with Siemens) and the whole of Ferranti's defence avionics business, while Thomson acquired Ferranti's sonar business as well as a range of Dutch and Spanish defence electronics companies such as Signall and Phillips Defence.
4.3 Aerospace Prime Contracting in the UK: BAe Military Aircraft and Dynamics Divisions

This section details the experiences of BAe's Military Aircraft and Dynamics division as these were the two aerospace prime contractors which were examined. Within Britain's military aircraft sector there is only one company involved in airframe design and aircraft assembly, the Military Aircraft Division of BAe. In narrow terms it is the only company at the first tier of the product hierarchy, as the products of all other companies are sub-systems to the aircraft. In broader terms though it is relevant to consider BAe Dynamics, the UK's main missile company, as also being a prime contractor due to its typically direct contractual relationship with government. The procurement of missiles in the UK is done directly between the MOD and the chosen prime contractor, separate from any aircraft which they may be used on. This contracting process is very different from that for other sub-systems such as avionics and electronics systems, which are controlled indirectly, via the prime contractor. For example in early 1996 the MOD held competitions for the prime contractorship of a number of missile contracts including the CASOM cruise missile (Gray 1996c) and Fmraam missile for Eurofighter (Gray 1996b), both of which BAe dynamics was competing for, which is very different from the way avionics contracts are awarded. This difference between missiles and other aircraft sub-systems is partly due to their more generic applicability which allows them to be used on a range of aircraft, for example with the new CASOM missile being designed for use on both the Eurofighter 2000 and the Tornado (Gray 1996c). This can be contrasted with avionics and electronic systems, which are specific to individual aircraft, requiring to be closely integrated with the airframe from the early stages of the design process. Therefore both the Military Aircraft and Dynamics divisions of BAe are considered as being prime contractors in the aerospace sector. While they are divisions of the same company they are financially separated within BAe and operate as virtually autonomous companies.
Before examining their capabilities and changes in strategy it is necessary to outline how they had been affected by the events following 1989.

4.3.1 Company Background And Post Cold War Changes

From Chapter 3 it should be apparent that BAe, in its current form, is a relatively new company as it was only formed in the mid-1970's by the amalgamation of BAC and HSA under the Labour government of the time, being run by that administration as a nationalized entity. Furthermore, it is only since 1985 that the company has been operating under fully private ownership.\textsuperscript{33} The size of the company's defence interests can be gauged when it seen that in 1994 it was the world's third largest arms company (Skons 1996). Defence and aerospace has always been the core of the company's business, with it representing 65% of the company's 1994 sales (BAe Annual Report, 1994).

Table 4.1 below outlines the changing fortunes of both BAe's Military Aircraft and Dynamics divisions, which both went through a period of profound restructuring between 1989-95. While the total sales of BAe defence have not declined, this masks the level of restructuring which occurred, and underplays the uncertainty in business levels that both divisions experienced. In the rest of this section the experiences of both divisions will be discussed together. This is not only because they are part of the same corporate group, but also because the strategies they both pursued since the end of the Cold War were very similar. The rest of this section will describe in more detail how both divisions were affected by the end of the Cold War, before the strategies they pursued are explored.

\textsuperscript{33}The company was privatized in two tranches in 1981 an 1985.
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<td><strong>BAe Defence</strong></td>
<td></td>
<td></td>
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<tr>
<td>Sales (£m)</td>
<td>3,844</td>
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<td>4,266</td>
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<tr>
<td>Profit (£m)</td>
<td>-</td>
<td>-</td>
<td>371</td>
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<td>-</td>
<td>27,000&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>-</td>
<td>16,000&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Turnover (£m)</td>
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<td>-</td>
<td>-</td>
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<td>397</td>
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<tr>
<td>employees</td>
<td>10,600</td>
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<td>-</td>
<td>3,800&lt;sup&gt;c&lt;/sup&gt;</td>
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Table 4.1: BAe, selected statistics 1989-94 (Source: BAe Annual Reports)

- Financial Times 1 December 1990:p6
- Interview source, December 1994
- In early 1995 further redundancies were announced, reducing employment to 2,500

While BAe Defence’s turnover did not decline between 1989-94 this masked the problems that the company was facing in these markets, which were caused by two inter-related factors. Firstly, the end of the Cold War created a period of uncertainty in these markets as governments started reducing their defence spending and delaying their procurement decisions. This meant that the long term order books of defence dependent companies became much more uncertain and unpredictable than had been typical (see below for the Military Aircraft Division). The second contributory factor was the changed procurement environment in the UK. This created a stricter and more cost sensitive environment, with defence equipment contractors having to accept a much greater proportion of technical risk and where contracts were awarded on a fixed price basis. As will be shown, the structural inefficiencies within BAe's defence businesses meant that its existing structures and practices were inappropriate for the new, more cost sensitive environment which had emerged in its markets. Above all the
company had always been technically rather than cost driven, which over the extended period that the Cold War had lasted, resulted in it not only developing large over-capacities of both capital and labour resources but also in it developing management and administrative practices which were not cost efficient.

The underlying problems outlined were masked within the Military Aircraft Division by its financial performance, as its turnover had remained steady during the early 1990's. The reason for this was the size and dominance of one major order, the Al Yamamah contract with the Saudi Arabian government, which at the time it was negotiated was the single largest arms deal ever. This contract involved much more than the supply of aircraft and included an enormous construction and training programme which involved the employment of over 4000 workers in Saudi Arabia itself (BAe source). This contract therefore had the effect of masking the problems which existed in the company's defence businesses. These problems were made apparent in early 1992 with difficulties and uncertainties in a number of the company's main contracts. Firstly, the second phase of the Saudi Arabia contract for more Tornado aircraft became uncertain and was delayed (White 1991). Secondly, the EFA development program faced similar problems, and there was concern that production might be of significantly smaller numbers than were initially planned (Abrahams & Goodhart 1991). Thirdly, following the governments' 'Options For Change' review (HC 393), the UK government cancelled its proposed purchase of Tornado's for the RAF in Germany (HC 218). Finally a number of potential export contracts (to Malaysia, Oman and Jordan) were either cancelled or faced large uncertainties (Betts 1990), all of which had severe implications for the company (BAe source). These events resulted in the Military Aircraft Division refocusing and restructuring itself, which profoundly changed its size, structure and operational practices. This resulted in the closure of two of company's most historic and significant sites
at Strand road, Preston and in Kingston, while at the same time the workforce shrank by over a third from 27,000 to 16,000 (Table 4.1).

BAe’s Dynamics division is the UK’s largest missile manufacturer, capturing over 65% of the UK market in 1994 (BAe Source), with the company operating in virtually all areas of the missiles market (Covault 1995, MMC 1991). While UK work accounts for the majority of the division’s business, export work accounts for a significant proportion of turnover. For example, in 1994, export orders accounted for approximately one third of the division’s business (Interview source). However, the dominance of BAe Dynamics in the UK did not mean that it was sheltered from the downturn in defence orders in the period from 1989-94. The negative effects of the end of the Cold War on BAe’s Dynamics Division were large, as seen from the figures in Table 4.1. For example, between 1989 and 1994 its turnover declined by over 35%, while between 1989 and 1995 employment levels shrank by over 75%. Similar to the Military Aircraft division, this shrinkage in employment was also accompanied by the closure of a number of sites, with Dynamics focusing down from eight to just three sites (Stevenage, Lostock and Bristol). This resulted in the closure of some of the division’s most historic sites, for example at Hatfield, Bracknell and Weymouth. As well as the level of business in the Dynamics Division shrinking between 1989-94, as with the Military Aircraft Division, this was a period of great uncertainty, both in terms of domestic and export contracts, and was a period during which the company introduced wide ranging changes to its internal operating practices. The rest of this section will outline the strategies that BAe adopted in response to these changes, before the character of their capabilities are examined more fully (section 4.6, and 4.6.1).

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34 Missile markets can be divided into a number of distinct niches, based on application (air to air, air to surface, surface to air, anti-ship, anti-tank). BAe’s Dynamics division has products in most of these niches, except for very short range ground launched missiles (MMC 1991).
4.3.2 BAe's Strategy

The response of both BAe's Military Aircraft and Dynamics divisions to the events following the end of the Cold War was not been to diversify out of its defence markets, but to actually focus more closely on them (White 1992). Both divisions have therefore remained focused on their traditional markets of defence and aerospace while at the same time reshaping their organizational structures and practices to cope with the new market environment. Therefore the focus of this section will be on describing these changes and the methods by which they were achieved. The adaptation undertaken was intended to radically change their operating practices, moving from being a technically driven businesses to being more cost driven, cost efficient ones. In the Military Aircraft division the scale of the transition was outlined in the following way. One interviewee said,

'the organization was traditionally dominated by engineering concerns..... it was never an incentive, price driven corporation.'

The 1993 business plan described the adaptation as intending to produce 'a culture change in a new market environment'. It should be noted that these changes have not gone unresisted by particular groups or departments, but this issue will be developed further in chapter 7 (see section 7.6.1). The strategies pursued by both division were found to be inextricably linked with the strategy being pursued by BAe's Corporate centre, therefore it is necessary to show the linkages between the strategies adopted at both levels. In the following sections the corporate and divisional strategies will be described separately, while the analysis of the relationship between corporate strategy and divisional autonomy will be examined in chapter 7 (section 7.5.3). Here it will be shown that strategy decisions made by BAe's corporate group place significant constraints on the autonomy of its divisions.
(a) BAe Corporate Level Strategy

While neither BAe's Military Aircraft or Dynamics divisions were pursuing diversification strategies, this was not true of BAe as a whole, as from the late 1980's until mid-1992 BAe was pursuing a strategy of diversification through acquisition. During this period the company diversified into a number of areas including property management, ordnance, and most noticeably cars, through its acquisition of Rover (Betts & Leadbeatter 1990). This resulted in the company substantially diluting its interests in defence markets, which by 1992 accounted for only 35% of the company's total turnover (BAe Annual Report 1993). This strategy was begun before the end of the Cold War, and was thus not totally related to the uncertainty which its defence businesses faced in the early 1990's. The acquisition of Rover and Royal Ordnance were also very attractive short term financial deals to the BAe, both because of the price the UK government sold them at, and because both acquisitions provided BAe with large and valuable land assets (Lovering & Hayter 1993). However, the uncertainties the company was experiencing in its defence markets reinforced the direction of its diversification programme. By 1993, due to cashflow problems, reduced uncertainty in defence markets and serious losses in its commercial aerospace business the company reversed this strategy, and began selling off its 'non-core' assets to concentrate on its defence and aerospace businesses (Gray 1995e, Paloczi-Horvath 1994). Following this strategy change BAe sold off a large number of businesses including Ballast Nedam (construction) and Rover (to BMW in early 1994). By 1995 this strategy had been taken so far that the company's defence businesses had increased to account for over 75% of the company's annual turnover (BAe Annual Report 35 The company disposed of a large proportion of these assets and did make significant profits from them.
In order to further reinforce its defence business BAe made attempts between 1993-95 to diversify into helicopter prime contracting, through its joint bid for the Tiger helicopter contract, and into submarine building, through its attempted acquisition of VSEL. These acquisitions broadened the company's interests in defence markets, but in prime contracting roles, which had a large element of synergy with its existing defence businesses.

(b) The Strategies of the Military Aircraft and Dynamics Divisions

The strategies of both divisions are divided into two components, internal changes to their operating practices and structures and changes to their external market strategy. In each of these areas both divisions introduced substantial changes.

(i) Internal Restructuring

The early 1990's was a period during which both divisions introduced new operating practices with the stated aim of introducing more cost efficient operating practices. The first public symbol of this for the Military Aircraft Division, which provided an indication of how it intended to achieve these changes, was the publication of its first public business plan in 1992. This plan identified a number of factors (critical success factors, CSF's) which the changes were intended to address. The first was cost and the second management information, which provides an indication to the focus of the company's efforts. While the BAe's Dynamics division did not publish a public business plan, its internal restructuring programme was similarly focused. However, the way this was achieved varied slightly. The changes introduced will be discussed in relation to two areas of company activity,

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36 BAe was unsuccessful in both these attempts, with GEC acquiring VSEL and Westland winning the helicopter order.
37 One of the purposes of the document as well as outlining the company's plans, which was given to every employee, was to inform and motivate staff towards the importance of the changes with the symbolism and language emphasizing teamwork, pulling together etc.
project management and manufacturing, as these illustrate the character and extent of the changes.

One traditional aspect of both divisions was the large number of sites they operated across, with the autonomy of each site being high. Due to the history of the company, where it was been formed by the amalgamation of previously separate companies (see chapter 3), each site tended to have a strong identity and product focus. This resulted in each site having its own particular working practices, with separate design and manufacturing capabilities. This site autonomy tended to predominate, even after the formation of BAe, as no effective integrative management practices were introduced, which resulted in little coherence between divisions which were, in name, part of the same company (Mair 1993; p6, BAe sources). Therefore, one of the most significant aspects of the restructuring for both division was to rationalize its operations across sites, which is seen most clearly in the case of manufacturing.

Internal Restructuring - Project Management

Traditionally, in both divisions, project management was controlled largely by the technical engineering functions, with development staff being organized functionally into different technical areas. Previously, as one interviewee said,

'projects were organized within technical functions, with them having overall responsibility.'

This was perceived to be one of the main ways in which their traditional technical focus was achieved, and was thus regarded as one of the main barriers to the implementation of more cost-conscious operating practices. In both divisions, one of the central elements of their restructuring programmes was to therefore reorganize their project management
practices. This was achieved by the development of multi-functional project teams, with a large element of organizational power being removed from the technical functions. The purpose of these new project teams was to both increase the cost and customer sensitivity of project management practices, while simultaneously breaking up the authority and dominance of the technical functions. Finally, they were also seen as providing a means of passing commercial responsibilities down to lower levels within the organization, which their previous practices had never done. This was achieved by costing and running projects separately, with each project board now having their own costing systems and being responsible for its own projects financial performance.

In the Military Aircraft Division these changes were achieved by the adoption of a full matrix management system. With this structure separate project boards were created with the responsibility for running individual projects, with these boards being made up of multi-functional teams. While the technical functions were still involved in the running of these project boards their power to control projects was significantly diminished. With this structure development staff were allocated to individual projects, having responsibility to a project leader, while simultaneously still retaining responsibility to a functional manager as well. While BAe Dynamics adopted a similar system, with the creation of financially responsible project teams, with development staff having greater responsibility to their project team than to their technical function, they did not implement a full matrix management system.

As outlined, the changes adopted by the Military Aircraft Division required the removal of extensive authority and organizational power from the technical functions and the redistribution of these powers to the project boards which were multi-disciplinary, but which had a narrow project focus. However, there was evidence that the technical functions were able to retain
enough power within the organization to partially resist the restructuring process. This resulted in an internal conflict, described by one employee as a 'battle', between the newly empowered project focused functions and the disempowered technical functions. This division extended from senior management committees down through the project boards and resulted in the workforce and company resources being pulled in different directions. This issue is explored more fully in the analysis chapter, where these problems are shown to be inherent to matrix management systems (see section 7.6.1).

Internal Restructuring - Cellular Manufacturing

The changes in manufacturing implemented by both divisions also showed large similarities, with both concentrating their manufacturing on a smaller number of sites while simultaneously reorganizing it. In the Military Aircraft Division manufacturing was concentrated on two sites, at Brough and Salmesbury (BAe source) in order to move away from the highly dispersed structure which used to predominate. In the Military Aircraft Division initial investments were focused on upgrading Salmesbury's facilities, with more than £40 million being spent on new facilities and retraining (BAe source). Similarly, BAe Dynamics concentrated all its manufacturing on one site at Lostock. Previously its manufacturing had also been spread across a large number of sites. The main intention of this was to eliminate the large overcapacities which existed and to minimize the amount of duplication being done.

The other element in the reorganization of manufacturing was adoption of different operating practices. In both divisions this was done through introducing a cellular manufacturing system, which involved both the retraining of staff and the physical reorganization of machinery. One of the
The main motivations behind these changes was to reduce the cost of manufacturing which have been achieved to a large extent by significantly reducing the number of production staff. In the Dynamics division in particular this has been the case, with the direct manufacturing workforce declining from between 2-3,000 in the late 1980's to a few hundred by 1995 (BAe Source). This was made possible by the erosion of traditional job demarcations and the introduction of multi-skilling where previously traditional craft demarcations had been strong. This process was developed further by the introduction of system of operator self inspection, thus while employment levels have declined, simultaneously there were also significant changes to the responsibilities of production staff. The adoption of more flexible manufacturing practices also required the physical reorganization of production areas. In both companies production had traditionally been organized into functional areas, with fitting, fabrication, milling and turning all being separated into different areas. The adoption of a cellular manufacturing system required this to be modified, with these traditional divisions being broken down in order to create cells consisting of a range of different machines.

Another area of change in manufacturing introduced by both divisions was to significantly reduce their supplier base through the introduction of a system of preferred suppliers (BAe source). In the case of the Military Aircraft Division the number of regular suppliers used by the company shrank from approximately 11,000 to under 4,000 (BAe Source).38 The intention of these changes were again to reduce the cost of manufacturing through reducing both the levels of inventory held and the number transactions required with suppliers. A further benefit of this system was that it also allowed them to pass more risk onto their suppliers, once confidence has been established in their competencies and capabilities.

38 The intention was to eventually reduce the number of suppliers further.
(ii) External Market Strategy

As well as attempting to change their internal organization there was a noticeable shift in the external market strategy of both the divisions examined. However for both diversification away from defence markets was perceived not to be a necessary or suitable strategy. It was not a strategy deemed necessary by either division as the large uncertainties which had existed in their markets in the early 1990's began to reduce by 1994. For example, the Military Aircraft Division's business gradually stabilized as Saudi Arabia eventually confirmed the second part of the Al Yamamah contract and the Eurofighter project moved successfully towards production. Similarly, important defence orders for the Dynamics division, such as the CASOM development contract, were confirmed. Diversification was felt to be an unsuitable strategy due to the perceived risks it entailed. It was argued by both divisions that their capabilities were very specific, being those of a large scale systems manager within a defence environment, and that they were suited to few other environments. Thus in neither division was organic diversification seriously attempted (White 1992, interview sources). One interviewee summarized this attitude by saying

'whenever we have gone away from our knitting we have come unstuck.....you need to concentrate on what you are good at'.

This issue will be developed more fully later (section 4.6.1)

Instead of diversifying out of defence markets they both put a greater emphasis on winning export business. The main focus of these efforts, along with the majority of other defence companies from France and the USA (Nordwell 1994, Fulghum 1994), has been in the expanding markets of the Pacific Rim and the Middle East (BAe source). Both divisions have been successful in these efforts, substantially increasing their proportion of export
business. For example, in the three years between 1993 and 1995 BAe's level of export sales did not drop below 80% (BAe annual report 1993-95). Many of these contracts, however, were won with the aid of significant levels of government support, through both direct government lobbying and the export credit scheme, which is an issue examined more fully in the analysis chapter (section 7.5.2).

Another important element of BAe's Dynamics strategy during the period examined was its merger attempts, which illustrate the tendency towards concentration which was occurring in the top tiers of many defence markets. Initially there was an attempt to form a joint venture with Thomson CSF's missile division. While the negotiations over this merger extended over a number of years (1988-91), and reached an advanced stage, the deal was never finalized, as financial terms could not be agreed (Gray 1995f). Following this the company began merger talks with Matra of France, with a similar proposal to merge their missile businesses. Again the negotiations were protracted, beginning in 1993, with the deal only being completed in 1996 with the award of the CASOM missile contract to BAe (Gray 1996e). This merger was important as it began the rationalization of Europe's missile industry, creating the world's third largest missile company with a turnover of approximately $1.5bn (Covault 1996). From the interviews conducted within BAe's Dynamics division it was apparent that these strategy decisions were made at and negotiated at the corporate level within the company, providing a good illustration of the way in which divisional strategy making can be shaped and constrained by corporate level decisions.
4.4. Avionics Manufacturers in the UK - Aerospace Industry's Second Tier

The second tier of this sector consists of those companies which are responsible for the design and manufacture of the major sub-systems required on modern military aircraft such as communication systems, data recorders, displays, radars, navigation systems etc. These systems now consist of very complex and sophisticated electronics assemblies, and therefore account for a significant proportion of an aircraft's development costs. For example, approximately 20% of production costs and over 40% of overall unit costs of a modern fighter aircraft are accounted for by avionics systems (Taylor & Hayward 1989; p43, Hartley, 1993; p308). The three companies examined were the Navigation Systems and Sensors divisions of GEC Marconi Avionics (GMAv) and the Aerospace division of Smiths Industries (SI). As outlined in the methodology chapter (section 2.4.1) a small number of companies dominate these markets, with GEC by far being the largest. Therefore, the three companies examined represent a typical range of avionics equipment suppliers. Their experiences over the last 5 years have been different in many respects which will allow useful comparisons to be made. One of the problems commonly experienced when studying parts of GEC is obtaining figures at a suitably dis-aggregated level (see for example Williams et al 1983) as the company tends only to publish general, highly aggregated figures. This was certainly found to be the case for this research as it proved impossible to obtain detailed financial data on the two GEC divisions examined.

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39 These divisions are considered as separate companies as that is the way they are operated under GEC, where they are run as financially autonomous businesses.
40 In the companies annual reports it is impossible to obtain figure for GMAv alone as the figures are only broken down to the level of 'electronic systems', which includes GMAv and all the other Marconi companies combined.
4.4.1 Company Backgrounds and Post Cold War Experiences

Within almost every area of Britain's defence industry GEC's presence is ubiquitous, and avionics markets are no exception, with it actually having a very dominant position in these markets. Even before the purchase of Plessey and Ferranti in the late 1980's its dominance had been identified (Taylor and Hayward 1989; p49-52), with these acquisitions only serving to strengthen it position within these markets. GEC co-ordinates its defence avionics businesses under the GEC Marconi Avionics group (GMAv), whose significance is apparent from the fact that in the early 1990's it was Europe's largest avionics company, with an average annual turnover of £650 million (GEC sources). Its interests were very much focused towards military rather than civil markets with this accounting for approximately 75% of the groups turnover in the early 1990's (interview source). With British markets accounting for 43% of its business and the rest of Europe accounting for another 32% it is also seen that its business is very much focused on European markets (interview source). Employment figures for the GMAv group as a whole declined in the 1990's, dropping from 15,000 in 1992 to 12,000 in 1994 (GEC sources).

GEC's Sensors division was established in Basildon in 1954 and was a development from Marconi's original factory in Cheltenham. This coincided with the rise in the importance of avionics systems, which had previously been rather basic and unsophisticated. The main business of the company has always been in military avionics markets, which was still the case in the 1995. In this year 75% of the divisions business was military related, with avionics accounting for approximately 80% of the divisions turnover. Until the early 1970's, when the company developed interests in thermal imaging products, its business was almost totally avionics based. This division was relatively unaffected by declining defence orders following the end of the
Cold War, as its turnover actually increased between 1990-95, while employment declined by 180 to its 1995 level of 2,000 (ECC 1994).

The history of GEC’s Navigation Systems Division is really the history of the old Ferranti company, as it was only in 1990, after the ISC ‘disaster’⁴¹ that GEC bought over Ferranti’s Edinburgh defence interests, including NSD. Ferranti first came to Edinburgh in 1943 and set up on one site manufacturing gun-sights (Ferranti 1993). Over the following 30 years the company grew to cover 7 major sites and 4 major product divisions,⁴² with defence work counting for the vast majority of the business in all its divisions. As the divisions title suggests the company’s main business is in the design of aerospace navigation systems. In the early 1990’s approximately 80% of NSD’s turnover was defence related, with Space being its only other significant market. In contrast with GEC’s Sensors division NSD did experience a reduction in work following the end of the Cold War, however no precise figures were available to quantify this. Figures were available on employment changes though, with NSD workforce declining by almost 25% between 1990-94 shrinking from 1250 to 958 (Law 1995; p133).

If the effects of the end of the end of the cold war have been ambiguous on the two divisions of GMAv examined the same cannot be said for Smiths Industries Aerospace division. This used to be the dominant division within the Smiths Industries group, accounting for the single largest element of the group’s business. The other two divisions in the group, Medical Systems and Industrial Products, historically were always significantly smaller. However, due to the decline in both military and civil aerospace markets this situation has been changing. Between 1990 and 1994 the Aerospace

⁴¹ In the late 1980’s, in an attempt to expand the company and gain entry to US markets Ferranti bought the American company ISC (International Signal). However it was later discovered that the deal had been fraudulent, which pushed Ferranti into serious financial difficulties.
⁴² The divisions were Navigation Systems, Radar Systems, Display Systems and Elector-optic Systems.
Division's share of group turnover declined from nearly 70% to under 50%, with 1993 being the first year in the company's history when the medical division returned a larger profit than the aerospace division (Smiths Industries, Annual Reports 1990-1994). While the Medical and Industrial division both grew during this period the changes outlined are also related to the decline in turnover of the aerospace group. In only 4 years, between 1990 and 1994, the Aerospace groups turnover declined by nearly 20% from £455m to £374m (Smiths Industries annual reports 1990-94).

The aerospace division operates as two autonomous groups responsible for military and civil products, with military work accounting for 60% of the aerospace groups turnover. The decline in turnover outlined was equally attributable to a decline in both military and commercial business. This method of organizing the Aerospace group was only introduced in the early 1990's as part of the group's reorganization strategy. The groups now operate independently, almost as autonomous companies. The main avionics products of both groups are display, navigation systems and data recorders (interview source). During the early 1990's the Aerospace Division managed to consistently maintain its profit margins at 10% of turnover, which resulted in the company being seen by the city as one of Britain's best performers in this sector, in what was a difficult period in a declining market (Bolger 1991, Tooher 1996). This performance was achieved by a severe rationalization and restructuring programme, described variously in annual reports in terms of 'reshaping', 'downsizing' and 'reducing our cost base'. This has resulted in the organizational structure of the group changing significantly (see below), and has also produced a significant decline in employment levels. In the period from 1990-94 the Aerospace division shed approximately 35% of its 8700 workforce resulting in a reduction of 3,300 to 5,440 employees (Smiths Industries annual reports 1990-94).
While the products of GMAv and Smiths Industries were very similar, the geographic focus of their markets were very different. As stated, GMAv had a very European and UK focus, whereas Smiths Aerospace Division shifted to having a significant proportion of its business in US markets. This was done in the late-mid 1980's, similar to Ferranti, through an acquisition programme specifically intended to give the division access to US defence markets. Unlike Ferranti however Smiths Aerospace Division were successful in these ventures and by the early 1990's possessed 3 separate US companies which has resulted in 60% of the Aerospace groups turnover being in US markets and the company being involved in some of the USA's most significant aerospace projects such as the F22, F18 and T45 (interview source).

4.4.2 Company Strategies

It will be seen in this section that the responses of the three companies to the changing environment in avionics equipment markets have a wide range of similarities. All were seen to be more concerned with internal restructuring and re-organization than with significantly changing their market focus. It will be shown for all the companies that diversification was also not seen as important or necessary. Another significant similarity in terms of their strategies was the importance of the role played by the corporate centre in shaping divisional strategy. Thus this section will begin by outlining the general strategies being pursued by GEC and Smiths Industries during the period immediately following the end of the Cold War.
(a) GEC and Smiths Industries Corporate Level Strategies

This section will begin by briefly describing the strategies pursued by both corporate groups before discussing the similarities which existed in their corporate-divisional relations.43

GEC is the UK's largest engineering conglomerate, with a turnover which exceeded £10bn in 1995 (GEC Annual Report 1995), and which was the UK's 15th largest company in 1996 (FT 1997). Its business interests are also extremely diversified, with the company producing power generating equipment (GEC Alstom), telecommunication systems (GEC Plessey Telecommunications), consumer goods (Hotpoint and Creda), office equipment and general industrial apparatus as well as defence electronics systems. In the early 1990's there were two strands to GEC's defence group strategy. The first involved broadening and strengthening its defence electronics interests in Europe, which was done through the acquisition of a number of significant European electronics businesses. While none of these acquisitions were on the same scale as the Ferranti or Plessey purchases, GEC was one of the most active companies in acquisitions during this period (Skons 1993). The second strand to its strategy was to increase its role as a prime contractor on defence equipment contracts (Gray 1994d). The most visible signs of this strategy were in its (failed) attempt to win the prime contractorship for the supply of helicopters to the UK army (1994a), and its successful acquisition of the UK's only nuclear submarine manufacturer VSEL in 1995.

In the period immediately following the end of the Cold War Smiths Industries was also undertaking important changes in its corporate level strategy. While its aerospace business was declining the company

43 Due to the size and diversity of GEC's business interests it is only possible, in the space available, to discuss the strategy it pursued in its defence businesses.
concentrated on expanding its Medical and Industrial products divisions, which had traditionally been substantially smaller than the aerospace group. This strategy resulted in both these groups expanding dramatically, with the Medical group growing from a turnover of £117m in 1990 to a £270m turnover in 1995, while the Industrial Product group similarly grew from having a turnover of £100m in 1990 to a turnover of £250m in 1995 (Smiths Industries Annual Reports 1993-95). This growth was primarily achieved through acquisition rather than organic growth (Butts 1996), for example, with the acquisition of the Vent-Axia air-conditioning business, which was added to the industrial product group (Wagstyl 1996).

While GEC and Smiths pursued radically different strategies there were two very important similarities in their corporate-divisional relations. Firstly, both corporate groups primarily measured division performance in relation to short term financial figures, setting extremely stringent performance targets (interview sources). Secondly, the autonomy of divisions in both corporate groups was limited by the corporate level acquisition strategies outlined above. In relation to the importance attached to financial performance targets GEC has traditionally been the corporation most often accused of financial short-termism (Leadbeater 1992) and pursuing conservative, financially driven strategies (TIC 1996, Williams et al 1983). However, from the interviews conducted Smiths was not found to be qualitatively different in its divisional management style or its emphasis on financial performance. From the interviews conducted with representatives from all three avionics companies it was apparent that they were set stringent short term financial targets, which combined with the corporate level acquisition strategies, substantially limited their strategic autonomy. These issues will be developed more fully in the analysis chapter (section 7.5.3).
(b) The Strategies of GEC Sensors, GMAv's NSD and Smith's Aerospace Group

(i) Internal Restructuring

Of the three companies, the Aerospace division of Smiths was the one which went through the largest and most extensive restructuring exercise. The Navigation Systems division of GMAv, while having experienced a significant reduction in employment underwent less in the way of an organizational transformation than Smiths. Finally, the Sensors Division of GMAv was the company which was least affected by the changes in defence markets. It lost little in the way of staff, its turnover remained constant and there was evidence of only limited organizational change.

While all the companies were affected differently in terms of changing business levels, they were similarly exposed to two changes in their market environment. Firstly their markets became more competitive and secondly they were all affected by the change in the UK government's procurement practices. The more competitive environment was caused primarily by the decline in military spending which occurred following the end of the Cold War, which increased the intensity of competition for contracts (Gray 1994c).

As stated, Smiths Aerospace group underwent the largest adaptation in response to these events. A significant component of this response was the downsizing of the Aerospace Group. The other main component of the restructuring in Smiths Aerospace group was the separation of its military and civil business into autonomous divisions. In the 1980's the Aerospace group was product focused, with the company having separate divisions with military and commercial work being done together within these divisions (SI 1992). The separation of military and commercial business was intended to refocus the company away from being product based to being customer
(or market) based. It was felt that the needs of the customers in these market had become so different that they would be better addressed by separating the company into two. The military and civil groups now operate as two separate companies with separate budgets, financial responsibilities, organizational resources and personnel. One of the few remaining shared resources was the site.

With regards to changed management and organizational practices the changes in the UK government's procurement practices forced Smiths to be more aware of the cost and delivery aspects of its contracts. Under the previous cost plus regime cost and delivery constraints were less important as the government carried all the risk and any contract slippage could be negotiated. These changes were thus one of the catalysts for the company's restructuring programme.

The response of both the GMAv divisions were similar and will therefore be discussed together. While NSD saw more of a significant reduction in its workforce in the early 1990's this decline wasn't solely attributed to changing defence markets. The other main reason for the reduction in employment was related to the cost cutting measures implemented by GEC after it took over the company. In the 2-3 years immediately following GEC's acquisition of Ferranti it introduced a wide range of organizational changes to bring its operating practices into line with those of GEC. One aspect of this was to reduce employment levels, as at the time of the acquisition there was considered to be an over-capacity of labour (interview source). In both NSD and GEC's Sensors division there was much less of a radical reorganization than had occurred in Smiths. While it was apparent that these divisions were also exposed to the more competitive and risk sharing nature of the UK's procurement practices, there was little evidence to indicated that either division had undertaken any major organizational changes as a result of this. In GEC's Sensors division it was stated that these were relevant
concerns for management rather than the workforce in general, therefore its response had been to retrain its managers alone in an attempt to increase the companies sensitivities to these issues. It was then felt that this change in emphasis or direction would then percolate through the company to the bottom.

(ii) External Business Strategy

The main business strategy of all three divisions was to remain focused on defence markets. The only significant change in the market strategy of all three divisions was to improve their level of export sales. Of the three companies examined only one, GMAv's NSD, was making positive efforts to diversify its interests into non-defence markets, but even there it was acknowledged that this was a peripheral interest (see below).

Smiths main strategy was to focus on developing its markets in both the USA and Europe. This was a strategy the company adopted in the mid-80's and the end of the Cold War did not alter this. It was felt that aerospace markets, while declining, still had adequate levels of work for them to survive (interview source). Demand in aerospace markets in the early 1990's was considered to be at a low point and therefore likely to improve towards the end of the decade. The company was also unconcerned over its existing level of defence work, therefore diversification out of defence or aerospace markets was not seen as necessary or important. It was felt by those interviewed in Smiths' aerospace division that diversification was too risky a strategy to pursue. The reasons for this, developed later, were that their defence products were not adaptable to other environments and that their organizational capabilities were not suitable for operation in other markets. The way Smiths Aerospace division pursued its strategy of entering US markets was through the acquisition of other related companies. Funding for
such ventures, as did these general strategy decisions, came largely from the parent group.

The strategy of both NSD and the Sensors Division of GMAv were very similar to those of Smiths. Diversification out of defence markets was considered by those interviewed as being both unnecessary and too risky. Their main strategy was to develop greater levels of business in export markets, however the focus of these efforts were more on Asian than US markets. As stated above however, NSD was trying to develop into some non-defence markets. This was done through setting up a separate Industrial product group within the division which had its own separate staff and a certain degree of autonomy. The focus of the group's efforts were to exploit the company's core capabilities in similar markets. The division was argued to possess generic capabilities in the development of high quality and complex precision engineered products to precisely defined specifications and felt there were opportunities to broaden and expand the group's business by applying them into non-defence markets. These efforts, however, were not intended to replace the company's core business, and were never expected to account for a large part of the division's turnover. In 1995, for example, the group only employed 10 staff, and had a very small turnover. One of the major constraints on this work was the lack of access to central funding within the group from either GEC or GMAv itself. The stand alone nature in which GEC manages its divisions meant that these efforts did not receive additional funding from the corporate centre. The divisions of GEC examined had little control over their broad strategic directions as this power was held higher up within the organization. The ability of these divisions to control or change their high level strategy was therefore significantly constrained.
4.5 Lancashire's Aerospace Supplier Network

This section will examine the third tier of the UK's military aerospace sector, where it will be shown that the character of the operating environment at this tier and the type of company which operate in these markets were substantially different from the other two tiers outlined. This section will be divided into two main parts, with section 4.5.1 detailing the results of the small postal survey that was conducted while section 4.5.2 focuses on the three case study companies which were examined.

4.5.1 Survey Results

The first stage of the empirical research into the aerospace supply base involved sending out of a questionnaire in July and August 1994 to a small number of Lancashire companies (see methodology chapter, section 2.4.1). Its purpose was to establish the experiences and responses of these companies to the changes which occurred within the local aerospace suppliers network following the end of the Cold War. The primary issues of interest to the research were; had the companies' business been adversely affected by these events; what was the adopted future strategy of each company; how adaptable/suitable were the company's capabilities to non-defence markets. Based on the survey results three companies were also selected for more detailed examination.

There have been a number of events since 1990 which were expected to have affected small aerospace companies in Lancashire with the closure of BAe’s Preston site, at the time one of Lancashire’s largest employers, being one of the most significant events. This was followed by a major re-organization within BAe's Military Aircraft Division. An important component of this re-organization, as outlined, was to change their sub-contractor relationships. It was thus expected that these events would have negative
effects on most of the small aerospace suppliers within the Lancashire region.

The questionnaire was sent to 45 aerospace companies and produced 19 usable replies, thus giving an overall response rate of 42%.\textsuperscript{44} The 19 companies were quite a homogeneous group, and were not representative of the full range of companies which supply the major aerospace companies. Virtually all 19 companies were precision engineers, machine shops or jig & tool manufacturers. There were only 4 companies whose main business interests were outside these categories. This supports evidence by Finch (1994) that the character of local suppliers to large aerospace companies was unlikely to be typical of the full range of suppliers. Also, they were all relatively small, with 31% (6 from 19) having less than 20 employees and a further 37% (8 from 19) having less than 100. Therefore only 31% (6 from 19) of companies had more than 100 employees.

The changes implemented by BAe's Military Aircraft Division had a variable effect on the surveyed companies, with only 9 of the 19 (47%) having lower current employment levels than 5 years ago. Of the remaining 10, 6 reported that their employment and turnover was actually the same as 5 years ago, while the remaining 4 had seen an increase in their employment and turnover. The number of companies whose business had been adversely affected was thus lower than had been expected. However, due to the small sample size these results cannot be taken as representative of all aerospace suppliers. There was also a mixed response to the question of whether reducing their level of military work was regarded as important, with the majority of companies viewing the issue as unimportant or of low priority. Of the 19 companies surveyed only 6 attached importance to the issue. The majority of these 6 companies were also only in the early stages of

\textsuperscript{44} 5 replies received from companies with no defence work at all were not used.
addressing the issue, and while attaching importance to it, at the time of the survey, had done little towards actually achieving it. The biggest factor influencing these attitudes appears related to the overall level of military work held by the companies. Thus, unsurprisingly it was the companies with the highest levels of military work which attached most importance to diversification. The level of military work within the companies surveyed varied tremendously, from only 2% to over 95%, with the statistical average being approximately 40%. However there were only 8 companies with more than 50% of their turnover based on military work, with half being interested in reducing their level of military work. Whereas of the 11 companies with less than 50% military work only two were concerned with reducing their levels of military work.

Therefore, based on the survey results alone, the effects on Lancashire's small aerospace companies of recent changes were less significant than expected. The survey results were also used as the basis for selecting three companies for more detailed study. As the main focus of the research was to examine the adaptability of military capabilities to other markets, and into how operating in defence markets influences and constrains companies it was decided to focus the case studies on companies with significant levels of military work. Thus all of the three companies selected had at least 70% of their business in military aerospace markets and were thus not representative of all the suppliers surveyed. Of the three selected one had expressed an interest in reducing their level of defence work.

4.5.2 Case Study Results

If the questionnaire showed a surprisingly positive picture of the effects of the end of the cold war, then the recent experiences of the three companies interviewed provided a counterbalance to this. However, this probably reflects the fact that the three companies examined had high levels of
defence work. While in 1995 they were all relatively stable and secure they had all experienced a significant loss of work in the early 1990's which had resulted in all three significantly reducing their employment levels. The data on the three case studies is based on interviews with senior company representatives which were conducted during site visits. The following section will provide background information on the companies interviewed outlining their product details, their history and their recent experiences with regards to changes in defence markets.

(a) Company Backgrounds

All of the companies interviewed were basically small or medium sized precision engineers producing high quality milled and turned components, predominantly for aerospace markets. Two of the companies had approximately 40 employees, while the third employed just over 90. However, in all three cases these levels were significantly lower than they had traditionally been. The early 1990's had been a very difficult time for these companies with all experiencing significant downturns in their business levels, with two of the companies actually having been bought out of receivership during this period. As stated above, their business was mainly in defence markets, with this accounting for 75-95% of their output. All three were set up either during or after the Second World War and had historically worked almost exclusively in aerospace markets. For all three the Cold War had been a period of relative stability in business terms, with all having long term relations with a constant number of aerospace companies. The other non-aerospace markets that they competed in were markets with similar demands for low volume, high precision components, for example the nuclear industry. However, for all of the companies non-aerospace work never accounted for more than 25% of turnover and in two of the three accounted for less than 10%. The ownership details of the companies also

45 The interviews were conducted in October 1995.
varied, with two of the companies being owned and run as small independent businesses, while the third was part of a larger engineering group.

All three companies typically manufactured small batches of high precision components for aerospace applications. This basically involved the milling and turning of aluminium or steel components to tight tolerances and high quality specifications. Batch sizes varied greatly, but never got to a scale which could be described as mass production or high volume. None of the companies undertook original design work and all simply manufacturing components to drawings and specifications supplied by customer. The companies were all BS5750 approved as this was a fundamental requirement for any manufacturer of aerospace components. This specification placed strict demands on companies for the traceability and monitoring of components requiring them to operate extensive quality, inspection and monitoring procedures for the processing of all work. This requirement therefore placed a heavy administrative burden on them, which made competing in higher volume, lower quality markets difficult (see later)

(b) Defence Market Changes, 1989-95 And Their Knock-on Effect

(i) Declining defence Orders
All the companies interviewed had experienced a major decline in their business following the end of the Cold War. A secondary factor, which exacerbated the problems of these companies, was the downturn in civil aerospace markets, which coincided with the decline in military aerospace orders. The effect of these events on the companies was dramatic, with all experiencing a virtual 50% reduction in their employment levels, and as said, with two of the companies actually going into liquidation before they were bought out or receivership by their existing owners. One of the companies, for example, went from having 4 sites and over 200 employees in the 1980's to its current position of one site with just over 90 employees.
All the companies described the period as producing a severe shakeout of the sector with a large number of companies not surviving the last 5 years.

(ii) Changing Contract Relations: Cost Plus Paternalism to Preferred Suppliers

The other major changes affecting the companies examined during this period was that their customers, the larger aerospace companies, had also changed their sub-contract relations and business practices. This therefore changed the market environment of these companies significantly. One of the major changes was that there has been an obvious shift by the large aerospace companies from supporting a large range of sub-contractors and small engineering companies to a system where a much smaller range of preferred suppliers were supported.

Under the previous system, during the period of the Cold War, the large aerospace companies had supported a wide range of subcontractors on either off load contracts or longer term strategic contracts. Strategic subcontractors were those companies which did sub-contract manufacturing based on long term contracts, which were planned strategically. This work provided companies with relatively stable and predictable workloads and allowed longer term planning to be undertaken. Off load work consisted of priority work which the large aerospace companies couldn't produce themselves and which had to be passed to a sub-contractor to be completed on time. Receiving off load work at short notice was not abnormal with the interviewees in all three suppliers providing anecdotal evidence that this type of work relationship was extremely common. The advantage to the companies undertaking this work were the premium rates which were paid for it and the reputations which could be built up by consistently meeting the demands of the work. During periods of buoyancy in military aerospace markets, such as the mid-1980's when Tornado production was at a peak, there was enough work for a wide range of contracts doing both strategic
and off load work. During these times, particularly when cost plus contracts were still prevalent, once small companies had built up a reputation, repeat contracts were usually forthcoming. As one company representative said,

'\textit{the company had just lived off its reputation and business had rolled in through the door.}'

In this environment there was therefore little cost based competition as companies tended to live off continuous orders for repeat work. In all the companies that were interviewed sales and marketing departments were undeveloped or unnecessary, with one of the companies describing the fact that it had no sales & marketing function or company brochures until the 1990's.

The above situation can be contrasted with the moves by many of the large aerospace companies, including BAe, towards supporting a much narrower range of preferred suppliers on longer term strategic contracts. These changes were intended to both minimize the amount of off load work required, while also reducing the number of strategic sub-contractors to a narrow core of preferred companies. This produced a significant shakeout of companies due to both the reduced levels of work available and this change in sub-contract relations. This resulted in these markets supporting a much smaller base of companies in an environment which was substantially more competitive than had been typical during the Cold War. The implications of these changes for the small, sub-contract manufacturers examined were that they had to operate in a much more competitive environment where there was much less work than was available previously and where the competition for the remaining work was much greater.
(c) Company Strategies

This section will examine the strategies adopted by these third tier companies in light of the above. The section will be divided into two parts, looking at any internal re-organization undertaken and at the external business strategy adopted.

(i) Internal Restructuring

In all the companies examined some form of internal restructuring or re-organization had been adopted in response to the new environment which occurred in their traditional markets. The more competitive environment which resulted in a greater emphasis being placed on cost than previously existed resulted in these companies adopting new management and organizational practices. Primarily this was achieved through the significant reductions in employment that have been outlined. The first reaction of the companies to declining defence markets was to drastically reduce workforce levels.

However, this was not the only change implemented. The greater emphasis on issues of cost and commercial competitiveness represented a significant change for these companies, as traditionally these considerations had always been secondary to issues of product quality. This resulted in these companies adopting a range of operating practices which had never been necessary before and which represented a significant change for them. This affected both management and shop floor organization. For example, to reduce overhead costs and improve cost margins flatter management structures were introduced and shop-floor changes such as operator approved inspection systems were adopted.
(ii) External Business Strategy
As well as internal re-organization all the companies examined adopted new business strategies as a result of the declines in business they had experienced. While there was an absolute decline in the level of work available in aerospace markets, they were still perceived by all the companies interviewed as being a market large enough to be the foundation of their business. One of the interviewees said, 'the nucleus of our business has been and will continue to be aerospace precision manufacturing.' This attitude was very representative of the outlook held by all the companies. The levels of defence work experienced in the early 1990's were regarded as the bottom of a trough and it was therefore expected that the level of work from both military and civil aerospace markets would increase significantly.

Of all the companies examined, only one seemed actively committed to reducing its level of military or aerospace work. For the other two companies the main strategy was to diversify and broaden their customer base within existing aerospace markets. Too great a reliance on a small number of customers, which had been the pattern for both these companies, put them in a vulnerable position due to the high levels of dependence involved in such relations. Broadening their customer base within aerospace markets was therefore seen as a way of reducing the risk of over-dependence on any one company. Both companies were considering non-aerospace work, but this business was peripheral to their main interests. One of these companies did undertake some non-aerospace work, which provides an illustration of the limitations to diversification which can exist. It undertook the manufacture of agricultural components but found that it couldn't compete with the necessary cost margins in these markets as the work was of a higher volume and lower quality levels than it was used to. This experience therefore made the company cautious when considering work in markets which were seen to be very different (discussed more fully later).
The one company which was more seriously committed to diversifying out of aerospace, and particularly military markets had adopted a new business strategy aimed at achieving this. The intention was to reduce its level of defence related work from 75% to only 50% of its turnover. This was to be achieved by aggressive sales and marketing efforts in a selective number of 'suitable' markets with the company allocating specific resources to achieving this. Suitable markets, similar to aerospace in their demand for small batches of high precision components, such as the nuclear industry and the oil and gas component industry were targeted. These efforts were therefore seen as of central importance to the future of the company, as there were felt to be continuing uncertainties over future levels of military aerospace work. It was felt by the company that its capabilities and organizational set-up were unsuited to the demands of lower quality, higher volume markets and thus it was not pursuing work in such markets. These developments were at a very early stage, but initial efforts appeared to be relatively successful.
4.6. Capabilities

This section will relate the empirical findings on the character of the company's capabilities to the nature of their operating environment, concentrating upon its market and technological components. It will be shown that the capabilities of the companies were contingent upon the character of their operating environment and that the particular requirements of defence markets did influence their structure and behaviour in very specific ways. The particular nature of defence markets will be seen to have their most substantial effect on the sales and marketing capabilities of the companies examined, which has implications for their adaptability to non-defence markets. The technical requirements were found to be an equally important factor, shaping the capabilities of all the companies examined in different ways. The technical requirements were found to vary greatly dependent upon the particular tier of the product hierarchy that the companies operated at.

4.3.1. Prime Contractors and Second Tier Suppliers

(a) System Integration Capabilities

The technical demands of aerospace work required that the companies designing and manufacturing military aircraft and avionics systems be large companies due to the financial resources and range of facilities required in this work. Development and production commitments span time periods of decades\(^\text{46}\) and require companies to be involved in a wide range of diverse activities including; system design and manufacture; system integration; testing and assembly; and operational servicing. The system integration

\(^{46}\text{For example the Harrier and Tornado aircraft, which BAe's Military Aircraft Division is still involved in, were both originally started in the 1960's.}\)
requirements involved in this type of work increased massively during the period of the Cold War due to the growth in the technical complexity of these systems.\textsuperscript{47}

The technical demands of this work required the companies examined to possess specific organizational capabilities. The capabilities required are those of a large scale integrator of complex engineering systems. From the interviews conducted with the prime contractors and avionics companies there was a large degree of consensus on this issue. For all of these companies system integration capabilities were regarded as one of their core competencies (Prahalad & Hamel 1990). There were two main dimensions to these system integration requirements. Firstly the design of large, complex technological systems required particular organizational capabilities and secondly these companies were required to manage a large supply base of companies during both design and manufacturing phases.

The development of these technical systems requires co-ordinating complex designs over extended time periods. This work is very capital intensive and highly technical and requires the employment of high proportions of engineering and scientific designers, therefore the companies examined employed high proportions of white collar, technical staff among their personnel. In BAe's Dynamics Division, for example, over a quarter of the workforce were educated to degree level (BAe Source) and in a typical division of GMAv the proportion of technical staff was approximately 45-50\% (GEC sources).\textsuperscript{48} Substantial test facilities, such as airstrips, wind tunnels and large environmental chambers were also required during the development of this equipment placing a further organizational requirements on them. The organizational requirements of co-ordinating a large supply

\textsuperscript{47} This was the result of the trajectory of continuous technological development which was pursued by the UK government during this period (see section 3.5)

\textsuperscript{48} Technical staff referred to cover graduate scientists and engineers as well as technicians, who are likely to possess vocational qualifications such as HND's, HNC's.
base were also found to be onerous. System integrators had responsibility for the allocation and management of a large number of sub-contracts for the design and manufacture of a diverse range of components. In BAe's Military Aircraft Division, for example, even after substantially reducing their supply base it still involved approximately 4,000 companies. This requirement occurs during the development and manufacturing as much specialist design work is sub-contracted, therefore the requirement is not only to manage the manufacture and assembly of large numbers of components, but also to co-ordinate the design efforts of a large number of companies over the development phase as well. Therefore these requirement placed extensive administrative burdens on all the prime contractors and second tier companies examined.

The demand for system integration capabilities was more related to the technical requirements of designing and manufacturing large technical systems than to any specific market requirements. These capabilities therefore did have relevance beyond defence markets to other environments where there were similar technical requirements. However, there are only a limited number of other markets to which these capabilities are transferable (for example the management of large construction projects). Thus these capabilities offered very limited opportunities for diversification out of defence markets.

(b) Manufacturing Capabilities

As with the system integration capabilities above, the technical requirements of these products resulted in the organizations examined possessing very particular manufacturing capabilities. In broad terms both the prime contractors and avionics companies examined manufacturing was concerned with the production of extremely low volumes of high quality complex systemic products. However the manufacturing systems of the
primes and avionics companies were different as the technical requirements of their work varied.

Crudely, military aircraft are physically large electro-mechanical systems, whereas the avionics systems produced by the second tier companies examined are primarily electronics systems, which are physically much smaller. This basic difference in products had significant implications for the type of manufacturing system required. The production of military aircraft, for example, physically required more factory space than the production of avionics systems. A more important technical difference between these systems was the greater component of mechanical engineering involved in the production of aircraft than in avionics systems. While electronics systems constitute a large part of a modern military aircraft these systems require to be integrated into the mechanical chassis of the airframe. This produces two significant differences in the manufacturing requirements of aircraft and avionics systems. Firstly, the prime contractor has the requirement of physically manufacturing and assembling the airframe, which the avionics company does not. This requires very large assembly areas, as well as large machine shops to produce components within. Secondly, aircraft prime contractors also have the added task of integrating all the aircraft's electronics sub-systems with the mechanical chassis. Thus, the manufacturing capabilities of the prime contractors and avionics companies varied significantly.

One area where the manufacturing systems of the prime contractors and avionics companies were the same was in the lack of emphasis which was placed on cost control during the Cold War. Under the contracting system which predominated during this period there was little incentive for them to reduce their cost structure or improve the efficiency of their manufacturing practices. Therefore they were never exposed to what could be described as a competitive market environment. As one interviewee said
'the company used to add up all its costs, add on a percentage profit and that was the price.'

The main criterion in controlling contracts was the company's compliance with the technical requirements of contract specifications. The nature of contract relations meant that as costs increased companies could simply add the extra costs into a contract. In this environment cost reduction or process optimization functions were relatively undeveloped. While there was a requirement on companies to give detailed accounts and breakdowns of contract costs this system didn't provide an effective method of putting pressure on them to reduce their costs. These requirements therefore resulted in the under-development of processes to control cost. Fundamentally, the emphasis on technical issues in military markets which predominated during the Cold War stopped these companies being exposed to more competitive market forces which would have encouraged the implementation of different management control functions (Lovering 1990, Gansler 1984).

The changes in the UK's procurement environment which occurred following the Levene reforms resulted in a greater emphasis being put on controlling costs, an environment to which the manufacturing systems of the companies examined were largely unsuited. This was the primary reason for the changes in manufacturing implemented by both of the BAe divisions examined, and to a lesser extent the avionics companies examined.

As with the system integration capabilities, the manufacturing systems of the companies examined were shaped both by the technical requirements of producing aerospace equipment and the character of their market environment. As outlined, the lack of cost focus in these markets shaped the character of their manufacturing systems. However, there was an important difference between the prime contractors and avionics companies in terms of the relevance of their manufacturing systems to other environments,
primarily due to the difference in their technical character outlined above. The manufacturing systems of the prime contractors were relevant to a substantially smaller range of other environments than those of the second tier avionics companies. The broader relevance of the avionics company's manufacturing systems was because they were primarily manufacturing complex electronics systems, which was a capability of more general relevance than being an aircraft manufacturer. However, the manufacturing capabilities of the second tier avionics companies were still relatively specific, with only limited applicability to other markets.

(c) Sales and Marketing Capabilities

Of the three broad type of organizational capability examined the sales and marketing capabilities of the prime contractors and avionics companies were the most specific in nature, having very little relevance beyond defence markets. This was primarily because the character of customer-supplier relations in defence markets were very distinctive. This distinctiveness was due to two main factors. Firstly, in defence markets the customers needs are defined in detailed specifications and secondly because the competitive process is also distinctive

In military markets there was less technical speculation as the requirements of the customer were defined in elaborate and detailed specifications. This resulted in the sales and marketing processes of the companies examined being very specific in nature. Speculative marketing, aimed at identifying potential customer or determining the technical requirements of customers was something that these companies were never required to do. The distinctive character of competition in these markets also influenced the sales and marketing capabilities required by the companies examined. In these markets competitions for major contracts extend over long periods, proceeding through a number of very formal stages. This therefore allows
companies competing for these contracts to extensively lobby government for the award of these contracts. Dunne & Smith (1993;p101) argued that the most important skill of a defence contractor was the ability to persuade governments to give them money, which was found to be true. Sales and marketing, particularly for military prime contractors did not require either the identification of customers or the identification of customer needs, being primarily concerned with lobbying governments for the award of contracts which have been extensively defined. Thus the sales and marketing capabilities of the companies examined were found to have little relevance beyond defence markets as there was no comparable market environment which operated in a similar fashion.

The sales and marketing capabilities required by the second tier avionics companies were slightly different as they did not have to directly lobby government to win business. Instead they were concerned with lobbying the prime contractors for the award of sub-system contracts. However, similar to the prime contractors, they also did not require to undertake large amounts of speculative sales and marketing as their direct customer (the prime contractors) also defined their requirements in detailed specifications. Thus, as with the prime contractors their sales and marketing capabilities had very little relevance beyond defence markets.

(d) Technological Capabilities

When examining any organization it is necessary to recognize that their technological capabilities constitute not only the products that they produce, but also the underlying knowledge and skills required to produce these artefacts (MacKenzie & Wajcman 1985, Laudan 1984). Thus in the following section both components will be examined, beginning firstly with their products.
In all the first and second tier avionics companies examined their products were found to be very different from their commercial, non-military equivalents. This will be illustrated with reference to Smiths Industries who produced display systems and general avionics equipment for both military and commercial markets, however the situation of all the aerospace companies examined was similar. From those interviewed in Smiths it was found that there were very substantial differences in the technical characteristics of the military and non-military systems they produced. These differences were so significant that their military products were totally unsuitable for their commercial markets, and vice versa. The distinctiveness of their military and commercial products was due to two separate factors. Firstly, the environmental requirements placed on their military systems tended to be much more severe than for their commercial equipment, and secondly there were a number of unique technical requirements which they were required to incorporate, which were totally irrelevant to non-defence markets. In terms of environmental requirements the general levels to which Smiths military displays was designed were higher than for their commercial products. For example Smiths were required to design their military displays to operate within a much broader range of operating temperatures than was required for their commercial systems, which was true for a large number of other environmental requirements such as vibration levels. The demands of these military environmental requirements significantly affected the design characteristics of their military systems making them very different from their commercial displays. There were also a number of unique technical requirements which also fundamentally affected the design of their military displays, further distinguishing them from their commercial equivalents. For example, their military display systems were required to identify and monitor missiles, which was obviously a unique military requirement.

These differences were so fundamental that they resulted in the trajectory of technological development in military and non-military aerospace sectors
being distinct and separate, which supports the findings of Harbor (1991). This was true for all of the first and second tier aerospace companies examined, with the result that their military products were unsuited to non-military markets, and that the development of military and commercial aerospace equipment occurred in separate spheres. Military equipment is generally therefore unsuitable, even after modification, to non-military environments. As one interviewee said,

'you can never take a military system, spray it silver and sell it as a commercial system.'

When considering the general technical skills and knowledge of the first and second tier military aerospace companies there was a greater level of generalizibility, however these capabilities were still, in general, specific with only limited relevance to other markets. In support of the arguments made by Pavitt (1984, 1987) the technological capabilities of the aerospace companies examined were specific and cumulative in nature, with little broad applicability to other market environments. From the fieldwork conducted the technological capabilities of the companies examined consisted of two components. Firstly there was a core of general non-specific knowledge, and secondly there was a more specific applied component to their capabilities. While it was possible to divide the technological capabilities of the companies examined into these two distinct categories it was not possible to quantify their relative importance. However, from the fieldwork conducted it was apparent that both components were significant.

Comparing the companies examined to their commercial equivalents,49 there was found to be a core of common knowledge which was transferable from military to non-military companies. This common knowledge consisted

49 All the first and second tier avionics companies examined had 'sister' companies producing commercial aerospace equipment
of a core of basic scientific and technical knowledge/principles. For BAe's Military Aircraft Division an example of this core would be the basic aerodynamic principles on which their aircraft were designed, or the more tacit, less codified knowledge related to aircraft testing. In both these areas these types of knowledge were transferable to non-military aerospace markets. However the another significant component to their technological capabilities which was substantially less generalizable, related to the specific expertise they had developed in applying their general, core knowledge to specific problems.

Much of the expertise of the companies examined, and any industrial organization which is involved in complex design/development work, was related to the application of general principles to particular techno-scientific problems. For the companies examined this was argued by those interviewed to constitute the largest and most important component of their technological capabilities. This was largely why they regarded organic diversification as being a difficult strategy to pursue, as the most important element of their capabilities were not transferable beyond defence markets. As was outlined above, in relation to the product characteristics of the companies examined, the design requirements of military aerospace equipment were substantially different from commercial aerospace equipment, and thus their applied technological capabilities had only limited relevance to commercial aerospace markets. This applied knowledge was therefore more specific than the other component of general unapplied knowledge as it was related to, and developed in response to, a narrow range of technical problems. Thus the specific expertise of the companies examined accounted for a significant proportion of their technological capabilities and was of only limited relevance in commercial aircraft design.
4.6.2 Third Tier Suppliers - Capabilities

As outlined previously, the three third tier suppliers examined in no way represented a typical range of aerospace component suppliers. Their similarities were such that they were representative of only one type of supplier, thus the capabilities described in this section should not be regarded as typical of all suppliers. In all three companies examined no original design work was done, with the companies simply manufacturing components to specifications and drawing supplied by their customers. Thus the technological capabilities of these companies were inextricably linked to their manufacturing capabilities. Because of this their technological capabilities will be considered as an aspect of their manufacturing capabilities and will not be addressed separately.

The core capabilities of these companies were as aerospace manufacturers, rather than as military manufacturers, as the constraints involved in military and commercial aerospace work at this level of the industry were virtually identical. Thus at this level of the defence industry supply base the distinctiveness of the operating environment was substantially less than for the prime contractors or second tier companies. Companies operating at this level of defence markets therefore do not possess organizational capabilities which distinguish them as operating in military markets. However, operating in military markets did have an important influence on their sales and marketing capabilities, as will be seen later. The primary capability of these companies, which had the biggest influence on the way they operated, was in the production of low volume batches of high quality, precision engineered components. This was well recognized by all the interviewees and can be illustrated by the following quotes,
we are in a niche market of high quality, high precision engineering work. It's no good diversifying into high volume manufacturing, as the style of operations is totally different',
or,
'you have to look at your core capabilities. Anything which is small batch, high precision work we will look at.'

The high quality and low volume nature of aerospace manufacturing shaped their organizational structures and operational procedures in distinct ways, which will be shown to place significant administrative and overhead burdens on the companies, requiring them to operate extensive and costly quality systems. These capabilities had been built up cumulatively over the period of the Cold War, where the character of their operating environment had remained relatively static. This restricted them to operating in markets for high quality, precision manufactured components, limiting the possibilities for competing in higher volume markets. Thus while their capabilities did not constrain them to operating in defence markets alone they were still found to be narrow and specific in nature with only limited general applicability.

Three aspects of the supplier's organizational capabilities will be examined to show how the character of aerospace work and the structure of aerospace markets shaped their behaviour and operating practices. Firstly the administrative and manufacturing capabilities will be examined before their sales and marketing capabilities are considered, where the effects of operating in defence markets were more discernible.

(a) Administrative Capabilities

The demands of aerospace work (of military and civil) had a significant effect on the administrative systems of the suppliers examined as it required them to operate extensive traceability and quality monitoring systems. For example, documentation was required to monitor the processing of
components through every stage of the manufacturing process from material preparation to final heat treatment. There were also demanding requirements for 100% inspection of all components. These requirements were specified in BS5750, which was a necessary minimum requirement for the manufacture of aerospace components. Compliance with these demands thus placed an administrative burden on these companies which resulted in significant overhead costs. This placed a significant constraint on these companies and restricted the range of markets they could effectively compete in, narrowing their opportunities for diversification. In other markets for higher volumes and lower quality components less administration and quality controls were required, making it difficult for aerospace companies to compete in these markets. This was backed up by the experiences of one of the companies which found it impossible to meet the price margins required to manufacture agricultural components, which was a market that it had attempted to diversify into. Thus these administrative capabilities were only relevant to markets with similar requirements for high quality standards.

(b) Manufacturing Capabilities

The manufacturing capabilities of the companies examined were also shaped primarily by the technical requirements of aerospace work. Thus for these companies their manufacturing and technological capabilities were concerned with the low volume manufacture of high quality aerospace components. Typically aluminium alloy was the main material used, with the companies requiring a wide range of machinery such as lathes, drills, shaping machines and milling machines to produce the complex and varied components that they manufactured. These facilities however were unsuited to the production of very high volumes of components due to the limited number of machines possessed and because production areas were not laid out to facilitate such work.
As outlined earlier in the chapter, one of the main elements of the strategies adopted by these companies was to modify their manufacturing processes, which was in response to the changes in their operating environment following the Levene reforms. The greater cost focus of the Levene reforms were passed onto component manufacturers via their customers, the first and second tier suppliers. Prior to these changes there had been substantially less emphasis on tightly controlling manufacturing costs, therefore as with the larger aerospace companies examined their manufacturing capabilities had evolved without the discipline of strict cost controls. Thus it has only been since the Levene reforms, and especially since the end of the Cold War, that there has been a greater emphasis on cost based competition, which has resulted in greater pressures being placed on the cost margins of the suppliers examined than had previously been typical. Even following these changes however their manufacturing capabilities were still relatively specific, with relevance to only markets with similar requirements for the low volume production of high quality machined components.

(c) Sales and Marketing Capabilities

The lack of focus on issues of cost during the Cold War also influenced the sales and marketing capabilities of the companies examined. During this period there was little requirement for the suppliers examined to undertake large amounts of sales and marketing activities as contracts were awarded on the basis of reputation and the quality and delivery standards achieved on previous orders. Repeat contracts with a small number of customers was typically how the suppliers examined gained work, thus there was little requirement for pro-active sales and marketing. From the evidence available on the third tier companies the award of contracts was based more on reputation and reliability. Once a company had proved its capabilities it was likely to get enough repeat business to sustain it.
The result of this, over a period of years, was a lack of marketing capabilities or market experience in another industrial sectors. The structure of these markets also influenced the character of customer relations, with suppliers dealing with only a small number of extremely large, easily identifiable customers. Therefore, speculative marketing to identify potential customers, was never required by these companies. This is one aspect of these markets which has not changed following the end of the Cold War, with the top tiers of aerospace markets actually increasing in concentration between 1989-95. This resulted in the sales and marketing efforts of the companies being relatively undeveloped. This therefore proved to be one of the main problems for these companies when trying to diversify into new markets, as their lack of marketing skills limited their ability to successfully enter and compete in other markets.
4.7 Summary

During the period examined the character of the UK's military aerospace market changed dramatically, which significantly affected all of the companies examined. These changes were the result of two main factors, which in the early 1990's combined to fundamentally alter the character of the UK's military aerospace markets. Firstly, through the Levene reforms, the UK government changed its domestic procurement practices. The core of these changes were to increase the level of competition for the award of contracts and thus pass both greater technical risk and cost control responsibilities down to industry. These changes therefore resulted in a substantially greater level of cost consciousness being introduced to these markets than had predominated during the Cold War. The second component of change in these markets followed the end of the Cold War, as the level of demand for military equipment declined, with the result that the level of competition for export contracts also increased. For the UK military aerospace companies examined these factors combined to alter the character of their operating environment in a profound way. Not only did most of them experience a substantial reduction in their levels of business, but they also simultaneously found that the character of their market environment had also changed. The strategies pursued by the companies examined were therefore driven by these events.

The strategies pursued by the companies examined, at all three tiers, were remarkably similar. In virtually every company examined, diversification out of defence markets, to any significant extent, was not the strategy pursued. Rather the strategies they adopted were to remain focused on defence markets, while simultaneously restructuring their internal operating practices. The only significant market change adopted by the companies examined was to focus more on export markets, in an attempt to offset declining levels of domestic orders. When diversification did occur it was at
the corporate level, through the acquisition of new business, rather than through organic diversification. Thus, for example, when BAe diversified in the early 1990's it was through acquisition that it was achieved.

While the specific nature of the capabilities possessed by the companies examined made organic diversification difficult, due to the limited range of markets to which they were applicable, this was not the only factor shaping the strategies they pursued. Other important factors shaping the strategies they adopted were the short term, financial focus of the performance targets set by their corporate owners and the lack of government support for diversification. This issue will be developed in the analysis chapter, where all three sectors will be examined together.

The chapter also examined the character of the capabilities possessed by the companies examined, which were found to be closely related to the particular nature of their operating environment, which was illustrated in a number of ways. For example, the technical requirements of aerospace design and manufacturing required the prime contractors, and to a lesser extent the second tier avionics companies, to possess large scale system integration capabilities. The very particular character of competition and customer relations in defence markets also shaped the capabilities of the companies examined in particular ways. Thus the sales and marketing capabilities possessed by all the companies examined were extremely specific in nature, with little relevance beyond defence markets.

The second way in which the close relationship between the character of a company's capabilities and the character of its operating environment was illustrated was by the large differences which existed in the type of company operating at each tier. At each of the three tiers examined large differences existed in the market and technological character of the operating environment, which resulted in the capabilities of the companies operating at
each tier varying substantially. Thus while the technical requirements of prime contracting required BAe's Military Aircraft Division to possess large scale system integration capabilities this was not the case for the third tier suppliers examined. While they were also shaped by the technical requirements of aerospace work, at the level of the market at which they operated these requirements were very different from those required by BAe. Primarily, at the third tier of aerospace markets, the main technical requirements were for the possession of extensive quality control systems, and the ability to manufacture high quality, precision manufactured components. Similar differences existed in the market characteristics of each tier, with, for example, both the level and character of competition varying substantially between all three tiers. This also had the effect of shaping the capabilities of the companies at each tier in different ways.

The final way in which the relationship between organizational capabilities and the market environment is illustrated is through the internal changes adopted by the companies examined, which were introduced primarily as a result of the changing character of their operating environment. The character of manufacturing systems developed by the companies examined during the Cold War were shaped by the relative lack of emphasis on controlling and reducing costs which predominated in defence markets during this period. Thus the manufacturing capabilities of all the companies examined had developed without being constrained by any strict cost reduction imperative. However, as illustrated, this changed following the Levene reforms and the end of the Cold War. Following these changes a significantly greater emphasis was placed on cost control. Thus the main factor shaping the internal changes adopted by the companies examined was in response to this environmental change.
CHAPTER 5

THE RESTRUCTURING OF BRITAIN'S MILITARY VEHICLE SECTOR: 1989-95

5.1 Introduction

The vehicle sector of the UK's defence industrial base, while being substantially smaller than its electronics or aerospace sectors, is still an important area of activity, receiving significant amounts of government funding. For example, in 1991-92 over £430m was spent on production and £46m spent on R&D in this sector (HC333; p109-110). Aggregate government spending in the motor vehicle sector actually increased in the early 1990's rising from £268m in 1989-90 to £423m in 1993-94 (Defence Statistics 1995, Cm1559). However, this aggregated picture is deceptive as large parts of this sector have not been exempt from the cutbacks in spending and changed priorities which have followed the end of the Cold War. As will be seen, the experiences of the prime contractors examined were found to vary substantially, with Alvis's turnover declining while that of Vickers Defence increased. Therefore the aggregate sectoral figures hides these varying experiences.

This sector, unlike the electronics and aerospace sectors, was divided into two rather than three tiers as there was no equivalent middle tier of substantial sub-system companies in this sector. In aerospace for example, the middle tier was represented by companies producing large sub-systems such as airborne radars, navigation systems, display and flight management systems. While there are some electronic sub-systems on modern military vehicles they were not of the same level of technological sophistication and complexity of those in
military aircraft and were therefore not considered to warrant separation into a
distinct tier. The empirical evidence on the supply base is based on a survey of
one prime contractor's major suppliers. Of the 124 companies surveyed, 56 replied, giving a response rate of over 45%. From these 56 companies, five companies were selected for more detailed examination, with a site visit and interviews being done with each company.

Firstly section 5.2 outlines the broad characteristics of the military vehicle sector
in Western Europe and the USA, which shows that in Western Europe this sector has remained relatively fragmented. Sections 5.3 and 5.4 then examine the UK companies which were examined. These sections show both how the companies were affected by the changes in defence priorities which have occurred since 1989 and also how the companies examined responded to these changes. While the experiences of the prime contractors varied greatly the majority of the suppliers surveyed actually experienced an increase in turnover, if not employment, over the last 5 years. While this was not attributable wholly to changes in the military vehicle sector, their absolute level of business on military vehicles had, in general, not declined. This positive picture from the supply base may not be representative of the situation of all suppliers in this sector, due to the potential response bias of the survey. In terms of strategy, at both levels in the industry diversification within the military vehicle sector and internal restructuring was found to be much more common than diversification out of defence.

Following this section 5.5 then considers how the capabilities possessed by the organizations examined were related to the character of their immediate market environment. For both tiers it was apparent that the capabilities and skills of the companies examined were to a large extent shaped by the requirements of their market environment, limiting their general relevance to other markets. However
it was only at the level of the prime contractors that capabilities were particularly limited to military markets. The products of the prime contractors were very specific to military markets, having limited relevance to any commercial market, whereas the products of the suppliers were, broadly, more generic, having wider applicability outside of defence markets. The prime contractors also had a much greater dependence on defence markets than most of the suppliers. The survey showed that the vast majority of suppliers had only a small proportion of business in defence markets, therefore the influence of defence markets on their organizations was not as extensive as that experienced by the prime contractors. While the suppliers operated without difficulty in both defence and commercial markets, diversification into commercial markets would therefore be more difficult for the prime contractors. For example, their sales and marketing capabilities were very specifically focused around the particular character of defence markets.
5.2 Market Changes and Sectoral Characteristics: W. Europe and the USA, 1989-95

In the military vehicles sector of Western Europe’s defence industrial base there was a high level of excess capacity in the early 1990’s, which was due to two main factors. Firstly, the end of the Cold War resulted in the level of demand for military vehicles declining massively. For example, while the number of new main battle tanks produced in Europe and the USSR was over 5,000 per year during the early 1980’s, approximately only 1,200 per year were produced in the 1990’s (Southwood 1994; p8). The second main factor contributing to this over capacity was the lack of international restructuring which occurred following this reduction in demand. Government policy decisions in Europe in this sector were driven by national priorities, which acted as an effective barrier to international restructuring (Wulf 1993b). The fragmented character of Europe’s military vehicle sector stands in stark contrast with that of the USA, where there were fewer political barriers to concentration. In the USA the early 1990’s did produce a lot of merger activity in this sector. This meant that by the mid-1990’s there were only two companies in the USA producing armoured vehicles, with General Dynamics having a monopoly in the production of main battle tanks (Tran, Beavis & Milner 1996). Thus Europe’s military vehicle sector has experienced substantially less international restructuring than other sectors such as electronics.

Significant differences existed in the level of concentration within the military vehicle sectors of Europe’s main military vehicle producing nations (the UK, France and Germany), with the UK having by far the most fragmented industrial base (Southwood 1994). Thus in terms of arms sales Vickers was only the fifth largest military vehicle producer in Europe, while GKN and Alvis were 15th and 16th respectively (Wulf 1993b) While in France Giat Industries was the only
military vehicle company and in Germany there was only Krauss Maffei and MAK, in the UK, in the mid-1990's there were still four significant companies manufacturing military vehicles. The UK's military vehicle sector had different prime contractors producing vehicles in different niches, divided primarily by vehicle weight. At the heavy end of the market, producing main battle tanks, was Vickers, who had a monopoly on these products in the UK. In the middle, producing lighter vehicles (between 10-30 tons) were Alvis and GKN, with Land Rover being the main UK supplier of the lightest armoured vehicles. These niches defined the structure of this market sector, which has been virtually constant for the last 40 years. There was no overlap between these niches, with each company competing solely within its self defined product group. For example, for the last 20 years Alvis has been virtually the sole supplier of light Reconnaissance vehicles to the UK's Army.

The fragmentation of Europe's, and particularly the UK's, industrial base in this sector is not likely to be permanent due to the levels of over-capacity which existed in the mid 1990's. However France, Germany and the UK decided in early 1996 to jointly develop a new armoured vehicle, the MRAV (Multi-Role Combat Vehicle (Gray 1996d). This competition is likely to be a significant factor in the restructuring of this sector. All of the UK's main vehicle prime contractors were involved in joint bids for this project, with Alvis and Vickers bidding with Thyssen, while GKN was part of a team involving Krauss-Maffei (Gray 1996d). This competition, along with the UK's independent project TRACER, for the development of a new reconnaissance vehicle are likely to be the main projects influencing the future structure of the UK's military Vehicle sector (Gray 1996d).
5.3 Selected Vehicle Prime Contractors in the UK

5.3.1 Alvis Vehicles

(a) Company Background and Effects of Defence Spending Cuts

Alvis Vehicles is an autonomous division within the Alvis group of companies and together with Alvis Aerospace & Transmissions made up the Holding company Alvis Industries, based in Coventry. Both divisions shared a common site, but were financially independent and operated virtually as separate companies. Throughout its involvement in the military vehicle sector Alvis has competed in a very narrow niche, designing and manufacturing light reconnaissance vehicles, with the Stormer group of vehicles providing the core of its business since the early 1970's (Foss 1996b, Day 1981).

Even before the end of the Cold War Alvis Vehicles experienced a decline in its level of military vehicle work. Its business declined to such an extent that between 1980 and 1988 both production capacity and employment halved (Quigley 1991;p213). While during the 1970's the company had typically been manufacturing hundreds of vehicles a year for the UK MOD, in the ten years between 1983-93 it manufactured only 140 new vehicles in total for them (Defence Industry Digest, October 1993). This trend, combined with the increased uncertainty in procurement which occurred in the Alvis's military vehicle markets between 1989 and 1995 resulted in the company being much more dependent on export orders. Between 1990-95 it was estimated that export orders accounted for 50% of turnover in the Vehicles group, whereas in the 1970's they had been approximately 20% (interview source). Putting a greater emphasis on winning export business resulted in the company selling to countries it previously hadn't dealt with, the most controversial of which was
Indonesia (Observer 5th March 1995; p5). The turnover of Alvis Vehicles declined significantly between 1989 and 1995, however there were no separate figures for Alvis Vehicles in the group’s Annual report making it impossible to be precise over the extent of the changes. However, sales in 1993-94 were the Alvis Vehicles lowest ever, at only £13m (Cheeseright 1995). For employment more detailed figures were available, showing that for the Vehicle and Aerospace groups combined, employment had dropped from 850 in the late 1980’s to 350 in 1994 (interview source), with the Vehicles group on its own operating on a core manufacturing workforce of only 160 (Cheeseright 1995).

The financial performance and employment levels at Alvis Vehicles were also affected by a number of recent acquisitions, which were intended to broaden the company’s product range within the military vehicle sector. The most significant acquisition was that of Unipower (February 1994), a company which produced bridge carrying vehicles. This acquisition brought a substantial level of potential production work with it, but the cost of integrating this business into the manufacturing area at Coventry meant that in 1993-94, Alvis Vehicles made a loss (Alvis Annual Report 1994, Financial Times 16th December 1994; p24, Foss 1996c).

While the reduction in orders for new vehicles during the 1980’s was attributed to the company not having a new product to replace its Stormer and Scorpion vehicles (interview source, Quigley 1991; p213) the continuation of this trend between 1989 and 1995 was due more to a noticeable change in the procurement priorities of both UK MOD and most export customers. During this period there was a noticeable shift towards refurbishing and upgrading existing vehicles, rather than purchasing completely new ones (Interview Source, Alvis Annual Report 1994). The UK’s procurement decisions have followed this pattern, with the number of vehicles purchased being substantially lower than in
the past (HC 333) and a number of new vehicle contracts being delayed. For example, in 1989 the MOD requested tenders for a complete family of new armoured vehicles (FFLAV - Future Family of Light Armoured Vehicles), however the award of this contract was subject to extensive delay. Finally, in the early 1990's the companies which had tendered (including Alvis) were told that the there was to be no procurement on the FFLAV programme (Interview sources). This requirement evolved into the TRACER specification, but this has also been delayed, without any definite decision being made by the end of 1995. In sum, the story of Alvis, since 1989, has been of declining business levels and a fundamental change in the type of business won.

(b) Alvis's Evolving Strategy

The evolving strategy within Alvis Vehicles between 1989 and 1995 appeared to be more reactive to the market changes rather than being primarily the result of independent company efforts. The most substantial change in the company's business, indicated above, was the move from producing new vehicles to the servicing, repair and refurbishment of existing vehicles. This was driven by changes in both domestic and export markets where there had been a substantial decline in the purchase of new vehicles. In the UK the MOD's procurement of new, light armoured vehicles in the 1990's remained at the low level typical of the 1980's. At the same time the privatization of vehicle service and maintenance contracts gave the company opportunities for business previously done by the UK's armed forces (interview source).

While the company was actively looking for opportunities to diversify outside of defence, its main efforts were geared towards developing new opportunities within defence markets. As one interviewee put it,

'we intend to stay in defence ..... our money will still be made in fighting vehicles.'
From its diversification efforts the company found few market sectors where its particular mix of design and manufacturing skills had direct relevance (interview source). Diversification was pursued by the allocation of a single sales engineer working full time developing and examining relevant opportunities. The main markets being examined were construction and offshore fabrication as they utilized the company's specialist metalworking skills. These efforts did result in the company winning one major construction order, to provide bulletproof fabrications for the UK house of Commons (Taylor 1996), and in the company developing a civilian vehicle for oil exploration (Networker 1996). But this work did not substantially reduce the company's long term dependence on defence work. The company also looked to diversify through acquisition, with Unipower being the main example of this (see above). Again these efforts were focused on diversifying within military vehicle markets, therefore the opportunities for further, similar acquisitions may be limited.

Equally significant to these efforts was the initiative started in late 1992 to restructure the company's internal operating practices. This was described in the 1994 annual report as being, 'a major program to reduce operating costs' (Alvis annual report 1994;p8). While design and management functions were not excluded from this rationalization, the focus of these efforts was on manufacturing. The reorganization of design and management was concerned more with flattening the organization structure through the removal of different layers of management than with fundamentally reorganizing the way projects were managed. The changes to the company's manufacturing systems however were much more fundamental. From the interviews conducted it was apparent that there were substantial opportunities for such changes due to the historically low priority that had been given to improving manufacturing or reducing manufacturing costs. This was very much a result of the Cold War procurement
system where there was virtually no incentive or requirement placed on the company to monitor or control manufacturing costs (Cheeseright 1995). Firstly there had been a severe under-investment in up to date machinery. In one early attempt at diversification the company tendered, unsuccessfully, for some commercial manufacturing work but found that it was not possible to compete, primarily because its machinery was out of date compared to commercial standards (interview source). Secondly, stock control and inventory management had been poor in the company. One interviewee said that, 'huge areas of the shop floor were taken up by parts', while another described how the delivery of components was very time consuming due to the need to manually unpack boxes, check delivery schedules and shelve components. Finally the layout of production had developed on an ad-hoc basis rather through any process of systematic development, which further acted to slow down production.

The restructuring of manufacturing was undertaken by rationalizing the company’s supplier base from approximately 600 to 200 companies and the development of a more coherent inventory control system (interview source). The company also moved towards a cellular manufacturing system, changing work practices to reduce demarcation and increase worker flexibility. The layout of the production area was also changed to allow work to process more smoothly between the different cells. Finally, the company has substantially reduced its workforce, moving to a core-periphery system, with the core workforce, as stated above, being approximately 160. While these changes have resulted in the company reducing its vehicle manufacturing lead time from 19 to 11 weeks, this has been paid for by the loss of a substantial number of manufacturing jobs.
5.3.2 Vickers Defence Systems

(a) Company Background and Effects of Defence Spending Changes

The fluctuations in Vicker's business from 1989 to 1995 were shaped primarily by the Challenger 2 contract with the UK MOD, as the company had been extremely dependent on this single contract throughout the period considered. Thus the defining point in the company's experiences was the announcement in mid-1994 by the UK government of its intention to procure a second batch of these tanks. With this single order the medium term future of the company had been guaranteed. Before going into the details of these events it is necessary to provide some background on Vickers Defence Systems (VDS).

VDS is an autonomous division within the Vickers corporation and has manufactured tanks on Tyneside since 1928 (Scott 1962; p188-89). In 1985, following its acquisition of the Royal Ordnance tank factory in Leeds, it became the UK's sole tank builder. In 1995 VDS ran both sites in parallel, with each having its own design and production facilities. This arrangement was likely to continue for the foreseeable future, as at the time of the interviews (mid 1995) the company had no plans to close either site, with both involved in the production of Challenger 2 tanks (interview source). Defence was one of four main divisions within Vickers (see table 5.1), and in 1994 it accounted for 17% of the corporation's business on a turnover of £126m, with VDS being the sole company in the defence group.

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50 This tank production work was done at Elswick. This site was closed in 1985, with all tank work being transferred to the company's Scotstoun site.
Automotive £287m
Propulsion Technology £145m
Defence £126m
Medical £119m

Table 5.1: Vickers, 1994 - Group Turnover

Following the acquisition of the Royal Ordnance factory domestic production became a much larger proportion of the company's business as Royal Ordnance had traditionally been the main supplier of tanks to the UK army, while Vickers had been much more dependent on export work (interview source, Stone & Peck 1992; p20). If the geographic sales of the two factories for the last 30 years are combined (Table 5.2) UK work accounts for less than half (48%), but without Royal Ordnance's business approximately 80% of VDS's output had been exported (interview source), with this business going to a small, but historically constant group of countries. After the late 1980's, domestic orders became even more important, accounting for the largest proportion of the company's business with UK work counting for at least 80% of the companies turnover in 1994 (interview source).

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>UK</td>
<td>48%</td>
</tr>
<tr>
<td>Iran</td>
<td>28%</td>
</tr>
<tr>
<td>Jordan</td>
<td>9%</td>
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<td>Kuwait</td>
<td>7.5%</td>
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<td>Nigeria</td>
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Table 5.2: Global distribution of combined VDS and Royal Ordnance military vehicle sales (1964-94)
Source: company
As previously stated since the late 1980's VDS has been very dependent on the Challenger 2 contract, which it won as a fixed price contract in 1991 (Financial Times, 2nd July 1994:p18). The initial development contract committed the UK government to purchase only 127 tanks, with more to be ordered in a second tranche, which the company required to win to guarantee its medium term security. It was only after a substantial delay, however that the second batch of 259 tanks was ordered, boosting VDS's order book to £1.5bn (Vickers Annual Report 1994), but this also increased its dependence on this single contract to between 80-90% (interview source). Without winning this second order the future prospects of VDS would have been substantially bleaker as there were no other potential contracts of a similar scale that the company was competing for. VDS had expected to win a number of export contracts for the Challenger 2 tank, but by 1995 it had only won export sales for 14 tanks to Oman (Financial Times, 26th July 1994, p10), losing out to the USA for sales to Kuwait. This loss of business to Kuwait was a substantial blow to the company (interview source), as Kuwait had been one of its most traditional customers (see table 5.2).

Until it won the second Challenger 2 contract in 1994 VDS's turnover had declined by 30% between 1992-94, dropping from £179m to £126m (Vickers Annual Report 1994). However the second tranche of Challenger 2 orders transformed this, with VDS's turnover in 1995 likely to increase to approximately £250m (interview source). Employment, similar to turnover, also declined between 1992 and 1994, dropping from 1800 (Stone & Peck 1992;p20) to 1400 in early 1995 (interview source). But, unlike turnover, employment will not increase because of Challenger 2 work, with a further decline in employment expected (Vickers Annual Report 1994; p4). Challenger 2 will provide VDS with work till at least the start of the next century, but after this the company faces a very sudden decline in business.
(b) Corporate Response

In the early 90's VDS's strategy was focused solely on winning the Challenger 2 contract (IPMS et al 1991; p23). Efforts were made to secure export orders for Challenger 2, but as shown above by 1995, this had resulted in orders for less than 20 vehicles. The most significant export contract that VDS had pursued was with the Saudi Arabian government, who were intending to purchase 150 tanks, however there was very strong competition from the USA, who had already sold over 300 tanks to the Saudi government (Foss 1996a). During the delay and uncertainty over the allocation of the contract for the second tranche of Challenger 2 tanks VDS did consider diversifying by acquiring non-defence businesses (interview source), but ultimately this strategy was not pursued. Since securing the second tranche of Challenger 2 orders the company has diversified within the military vehicle market, due to the low perceived future demand for heavy, main battle tanks (company source). In the mid 1980's NATO and the Warsaw Pact were together producing over 5,500 tanks a year, however by 1994-95 this had dropped to just over 1,200 tanks per year (Southwood 1994). One interviewee described the transition being undertaken as changing from being a tank manufacturer to being a military vehicle prime contractor. This move was also highlighted in VDS's 1995 mission statement which talked of trying to

'become the world's leading land system prime contractor ...... of armoured fighting vehicles.'

This policy was to be achieved mainly through acquisitions or joint ventures, with VDS already having acquired a UK bridge building vehicle company (Financial Times, 20th June 1995). VDS was also competing for the two main future UK vehicle projects (MRAV and TRACER) through collaboration (Gray 1996a).
The apparent lack of importance attached to organic diversification by VDS, even when their core business seemed very uncertain may be related to diversified nature of the corporate group (Table 5.1 above). The Vickers corporation, both currently and historically (Beynon & Wainright 1979), has been more concerned with being diversified at the corporate level rather than at company level, resulting in many of its divisions, including VDS, being very dependent on particular niche markets.

Since 1994 VDS also pursued a strategy of internal restructuring, aimed primarily at modifying its project management structures, but also with implications for its traditional manufacturing systems. However, by mid-1995 these changes had not been implemented and were only at the consultation stage (Vickers Defence Systems, July 1995). This internal restructuring was driven by two motivations. Firstly, it was argued by the company (interview source, Vickers Annual Report 1994) to be a necessary refocusing of the company towards more commercial operating practices due to the increasingly competitive nature of its procurement environment. Undoubtedly, there was a change in the procurement environment the company operates in, both domestically, due to the UK's procurement changes, and internationally where the intensity of competition for export orders increased. The loss of the Kuwait order to the USA was illustrative of this as Vickers had previously had a long term relationship supplying equipment there. Secondly, it was also motivated by the more short term goal of reducing manufacturing costs in order to maximize the company's return on the production phase of Challenger 2 (interview source).

The intended changes to VDS's project management system were aimed at developing more autonomous business units, with different product groups
having responsibility for its own financial and project performance. These groups would be run by management teams with different functional responsibilities, the intention being to replace the company's traditional technically focused project management systems with more commercially aware and financially responsible business units, passing financial responsibilities to levels lower than previously (interview source).

The changes to be introduced to the company's manufacturing systems were motivated by a drive to reduce manufacturing costs (see above), but could also be related to the company's strategy of diversifying within military vehicle markets. Management's stated intention was to replace the existing system of organization, which was very specific to tank manufacture, with a new, more generic system able to cope with a range of different vehicle types. This was to be achieved by the development of a cellular manufacturing system, with the cells having responsibility for broad functions such as transmission or traction. More specific details were not available on this as this development was in its embryonic stages when the fieldwork was conducted.

5.3.3 Land Rover

(a) Company Background and Effects of Defence Spending Changes

Land Rover has historically been the UK army's main supplier of 4x4 vehicles (HC 333; p109), but like all of the other prime contractors considered, it has experienced a number of changes in its military business since 1990. During the same period its commercial business also changed, probably more substantially, which was due largely to the two changes in corporate ownership it experienced since 1989. Therefore before detailing the changes in Land
Rover's military business it is necessary to outline the changing corporate background.

In 1989, as part of the UK government's privatization drive, the Rover car group, of which Land Rover was a part, was sold to British Aerospace. BAe's motivation for the purchase was two-fold, being firstly part of a diversification strategy, to reduce the corporation's level of defence business, and secondly as a purely short term financial deal (see section 4.2.2). Given the generous terms in which Rover was offered to BAe, it was virtually impossible for them to make a loss on the deal (Lovering & Hayter 1993). BAe, however, owned the group for only 5 years, as in early 1994 it sold the complete Rover group to BMW. Since acquiring the group BMW has successfully increased Land Rover's commercial sales through aggressive marketing into new area, particularly in the USA (interview source). This pushed Land Rover's Annual output of vehicles up from its 1990's high of over 90,000 in 1994, to over 120,000 vehicles in 1995 (Financial Times, 25th January 1995; p7) and resulted in employment increasing by 3,000 in less than 18 months (Financial Times, 6th January 1995).

Land Rover's defence business is administered within the Land Rover group, which is an autonomous business unit within the Rover group. Within the Land Rover group there was no strict separation between military and commercial business. The only organizational function which was separate was sales and marketing (see later). Defence sales accounted for only a small proportion of the company's business, accounting for less than 10% of sales in terms of the number of vehicles sold (interview source). In the early 1990's Land Rover had three main products, the Defender, Discovery and Range Rover (see Table 5.3), with military business being almost completely of the Defender vehicle. Of Defender sales, approximately 25% were to military or government customers,
whereas only 1-2% of Range Rover and Discovery sales were for military type customers.\footnote{Military type customers include military police, coastguards etc.} Defender was the smallest of the three product groups with only 21% of Land Rover's sales in 1994 (table 5.3).

<table>
<thead>
<tr>
<th></th>
<th>1992</th>
<th>1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defender</td>
<td>12,967</td>
<td>19,603</td>
</tr>
<tr>
<td>Discovery</td>
<td>24,099</td>
<td>52,004</td>
</tr>
<tr>
<td>Range Rover</td>
<td>15,712</td>
<td>16,846</td>
</tr>
</tbody>
</table>

Table 5.3: Land Rover, Sales Volume (No. of vehicles)

Source: Land Rover

Unlike the other prime contractors, Land Rover has not traditionally built custom made military vehicles, with the military vehicles being modified commercial vehicles.\footnote{The company is currently breaking with this tradition by designing two vehicles for specific military applications for the first time (see later).} The military vehicles produced by Land Rover were upgraded commercial vehicles, with the required modifications being done as a post-production, add on process. The only organizational function which was separate for military work was sales and marketing, with this group (government and military operations) employing approximately 10 people. In all other areas of Land Rover's business there was no separation of military and commercial business. This made it impossible to separate and measure defence employment or turnover, therefore Land Rover's level of defence business is measured purely in terms of the number of vehicle sold to military customers.

The end of the Cold War resulted in changes to Land Rover military business, but not in terms of the number of vehicles sold, as this remained virtually
constant between 1990-95 (interview source). The main difference experienced by Land Rover was in the nature of competition and the allocation of contracts. Due to the Levene reforms to the UK's military procurement practices the amount of competition increased dramatically. This was possible because the sector that Land Rover competes in has a large number of potential alternative suppliers. Rather than Land Rover being the automatic supplier of vehicles to the British Army, which it had been historically, all vehicle contracts since the Levene reforms were put out to open competition. The effect of this was to put greater competitive pressure on Land Rover, and resulted in one case, in the loss of a contract for 400 vehicles to Steyr Daimler Puch (Defence Industry Digest, January 1995). Overall, compared to the other vehicle prime contractors, Land Rover experienced the least decline in business and went through less in the way of organizational change as a result, however, this will be discussed more fully below.

(b) Land Rover's Strategy

Land Rover has not undertaken any substantial change in strategy since 1990 with regard to its military work, which is probably a reflection of the relative stability the company has had in its level of military sales. In strategic terms, the company was more concerned with expanding and developing the commercial side of its business. Also, as military sales only count for a small proportion of Land Rover's business, and military work was not organizationally separated within the company, it was not possible to attribute any internal organizational changes as being in response to any defence market changes. The most substantial change in the company's military business undertaken in the early 1990's was to partially break with its tradition of using modified standard vehicle for military applications. For the first time in its history Land Rover designed two vehicles (a light military vehicle and an ambulance) which were not based on
standard commercial products. This was in response to a UK procurement request which the company could not meet through the modification of its commercial Defender product. While these vehicles were to be manufactured on the company's commercial assembly line, they required separate design teams to produce vehicles to the particularly demanding requirements of the specifications. The award of the ambulance contract was made to Land Rover in early 1996 (Financial Times, 16th January 1996, p7). However, the competition with Steyr Daimler Puch of Austria was close, with MOD's procurement executive favouring the foreign bid (Guardian, 4th October 1995). This further illustrates the greater competitive pressure that Land Rover experienced for the award of military business.

The perception within Land Rover was that since the Levene reforms the UK procurement environment had changed substantially, with the MOD holding genuinely open competition for the products that Land Rover previously supplied virtually automatically. While this put greater competitive pressures on Land Rover, it did not result in the company fundamentally changing the way it organized and produced its military vehicles. Similarly, in export markets for military vehicles, the bidding process became more competitive. There have been a number of changes in international competitions for military vehicle contracts which indicate that there has been a qualitative increase in the level of competition for these contracts. Firstly, more companies now compete for export contracts as a way of replacing reduced domestic demand. For example, Land Rover found that in export competitions in the Middle East or Asia that it faced competition from countries like China or the former USSR, which it previously did not. Secondly, and related to this, there was an increase in the demands export customers now made when purchasing military hardware. The effect of this increased level of competition on the company's internal practices, however, were marginal. Therefore, Land Rover's operating practices for the
design, production and sales of its military products changed relatively little between 1990-95.
5.4 Suppliers: Experiences and Strategies

This section will be split into two separate parts, with section 5.4.1 examining the survey results, while section 5.4.2 considers the five case study suppliers, which were examined in more detail.

5.4.1 Survey Findings

The survey produced surprising results as very few of the companies surveyed, even those with high proportions of defence work, experienced a substantial decrease in business between 1989 and 1995. Before discussing this the range of companies surveyed will be described. In terms of product type the supply base was broad, but it was divided into two categories of company, sub-system suppliers such as electrical equipment (radios etc), electro optics systems (night vision equipment), and secondly component suppliers. The products of the component suppliers were extremely diverse, and included lighting products, cabling assemblers, driveshafts, gears and clutches, control panels, sheet metal work, fasteners, seating and suspension units, to name only a few. Unsurprisingly the range of products and skills covered by the survey were typical of those required by any vehicle manufacturer. The range of turnover, employment and proportion of defence work of the companies surveyed are shown in figures 5.1-3.
Employment was evenly spread in the categories up to 250 people, but declined over this level with only 21% (12 from 56) having over 250 employees. Turnover was more concentrated, with 54% (30 from 56) having between £1-10m annually. However, the proportion of defence work showed the greatest concentration, with 57% of companies having less than 20% defence work and 75% of companies having less than 40% defence work. In sum the majority of companies were relatively small, and tended not to have a large proportion of defence work, with only 12.5% having more than 80% defence work.

Figure 5.1: Employment Levels - Vehicle Suppliers survey
The effect of defence cuts are only discussed for the eleven companies with more than 60% defence work, as the experiences of those with less than this level will have been affected by the changes in their other non-defence work and are thus unlikely to give an accurate indication of defence market changes. The experiences of these eleven companies were surprising, given the general climate of reducing defence budgets, as the turnover in eight (70%) increased over the last 5 years. Only two of the eleven (less than 20%) actually reported a decrease in their turnover. The situation was different when their employment levels were considered, though, as more than half of the eleven (six) had experienced a decrease in employment over the same 5 year period. The success of these companies in improving their business levels during a period of general decline can be explained by a bias within the population of companies surveyed.
The 124 companies surveyed had remained as regular suppliers to the prime contractor who provided their names and are therefore likely to be typical of the successful companies which maintained their relationship with the prime contractor over the period examined. The companies omitted from the survey are therefore likely to be the most unsuccessful ones who had lost their business with the prime contractors. This may represent a large number of companies as the prime contractor who provided the supplier list has gone through a process of actively reducing its supply base over the period considered.
5.4.2 Case studies

(a) Company Backgrounds and Effects of Defence Spending Cuts

The companies selected from the survey for detailed case studies were intended to cover the diversity of companies described above, with a partial bias towards companies with significant proportions of defence work, with two subsystem and three component companies being interviewed. The two subsystem companies were Pilkington PE and Marshall SPV, with Pilkington producing electro-optic systems such as periscopes, night vision equipment and gunsights while Marshalls produced vehicle body shells. One major difference between them was their levels of defence work, with Pilkington being virtually 100% defence dependent on defence work while Marshall SPV had approximately 50% of its work in non-defence markets. The three component companies interviewed were: Spectrum Hose, which produced hydraulic hose assemblies for a range of markets, with 35% of its business being defence related: Westair, a vehicle lighting company which had over 95% of its business in defence markets: Twiflex, which produced vehicle and Industrial brakes and clutches, which only had about 3% of its business in defence markets. The experiences of each company over the last 5 years will now be examined separately.

53This reflects the focus of the research which is more concerned with issues related to the influence of defence markets on the behaviour of companies. Thus companies with less than 20% defence work, while representing more than half the companies surveyed, are less likely to be constrained by the defence markets they do operate in. These companies are therefore of less direct interest to the research than those companies with a higher proportion of defence related work. (based on the assumption that the influence of a particular market on a company is to some extent directly related to the company's proportion of business in that market)
Pilkington PE is a division of the Pilkington Optronics Group, which is a 50:50 joint venture company between Pilkington and Thomson CSF (Skons, E 1993). The experiences of PE reflect the general findings of the survey, in that its turnover remained relatively constant between 1989 and 1995, at about £25m, while its employment decreased dramatically, dropping from 800 in the mid-1980's to 450 in 1995. As well as supplying products for the defence vehicle market Pilkington PE also produced rifle gunsights and avionics products with sales and turnover in all areas being relatively constant over the last 5 years. The decline in employment was attributed by interviewees to internal restructuring aimed at making the company more economically efficient (see strategy section for details).

Marshall SPV is also a division of a larger industrial group, being part of Marshalls of Cambridge. SPV is one of three divisions, with the other two being Aerospace and Commercial Motor sales, however the divisions operate autonomously, having separate financial responsibilities. Over the last 5 years both turnover and employment in SPV have increased substantially to their current levels of £50m and 450 employees. This increase was more attributable to the acquisition of new businesses however, than to the organic growth of its traditional vehicle business. But sales of its traditional products, such as vehicle bodies, weapons platforms and portable shelters also increased in the early 1990's as the demand from the UK military for this type of equipment increased (interview source).

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54 This joint venture was finalized in late 1991 and was part of the defence restructuring conducted by the Pilkington group. This will be further discussed in the strategy section.
55 A restructuring process with similar motivations occurred at Barr & Stroud in Glasgow, which is another division in the Pilkington Optronics group and whose business was closely related to that of Pilkington PE. In Barr & Stroud employment dropped from 1200 to approximately 600 between 1985-95, during which time the company moved to a new, custom built site.
56 The most significant acquisitions to SPV were Bedford Trucks, a bus manufacturer and a waste compactor business. The details of the internal restructuring will be detailed in the strategy section.
The three component companies examined were all substantially smaller enterprises than the two sub-system companies, with the largest, Twiflex, employing about 100 people on a turnover of £8m, while the smallest, Spectrum Hose had only 10 employees on an unspecified turnover, with Westair employing 45 on a turnover of nearly £3m. In both Westair and Spectrum Hose turnover, in their defence markets, had increased since 1990, but the perception from interviewees in both companies was that this had been achieved through increasing their market share, as spending in military vehicle markets has been relatively static. Employment in both companies had also gone up, but it was difficult to attribute this solely to changing levels of military vehicle work as both companies had business in a number of other markets which had also changed dramatically between 1990-95. Westair, for example, were involved in both naval military and commercial industrial markets, which added together accounted for about one third its turnover and which grew substantially between 1985 and 1995. Similarly, Spectrum Hose sold hydraulic hoses, with commercial markets in 1995 accounting for over 65% of its business. Spectrum Hose grew from 3 employees when it started in 1982, with the increase in business levels being attributable as much to expanding levels of commercial as well as defence markets. While Twiflex, Spectrum Hose and Westair were all categorized as component suppliers the type of items they produced were substantially different. Spectrum Hose's business tended to be high volume work, on relatively short contracts which was predominantly with a small number of long term customers. While both Twiflex and Westair had similarly small customer bases, their product volumes were much lower, with a higher level of value added work.

In summary, from the survey and case studies examined, companies at the second tier of the military vehicle sector had not been adversely affected, in terms of turnover, by the general decline in UK defence spending which has
occurred since 1990, even though some of the prime contractors in the military vehicle sector had. However, as discussed previously, this does not represent the experiences off all suppliers in the sector, as the companies surveyed exemplify the experiences of the most successful companies only. Given the reduction in business experienced by Alvis and the other prime contractors and the shrinkage the primes undertook in their supply base it can be speculated that there are likely to be a significant number of suppliers who experienced a decline in their business levels during the period considered. None of the five suppliers interviewed, however, were totally dependent on the military vehicle sector for their business, with most having business in a number of other defence as well as commercial markets. Therefore at this level in the industry it was not possible to identify a separate supply base specific to the military markets.

(b) Strategy Changes

The strategies adopted by the suppliers examined were broadly the same, which can be related to a number of similarities in their circumstances and experiences. Firstly, as outlined above, none of the five companies interviewed had experienced a decline in their absolute level of military work in the early 1990’s, even though the overall level of work available in the military vehicle sector did not increase in this period. As both Alvis and VDS shrank their supplier base during their own restructuring many suppliers lost out, while those retained found their business relationship improved. The suppliers interviewed therefore represent the successful ones who have been able to maintain their relationship with the prime contractors. Secondly, and related to the last point, none of the suppliers examined were concerned about attempting to reduce their levels of defence work, therefore diversification out of defence was not a
strategy adopted by any of them. In all five companies, projected levels of defence work were felt to be adequate to sustain their businesses. Finally, apart from Marshall SPV, all the suppliers examined were very dependent on a relatively small number companies with which they have had long term relations. In Westair, 90% of its business was accounted for by approximately eight customers. Similarly, Spectrum Hose, whose overall customer base was approximately 250, was dependent on about six customers for about 60-70% of its business. Pilkington PE also had a relatively concentrated customer base. This resulted in these suppliers being extremely dependent on their larger customers, making them very sensitive to changes introduced by these customers. This was a major factor influencing the strategies adopted by the suppliers, which were aimed, to a large extent, at adjusting to the changed nature of relations with these traditional customers. Details of the specific strategies adopted by the suppliers will now be considered.

(i) Diversification by acquisition

This was a policy pursued by Marshall SPV, Pilkington PE and Westair, however, in all three cases its primary purpose was to broaden the companies capabilities, products and markets rather than reduce their level of defence work. In the case of Pilkington, which bought Thorn EMI’s defence electronics business (Vinel 1995) and Westair, which bought a naval lighting company, these acquisitions deepened their interests within the defence sector, although in sectors not traditionally competed in. Marshall SPV diversified most substantially in this way through its acquisition of a commercial bus company, Bedford Trucks (50% of whose business was defence related) and a commercial waste compactor business. This strategy was developed at the corporate level, by Marshall of Cambridge, rather than at company level, by Marshall SPV. Marshalls of Cambridge's motivation for these acquisitions was to
broaden the company’s customer and market base to provide corporate stability in a period of increased uncertainty in its traditional defence and aerospace markets. This strategy was largely successful as both employment and turnover in Marshall SPV increased, with SPV’s customer base including GEC and Land Rover as well as GMTV (a commercial television company) and McDonalds, the burger chain. In none of these companies, however, was organic diversification, through the adaptation of existing products or capabilities, pursued, as this strategy was argued by interviewees to be more complicated, more financially risky and ultimately much less likely to succeed than diversification through acquisition.

(ii) Internal Restructuring

Even though absolute levels of defence work had not declined in the suppliers interviewed, all five had experienced an increase in pressure to reduce their cost and profit margins. The contract relationship between these suppliers and prime contractors did not fundamentally change, as at this level in the industry the prime contractors have always used fixed price contracts for allocating work to the suppliers interviewed. What did change was that the prime contractors put greater pressure on their suppliers to reduce their costs. It was possible for the prime contractors to do this due to the power they held over their suppliers. Only one of the suppliers interviewed, Pilkington PE responded to this pressure by radically restructuring its internal operating practices. The other four suppliers interviewed reduced their costs in less drastic ways, primarily by accepting lower profit levels but also by reducing their overhead costs, for example by putting pressure on their suppliers to reduce material costs or using cheaper, more standard commercial components. The internal restructuring undertaken by Pilkington PE was much more substantial. For production and inventory control a JIT system was adopted, which required the production area to be
reorganized and allowed substantially lower stock levels to be held. Its own supplier base was also substantially reduced through adopting a preferred supplier scheme. Project management systems were also changed to give greater financial responsibility to individual project teams. Finally, overhead costs were drastically reduced through almost halving employment, which was spread equally across production, design and administrative functions. Even though the company's turnover actually went up during this restructuring, these changes were argued to be necessary due to the increased pressure on cost margins. Without these changes the interviewees argued that the company would have been in danger of losing contracts to other companies.
5.5. Capabilities

This section examines the capabilities of the prime contractors and the second tier suppliers, considering how they were related to their particular market environment. The most distinctive aspects of the defence market environment in this sector, which resulted in capabilities not suited to commercial vehicle markets, was found to be in the area of sales and marketing and in the technical requirements of the products, especially those of the prime contractors.

5.5.1 Military Vehicle Prime Contracting

The organizational capabilities of the three prime contractors were as much influenced by the requirements of producing vehicles as they were by being involved in military markets. Therefore, in terms of their organizational capabilities, there were many similarities with commercial vehicle producers. The organizational capabilities of the military vehicle prime contractors were defined in terms of three particular elements: system integration skills, related to the requirements of co-ordinating the development and design of a complete technical system; batch manufacturing, concerned with the low volume, high value added nature of production; and sales and marketing skills, related to the particular characteristics of a prime contractor’s relationship to their dominant customer (domestic government).

(a) System Integration Capabilities

System integration skills were one of the defining features of the vehicle prime contractors examined, however in all three prime contractors they were similar to those required for commercial vehicle prime contracting. In this respect there was little difference between military and commercial operating environments.
For military vehicle prime contractors system design and integration involved designing the mechanical chassis of the vehicle and then integrating all other equipment into it. In the design of the chassis there was a requirement for extensive mechanical engineering skills, as this work primarily involved the shaping, heat treatment and fabrication of large metal panels (Hartley and Hooper 1990). There was also a requirement to sub-contract a significant proportion of work, due to its specialized nature. For example the production of electronics systems such as radios and navigation aids, electro-optics systems such as vision systems and gun-sights as well as mechanical components such as tracks, engines were all subcontracted out. Therefore there was a requirement for all the prime contractors examined to integrate the assembly of this equipment into the vehicle chassis. The level of supply base to be controlled, the type of systems and components sub contracted and the length of development and production contracts were found to be similar for comparable military and commercial vehicles, for example agricultural vehicles, commercial vans or even cars. The major exception to this was in the length of the tendering process. Representatives from all three companies argued that the tendering process in the military vehicle sector was substantially longer than that required in commercial environments. This was related to the bureaucratic nature of the tendering process in defence markets and the number of different stages companies require to go through prior to the allocation of contracts. A direct comparison of these requirements was possible in Land Rover, which used the same project management systems to co-ordinate the development and production of its military and commercial vehicles.

The system capabilities required by the prime contractors in this sector, however, were substantially less demanding than those required in the aerospace sector. Firstly, the number of components required for military vehicles was substantially less than for military aircraft, therefore the supply
base to be managed was smaller. Thus, for example, Alvis's supply base in the 1980's extended to approximately 1000 companies, while BAe Military Aircraft's was 10,000 (interview sources). Secondly, both the absolute number, and the technical complexity of electronic sub-systems on military vehicles was substantially less. Compare, for example the requirements of aircraft for radar, flight management systems, radios and display systems with the electronics in military vehicles. One Alvis interviewee said the electronics systems in its vehicles (radios, night vision equipment) were treated as 'stand alone, black boxes', which simply required to be screwed down. The administrative burden on military vehicle prime contractors, in terms of sub-contract management, was therefore substantially less demanding than in the aerospace sector, requiring lower levels of both development and administrative staff to manage similar types of contract, for example the Tornado and Challenger 2 contracts. The technological complexity of future vehicles is likely to increase substantially, with an increase in both the number of electronic systems required and the level of system integration to be conducted in future generations of equipment (Barrie 1994). Comparing Vicker's Challenger 1 and 2 tanks, for example, the number of on-board computers increased from one to 14 (interview source). However, the complexity and sophistication of the electronics required for military vehicles are unlikely to ever exceed those required on military aircraft.

(b) Manufacturing Capabilities

In considering the manufacturing capabilities of the prime contractors the focus will be on Alvis and Vickers as they had manufacturing facilities dedicated to military work, whereas Land Rover's production facility was dominated by its commercial work. For both Alvis and VDS, peak production in the early 1990's was usually between 50-100 new vehicles per year (interview sources), compared with Land Rover's 1994 production of approximately 19,000 Defender
vehicles. Therefore manufacturing for Alvis and Vickers involved the batch production of low numbers of vehicles and was relatively labour intensive, utilizing little automated production machinery. The production of armoured fighting vehicles also required a large proportion of employment in the 'traditional' metal working crafts, as producing the hulls for these vehicles requires manufacturing efforts to be focused on the manual manipulation of thick metal panels. Alvis representatives, reflecting this, described their company's core manufacturing capability as being focused round the use of thick aluminium. The shaping, welding and heat treatment of thick aluminium panels, typical in the production of armoured vehicles, required very particular manufacturing skills and capabilities. The low volume and highly labour intensive nature of the manufacturing capabilities possessed by Alvis and Vickers inhibited the introduction of mass production techniques such as routinization or deskilling (Lovering 1990; p457)

As was seen previously, one of the core organizational changes introduced in the early 1990's, by both Vickers and Alvis, was to substantially restructure their manufacturing facilities. This was driven primarily by changes in the defence procurement environment, which resulted in a substantially greater focus being put on manufacturing costs than had existed previously in the military vehicle sector. But for both Alvis and Vickers the restructuring of their manufacturing systems was not undertaken until the early 1990's when the effects of the Levene reforms were combined with the global decline in defence spending. Thus the strategy of both companies to restructure their manufacturing procedures was shaped largely by these changes in the defence market environment. Prior to this the importance of controlling and reducing manufacturing costs in these markets was very small. One Alvis interviewee described this by saying,

'we didn't have to be that precise on how we costed things.'
Therefore the assertion that historically defence companies have neglected to develop their manufacturing facilities, see for example Dunne & Willett (1992), was true, and can be related to the relative unimportance attached to manufacturing costs in the defence market environment prior to the 1990's. The early attempt by Alvis to diversify into the manufacture of commercial components described above also illustrated the comparative inefficiency of their manufacturing facilities, as the primary reason they failed to win the commercial work tendered for was the uncompetitive pricing of their bid.

(c) Sales and Marketing Capabilities

The third aspect of the military vehicle prime contractors organizational capabilities considered, was their sales and marketing capabilities, which were found to be shaped by the particular characteristics of the defence procurement environment. Compared to their manufacturing and system integration capabilities their sales and marketing capabilities were substantially less relevant outside defence markets. The specialized nature of these capabilities for military markets was illustrated by Land Rover's separation of its marketing function into distinct military and commercial groups, the only area of work where this was done.\footnote{Not all commercial vehicle markets have the same characteristics as those of Land Rover, with there being a broad range of different commercial vehicle markets. These can range from small, niche markets for construction equipment to global mass markets for cars. However, the differences between military and commercial markets illustrated still have substantial general relevance.}

For all three prime contractors contact with their customers, whether domestic or export, was very direct, which was possible due to the small number of customers and the long term nature of customer relationships. This was most vividly illustrated by the example of Vickers, where the vast majority of the company's business since the 1960's had been concentrated on a relatively
small number of long term customers. When military customers purchase vehicles they define their requirements in detailed specifications, which allows the prime contractors to directly lobby them. Therefore the majority of marketing was done directly between the vehicle supplier and the customer, conducted through informal networks of contacts with the relevant government department or military Service. In Land Rover's commercial markets however, customer contact was more indirect, being conducted through advertising or speculative market research. This is more typical of the sales and marketing required for non-defence markets, as there are very few product sectors where customer requirements are so explicitly defined.\(^58\) The most distinctive and particular aspect of military vehicle markets was in the power of the UK government as the dominant customer. This power allowed government to determine the characteristics of products, the winners of contracts and the terms on which competitions were conducted. This can be illustrated by their decision to delay and eventually cancel the FFLAV vehicle contract, which had substantial implications for Alvis, and also with the decision over the Challenger 2 order, on which Vickers was totally dependent. Therefore much company marketing was directed towards the direct lobbying of government, due to its power as a monopsonistic buyer (Markusen & Yudken 1992).\(^59\)

The distinctiveness of the prime contractor's sales and marketing capabilities were therefore the direct result of the way in which defence procurement is conducted. Using the language of technological constructivism (Law & Callon 1992, Sorensen & Levold 1992), the heterogeneous networks required by companies to secure business had very particular characteristics within defence

\(^58\)Commercial markets which are similar to defence in this respect are typically other government markets for large, non-defence technological projects.

\(^59\) The monopsonistic nature of the market is most focussed at the initial development stage, where projects are initiated and funded by domestic government (or a collaborative project including other nations). Export sales of equipment to foreign governments is done after this stage, with these buyers having no power or control over the initial development and project definition stage.
markets, which substantially limited their general applicability. In these markets there were limited numbers of both customers and suppliers. The majority of companies had long term business relations with a small range of customers, for example VDS's business over the last 30 years has focused on only four countries. Finally, domestic government, through its various roles had a central influence on all the prime contractors, binding the interests of industry closely to government policy (Dunne 1993, Gummett & Reppy 1990). Overall, this resulted in sales and marketing capabilities which were very specific, being primarily the result of the defence market environment.

(d) Technological capabilities

The technological capabilities examined represent not simply the products manufactured, but also the broader collection of technical knowledge and skill possessed by the companies. In this respect Land Rover's products and capabilities were very different from those possessed by Alvis and VDS, which is related to the differing type of the products they supplied to the armed forces. Using Thorsson's (1984) typology, Land Rover supplied commercial products which were modified for military use, whereas Alvis and VDS supplied equipment specifically designed for military usage (see section 2.7). This distinction is important and results in both the products and technical capabilities of Alvis and VDS being less relevant to the requirements of non-defence markets. In this section the emphasis will be on these two companies due to the more specific influence of military markets on their capabilities. For both, due to the very particular design requirements for vehicles to operate in battlefield conditions, their products had virtually no relevance to any commercial market. As one Alvis interviewee said,

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60The role of government policy will be developed in the analysis chapter (section 7.5.2). However the three main ways government influence companies is as a customer, in defining domestic procurement rules and through support for export efforts.
'there aren't many applications for a cross country vehicle that can do 60 miles per hour and also withstand a nuclear blast.'

This illustrates the specific nature of military technical design requirements which ultimately results in products which are not relevant (or even adaptable) to non-military applications (Harbor 1991). Land Rover's military products, as they were designed primarily for commercial markets, had much greater relevance to both military and commercial markets.61

The general technological capabilities of Alvis and Vickers, while still being specific in nature, had greater relevance beyond military markets. Their design and manufacturing capabilities, being concerned with the low volume, batch production of high value vehicles, were however only relevant to non-defence markets with similar technical characteristics. Alvis had successfully diversified (to a relatively small extent) and found its technological capabilities transferable to a number of commercial sectors including construction and offshore. The relevance of the commercial sectors they entered was in their emphasis on low volume, high quality work which was very suited to the company's existing technical capabilities.

(e) The Specificity of Company Capabilities

For all three prime contractors their capabilities were found to be specific and particular in nature, being shaped by the character of their immediate market and technological environment. Thus while many aspects of their capabilities, such as their manufacturing capabilities or system integration capabilities, had relevance beyond defence markets, they were not broadly relevant to a wide

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61The majority of vehicles supplied by Land Rover were not designed for front line, battlefield operation being used for more general supply and transport applications. Therefore these products did not require to incorporate the particular requirements of operating in these environments.
range of markets. Their manufacturing systems, while being focused around low volume batch production, were in no way limited in relevance to only defence markets. The most specific and unique feature of the defence market environment, which did result in capabilities not relevant outside of defence markets, was in the nature of customer relations. The unique nature of customer relations in defence markets had a profound impact on the sales and marketing capabilities of the prime contractors, which had very little relevance beyond defence markets.

The specific nature of the prime contractor's capabilities meant that they had most relevance to markets which had similar characteristics. Primarily, this restricted them to operating in markets where a small numbers of customers had a dominant position and with requirements for the low volume production of large metal assemblies. The character of their sales and marketing capabilities, for example, were unsuited to other market types, particularly diffuse mass markets, as in their military markets there had never been a requirement for this type of sales and marketing capability. As was illustrated by the comparison of Land Rover's military and commercial business, operating in military markets required sales and marketing to be done in a very specialized and particular way, which had little relevance to other market environments. Their production systems were also unsuited to larger volume markets as the production demand in their military markets had always been for low volumes of vehicles. Thus the manufacturing capabilities of the primes had been developed to meet these requirements. Similar conclusions on the specific character of organizational capabilities were found in all tiers of the aerospace sector (see section 4.3), and as will be shown, in the second tier of the vehicle sector. This is an issue, however, which will be examined more fully in the analysis chapter (see section 7.3.2).
5.5.2 Supply Base Capabilities

This section will describe the organizational and technological capabilities possessed by the five suppliers interviewed, examining the extent to which they were shaped by the particular nature of the defence market environment they experienced. The specificity of these capabilities to defence markets will also be examined, where it was less possible to generalize, due to the variations which existed between the suppliers.

(a) Sales and Marketing Capabilities

The sales and marketing capabilities of the suppliers interviewed were very similar, being focused around building and maintaining relationships with the small number of dominant customers with which they all depended on for repeat business (see earlier). For all five suppliers, repeat business, from their long term customers accounted for the largest proportion of their business. Thus sales and marketing directed towards the military vehicle prime contractors was about maintaining informal contacts, often with particular company representatives. For example, in the suppliers interviewed, most of the managing directors had long term, personal friendships with the purchasing staff in particular prime contractors and would use these contacts to find out potential future requirements. In none of the five suppliers interviewed was there any significant focus on gaining business through speculative, pro-active sales and marketing efforts. None of the companies, for example, invested large amounts of time speculatively pursuing customers they had not previously dealt with, or sold to mass markets through standard product catalogues. The character of these capabilities was related to the structure of the markets in which they operated, where the number of customers was limited, and were easily identifiable. The pyramidal structure of defence markets, where there are only a
handful of easily identifiable prime contractors is an extreme example of this market type. This type of market structure was not however unique to defence markets, as the commercial markets that some of the suppliers operated in, for example Westair's industrial lighting market, had similar structures. These type of capabilities were limited in their applicability and were only relevant to markets where the customers to be sold to were large and easily identifiable, therefore these capabilities substantially restricted the range of markets these companies could easily enter.

(b) Administrative Systems

The quality and administrative standards used by all the suppliers were also very similar. To operate in defence markets there was a minimum standard for quality systems, without which a supplier would not be considered. The standard in the early 1990's was ISO 9000, which covered documentation, contract and inventory control as well as inspection and manufacturing standards. Operating to this standard put a large overhead cost burden on the suppliers, due to the levels of administration required. This cost burden effectively prohibited these companies from competing in lower quality markets, but in no way limited them from operating in commercial markets. For the suppliers with significant levels of commercial work - Spectrum Hose, Twiflex and Marshall SPV - exactly the same quality standards were applied to their military and civil work. Therefore while operating these quality standards limited the range of markets which these companies could compete in this was in no way a barrier to undertaking non-defence work.
The production capabilities of the five suppliers varied greatly, making generalizations on the character of their capabilities difficult. The first type of variation was in the volume of production. Most were involved in low volume batch manufacturing, for example, for Westair a large batch of work on any single contract was for approximately 200 units, which was likely to be spread over 6-12 months. Similarly, while Marshall SPV had a wide range of different products, the volume of work for any individual contract would be unlikely to exceed 50-100 units. However, Spectrum Hose's volume of output was substantially higher, but its products were the simplest of any of the suppliers interviewed, with the value added and profit on individual components being low. Secondly there was also wide variation in the capital and labour intensity of the suppliers examined. For all three of the component companies - Twiflex, Spectrum Hose and Westair - production was very labour intensive, consisting mainly of assembly operations. In all three of these companies little machinery was required for production with most manufactured parts being bought in and assembled in-house. For Marshall SPV and Pilkington PE, manufacturing was much more capital intensive, requiring substantially more machinery and equipment than was required by the component companies. In Pilkington especially, where manufacturing required very specialized capabilities, for example to grind and produce optical equipment, the level of capital intensity was very high. Thus, in terms of production capabilities at the level of supplier, there was no homogeneity among the companies interviewed. While the production facilities of some of the suppliers were particular in nature, limiting their relevance to other markets, these suppliers were not restricted to operating in defence markets alone. Westair, for example, had production facilities which were relevant to niche lighting markets, whether military or commercial, but they were totally unsuited to producing for high volume mass markets.
(d) Technological Capabilities

As outlined previously, the technological capabilities of any company encompass far more than the character of their products, extending to the level, depth and type of technical knowledge held within the company and with its general manufacturing skills (Laudan 1984). This section examines their capabilities in terms of the first two categories, while their manufacturing capabilities were discussed in the previous section. The focus will be on the product characteristics and the design priorities of the suppliers, as the empirical material gathered was not adequate to fully examine the character and extent of the companies' knowledge base.

The technical character of the suppliers products varied tremendously, making a concise, homogeneous description impossible. In terms of technical sophistication they varied from relatively simple components such as the hydraulic hoses produced by Spectrum Hose to the extremely sophisticated electro-optics products of Pilkington PE. This diversity of component type is unsurprising at this level in defence markets as weapons platforms involve such a large number of different components. Further, in terms of their general applicability to markets beyond military vehicle applications there was also substantial variation. While the products of the three components suppliers - Twiflex, Spectrum Hose and Westair - were broadly relevant to a wide range of markets, both defence and commercial, the defence products of the sub-system suppliers - Marshall SPV and Pilkington PE - were much more specific, having limited applicability to other markets.

Westair's lighting products, for example, for the defence and commercial markets it served, were very similar. In terms of technical sophistication there
was virtually no difference between them, with some products being sold in both markets. While its markets were low volume, specialized niches, bearing little similarity to the type of lighting products sold in commercial mass markets its products were in no way limited to defence markets alone. Similarly, for Spectrum Hose, and Twiflex there was no significant difference between the technical standard of their commercial and military products.

The specificity of Marshall SPV's and Pilkington PE's products for defence markets was related to their more essential role in the specifically military functions of the vehicles. If components are essential to the military function of a platform, they are likely to have technical characteristics specific to purely military operating environments. SPV's vehicle bodies were designed to withstand battlefield conditions, performing a primarily military role, requiring the ability to withstand nuclear blasts etc, which therefore made these products very particular to defence markets. Similarly, Pilkington PE's products were an essential part of the vision and weapon aiming systems for military vehicles. Therefore both product types were of central importance to the military function of the vehicles they were designed for, making them less relevant to non-defence markets. Thus it cannot be said that products lower down the product hierarchy from the weapons platform will be more generic (Gummett 1990, Schofield 1992). The specificity of a company's products was more influenced by their relationship to the essential military function of the weapon system.

(e) Specificity of Capabilities

While the suppliers interviewed, in general, had business in a broader range of markets than the prime contractors, their organizational and technological capabilities were still specific in nature, as the range of different markets they
operated in had similar characteristics. For Westair, the requirements of operating in military vehicle and naval markets placed similar demands on the company. The volume of production was similar, consisting of low volume batch manufacturing. The technical requirements of the products and the quality standards for each market were the same. Finally, customer relations were conducted in the same way, being based on long term relations with a small number of customers. Thus while they operated in a range of markets the technical and market character of the markets they operated in were similar. However, substantially greater variance existed in the specificity of their capabilities than was found for the prime contractors.

The general applicability of the supplier's capabilities and products to other markets varied greatly between the five suppliers examined. The constraint placed on the companies by their capabilities, in terms of the range of different markets to which they were relevant, varied substantially. Therefore while the capabilities of all companies were shaped by the particular characteristics of their market environment (Pavitt 1984, 1991) little consistency existed in terms of their general relevance. The specificity of their capabilities was related to the importance, in terms of military function, of their products. Spectrum Hose and Twiflex had the most generic, non-specific capabilities as their products (hydraulic hosing, brakes and clutches) were not directly related to the military function of the vehicles. Their products were thus relevant to a wide range of other industrial applications, which was found to be the case for both companies. Pilkington PE, at the other extreme, had the most specific capabilities, with its products being of central importance to the military function of the vehicles. Therefore of all the suppliers interviewed, Pilkington's were the most specific in nature, having very limited relevance beyond defence markets.
In sum, due to the diversity of product types which exists at this level of the supply base in defence markets there was little consistency between the five suppliers examined either in terms of the character of their capabilities or in terms of their generalizability to other markets.
5.6 Conclusions

Between 1985-95 there were substantial changes in the military vehicle market, which influenced many of the companies in the sector to dramatically restructure both their internal operating practices and the range of markets that they were involved in. The market changes undergone in the UK can be characterized in three ways, all of which put greater cost pressures on the vehicle prime contractors. Firstly, the nature of military procurement in the UK changed following the Levene reforms, with the move towards more cost conscious practices. It is questionable whether large projects such as the Challenger 2 tank contract would ever have been awarded to foreign bidders in what was supposedly an open, competitive contract, as domestic political issues played a significant role (Adams 1990). But the competition did succeed in greater cost pressures being put on Vickers when submitting their bid for the contract. Therefore, through this mechanism, domestic procurement has become more cost conscious.

Secondly, in export competitions there was also an increase in the level of competition, with Vickers losing a contract to Kuwait, one of its most traditional customers and Land Rover competing with countries such as the former USSR and China where it previously hadn't. While governments play a substantial role in deciding the award of such export competitions, there has been greater pressure on the prime contractors to reduce the cost of their bids. The third change in vehicle markets which has put pressure on the prime contractors was the significant reduction in the number of new contracts awarded, which meant that the importance and significance of the remaining contracts increased. For all of the UK's military vehicle contractors there were only three major potential development contracts of any consequence: the European MRAV programme, a UK only MRAV variant and the UK's TRACER programme (Gray 1996d). The
level of competition for these contracts will therefore be substantial, as the implications of losing any of them are substantial for all of the companies involved.

In sum, all of the above has resulted in the market and technological character of the UK’s military vehicle market changing substantially. The impact of these changes on most of the companies examined, both prime contractors and suppliers, was to act as a catalyst to internal re-organization, much of which was fundamental in nature. Manufacturing and stock control systems were re-organized in a number of companies with the aim of introducing more cost effective operating practices and reducing manufacturing costs. Employment practices were also changed in a number of companies, mainly for production staff, with greater levels of flexibility and reduced levels of demarcation introduced. Finally, overhead costs were reduced through reductions in management structures and substantial changes in the supply base management policies of the prime contractors. This has led to what has been called the ‘normalization’ of the defence industries (Lovering 1995; p108), where many of the operating practices which were prevalent in defence companies when there was less of an emphasis on cost competitiveness, have been eliminated.

Therefore, following these changes, do the operating practices and capabilities of the companies examined still have any distinguishing aspects, which are relevant to only defence markets? The simple answer to the question is yes for the prime contractors and no for the suppliers. While in many ways, the capabilities of the prime contractors have changed substantially (see above), in the area of customer relations military markets were still distinctive, resulting in the sales and marketing capabilities of the prime contractors being specific to defence markets alone, with little relevance elsewhere. This distinctiveness was
related to two factors. Firstly, the customer relationship was unique, due to the strategic importance of weapons to government. The power and influence of government in these markets was therefore pervasive, and fundamentally shaped the sales and marketing capabilities of the prime contractors in very distinct ways. Secondly, the nature of the competition was also distinct in these markets, where companies bid for work against detailed technical specifications prior to actually developing and manufacturing the weapons, which again fundamentally influenced the nature of their sales activities. In all other areas the capabilities of the vehicle prime contractors were relevant beyond defence markets.

The capabilities of the suppliers examined were found to be equally relevant to both military and commercial markets. Very few of the suppliers surveyed had a large dependency on the military vehicle sector alone, unlike the prime contractors, thus their capabilities, structures and behaviour were not shaped by these market influences alone. At the level of supplier in the military vehicle sector there were no distinctive or unique market or technological requirements on suppliers that were not experienced in their other markets. Thus the capabilities possessed by the suppliers examined were relevant to commercial markets as well as defence markets.

The strategies pursued by the companies examined were remarkably similar, consisting of internal restructuring, diversification through acquisition within defence markets. Organic diversification was a strategy that was not pursued to any significant extent by any of the companies examined. The strategies pursued by Alvis and VDS were motivated by medium term economic decisions, and were very defensive in nature. VDS put all its expectations on winning the challenger 2 contract, and had not developed contingency plans for any other outcome. The loss of this contract would have had dire implications for the
future of VDS as a company, but limited implications for the Vickers Corporation as a whole. Diversification out of defence for VDS was deemed to be too risky a strategy to pursue. Throughout the whole period of uncertainty for VDS the company was making substantial profits, and through the internal changes introduced substantially increased its profitability. Similarly, while Alvis Vehicles shrunk dramatically in terms of turnover and employment, the company did not diversify out of defence markets to any large extent. Rather the company's strategy was primarily focused on maintaining its share of a declining market. The strategies of the suppliers were less driven by the changes in military vehicle markets, due to their lower levels of dependence on this market sector. However, they were found to be to be influenced significantly by the behaviour of their largest and most dominant customers. Thus in this way the cost cutting measures of the prime contractors were found to have had a noticeable effect on the suppliers most dependent on this sector.
CHAPTER 6

THE RESTRUCTURING OF BRITAIN'S MILITARY ELECTRONICS SECTOR: 1989-95

6.1. Introduction

The ubiquity of electronics in virtually every piece of modern military equipment means that the electronics sector is one of the largest and most important parts of Britain's defence industrial base. The pervasiveness of electronic systems however results in the sector being extremely broad and heterogeneous, involving a diverse range of companies, products and market sub-sectors. For example, in this research, the sector is considered to include such different products as ground launched missiles, mobile communications systems, static communications networks, naval sonar and radar and electronic warfare systems. Whatever the difference in the function, shape or technical characteristics of these products though they are all primarily electronics systems and therefore warrant inclusion in this sector. As with the aerospace sector, the electronics sector is also divided into three distinct tiers of companies, formed into the typical pyramidal structure, with a small number of prime contractors at the top tier designing and assembling complete equipment systems, a middle tier of second order systems designers producing major sub-systems and a third tier involving a large number of companies producing discrete components for integration into either first or second tier systems.

In section 6.2 the characteristics of the electronics sector in Western Europe and the USA will be outlined. This will provide a contextual background with which the experiences and behaviour of the case study companies can be compared. The case studies will then be detailed in sections 6.3, 6.4 and
Here it will be shown that while spending in the defence electronics sector declined by over 25% overall between the late 1980's and the mid 1990's, the effects of this reduction were not evenly spread across all companies. However the broad similarity in the strategies adopted by all of the first and second tier companies examined was remarkable. Firstly, all introduced some form of restructuring to their internal operating practices driven by the same priority - to reduce costs and increase cost consciousness in all practices from project management to manufacturing. The second similarity in their strategies was to remain focused on defence markets, with none of the five defence companies examined undertaking any substantial diversification activities, whether through organic internal development or acquisition. The experiences of companies in the third tier were established through a postal survey, with three of the 26 companies which returned the questionnaire also being examined more closely through site visits. The most significant finding was that the vast majority of companies operating at this level in the defence industry only had a small dependence on defence work. Thus at the third tier there was no distinct and separate military supply base, with most companies supplying products to a range of different market sectors.

In section 6.6 the focus of the chapter shifts to consider the the relationship between the capabilities of the companies examined to their operating environment. It is concluded that the capabilities of all the companies examined were specific in nature, having relevance to only a limited range of market environments. The lower down in the product hierarchy that a company operated the more likely that its capabilities and products had relevance beyond defence markets. Thus, at the third tier level the vast majority of suppliers operated in both defence and non-defence markets. The capabilities and products of the prime contractors, on the other hand, had substantially less relevance to commercial markets, with their sales and
marketing capabilities having little relevance to non-defence markets due to the particular dynamics of their customer relations.
6.2. Market Changes and Sectoral Characteristics: W. Europe and the USA, 1989-95

Electronics is one of the most important sectors in the defence industrial base and is second only to aerospace in terms of funding. Between 1987-88 approximately 23% of the UK's military procurement budget was spent on electronics, while the aerospace sector received 31%, with munitions being the next largest sector with only 8% of funding (Wulf 1993b). The sector is so important because electronics systems are an integral part of virtually all military equipment, from radio to airborne radar (Barnaby 1985). For example, electronic systems account for approximately 40% of the cost of a modern military aircraft (Taylor and Hayward 1989; p43). In employment terms the sector's significance is also apparent, with over 335,000 workers in 1990, of which approximately one third was in the military sector (IPMS et al 1990).

In terms of products and markets the military electronics sector is extremely diverse, making an accurate definition of its boundaries difficult. The range of products considered to be electronic systems include- electronic warfare systems\(^{62}\), missiles, naval equipment such as sonar or radar, ground radar, communications (both mobile and static) and command and control equipment. Avionics\(^{63}\) represents a very significant portion of the electronics sector, but is considered as separate and distinct for the purposes of this research, being defined as part of the aerospace sector. The reason for this distinction is that avionics products have very particular technical characteristics due to the extreme demands of their operating environment. While all military electronics equipment is designed to demanding specifications the extreme requirements of the aerospace environment (light weight, low volume, high vibration levels etc) results in avionics equipment

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\(^{62}\) electronic warfare systems refer to equipment either for detecting the presence and location of enemy equipment or for hiding the location of equipment from electronic detection.

\(^{63}\) This includes all equipment designed specifically for use on aircraft.
possessing distinct technological characteristics from other military electronics systems. Many companies such as Cossor, however, produce both avionics and electronics equipment as the technical capabilities and systems requirements (as will be seen) are similar for both product types. Thus, while avionics products can be identified as distinct, avionics producing companies cannot. The diversified nature of the electronics equipment market also means that many companies operate in distinct niches, where the level of competition can be low (Skons 1993).

In the UK military electronics sector by far the most dominant company is GEC, which has divisions operating in virtually all areas. In 1986, GEC and Plessey collectively received 70% of all defence electronics contracts (Taylor and Hayward 1989; p49). Since then GEC's position has become even more concentrated, primarily due to its sole acquisition of Ferranti and its joint acquisition of Plessey (with Siemens). In this research two divisions of GEC were examined, however they were both considered to be avionics companies and are included in the aerospace chapter. Thus the experiences of GEC's defence electronics businesses are considered there. The five companies which were examined as first and second tier electronics companies are Shorts Missiles Systems (SMS), Siemens Plessey Systems (SPS), Northern Telecom, Cossor and Racal Radar, who represent the next most significant companies in the sector. Therefore, all the largest electronics companies are considered, providing an extensive illustration of the different experiences and range of responses developed by each company.

The distinction between first and second tier companies was less related to the sophistication or complexity of their products, than to their customer and product relationships. Much of the equipment produced by the first and second tier companies was of a similar level of technical complexity. For example the naval radars produced by Racal Radar were as complex as the
missiles of SMS or the communication systems of SPS, but Racal was considered to be a second tier company, as was Cossor, while SMS, SPS and Northern Telecom were all considered to be prime contractors. The first tier companies are directly responsible for the supply of complete product systems, and thus operate as prime contractors, directly responsible to the final customer. The second tier companies, on the other hand, do not deal directly with the purchaser of the complete system, instead dealing directly with the prime contractors. Thus the second tier companies only have an indirect relationship with government. This distinction is very important and will be shown to substantially influence the behaviour and capabilities of the companies.

Despite the electronics sector's importance it has not been excluded from the decline in defence spending which has occurred since 1989 with defence spending in the sector declining in the UK by over 25% from £1.76 billion to £1.31 billion between 1988-89 and 1993-94 (DS 1995). Due to the diversified nature of the electronics market the effects of this reduction have not been evenly spread across all products and companies, which requires the particular experiences of each company to be examined separately. One common trend in this sector, which has occurred to a greater extent than in other sectors such as aerospace or vehicles, has been the change in ownership patterns and the increase in international restructuring. Every one of the five first and second tier companies examined either changed owners, acquired interests in other companies or developed collaborative contractual agreements with other companies, which was typical of the sector in general.
6.3 Prime Contractors in the UK

6.3.1 Shorts Missiles

(a) changes in ownership and business levels: 89-95

Short Brothers in Belfast began operating at the start of century as one of Britain's first aircraft companies (Reference Services 1993). It was only in the late 1950's that the company moved into the missiles business. However, this always remained a relatively small part of the company's business, therefore by the early 1990's aerospace was still the largest part of the company's business with missiles and other defence products only accounting for 25% of the group's turnover in 1993 (Shorts Annual Report 1994). For most of its existence the group had been government owned, but as part of the Thatcher administration's privatization programme, the complete group of companies was sold to Bombardier of Canada in 1989 (Taylor 1992). Following the acquisition the missiles business was run as a completely separate company from the aerospace group and in early 1993 Bombardier sold 50% of this business to Thomson CSF, with the joint company called Shorts Missile Systems (SMS). This move was partly stimulated by Bombardier's desire to find a partner to share the responsibility for the business, and partly by the opportunities such a move would present the company in terms of new markets. Shorts missile business had been very dependent on the UK MOD, with only 20% of its business being exported, therefore the Thomson alliance had the potential of opening up new market opportunities.

64 Bombardier was primarily interested in the aerospace business, as it had no other defence businesses, but it was a condition of the sale that the whole group should be kept together (interview source). Since the acquisition Bombardier has invested heavily in the aerospace group and succeeded in returning the business to profitability, while simultaneously more than doubling its turnover and increasing employment by over 1,000 (Financial Times 19th June 1992; p7)

65 Bombardier had been actively talking to a large number of companies about a similar alliance.
In the decade following 1985 employment declined substantially in Shorts missiles, dropping from 1200 in 1985 to approximately 570 in 1995, with most of this reduction coming in the 1990's (interview source). Due to the formation of SMS in 1993, it was not possible to estimate the change in turnover during the same period, however, in the niche missile market that SMS operates in there has been a general decline in since the end of the Cold War. SMS’s products are for very short range defence, which is a specific niche, with little domestic competition in the UK (MMC 1989a). Its products are for ground use primarily and are often small enough to be manportable.\(^{66}\) In export markets, where SMS sells its Starburst system the period since 1989 has been one of uncertainty and delays in orders, with exports on average only accounting for 20% of turnover during this period. At the same time its main missile for the UK MOD, Starstreak, completed development in the early 1990’s, and was well into its production phase in 1995. When the development work on this project was completed the company had no new major development projects of an equivalent size, therefore a substantial proportion of the redundancies within the company have been of development staff (interview source). As the UK MOD has not developed a replacement missile for this system the company is dependent to a large extent on production work. While the company has supplied over 5000 missiles to the UK MOD (Financial Times, 19th May 1995; p10), due to delays in the development phase of the contract, there was a threat by the MOD to open up this production to competition (Financial Times, 6th March 1995).\(^{67}\) Therefore, while the period since 1989 has not seen a large decline in the company’s level of business, unless SMS wins new work, it is will continue to be very dependent on the Starstreak production work from the UK.

\(^{66}\) The requirement for small missiles means that there is a specialist requirement for miniaturization which does not occur on larger, longer range missiles.

\(^{67}\) In the end the threat was never carried out.
SMS's Evolving Strategy

The period between the late-1980's and mid-1990's produced significant changes in the ownership of Shorts missile business, which has been accompanied by some equally significant changes in both the internal organization and in the market strategy of the company. During the same time period however there was a significant decline in the company's absolute level of military business, but SMS did not attempt to diversify out of defence products. The two main reasons for this were that firstly the company was confident that defence markets would provide adequate levels of business to sustain it and secondly that its products, capabilities and skills had little immediate relevance to other markets. The company did however, attempt to diversify within the short range air defence market, primarily through its alliance with Thomson. As outlined above, the Thomson joint venture offered Shorts potential access to new geographic markets. Thus far (early 1996) this potential has not been fulfilled, as SMS is still dependent on the UK MOD for a substantial part of its business. One reason for this was that the UK and French governments had not fully supported the company's export efforts as neither government recognized the company as unambiguously representing their own national interests (interview source).

The period since Bombardier took over Shorts has also witnessed a high level of change to the internal organization and management of the missile business. Bombardier invested substantially in the division, opening a custom built site for the missile company in 1990. Bombardier's intention was to introduce standard, commercial cost management practices, which it had developed in its commercial aerospace work, to the running of the missile business. The stated mission of the missile company, to become a 'world class... best cost producer', is indicative of its intentions. This greater focus on cost management was also influenced by changes to the UK's procurement practices. The move to fixed price procurement for
development contracts, which Shorts first experienced with Starstreak, required a significant change to the way business was managed. The delays and problems that the company had on this contract brought the realization that its traditional operating practices were inadequate for the greater risk and financial responsibility that fixed price procurement entailed.

While the internal restructuring affected all functions of the company's business, the greatest changes occurred in the organization of manufacturing. These changes followed a pattern common to a wide range of defence companies in the early 1990's and entailed; a move towards cellular manufacturing, where production was organized into a number of homogeneous cells laid out in a linear sequence; the introduction of JIT stock control, managed through a new computerized inventory control system; and increased flexibility amongst the workforce, with rigid demarcations between trades being substantially reduced. These changes represented a fundamental shift in the way the company managed its production, and while they allowed manufacturing lead times to be reduced they also resulted in a significant reduction in the size of the manufacturing workforce. The changes to the company's project management systems involved introducing more strategic planning and cost accounting systems, which were functions that the company had not traditionally placed great importance on. The overall intention of all the changes introduced was to increase the emphasis on cost management, which was perceived by the interviewees as being necessary to compete effectively in defence markets in the 1990's.

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68 For example BAe Military Aircraft, BAe Dynamics, Alvis, VDS, Pilkington PE and Smiths Industries.
69 Strategic planning in this context involves a range of tasks including: estimating the potential global market for the company's products; assessing the company's potential share of this market; assessing the likely changes in the structure of the market; assessing the level of competition and the strength of the company's competitors.
6.3.2 Siemens Plessey Systems

(a) defence market changes; 89-95

By the late 1980's the Plessey company had grown to a substantial size, with sales of £1.3 billion in 1988 (MMC 1989b). One third of this business was in defence markets, but it was spread across a wide range of areas including naval and ground radar, underwater systems, avionics, defence systems, command and control systems, communication and encryption. At this time Plessey's defence business was so large and wide ranging that it was the UK's second largest defence electronics company (Taylor & Hayward 1989). However in 1989 it was the subject of a hostile joint take-over by GEC and Siemens (MMC 1989b; p59), which resulted in the Plessey defence businesses being split up, with GEC getting the avionics and underwater systems businesses and Siemens getting the radar and communications businesses (Financial Times, 12th January 1990; p17).

Following the take-over Siemens kept the Plessey businesses it had acquired together, within a group named Siemens Plessey Systems (SPS).70 The business consisted of four divisions - Air Traffic Control, Air Defence, Tactical Communications and Defence Systems - with Air Traffic control being the only division dominated by civil business. These divisions operate with a large degree of autonomy, each having their own financial responsibilities, sales and marketing and product support functions. The purpose of the SPS central group is primarily to provide strategic advice to the divisions. The interviews for this research were conducted with strategic management staff from SPS, who had an overview of all four divisions, therefore the experiences of all three defence divisions were examined. Unfortunately however precise details on the changes in turnover and

70 In contrast with this GEC broke up the Plessey companies it acquired, in order to fit them into its existing organizational structure.
employment of each division were not given for reasons of company confidentiality.

Overall, the early 1990's saw the turnover of the SPS group increase, but this was attributable primarily to the expansion of the Air traffic control business, whose order book grew from £15 million in 1989 to £130 million in 1993 (Lorenz 1994). However during the same period the SPS group as a whole was actually making a loss (Financial Times, 19th January 1994; p27) and overall employment in the group declined by approximately 10% to just under 3,000 (interview source). For all three defence divisions this was a period of great uncertainty, as many defence equipment orders were either delayed, reduced or cancelled. Defence Systems was the division which experienced the greatest reduction in business, while the Air Defence division actually experienced an increase in turnover (Lorenz 1994, interview source).

The future prospects for all three defence divisions were potentially good, but each was dependent on winning a single large contract, without which their levels of business would be substantially lower. For example, the communications division was dependent on winning the UK's BOWMAN contract, which was the third largest procurement program in the UK in the early 1990's (DID, December 1992). Thus while the defence divisions of SPS had not experienced a large decline in business following the end of the Cold War, by 1995 their medium term futures were dependent on winning a small number of large contracts.

(b) SPS strategy changes

The take-over of Plessey in 1989, as outlined, was hostile, and was not part of a deliberate strategy by the company. However it is indicative of the
concentration which has been occurring in the defence electronics sector since the late 1980's, where many of the smaller companies in the sector have been taken over. The European defence electronics sector has witnessed the greatest amount of mergers, joint ventures and contractual alliances of any defence sector, with GEC and Thomson being the largest and most active companies (White 1990, Skons 1993). This trend of concentration has primarily been driven by the decline in overall spending levels and the reduction in the number of defence equipment projects.

SPS's strategy since 1989 has been to maintain and improve the company's position within defence markets, and has not been concerned with diversifying out of defence. Referring to diversification one interviewee said, 'it's not one of our priorities to do that sort of thing.'

The two main reasons for not considering diversification were that, firstly, the company did not feel it was necessary, as its defence business had not declined enormously and secondly, that diversification was seen as something which would be difficult to achieve due to the company's lack of experience in non-defence markets (see capabilities section for further discussion).

Due to the changes in Britain's defence procurement practices, and the reduction in the number of procurement programs globally a large number of companies have placed a greater emphasis on strategic planning than they had previously (Matthews 1994). To attempt to win a bigger share of a decreasing market many companies have put a greater emphasis on long term planning while simultaneously restructuring their internal operating practices. In both respects this is an accurate description of the strategy pursued by SPS's defence divisions since 1989. Under a Siemen's program called Time Optimised Processes (TOP) every function of the defence divisions was assessed for its cost efficiency with the operating practices of

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71 The increase in the Air Traffic Control divisions business, outlined above, was not due to a deliberate strategy of diversification. The increase in business was due to the expansion of the sector, with SPS achieving its growth without an increase in market share.
a function being modified if they were found to be inefficient. Overall, the system was intended to introduce commercial cost management practices to the groups defence divisions. This assessment resulted in the operation of a number of functions being modified. Project management systems were changed to put greater financial responsibility and autonomy onto individual projects. Cost accounting systems were changed, mainly due to the shift towards fixed price contracting in Britain. One interviewee argued that cost plus accounting systems were based on the ability to collect cost data, but that these systems did not provide any incentives or pressures to reduce costs. Thus these accounting systems were modified as they were found to be unsuited to the more cost sensitive requirements of fixed price contracting. The most visible changes in the companies operating practices were in manufacturing, where SPS was reducing the amount of manufacturing done in-house, to concentrate on systems design and final assembly functions. Due to this the vast majority of the job losses incurred since 1989 were in the manufacturing function. A much greater proportion of manufacturing work is therefore now sub-contracted outside the company, with the amount of off-the-shelf commercial equipment used also increasing. For example, the company now uses commercial standard computer terminals for its radar and defence systems, whereas 10 years ago it used to design and manufacture them internally. Thus while the company's product markets have not changed since 1989, its internal operating practices have, which has been the main focus of SPS's strategy during this period.

6.3.3 Integrated Networks (Northern Telecom)

For Integrated Networks (IN), the UK defence division of Northern Telecom, it was not possible to separate the division's business experiences over the last 5 years from its strategy, as the major changes in business have been a
central part of its strategy. Thus for IN it is necessary to discuss both issues together.

IN is the reincarnation of STC, a UK electronics company which focused on telecommunications, but which was taken over by Northern Telecom in 1990. While defence work counted for only a small proportion of STC's overall turnover (Southwood 1985) it was still one of the UK's largest defence electronics companies, receiving over £50m from the MOD in 1989-90 (Cm 675). Its acquisition by Northern Telecom was typical of the concentration which took place in the international telecommunications markets during the late 1980's, when a large number of small, nationally based companies were taken over (Cooke 1992). Northern Telecom's business is primarily concerned with designing and supplying fixed telecommunications infrastructures and networks to commercial customers, with military business counting for an almost insignificant proportion of the corporation's turnover. In 1993 the company's total revenues amounted to over $8,874 million, while IN's turnover was $100 million (Northern Telecom Annual Report 1994; p3, interview source). The acquisition of STC, however, was part of Northern's plans to expand out of North American Markets and become a global telecommunications company (Northern Telecom Annual Report 1994; p4). Since 1990 Northern has also set up a joint venture with Daimler Benz in Germany and Matra in France (Financial Times, 3rd July 1995; p26) as well as pursuing other non European expansions.

While IN was financially and legally an autonomous division of Northern Telecom, with its own board of directors and accounting responsibilities, its strategy since 1990 was very much directed from the corporate centre. The strategy pursued by IN was to focus on the company's telecommunications

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72 In 1994 the company changed its logo to Nortel, as Northern Telecom was a name which could be interpreted as have a geographic focus in North America or the Northern Hemisphere, which the company was trying to move away from.
business and sell off any businesses seen as non-core. By 1993 this had been achieved with the land cable, electronics component and electrical distribution businesses all being sold (Financial times, 28th October 1993; p24), with the company operating from only two sites at Newport and Harlow. Thus in a relatively short period the business has been substantially transformed, with IN’s business interests and markets being very different from what they had been under STC.

By 1995 IN’s business had three main focuses, fixed telecommunication systems for both military and non-military markets, portable/tactical telecommunications primarily for military customers and naval equipment such as towed sonar cables and underwater communications (Holt 1995). Overall, military work accounted for 60-70% of turnover in 1995, with the fixed telecommunications business being by far the largest single element of the company’s business. Geographically the company’s business was predominantly UK based, with the MOD being one of its main customers. The non military business of the company was split between other government telecoms work, for example at GCHQ, and commercial customers such a banks or large multi-national corporations. One of the largest potential contracts IN was competing for was the MoD’s BOWMAN project to design and produce over 60,000 radios for the army.\(^\text{73}\) This project was the third largest MOD program of the early 1990’s and would provide IN with a substantial amount of business, however the winner of the demonstrator phase will not be announced till 1997 (DID, December 1991, December 1992, Financial Times, 20th August 1993; p7).

Determining whether IN's defence business had been adversely affected by the reduction in defence orders following the end of the Cold War was impossible to ascertain due to the large corporate changes which had been made during the same period. Between 1990 and 1995 IN's turnover

\(^{73}\)IN was partnering ITT on this bid
quadrupled from $25 million to $100 million, with employment also increasing, but by a much smaller margin (interview source). However, these increases were mainly due to the strategic changes which had been made to IN's business focus, which resulted in the company's business changing substantially over that 5 year period. As well as focusing IN's business on telecommunications, Northern Telecom also changed the company from being the designer and manufacturer of discrete electronic components and sub-systems, as it was under STC, to being a designer of complete telecommunication systems (interview source). Thus the company has been transformed into a prime contractor, which was achieved by the integration of Northern Telecom's commercial prime contracting capabilities with the defence market knowledge and capabilities of the old STC company. This dramatic transition, and the entry of a commercial company with no previous defence market experience to prime contracting on military projects is indicative of the rapid evolution which has occurred in commercial communications technologies over the last 15 years. Communications technologies in commercial industry had developed and evolved quickly throughout the 1980's, with the global telecommunications industry expanding tremendously during this period and a massive range of product and process innovations being introduced (Stoneman 1985, Weinstein 1992). For example, the European electronics and Information technology industries grew by approximately 15% per annum throughout the 1980's (CEC 1991). The result of this growth and extra investment was that the forefront of commercial technological development had reached the stage where commercial telecoms systems had the potential to be technically as advanced and sophisticated as systems developed for military applications (Gummett 1991; p59). This convergence in the requirements and standards of military and commercial users for fixed telecommunication systems has thus made the capabilities and skills of commercial companies more relevant to defence markets, providing greater opportunities for commercial companies to enter these markets. This advance in commercial
communications technology is such that IN modifies its commercial system designs for use in military markets, whereas 20 years ago the development would have been in the opposite direction, taking military technology and applying it to commercial applications. The trend in a number of defence electronics sub-sectors is therefore to use increasing proportions of components and software which originated in commercial markets (JDW 1996).
6.4 Second Tier companies

As outlined earlier, the second tier of the electronics sector contains companies producing major sub-systems, which are supplied directly to the prime contractor for integration into complete equipment platforms. Thus the customer of the second tier companies is not government directly, but the prime contractors. Both Cossor Electronics and Racal Radar fulfill this criterion and represent typical second tier electronics companies. While they supply to distinctly different sub-sectors of the defence electronics market producing, technically, very different products their experiences since 1989 and the strategies pursued have been remarkably similar. This section will begin by outlining the corporate background and products of each company before describing the adverse effects the post-1989 changes in defence spending have had on their business levels. Finally, their strategies will be outlined, where the similarities in their behaviour and priorities will become apparent.

6.4.1 Corporate Background and Product Characteristics

Racal Radar is one of two autonomous divisions within the defence group of Racal Electronics, the other division being Racal Avionics. While the defence group is a financially separate part of Racal Electronic's business the company also has defence contracts within its radio communications group. In 1993-94 defence work accounted for approximately a quarter of Racal Electronics business, with this being evenly split between the defence group and the radio communications group. For example, from Racal Electronic's turnover of £886 million in 1993-94, the defence group's turnover of £110m accounting for 12% of the company's business, with the remaining defence business being in the radio communications group (Racal Electronics Annual Report 1994). Racal therefore has a significant amount of defence work, with Taylor and Hayward (1989; p49), putting the company
in their top tier of the UK's six largest defence electronics companies. Racal's defence business was built up through a number of acquisitions, the most significant of which was the DECCA group in 1980, which almost doubled the company's level of defence work (Jansen 1993, DID 1991, Feb; p4-5). Therefore the growth of its defence business has occurred relatively recently. Apart from defence Racal's other business areas include data communications, radio communications and marine/industrial engineering, making it a diversified engineering company.\textsuperscript{74}

Racal Radar's defence business was in three main areas: electronic warfare systems; naval radar; and command and information systems. The electronic warfare business produces both surveillance and intelligence gathering as well as electronic jamming/suppression equipment. In 1995 over 90\% of the divisions business was defence related, being relatively evenly divided between each of the three product areas. The small amount of commercial business within the division was in the production of command and information systems for port traffic management. Naval electronics systems accounted for the vast majority of Racal Radar's business, with Yarrow and Vosper Thornycroft being its main UK customers.\textsuperscript{75} However, over 70\% of its business is exported, with its main export customers being German shipyards such as HDW (submarines), Leurssens (light frigates) and Blohm & Voss (Interview source).

Cossor Electronics is also an autonomous division of a larger corporate group and is owned by Raytheon, the diversified American electronics corporation. In economic terms Raytheon is enormous and in 1992 was the world's ninth largest arms producer, with global arms sales exceeding $4,800m (SIPRI, 1994; p504). Military business is the largest of its activities,

\textsuperscript{74}Racal's data communications group has a 22\% share in the Camelot consortium, where it supplies the networking equipment connecting the computer terminals to Camelot headquarters.

\textsuperscript{75}One of the company’s largest orders during the period examined was for the supply of electronic warfare and command and control systems on Type 23 Frigates, produced by Yarrow.
accounting for over 57% of the groups business in 1990, with its military activities being focused in the areas of electronics systems and missiles (Reppy 1993). Cossor, which has been owned by Raytheon since 1961, is not one of the largest UK defence electronics suppliers, but it is an important supplier in the niche market of IFF (Identification, Friend or Foe) equipment (Taylor and Hayward 1989; p55). While Cossor is responsible directly to Raytheon in the USA for its business, it operates with a large degree of autonomy from the corporate centre.

Cossor, as with Racal Radar, exports 70% of its business outside the UK, but unlike Racal it had a significantly higher proportion of non defence work, with this accounting for 30% of the divisions turnover in 1994-94 (interview source). The non-military work within the company is in the area of air traffic control as the other main business areas within the company - IFF, project management and GPS navigation systems - were all totally dependent on military work. In 1994 the proportions of business in these areas was as follows:

<table>
<thead>
<tr>
<th>Business Area</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Traffic Control</td>
<td>30%</td>
</tr>
<tr>
<td>IFF</td>
<td>30%</td>
</tr>
<tr>
<td>Project management</td>
<td>15%</td>
</tr>
<tr>
<td>GPS navigation systems</td>
<td>10%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 6.1 Cossor Electronics: Business activities 1994 (Source: interview)

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76 One of the companies most famous products is the Patriot missile, which came to prominence during the Gulf war. Following this conflict the company's sales of Patriot missiles increased substantially, however since 1989 the majority of Raytheon's defence businesses have declined and shrunk.
Both the project management and GPS businesses were relatively new to the company, with the project management services being developed internally throughout the 1980's, while the GPS business was acquired from Northern Telecom in 1991 (DID, December 1991). This acquisition was part of the company's changing strategy during the early 1990's and will be discussed more in the strategy section. Finally, Cossor's business was relatively evenly spread across land sea and air platforms, with the company selling to prime contractors in all of these areas.

6.4.2 Changes in Business Levels since 1989

Both companies have been adversely affected by the changes in defence spending which have occurred since 1989, with the early 1990's being a period of great uncertainty in their traditional markets. Potential contracts, both within the UK and in their export markets were subject to delay or outright cancellation, which produced a substantial reduction in their levels of business. For Racal it was not possible to separate the financial experiences of the Radar division from the avionics division, but both experienced reductions in business of approximately equal proportions. Turnover in Racal's defence group declined by almost 50% from its mid 1980's high of £180 million to its 1994 level of £100 million (interview source). Because of this reduction the defence group made a loss in 1990 and 1991 (DID February 1991; p4-5). However, by 1992 this situation had been reversed, due partly to the reduction in employment which was achieved. Cossor's traditional business's of air traffic control and IFF also declined significantly during the early 1990's, with the IFF business in particular experiencing great uncertainty. While the overall turnover of the company has remained relatively constant over the last 5 years, at approximately £45 million (interview source), this has been due to the acquisition of the GPS business, which brought in extra revenue to the
company. Without this, the company would have experienced a decline in its turnover in this period.

One of the main strategic responses of both companies to this decline in business was to reduce employment substantially (see strategy section). In Racal's defence group employment was reduced by over two thirds from 3,500 to 1,100 in just over 5 years, while in Cossor employment levels were reduced by over 50% from 1,500 in 1988 to 640 in 1994 (interview sources). Another similarity for the two companies was that for both the greatest reduction of employment occurred in their manufacturing facilities, however, there were slightly different reasons for this. In Cossor the reduction in employment was a straightforward response to the shrinkage in its business. In the early 1990's it did not have adequate levels of manufacturing work to sustain its existing factory, therefore the manufacturing area was reduced from 20 to 12 acres, with this accompanied by a proportional reduction in employment (interview source). In Racal Radar on the other hand, while the reduction in manufacturing employment could be partly explained by the reduction in business levels, it was also the result of a deliberate change in its manufacturing strategy. As will be seen in the strategy section, one of the key strategies adopted by Racal Radar was to reduce the amount of manufacturing done internally, and to concentrate on its system design and assembly capabilities.

Thus while the end of the Cold War has produced a large decline in the traditional business of both the second tier companies examined this has not resulted, in either case, in an attempt to reduce their levels of defence work. The following section will examine the strategies that were adopted in order to ensure their survival within defence markets.
6.4.3 Changing Strategies 1989-95

The strategies adopted by Racal Radar and Cossor as a response to the reductions they experienced in their defence businesses were remarkably similar, and can be summarized as having three focuses. Firstly, both focused on keeping defence work as their core business, operating as niche players in their own particular sub-sectors. Secondly, neither saw diversification out of defence as being a viable strategy, and any diversification undertaken was peripheral to the main strategy of developing their defence business. Finally, both companies, have significantly restructured their internal operating practices and reduced their levels of employment. These internal changes were regarded as central to their business strategy and necessary to ensure their continued operation within defence markets. The structure of this section will be to examine each of these issues in more detail.

In both Cossor and Racal Radar, the core of their strategies in the early 1990's was to remain within defence markets and develop their positions within the niche sub-sectors that they operated in. Both companies were described as being 'niche suppliers' in distinct segments of the defence electronics markets. While both had experienced a significant reduction in their levels of defence business the company representatives interviewed were confident that there would be adequate levels of work to sustain them at their existing sizes for the foreseeable future. To strengthen their position within their markets both had acquired other companies, with Cossor acquiring Northern Telecom's GPS business in 1991 (see above) and Racal buying Thorn-EMI's radar and electronic warfare business in early 1995 (Observer, 26th March 1995; p2). These acquisitions had both technical and market synergies with their existing businesses and were undertaken by both companies to strengthen their position within their traditional niches.
The concentration which has occurred in these markets since 1989\(^{77}\) is typical of the concentration through mergers and acquisitions which has been occurring in defence electronics markets in general (Anthony et al 1992; p438-443, Skons & Goncher 1995; p465-467).

The second distinctive element of their strategies was the lack of emphasis placed on diversification, either through organic, internal development or through acquisition. Given the significance of the reduction in defence work both companies had experienced between 1989-95 this could be perceived as being surprising. However, in neither Cossor or Racal Radar was diversification regarded as either viable or necessary. It was not regarded as necessary by those interviewed as there were perceived to be adequate levels of defence work to sustain them. Thus, the Cossor representatives argued that the company was not concerned that military work constituted 70% of its turnover and that the company was not developing a strategy to reduce this level. Diversification was also regarded as not being a viable strategy by both companies due to the distinctiveness of their capabilities and products. The opinion among those interviewed was that the capabilities they had developed within defence markets had little transferability to non military markets, and that diversification was thus unlikely to succeed. For example, their manufacturing capabilities and overhead structures were focused around the development and manufacture of small batches of high specification electronics, which was argued to be a very specific capability with little commercial relevance. A lack of understanding of the dynamics and customer requirements in non-defence markets was also perceived to be a barrier to diversification (these issues will be examined more fully in the capability section). Racal Radar had been pursuing a small diversification effort, into commercial port vessel management systems. However this was

\(^{77}\)In Racal Radar's niche market of naval radar and electronic warfare there has been a large degree of concentration, with the smaller companies being taken over by larger enterprises. For example Siemens and GEC acquired Plessey's naval electronics businesses, GEC acquired Ferranti's naval business, while Thomson CSF have also made a number of acquisitions in this area. Therefore, the number of competitors in these markets has reduced from about 5-6 in the late 1980's to 2-3 in the mid 1990's.
not central to the division's strategy and was not expected to provide more than a small proportion of the division's turnover. The viability of this venture was perceived by Racal Radar to be due to the similarity of the market structure and technology to military markets, making its existing capabilities transferable to this market.

The final element of Cossor and Racal Radar's response to their changing markets was to introduce substantial changes to their internal structures and operating practices. In both companies large scale redundancies were a key part of their changes, with previous employment levels regarded as being unsustainable. This was partly driven by the absolute reduction in business both companies experienced, but was also due to the introduction of stricter cost management practices. When Cossor was making a loss in the early 1990's Raytheon, its owner, intervened and introduced a range of different planning and project management structures in order to improve Cossor's project cost and delivery performance. Cossor's traditional project management practices, developed during the Cold War period, were regarded as inappropriate for the more competitive defence markets of the 1990's. Cossor's previous project management practices were regarded as being too informal and not being adequately focused on issues of cost efficiency as they had developed in an environment where such pressures were significantly less.

Similarly, the internal restructuring introduced by Racal Radar was also aimed at implementing stricter cost management practices, both at the development phase and during manufacturing. However, an extra dimension to Racal's restructuring has been the deliberate move by the company to reduce the amount of manufacturing work done internally and to concentrate on its system integration capabilities. The intention was to buy in more components 'off-the-shelf', rather than design and manufacture them internally. For example, for its radar and command systems, where
previously the company used to design and manufacture display consoles internally, there was a shift towards purchasing commercial standard computer workstations (interview source). This transition was possible partly due to the technical developments in commercial computers and information technology systems, which made the use of these products in some military applications achievable, and also by the greater emphasis on cost in military development programs, which has encouraged companies to consider these options, where previously they would not have.

Thus in both of the second tier companies examined, one of the key changes in the period between 1989-95, was the introduction of more cost conscious operating practices as this was perceived as being necessary to effectively compete in post Cold War defence markets.
6.5 Third Tier Suppliers

As with the other two empirical chapter this section is divided into two parts, with section 6.5.1 examining the results of the postal survey, while section 6.5.2 considers the three companies on which case studies were conducted.

6.5.1 Survey Results

The empirical data in this section is based on a survey of the supply base of one of the second tier companies. A list of 85 companies was provided, which represented a typical sample of suppliers commonly used. Of the 85, ten were located outside the UK, however all 85 were included in the survey. From this 26 usable replies were received, providing a response rate of over 30%. However, as the supply base for the UK's military electronics sector involves a vast number of companies, it is difficult to make general statements about the representativeness of these findings for the whole sector. To obtain fully representative data on the supply base of the electronics sector would require surveying the suppliers of all first and second tier companies, which was a task beyond the scope of this research. What the survey does provide is a good description of the experiences of a typical range of one company's suppliers.

As with the survey of military vehicle suppliers only a small proportion of the companies surveyed had a large dependence on military work. Of the 26 companies which returned the questionnaire only 15% (four companies) had more than 60% of their turnover dedicated to military work, while over 75% (20 companies) had less than 40% and half had less than 20% dependence (Fig 6.1).

78 In 1989 the MoD contractors list contained over 8,000 companies (Taylor and Hayward 1989).
Thus the defence industrial base at the third tier is an integrated part of the electronics industry supply base, and is not separate from commercial electronics suppliers. Most of the companies surveyed thus supply products to a range of commercial sectors as well as defence markets, the most significant of which was communications, but which also included the avionics, automotive and computer sectors. The most significant growth market in recent years for the companies surveyed was in mobile communications, which expanded massively in the UK in the early 1990's. Typical items produced at this level in the industry are small electronic or micro-electronic components such as printed circuit board processors, printed circuit boards, wiring and connector systems or mechanical packaging and screening systems. Thus, in comparison to the first and second tier companies, who produce integrated electronic systems consisting of large numbers of components, at the third tier level in the industry the output of companies tends to be individual, discrete electronic
components. Figures 6.2 and 6.3 show the size of the suppliers, in terms of annual turnover and employment, with a typical supplier having between 50 and 250 employees (54%) and an annual turnover of £1-25 million. Thus most third tier suppliers were found to be relatively small enterprises.

Fig 6.2: Employment Levels - Electronics Suppliers Survey
The effect the spending reductions in defence electronics markets of the early 1990's had on the companies surveyed was ambiguous, as no consistent pattern of changing experiences was found. It was expected that, in general, there would be signs of reduced levels of business due to the reduced government spending experienced directly by the prime contractors. However, from the evidence available this has not been the case. For the four companies most dependent on defence work, with over 80% of their turnover in these markets, employment and turnover over the last 6 years actually increased in two cases (decreasing in the other two). Whether this is representative of the supply base as a whole cannot however be determined due to the small number of survey returns.

To obtain more information on the experiences of the third tier suppliers three companies were selected for more detailed study. The three companies chosen had differing levels of defence work, with one having less than 20%, one having between 20-40% and the third having more than 80%
defence work. Their experiences of the changes in defence markets since 1989 are described in the next section.

6.5.2 Case Study Experiences

The three companies chosen for the case studies were intended to illustrate the range of different suppliers involved. As well as having different proportions of military work they also produced very different products and had very different corporate backgrounds. However, as will be shown, their experiences of change in military markets since 1989, and their responses to these events show a large number of similarities. Before outlining this a brief description of each company will be given.

(a) Company Descriptions

Analog Devices had the smallest proportion of defence work of the three suppliers examined, with military sales in 1994-5 amounting to $29 million, approximately 10% of the company's total annual sales of $290 million (interview source). Analog Devices is the UK sales and distribution division of a larger American corporate group, Analog Devices Inc, whose sales in 1994 exceeded $773 million (Analog Devices Inc, Annual Report 1994). Its products are custom designed Integrated Circuits (IC's), which are very small micro-electronic components used on printed circuit boards.79 Analog Devices in the UK does not undertake any design and manufacturing work, and is purely a sales and distribution enterprise, with employment in 1995 being 65. Integrated circuits are extremely generic components, having applications in virtually any product using printed circuit boards. Thus the company's markets were very diverse and include communications, computers, consumer goods and cars as well as military markets.

79 The company is called Analog Devices as it began in business analog components for radio's, however as analogue components gave way to digital ones the company gradually moved into these markets (interview source).
Predominantly the company's military business was in the UK and France, which together accounted for 60% of its military output in 1994, with the company having less than 20 main customers in this sector (interview source). The products sold in military markets were of a much lower volume than to its commercial markets, however they required greater design efforts to package them for the more severe military operating environments and are thus were also much more expensive than the components sold in commercial markets.

Hypertac, the second component supplier, is also part of a larger corporate group, being an independent division within Smiths Industries Industrial group. Hypertac produces high quality connectors for low-medium volume niche markets, with its military business accounting for approximately 40-50% of turnover in 1994. Its non-military business was concentrated in civil aerospace and rail transportation markets. The company did not compete in high volume connector markets as all of its products were designed to specific customer requirements and produced in small batches. The company's annual turnover in 1995 was less than £10 million, with a workforce of just over 110. Unlike Analog Devices, Hypertac's business was concentrated in the UK, with this accounting for on average 75% of its output. However, as with Analog Devices its business was focused around a relatively small number of customers, with which it had been dealing for the last 20-30 years. In its military markets this included the majority of the large aerospace and electronics prime contractors such as Smiths industries, Racal, GEC and British Aerospace.

Roband, the final component supplier, unlike Hypertac and Analog Devices, was not part of a larger corporate group and had been privately owned within the same family since it began in the mid-1950's. While the company did not originally begin with any business in the defence sector, its proportion of military work gradually increased throughout the 1960's, until
by the mid-1970's it had become almost completely dependent on these markets. Military work has remained at that level ever since, with the company being virtually 100% dependent on military work, with its main customers being UK prime contractors such as Racal, BAe Dynamics, Shorts and GEC. Thus, as with the other two component suppliers Roband was also largely dependent on a small number of customers for the vast proportion of its business. The company's products are high quality military power supplies, which are specifically designed to the particular requirements of their customers. Roband's manufacturing capability was for low volume batches of components, with a typical monthly output being 15 units, from a direct manufacturing workforce in late 1995 of over 40. The company's work was also very design intensive, thus most of the company's other 45 employees were involved in design/development activities.

(b) Effects of Defence Spending Changes 1989-95

In terms of business levels, both Hypertac and Analog Devices have had similar experiences during this period, and for similar reasons. Between 1989-95 both companies actually increased their levels of defence business even though overall spending levels in their product sectors had gone down. In both cases this was primarily because they had made efforts to expand their share of their existing markets when a number of their traditional competitors withdrew from defence markets. Motorola, for example, one of Analog Devices main competitors, withdrew from defence markets during this period because of increased uncertainty in spending levels and changes in procurement practices. Of the three component suppliers examined Roband was the only one to experience a decline in its defence business, with turnover halving between 1985-95, which was directly attributable to a reduction in spending by their main customers during the uncertainty of the early post Cold War years.
However, even though two of the three suppliers interviewed had increased their turnover, employment in all three declined between 1989-95, but by different levels and for different reasons. In Analog Devices employment dropped from 90 to approximately 60, but this was more related to changes in their dominant commercial markets than any defence market changes. However, the increased level of cost competition which occurred in their military markets was argued to have been a contributory factor. In Hypertac employment declined from over 200 in the late 1980's to approximately 115 in 1995, a drop of over 40%. This reduction was mainly, but not exclusively in the company's manufacturing facility and was due to changes in the internal structure and operating practices of the company, introduced as a result of the greater cost pressures passed onto them by their main military customers (see strategy section). In Roband the decline in employment levels was of a similar proportion to that of Hypertac, reducing from 135 in 1989 to 85 in 1995. In Roband the reduction was partly as a direct response to the reduction in business the company had experienced but also due to a cost reduction exercise introduced to make the company more cost competitive (see strategy). The reduction of employment in Roband, unlike Hypertac, however was evenly spread across all functions from design, production, quality to administration.

(c) Company Strategies

The strategies adopted by the three component suppliers, as with many of the other sub-sectors examined, showed a large degree of similarity. All three had introduced a range of organizational changes to their internal operating practices, of varying degrees, due to the changes in competition experienced by them in their defence markets. Similarly, all three had not been concerned with reducing their levels of defence work, and had actually focused their efforts on developing their business within defence markets.
(i) Internal Restructuring
The changes implemented by the three suppliers to their operating practices were primarily in response to the increase in cost competition they had experienced in their military markets since the end of the Cold War. These changes were passed to them by their main customers, the prime contractors who were introducing more competitive practices to their component procurement practices. The power of the prime contractors to introduce these changes was due to their position as large and important customers to their suppliers, allowing them to control the basis on which business was allocated. The introduction of much stricter, cost driven procurement practices by the prime contractors from the late 1980's onwards was argued by the company representatives interviewed to have been a marked change from their previous practices, where the suppliers had built up long term relationships with repeat contracts and where contract negotiations were less strictly focused on issues of cost reduction.80

For Analog Devices it was not possible to identify how the internal changes it had introduced were related to changes in defence markets, as this work only accounted for 10% of its turnover. However, in the cases of both Hypertac and Roband, which had substantially greater proportions of defence work, it was possible to identify the effects of these changes. While both companies reorganized their internal structures with the same goal, reducing their cost margins, the way this was achieved varied greatly. In Roband operating practices and structures were not substantially changed, with the company continuing to operate on the same basis as previously, but there was a general reduction in the size of the company's workforce, spread evenly across all functions. Roband's management realized that it could 'operate effectively with lower staffing levels' and saw its workforce reduction program as a way to 'shed excess layers of fat'. In Hypertac the

80 This will be developed more fully later in the analysis chapter (see section 7.3.2).
reduction in workforce undertaken was not as evenly spread, being concentrated more in its manufacturing area, and unlike in Roband did result in a significant change to its operating practices. There was a move to a cellular manufacturing system with work arranged into units of common activity so that machining and assembly were totally separated. This was also accompanied by changes to the company's quality and inspection procedures, putting a greater emphasis on operator inspection, and the introduction of a new computerized stock management system. All these changes resulted in a substantial reduction in the direct labour force and represented a significant change in the organization of Hypertac's manufacturing system.

(ii) Developing Defence Markets
The other common theme among the three suppliers was the market focus on developing their defence businesses. All three companies saw defence work as being an important part of their business and were actively trying to develop and expand it rather than reduce their dependence on military business.  This strategy was partly due to the expectation in all three companies that there would be adequate levels of defence work to sustain them and partly, as with the prime contractors and second tier suppliers, because they saw their organizational and technical capabilities as having limited relevance to other markets.  Hypertac's market strategy was to develop its business within its existing markets rather than develop into new markets. Its design and manufacturing capabilities were perceived as not being relevant to the requirements of mass production connector markets, limiting the relevance of its capabilities to niche connector markets. In terms

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81 In Analog Devices defence work declined from 40% to 10% of the division's business over the last 10 years, but this was more related to the expansion of its commercial markets than any deliberate efforts to reduce the company's dependence on military work. The expansion of its commercial business was primarily in the area of mobile communications, with the company's output to this sector increasing tenfold between 1990-95.

82 Analog Devices products and capabilities were substantially more generic than those of either Hypertac or Roband, however this issue will be developed more fully later in the section on technological capabilities.
of its defence business Hypertac has done this by diversifying into niches it has not previously operated in, in an attempt to broaden its position within its specialized defence markets. Roband, reaching similar conclusions about the limited relevance of its capabilities to other markets and also focused its market strategy on developing within its existing niche defence markets. For Roband this was to be achieved through attempting to broaden its customer base within defence markets by winning business from first and second tier defence companies it previously had never dealt with. In both cases these strategies were in too early a stage of implementation, when the interviews were carried out, to determine their success.
6.6. Capabilities

This section describes some of the most important capabilities of the companies in each tier, examining their relevance beyond defence markets. For the prime contractors and second tier companies, for example, the companies are described with reference to three defining characteristics only, however they were all extremely important capabilities. The analysis of the relationship between these organizational capabilities and the changes which have occurred in the defence market environment is begun here, but will also be developed later in the analysis chapter, where a cross sectoral comparison will be undertaken.

6.6.1 Prime Contractors and Second Tier Companies

As with the prime contractors in the other two sectors, the organizational capabilities of the electronics prime contractors are defined in terms of three primary features; their system design and integration capabilities; their manufacturing capabilities, which are concerned with the production of low volumes of high quality electronic systems; and their sales and marketing capabilities, which have a very distinct character due primarily to the structure of defence markets. While the prime contractors from all product sectors possess the same generic characteristics, there are a number of significant differences across sectors in their capabilities, due to the differences in the technologies and products that they design and manufacture, which will be developed below.

The prime contractors and second tier companies are considered together in this section due to the number of similarities in the nature of their organizational and technological capabilities. The second tier companies possess similar generic organizational capabilities to those of the prime
contractors and can be described using the same three features. However, there are important and significant differences between the primes and second tier companies which will be outlined as the section develops. For example, the second tier companies have different customers to the prime contractors which distinguishes their sales and marketing capabilities.

(a) systems design capabilities

One of the most significant features of the prime contractors and second tier suppliers in this and other sectors of the defence industry is their capability to design and manufacture technologically sophisticated electronics systems. Whether the product is a missile, a naval radar or a battlefield radio, all can be considered to be fundamentally large, complex electronic systems, the design and production of which requires extensive and specific organizational capabilities. Firstly, the development phase of a project, during which the technical specification of the product is turned into an actual artefact, is usually the largest part of a project, and is extremely time and labour intensive, requiring the employment of specialist scientists and engineers over extended periods. Thus within these companies development staff account for a large proportion of total employment. Secondly, there is also a substantial requirement on these companies to subcontract specialist work to an extensive range of companies and manage these relationships over the period of the products development and production. The size and complexity of the products involved means that the supply base for these companies was in the order of hundreds of companies.83 The system capabilities of the prime contractors were not identical in the three sectors examined, with the main difference between the electronics companies and the equivalent vehicle or aerospace companies being in the technologies used. The vehicle prime contractors

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83 The supply list provided for the third tier survey included 85 companies, which represented not all, but only the most significant suppliers used by one of the companies.
capabilities were primarily in metalworking and mechanical engineering, the aerospace prime contractors in the design and production of airframes which required both specialist mechanical engineering capabilities and system integration capabilities, while the capabilities of electronics companies were primarily in electronic and micro electronics design.84

The main difference between the prime contractors and second tier suppliers was in the size and complexity of the systems they were designing. While the companies in both tiers were using similar technologies and were designing to specifications of similar technical standards, the scale of their products were different, with the products designed by the second tier companies generally being physically smaller and less complex systems. For example, Cossor's IFF systems were of a different scale to either SMS's missile or Siemens Plessey's communication systems, requiring a smaller design team and involving a smaller base of component suppliers.

One of the strategy changes introduced by Racal, Siemens Plessey and Nortel, illustrating the importance of these capabilities, was to focus on and develop their systems capabilities as this was seen as their most important and distinguishing feature and the best way of developing their military business in the more cost competitive procurement environment of the 1990's.

These capabilities were extremely specific and of relevance to only a limited range of what one interviewee called 'adjacent markets'. This referred to markets with similar requirements for complex electronics systems and of a similar structure to defence markets, where there are a small number of customers with the market power to define and control the technical requirements of the products they require. This primarily refers to other

84These difference will be more fully developed when the manufacturing and technological capabilities of the companies are examined.
government type, non-military markets such as air traffic control equipment, police command and communication systems or equipment for coast guards or port authorities. Thus while their systems management capabilities had relevance beyond defence markets, they were extremely specific, being applicable to a narrow range of markets with the same distinctive structures and technical requirements.

(b) batch manufacturing capabilities

The manufacturing capabilities of all the first and second tier electronics companies examined were in the production of small batches of complex electronics systems, but the post Cold War period witnessed a large change in the management and organization of their manufacturing systems. While the character, complexity and volume of their products remained relatively unchanged, there was a noticeable change in both the type of manufacturing work done and also in the emphasis on cost in manufacturing. These changes were primarily driven by UK government's procurement changes and the general decline in demand for defence products in the same period, which has resulted in manufacturing costs being given a substantially greater emphasis than was previously normal in these markets.

As outlined, the changes introduced were twofold. Firstly Nortel, SPS and Racal Radar reduced the amount of manufacturing work done internally and concentrated on maintaining their assembly and integration operations, which was a change undertaken by a large number of companies throughout the industry. This resulted in the shrinkage of their manufacturing facilities with work traditionally done internally being subcontracted out to suppliers as outside companies were found to be able to produce the required quality of goods at lower costs. PCB's (printed circuit board), display consoles and power supplies are just three examples of items
previously manufactured internally by the some of the companies which by 1995 were being subcontracted for outside manufacture. Secondly, the organization of the remaining manufacturing work was also changed. In all five of the companies examined some form of change was introduced to their manufacturing systems, with SMS introducing the most sweeping changes, where a completely new manufacturing facility was built. The changes introduced by all five companies were concerned with the adoption of more cost conscious manufacturing practices, often with the adoption of a cellular manufacturing system and JIT style inventory control systems. In every case this also resulted in a reduction to workforce levels and the introduction of greater levels of flexibility amongst the remaining workforce. The importance of these changes was illustrated by their centrality to their overall strategy of the companies. The 'indulgent age' of Cold War defence procurement, where the reduction of manufacturing costs was a low priority and where productivity was not governed strictly by any market cost mechanism, is over (Lock 1995, Lovering 1990). The predominant responses of most large defence producers in the electronics sector and beyond, was to reorganize their manufacturing systems and introduce different employment practices in an attempt to introduce a stricter regime of cost efficiency.

The main difference between manufacturing in the top two tiers of the electronics sector compared to the vehicle or aerospace sectors, was that there was substantially less metal working and mechanical engineering. While manufacturing for BAe's Military Aircraft Division or Alvis involved a large amount of metal working, such as machining, turning or fabrication, this was not the case for any of the electronics companies considered. Manufacturing for them was more concerned with the assembly and integration of electronics systems, than with mechanical engineering. Again, as with their system capabilities, their manufacturing capabilities, had relevance beyond defence markets, being applicable to a limited range of
other markets. The machinery and layout of production in these companies was suited to small scale batch production, and thus not adaptable to the production of larger volumes of work. In Cossor, for example, while the system design capabilities to produce military and civil GPS systems were similar entering non-military markets was not felt to be feasible due to the size of the commercial market, which would require volume production on a scale not suited to their existing facilities (interview source). Thus the manufacturing capabilities of the companies in the first two tiers of the defence electronics sector were extremely specific in nature, with limited applicability to other markets.

(c) sales and marketing capabilities

Of the three features characterizing the prime contractors and second tier companies, their sales and marketing capabilities were the most specific, due to the very particular structure and dynamics of defence markets. In this respect alone defence markets are unique, resulting in the prime contractors possessing sales and marketing capabilities which were not relevant outside of defence markets. Extended quotes by two interviewees illustrate the character of this distinctiveness;

'If you are trying to make a commercial product...you are trying to find out what people want, what they are prepared to pay, what they need, what they don't need. In our business its quite the opposite. You sell it first and then when you've made the sale you start designing it.'

also;

'There was no market to research. Your customer was there and 90% of the job had been done. If there was a contract going, they (government) would ask if you wanted to bid'

Specifically, the main distinguishing characteristics of these markets were; firstly, each company was extremely dependent on a small number of
powerful customers (national governments) for their business levels; secondly, these customers defined their requirements and needs explicitly in specifications; thirdly, competition occurred before the products were even designed or built; finally, the tendering process, which can extend over long time periods, required companies to go through a number of distinct phases such as project definition and prototype demonstration in order to win a contract. Thus, the competitive process in defence markets was very distinct, requiring defence companies to develop very specific sales and marketing capabilities which had little relevance to non-defence markets.

In this respect, there was a significant difference between the prime contractors and the second tier suppliers, as their customers were fundamentally different. For the prime contractors the customer is government, therefore all their sales and marketing efforts are directed towards them. Whereas, the customers of the second tier companies are the prime contractors themselves. So their sales and marketing efforts, while incorporating most of the distinguishing characteristics of the prime contractors, were slightly different. For the second tier companies, sales and marketing was more concerned with developing and maintaining relationships with the prime contracts, requiring slightly different capabilities to those of the prime contractors. Thus the second tier companies were less directly involved with government than the prime contractors, whose sales and marketing efforts were focused directly around the lobbying of government.

While 'adjacent' non-military markets, for equipment such as air traffic control systems have a similar market structure and competitive system for the allocation of contracts, maintaining such capabilities indigenously is less of a strategic issue to governments. Maintaining indigenous capabilities in weapons design and production is one of fundamental importance to a large number of industrialized states, including the UK, making the relationship
between government and military industry different from all other industries. This is the most distinctly different aspect to the operation of defence markets and impacts primarily on the sales and marketing capabilities of the first and second tier companies interviewed, making them the most specific and particular of their capabilities with only the vaguest relevance to the vast majority of non-defence markets.

(d) Technological Capabilities

In this section the relevance of the technological capabilities possessed by the first and second tier companies in the electronics sector are examined. Even in this sector, where there has been a vast reduction in the gulf between the levels of development in military and commercial electronics in many areas, the technological capabilities of the companies examined were found to be specific in nature, with only limited relevance to non-defence markets. As for the aerospace and vehicle sectors the technological capabilities of the companies were considered to consist of two elements; firstly, their products; and secondly their general technical skills and knowledge base.

The products of both the prime contractors and the second tier companies examined were extremely specific in nature due to the particular requirements of the military environment they were designed for. Given the diversity and breadth of the electronics sector the products of the five companies examined were very different, ranging from missiles through battlefield communication systems to naval radars. However in all areas but one these products had very specific technical characteristics which made them unadaptable for commercial use. The specificity of their military products stemmed from either unique technical requirements or extreme environmental operating requirements. Racal Radar’s Electronic Warfare
systems, for example, were designed to perform a unique military function, and thus had no direct commercial usage. As one interviewee explained,

'EW (electronic warfare) is about detecting radar emissions, identifying them and passing the information to weapons systems without emitting anything yourself. There isn't a great deal of call for that in the commercial market place.'

Another example was of Nortel's battlefield communication systems, where the unique requirements of their military application (for ruggedness, portability and security) required the products to be developed in ways which make them unsuited, even after modification, for commercial usage. Even when the products did have direct commercial applications, for example, with Cossor's IFF and GPS systems, the extreme environmental demands required of military products, for example to withstand high vibration environments and extremes of temperature, meant that the military products had to be designed specifically. The result being that the military products were very different from those designed for commercial applications. Thus while there was evidence that the prime contractors and second tier companies were utilizing a greater proportion of standard commercial components in their systems (see earlier) there was little evidence of convergence in military and commercial products at the level of the complete weapons platform or even at sub-system level (Molas and Walker 1992; p22, Gummett 1991; p44). The only systems product in the five companies examined where the requirements of military and non-military markets were similar was for large scale communication infra-structures. For these products the major technical requirements, for security and reliability were virtually the same, making the systems produced for these markets very similar (interview source). The reason for the convergence of requirements in this area, which has only occurred since the mid-1980's, is due both to the rapid increase in technological innovation which has occurred in commercial communications markets since the late 1970's (Gummett 1991) and also

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85Nortel produce communication network for both military and non military markets
because with these systems there are fewer specific military requirements as these systems are not designed to function in battlefield conditions.

When considering the general technological capabilities and skills of these companies, however, the situation was markedly different, as there was little difference in the core technical skills required to design and produce electronics systems for military and commercial markets. From the companies interviewed, whether the product was a commercial air traffic control system, a military communications infrastructure or a naval radar, the fundamental range of technical skills and knowledge required to design or manufacture these systems were remarkably similar. For example, while SMS's missiles had no commercial applications as products, the technological capabilities possessed by the company to design and produce these systems were much more generic and widely applicable. To produce missiles, or any of the military electronics products considered required the possession of generic skills and capabilities in the area of electronic and micro-electronic system design, which in themselves were applicable to a wide range of products and markets. This convergence in the technical sophistication of commercial and military electronics systems was largely due to the rapid evolution which occurred in commercial electronics particularly in the areas of IT, communications and computers (Molas & Walker 1992, Lock 1995). As detailed earlier, since the late 1970's there has been a massive increase in the development of computers and communications in the commercial sector which has seen these technologies develop to the stage where, in certain areas, commercial capabilities are in advance of those possessed by companies operating solely in military markets. Thus the gulf which used to exist between the forefront of technological development in the military and commercial sectors has been reduced, and in some areas reversed.
In sum, while the products of the prime contractors and second tier companies have little commercial relevance being very specific to defence markets, their core of technical skills and knowledge have a much broader relevance. However, due to the specificity of the organizational capabilities previously described, there are a very limited range of markets to which they could be applied.

6.6.2 Capabilities - Third Tier Suppliers

Due to the diversity and range of companies which operate at the third tier of the defence industrial base it is impossible to produce a universal model of a typical supplier. At the level of prime contractor and second tier supplier there are a smaller number of companies involved, and a much greater degree of homogeneity in their capabilities. However, as all sectors of the defence industrial base are pyramidal in structure at the third tier there is both a greater number and diversity of companies, making broad generalizations difficult. In terms of their technical and manufacturing capabilities in particular there was a massive diversity across the supply base. The electronics sector survey showed that, as in the vehicle sector, there was no distinct and separate supply base for military markets, as for the vast majority of the suppliers surveyed (75%) military work constituted less than 40% of their turnover. For this reason, and also because their experiences of defence market requirements were filtered through at least one other company, the effects of defence markets on the capabilities of the suppliers was more diluted than for the prime contractors or second tier companies. Operating at the third tier of the defence industrial base therefore appears to shield suppliers from the most particular defence market requirements. The capabilities of the vast majority of companies at the third tier were therefore found to be of more relevance to non-defence markets than those of the companies operating in the top two tiers. The
empirical material in this section is based on the three suppliers which were interviewed, however due to the broad differences in their products, capabilities and circumstances they illustrate the diversity which exists in the supply base of the defence electronics sector.

The most distinguishing aspects of the organizational capabilities of the three suppliers examined were their sales & marketing and manufacturing capabilities. By describing these two areas alone a clear illustration of their particular organizational characteristics emerges.

(a) sales and marketing capabilities

Sales & marketing was the one area where there was a large degree of commonality across the suppliers. For all three companies interviewed, sales and marketing was primarily concerned with building, developing and maintaining working relationships with a relatively small number of time-constant customers. The vast majority of their business was with less than 10 main customers, with whom they had been dealing over long time periods.\(^{86}\) The long term nature of these customer relationships meant that informal relations often developed between individuals in the supply companies and their customers, with representatives from all three suppliers having long term friendships with either purchasing or design staff from first and second tier defence suppliers, their main customers. One interviewee even described their relationship with their defence customers as 'incestuous' because of the long term, repeat nature of their involvement. Thus sales & marketing for the third tier suppliers was focused on developing relations with known and established customers, rather than speculative marketing aimed at unknown customers. The pyramidal structure of defence markets, where the number of prime contractors and

\(^{86}\)As Analog Devices business was spread across a wide range of different markets, overall the company had a larger customer base that Hypertac or Roband. However, in their defence markets, the size and character of their customer base was similar.
second tier companies is proportionally much less than the number of suppliers, gives these customers a large degree of power to control the nature of their business relationship. The ability to possibly withdraw business from their suppliers allows the prime contractors to control the terms of business, and through this mechanism have put greater pressure on their supply base since the early 1990's to reduce their costs (see earlier strategy section).

Another distinctive dimension to the sales & marketing capabilities of the third tier suppliers was that they were primarily involved in technical sales. The procurement decisions of their customers had a large technical dimension, with the opinion of the engineer/designer carrying substantial weight in procurement decisions. Representatives from all three companies argued that in their defence markets they were primarily selling to engineers, therefore the technical characteristics of their products were as significant a part of any procurement decision as cost was. While these capabilities were specific they did not limit the suppliers to operating in defence markets alone, as there were commercial markets which had similar structures and supply relations. In Hypertac, for example, business transactions in its civil aerospace and rail transportation markets were carried out in a very similar way as occurred in its defence markets. Thus while their sales & marketing capabilities were very particular they had relevance to more than just defence markets.

(b) manufacturing capabilities

The manufacturing capabilities of the three suppliers had very little in common as the products they manufactured were so different. In terms of manufacturing no general pattern was found in the supply base. Whether considering the volume of production, the level of labour intensity or the type of machinery used the three suppliers examined were all different. At one
extreme was Roband, which manufactured low volumes of power supplies. Roband’s power supplies were designed and manufactured to the particular requirements of individual customers, with a lot of the added value in its components being built in during manufacture. For Roband production was very labour intensive, requiring highly trained operators and the use of very specialized machinery, for example to wind copper onto transformers. At the other extreme was Analog Devices, for whom manufacturing involved the mass production of identical components, each of which had a relatively low value. For Analog Devices, therefore, production was capital intensive with manufacturing accounting for a very small proportion of their products added value. Hypertac’s manufacturing capabilities were somewhere in between these two extremes. For Hypertac, manufacturing involved the production of small-medium sized batches of components, with its machinery and production layout being suited only to batch and not volume production. However its manufacturing systems was substantially less labour intensive than those of Roband. Thus the differences were greater than the similarities in the manufacturing capabilities of the three suppliers.

While Roband’s manufacturing capabilities were found to be very specific to the particular requirements of defence markets, with little relevance in other market sectors, compared to the other companies surveyed and interviewed its circumstances were exceptional rather than typical, due both to its extremely high dependence on defence work and the very specialized nature of its products. Analog Devices’ situation was also exceptional as it required to identify and separate components suitable for its military customers from its commercial products. For Analog Devices the quality requirements of its commercial products were lower than those in its military markets, as the military components had to operate in a more severe

87 Only a small fraction of Analog devices’ output was for its military markets, as the volume of components required by them was small compared to those for its commercial markets. While Analog Devices sold millions of components to its automotive, computer and communications customers, the typical volume of components required by a military customer was only in the order of hundreds (interview source).
environment. Thus to satisfy both these different requirements the best components from the assembly line were separated for use in military applications.\(^8\) However this was only possible due to the high volume of its commercial production and the low number of components required by its military customers. In terms of manufacturing capabilities Hypertac represented a more typical third tier supplier. While the type of components it produced were of extremely high quality its manufacturing capabilities were not relevant to defence markets alone, being applicable to a range of commercial markets, although ones requiring a similar quality of components. Overall the manufacturing capabilities of the third tier suppliers had substantially greater relevance to non-defence markets than those of the prime contractors or second tier companies.

(c) Technological Capabilities

As the manufacturing capabilities of the third tier companies have already been examined, this section focuses on the technical characteristics of the suppliers' products, primarily addressing the questions: how specific are they and what relevance do they have beyond defence markets? The simple answer to the second question is yes, as the vast majority of the third tier suppliers surveyed were operating in both defence and commercial markets. In general, compared to the first and second tier suppliers in the electronics sector, the products of the third tier companies were more generic, having substantially greater relevance to commercial markets. This was because of the position of their products within the hierarchy of the complete military platform. The specific military functions of these platforms are generally designed at the systems and sub system level, which the prime contractors and second tier companies operate at. Thus the products of the third tier

\(^8\) The best components in this context were those which were closest to the required performance specifications.
suppliers, being situated lower down in the hierarchy of products are less likely to be designed for a narrow military function (Gummett 1990, Schofield 1992).

However the previous blanket statement does not do justice to the diversity found in terms of product specificity. Due primarily to the broad range of artefacts produced at the third tier the specificity of the supplier's products varied greatly. At one extreme was Roband, whose power supplies were very specific in nature, with little relevance to commercial markets. At the other extreme was Analog Devices, whose products were extremely generic, being sold into product markets as diverse as computers and military aircraft. In between these extremes again was Hypertac whose products, while being relevant to commercial and military markets, were rather specific in nature being suited for low volume high quality, niche connector markets. The difference in the generalizibility of these diverse components is unrelated to any military requirement. As Walker et al (1988) argue, some products are generic, with broad applications, such as Analog Devices IC's, or using a more low tech example, nuts and bolts, while others have very specific applications. Thus, due to the diversity of product types at the component level, generalizing about their predominant characteristics is difficult to do.
6.7. Conclusion

During the period considered there have been some substantial changes in defence electronics markets, both on the supply and demand side, with the post Cold War period producing the most fundamental and rapid changes in the history of the sector. This chapter has described these changes, and has related the character of the organizational capabilities of the companies examined to the specific character of their operating environment. However the relationship between the changes in the market environment and the character of the corporate responses is developed more fully in the analysis chapter.

Demand in the defence electronics sector, as in the aerospace and vehicles sectors, changed in two ways. Firstly there was a noticeable decline in absolute demand, with procurement levels for military electronics equipment declining globally, with demand in the UK reducing by approximately 25%. The impact of this decline on the companies examined was somewhat variable, with turnover in Racal Radar and Cossor declining by almost half, while in two divisions of Siemens Plessey it remained relatively constant. However, of the prime contractors examined only one, Nortel's Integrated Networks division actually saw its turnover increase, with this being due to changes in the company's market focus rather than a growth in its traditional markets. Part of the reason for the variability in company experiences is because the defence electronics sector is made up of a number of discrete sub-sectors, with the procurement cuts being spread unevenly across them. Thus while all the companies were considered part of the electronics sector its heterogeneity was such that they were all competing in different product markets. The second significant change in demand, the move towards more cost focused procurement, was experienced evenly by all companies, with the first and second tier suppliers passing on the change to the third tier component suppliers indirectly. In the UK this was achieved by the move to
strict fixed price contracting, which passed a greater element of technical risk and cost consciousness onto the prime contractors than they had traditionally been used to.

On the supply side there were also a number of significant changes, affecting both the overall structure of the industry and the internal management of business within each company. The strategies adopted by the companies in the top two tiers were remarkably similar, with all introducing some form of change to their internal operating practices and all being affected by changes in ownership patterns. In general the post-1989 period was one of concentration with the number of competitors in virtually every product sub-sector declining. This shrinkage in the absolute number of companies occurred by a number of different mechanisms. Some companies, Thorn-EMI for example, exited defence markets voluntarily by selling their defence businesses (Racal acquired its electronics warfare business in this way as did Cossor with Nortel's GPS business). There was also a tendency for the larger companies such as GEC and Thomson to acquire some of the smaller companies such as Plessey and Ferranti. Finally there was also a number of joint ventures, with companies which had previously competed in the same markets undertaking strategic alliances on both a permanent and temporary basis, with Thomson and Shorts, for example, agreeing a permanent 50:50 joint venture in ground launched missiles. While the trend towards concentration has also been occurring in other sectors of the defence industrial base, it has been more pronounced in the electronics sector, due primarily to the central importance of electronics to modern weapons systems, making ownership of such businesses extremely important. All of the companies examined pursued strategies of developing and re-focusing their defence businesses\(^89\) rather than

\(^89\) The vast majority of all companies in the defence electronics sector have pursued similar strategies, with the number of corporate groups exiting defence electronics markets being extremely low.
diversifying out of defence or exit defence markets, therefore such strategic changes in ownership have been an important strategy mechanism.

The second major supply sided change in the defence electronics sector was the introduction of different internal operating practices, which in every case were implemented with the primary intention of improving their cost efficiency. In all of the five companies examined there had been both a decline in absolute employment levels and the introduction of different internal structures and business practices. The extent and nature of the changes introduced varied substantially however. SMS introduced the most fundamental change by building a new production site where a cellular manufacturing system and computer managed JIT-type stock control system were implemented. The changes introduced by Cossor while being less far ranging, were introduced with the same objective of reducing costs and increasing the companies cost management practices. In their case this was primarily implemented through the introduction of a new project management system.

Another significant change affecting the defence electronics sector was the rapid expansion and rate of technical innovation in commercial communications and computer markets which occurred from approximately the mid 1980's onwards. This expansion and growth saw commercial technical standards increase in these sectors to such an extent that it made possible a substantial increase in the use of commercial equipment in military systems. Until the early 1990's this had not been possible as the technical standards in military communications were so far in advance of those in the commercial sector that the use of standard commercial products and components was not considered feasible. This change in commercial standards has been an important factor influencing a number of the companies examined, including Racal and Siemens Plessey, to use more commercial standard components and to reduce the amount of specialized
component design and manufacturing done internally. The advance in the technical standards in the commercial sector have been so significant that by the mid 1990's it was possible to use a significant proportion of equipment which originated in the commercial sector in military equipment such as fixed communications infrastructures of command and communications centres.

Finally, a conclusion on the nature and specificity of the capabilities found in the companies examined is necessary. Firstly, the capabilities possessed by all the companies examined were found to be closely related to the character of their operating environment, with the large differences which existed in the character of the operating environment at each tier being reflected in the differing type of company which which operated at each tier. Secondly, while the capabilities of the companies in each of the three tiers varied substantially, the common factor across all tiers was that the specific nature of their capabilities meant that they were only suitable for application in a narrow range of different markets. While the products and capabilities of the third tier suppliers were, in general, less specific to the requirements of defence markets, in most cases they were still only relevant to a narrow range of alternative markets. This was less to do with any particular requirements in defence markets than with the narrowly specific nature of any companies capabilities, skills and knowledge. However, this is another issue which will be developed more fully in the analysis chapter.

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90 Another factor influencing the use of more commercial components was the greater cost focus discussed previously.
CHAPTER 7

ANALYSIS:
THE RELATIONSHIP BETWEEN ORGANIZATIONAL CAPABILITIES, STRATEGIES AND THE DEFENCE MARKET ENVIRONMENT

7.1. Introduction

The analysis chapter draws together the empirical evidence on the experiences, behaviour and capabilities of all the companies examined to allow comparisons between the sectors to be made, and to relate the empirical findings to theory on the relationship between organizations and their operating environment. The main aim of the research was to examine the extent to which the capabilities, structures, behaviour and strategy of companies operating in defence equipment markets were shaped and constrained by external, environmental factors, primarily focusing on market and technological issues.

Sections 7.2., 7.3. and 7.4. which constitute a large part of the chapter, show in detail the ways in which the particular character of market and technological factors in the defence procurement environment shaped the capabilities possessed by the companies examined. Section 7.2 outlines the market and technological characteristics of the defence market environment. These environmental factors were extremely important in shaping all the categories of organizational capability examined (system integration, manufacturing, sales & marketing and technological). Therefore, following this section 7.3 relates the capabilities of the companies examined to these environmental characteristics
providing a comparison of the sectoral differences in both the character of the operating environment and the capabilities of the companies examined. Section 7.4 then relates these findings to evolutionary economics. The empirical evidence provided supports the ideas of evolutionary economics on the close relationship between the capabilities of an organization and the particular characteristics of its operating environment. This relationship resulted in the capabilities of the companies examined being specific in nature, with only limited relevance to markets with substantially different operating environments.

Following this, in section 7.5, the focus of the chapter shifts to the strategies adopted by the companies examined. Primarily, the issue of interest is the extent to which the strategies they pursued were shaped by environmental constraints and the degree of 'strategic choice' they possessed (Child 1972). While it will be shown that the environmental constraints impinging on the strategic freedom of the companies examined were considerable, making organic diversification difficult, their strategies were not totally determined by environmental factors, giving them an important element of choice and control. While the specific nature of their capabilities was one of the major constraints on their strategic freedom these were not the only factors which explain the lack of organic diversification found. The most striking observation from the empirical evidence was that the strategic responses of the companies in each sector had been remarkably similar. The typical response was not to diversify out of defence markets, but to remain within them, while introducing significant changes to their internal operating practices and structures. Their strategies were as much shaped by other environmental factors, such as the specific policies adopted by government and the short term economic focus of their corporate owners. Therefore section 7.6 considers the exact nature of the constraint produced by both these factors on the strategy of all the companies
examined before examining the degree of choice this leaves the companies examined to control and shape their strategies.
7.2. The Characteristics of the Defence Procurement Environment

As outlined in the methodology chapter (section 2.2.3) this research concentrates on examining the market and technological dimensions of the operating environment of the UK’s defence industrial base. However, to properly analyze the character and influence of both these elements it was necessary to divide them into more specific sub-categories. In some contingency theory research (Woodward 1958, 1965, Burns & Stalker 1968, Lawrence & Lorsch 1967) market and technological factors have been regarded as single dimensional characters. For example, Woodward argued that the most significant factor influencing a company’s internal organizational structures was its production system (Dawson 1992; p63-68, Thompson & McHugh 1995; p68), while Burns & Stalker (1968) and Lawrence & Lorsch (1967) both argued that the single most important factor which influenced the system of internal organization was the level of change in market and technological factors. However, one problem with these arguments was that they oversimplified these factors (Brown 1992; p124). For the purposes of this research therefore both environmental categories were subdivided into more detailed elements. This allows the relationship between these factors and the capabilities and strategies of the companies examined to be studied more fully.

7.2.1 Defence Markets - contingent characteristics

From the data on all three sectors a number of contingent factors were identified which made the defence market environment very specific. However, the character of the market at the third tier was substantially different from the first and second tiers. Therefore it is necessary to describe the character of the
market at the third tier separately, while the similarities of the market environment at the first two tiers allows them to be described together.

The first distinguishing characteristic of the top two tiers of defence markets is in their structure, in terms of both supply and demand. On the demand side they are monopsonistic in nature, with domestic government having substantial power as the largest customer (Markusen & Yudken 1992, Todd 1988, Kaldor et al 1986). The dominance of the UK government as the main customer to most of the UK’s major defence companies has declined since the early 1980’s as most companies increased their level of export business. In the early 1980’s MOD purchasing accounted for about 80% of arms produced within the UK (Smith 1980), however, this percentage was substantially smaller in the early 1990’s. But, as will be shown (see section 7.5.2), the role of government in supporting and encouraging exports has been extremely significant in the UK, thus maintaining the importance of its role in these markets. While many companies reduced their dependence on the UK government through greater export sales the majority of this business for most companies was with a relatively small number of countries. The monopsonistic nature of these markets was most pronounced at the development stage, with the UK government being the main source of the vast majority of original development contracts. On the supply side these markets are oligopolistic, as they consist of a large number of specific niches in which there are only a small number of competitors91, and with large entry barriers preventing the access of new competitors (Gansler 1984; ch2). In all three sectors examined this was the case, with the UK government being the most important customer of almost every company, and with every company having only a small number of direct competitors. The nature of

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91 For example, avionics markets can be divided into a number of distinct niches including, communication systems, navigation systems, data processing equipment, Displays and instruments, radars, electronic warfare systems (AW&ST 1996; p151-173). Each of these niches represent very different product areas in which the range of companies competing varies greatly.
competition was also very particular in these markets, with customer requirements being defined explicitly in advance, competition occurring prior to the development and production of equipment and with competition being 'all or nothing' (Gansler 1989; p159-160. Todd 1988; p70-71). The 'all or nothing' nature of competition resulted in companies becoming dependent on winning particular contracts. For example, VDS were almost totally dependent on winning the Challenger 2 contract, while for both SPS and Nortel the award of the BOWMAN radio contract was crucial for their future business levels (Financial Times 20th August 1993; p7). Customer relations in these markets are also very particular and represent a further contingent factor. Even though tensions exist between government and industry, there are many common interests between them which make their relationship close (Dunne 1993, Gummett & Reppy 1990). The market structure detailed above, for example, creates a dependence on both sides, while the entry and exit barriers have resulted in most prime contractors developing long term relationships with the armed forces and MoD procurement functions. These markets are also highly regulated, with the government being intimately involved in every aspect of business (see later), including the control of export contracts as well as domestic procurement practices. The way in which demand is identified represents the final contingent factor. In defence markets demand emanates from nation states, who define their requirements explicitly in contracts, therefore in these markets measuring the level of demand and identifying potential customers is straightforward. However this demand is extremely inflexible, with companies having little ability to change it. Gansler (1991; p143) concluded that all these factors result in the market environment for defence equipment being unique.
At the level of component suppliers, the market was very different, with fewer characteristics unique to military procurement, and with commonality to a broader range of non-defence markets. At this level of all three sectors there was no direct involvement with government, with the customers of the component companies examined being the prime contractors and second tier companies, therefore customer relations were very different. The structure of the market at these tiers was also substantially different, as on the supply side the number of competitors was significantly larger, and on the demand side there was also a greater number of customers. Finally, the nature of competition and the interpretation of demand characteristics varied substantially from the top tiers of the market, with demand being more elastic and less easily measured. At this level of the industry more companies than at the top two tiers had business in both military and non-military markets, which suggests that at this level the characteristics of defence markets were less distinctive.

7.2.2 Technological contingent factors

Similarly, the technological environment of companies was divided into a number of separate and distinct elements. The volume of production and type of manufacturing system required was an important contingent factor, influencing the capabilities of the companies examined. While manufacturing systems varied greatly between tiers, due to the different technical characteristics of the products at each tier, the low volume and batch nature of production was a characteristic largely common across all tiers and sectors. Secondly, the range and type of technologies required for both design and manufacturing was another contingent factor. Large differences were found between sectors in the

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92The second tier of the Vehicle sector and the third tier of the aerospace and electronics sectors.
technologies used, which influenced the nature of the capabilities possessed by each company. Considering the prime contractors for example, the technical requirement of producing armoured vehicles meant that the capabilities of the prime contractors in this sector, being concerned with the manipulation of thick metal panels, were substantially different from those of the other prime contractors. Finally, the rate and type of technical advance was an important contingent factor which showed significant variations between sectors. In each sector the relationship between military and civil products and technologies was different, with the electronics sector having the greatest element of commonality between products in military and non-military markets. This was important as the rate of technical advance in certain commercial electronics sectors through the 1980's was so significant that it had an impact on the development of military products, particularly in the area of communications systems.

7.2.3 Demand Side Changes in the Character of UK's Defence Markets

The empirical evidence from all three sectors examined showed that two significant changes on the demand side of defence markets had occurred in the decade between the mid-1980's and mid-1990's. Firstly there had been an absolute decline in spending on arms production and development. In global terms arms spending peaked in 1986/87 at over $1,000 billion, since when it has declined continuously in real terms, with the overall reduction across NATO countries being approximately 15%. In the UK the reduction in military spending was even more significant decreasing by over 20% in that 10 year period (Ball et al 1994). In GDP terms UK military spending declined from its mid-1980's high of 5.6% to 3.9% in 1992/93 (Cm 2501). While the effects of this reduction in spending were not evenly spread across all industrial sectors and companies, most of the companies examined did experience some level of decline in their
absolute levels of military business. While military spending in the Cold War period was always cyclical the decline in spending in the post Cold War period represented the sharpest and largest reduction since the end of the Second World War. Thus this was an extremely significant change in the defence market environment.

The other major change affecting the UK's defence markets were the procurement reforms of the mid-1980's, introduced under Peter Levene. As shown in chapter three, these reforms were primarily concerned with improving the financial efficiency of the UK's military procurement practices through passing greater cost and technical risk onto industry (Levene 1989, Walker & Gummett 1989). These changes were achieved primarily through reforming the procurement system, with a much greater emphasis being placed on cost management in the allocation of contracts, than had existed previously. Under the previous system, which predominated until the mid-1980's, there had been little incentive for defence contractors to control or minimize their production and development costs. This was replaced by a stricter fixed price contracting system with a strict price being agreed at the beginning of a contract with contractors being responsible for managing projects within the agreed budget. The responsibility for cost over-runs and technical problems was therefore passed to industry, putting a much greater financial responsibility on them. In the cases of projects where technical problems occurred, for example with SMS on the development of the Starstreak missile (Financial Times, 6th March 1996; p8) and with VDS in the production phase of its Challenger 2 contract (Tusa 1996), both companies had to accept the financial burden of the cost overruns incurred. From the interviews with the prime contractors in all three sectors these changes have resulted in a greater cost management burden being passed to industry.
The other major way in which the emphasis on cost control was achieved was through encouraging greater numbers to bid for contracts. While it has been shown that in the allocation of some major contracts, such as for the CASOM missile or the Challenger 2 tank, that maintaining domestic capabilities was still a more important issue than cost in deciding the allocation of contracts there has still been a greater emphasis on cost reduction. This has been possible as the introduction of foreign bids has allowed the government to apply pressure to domestic companies to reduce the cost of their bids. Therefore, the Levene reforms to procurement represent a significant change in the defence procurement system, with a substantially greater emphasis being placed on issues of cost.

The purpose of this section was to outline the most significant market and technological contingent factors in the defence procurement environment as well as showing how the demand sided character of the UK’s defence op environment changed between 1989-95. In section 7.3 the effects of these factors on both the capabilities of the companies will be examined before these findings are related to evolutionary economics in section 7.4.
7.3 Organizational Capabilities and the Operating Environment

In this section the empirical data on the capabilities of the companies in each sector are brought together to provide a sectoral comparison. While significant differences were found in organizational capabilities between the different tiers within each sector, there were large similarities across the sectors when companies at the same tier were compared. Thus, the capabilities of the prime contractors in each tier were similar, but were very different from those of companies at lower tiers of defence equipment markets. This was primarily because the technical requirements and market characteristics affecting companies were substantially different at each tier in the market, but were similar across sectors. Thus the assertions from contingency theory and evolutionary economics that the capabilities possessed by any organization will largely be shaped by the technical and market requirements of their operating environment, are reinforced by the research findings. This relationship is further supported by the findings that the changes in internal operating practices adopted by the companies examined since 1989 closely reflected the changes which occurred in the operation of these markets, with a much greater emphasis in procurement being placed on cost management. The significance of the changes in internal operating practices introduced by many of the companies examined also shows that organizational capabilities should not be regarded as static and fixed, but as things which evolve and change through interaction with their operating environment.

Using the same framework as in the empirical chapters, the effect of the contingent market and technological factors on the capabilities of the companies in all three sectors will be considered.
7.3.1 System Integration Capabilities

The ability to design and manufacture large technical systems was one of the most distinguishing capabilities of the prime contractors from all three sectors and of the second tier companies in the aerospace and electronics sectors. Whatever the final product, whether an aircraft, tank, missile, radar or radio, all are essentially large, complex technical systems. Thus the point made by Schofield (1992), that VSEL was as much a system integration company as a submarine manufacturer, can be extended to all prime contractors. The products of the prime contractors represent the apex of a hierarchy of components and sub-systems, which integrated together constitute a complete weapons system (Gummett 1990, Walker et al 1988). The point made by Walker et al (1988; p19-20) that, ‘as the hierarchy is climbed, the products become more complex, few in number, large in scale, and systemic in character’, was reinforced by the empirical evidence from all three sectors. Thus at the lowest levels of the product hierarchy, where individual components are designed and manufactured, the system integration requirements were negligible, with most companies producing only small, relatively simple components.

The requirement for system integration capabilities is driven by the technical needs inherent in the production of weapons systems rather than by any characteristic of defence markets. It is a requirement which has become increasingly more demanding over time, as the technical complexity and sophistication of weapons systems increased. During the Cold War period, as outlined in chapter 3, with the drive to increase the performance of successive generations of military equipment, weapons systems became increasingly more complex, with a massive increase in the number of components and sub-systems to be incorporated. The prime contractors therefore had to continually
adjust to this growing complexity through the development of organizational capabilities and systems to cope with this continually expanding supply base, requiring the co-ordination, during both the design and manufacturing, of greater and greater numbers of components and companies. Current military products are so complex that these requirements are extremely onerous and any company undertaking the design and manufacture of these systems needs to possess a very particular range of capabilities.

The complexity of these systems means that the development phase of projects has become very long, requiring the employment of large proportions of professional and technical staff over extended periods. Woodward (1965) argued that for companies involved in the batch production of very low volumes of specifically designed products, development would be the most critical function. In all the prime contractors and second tier companies examined this was true, with development departments employing large numbers of staff and with this work accounting for a very significant proportion of corporate resources. Comparing the research intensity of these companies to other industries was not possible due to the lack of detailed information on R&D Spending. R&D figures available publicly, for example CRL (1994), do not disaggregate figures below company level, making it impossible to identify the R&D spending of individual divisions. However, the design intensity of this work can be gauged in employment terms from the high proportions of professional staff employed by the major defence equipment manufacturers. The requirement for professional design and development staff in these industries is such that between one quarter and one third of the UK's engineers, scientists and technologists are involved in defence work (Lovering 1991, Kaldor et al 1986). The proportion of these workers in the companies examined is likely to have increased between 1990-95, as the reductions in workforce which occurred fell disproportionately on manufacturing and administrative functions. A
second characteristic of being a large systems integrator was the requirement of co-ordinating a large supply base of companies through both development and production phases. This placed a large bureaucratic burden on these companies, as it involved a significant amount of administrative work. Typical of such work was the need to: select and assess the ability of sub-contractors; define technical specifications for all work sub-contracted; conduct competitions for the allocation of work; and monitor the performance of suppliers against performance and delivery schedules. When the supply base extends to thousands of companies, producing very different types of items, as was the case for all the prime contractors examined, the organizational demands of this work are substantial. The technical requirements of being a system integrator also affects the manufacturing and general technological capabilities of companies, however, these elements will be examined separately. Therefore, the technical requirements of being a systems integrator were shown to place extremely specific and demanding constraints on organizations.

While all the prime contractors can be considered to be system integrators important differences were found in the character of these capabilities across the three sectors examined. The main difference between the system capabilities of the prime contractors in each sector, apart from the technologies used which will be discussed later, was one of scale. In the vehicle sector the scale and complexity of the weapons systems were quantitatively smaller than those in the electronics or aerospace sectors. For example the size of the supply base to the vehicle companies was significantly smaller, and the electronics systems incorporated into military vehicles were much simpler and fewer in number than for other weapons systems. For the vehicle prime contractors the electronics systems incorporated were discrete items whose installation within the vehicle was relatively straightforward, whereas the electronics within other systems, such as missiles, radars or aircraft were
substantially more complex and required a greater degree of integration with other functions. These were the primary reasons that this sector was only considered to consist of two tiers, while the others had three.

As outlined, at the second tier of the aerospace and electronics sector there was also a large technical requirement for system integration capabilities. Thus Racal Radar, Smiths Industries and all the companies at this tier of the market can also be considered to be system integrators. As with the prime contractors, they also design and manufacture complex technical systems and thus face the same organizational demands highlighted above. In terms of system integration capabilities the boundary between the prime contractors and second tier companies in these sectors was indistinct, as both the scale and nature of these requirements were similar.

The technical requirements of being a systems integrator in the defence environment result in the capabilities of organizations being very specific, with relevance to only a limited range of markets (Schofield 1992). The number of markets where these capabilities would be immediately relevant is extremely small. However, these technical requirements, and the organizational capabilities they demand of companies, are not unique to defence markets alone. There are a number of commercial markets where similar technical requirements operate and where these organizational capabilities are suitable. For example air traffic control equipment, telecommunications infrastructures or large civil engineering projects such as power stations are also complex technical systems which have similar technical requirements and where the system integration capabilities of the companies examined are suitable. These markets were referred to by one interviewee as 'adjacent markets', due to the similarities with defence markets. The systems capabilities detailed greatly limit the number of markets to which the companies described could compete in
without major transformations and thus represent one of their most specific capabilities, limiting their opportunities for diversification.

7.3.2 Manufacturing Capabilities

While design/development is the most important activity undertaken by large defence contractors manufacturing is still an extremely important function representing a distinctive component of their overall capabilities. Unlike the system capabilities described above, these capabilities were shaped by both market and technological factors, with the companies at each tier possessing very different capabilities. The divergence in manufacturing capabilities between tiers was primarily related to the differing technical character of the products at each tier. At the top tier, and to a lesser extent the second tier, the products being manufactured were large, technological systems, whereas at the third tier the products were individual components, thus different manufacturing capabilities were required. One requirement, which was largely consistent across the tiers, was that manufacturing was predominantly concerned with the low volume, batch production of custom designed products. At the level of component suppliers this was not always the case, as some components, such as electrical connectors or hydraulic hoses for vehicle engines were standard parts which could be mass produced. However, even at the lowest tiers of all three sectors products were predominantly custom built, rather than being standardized.

The manufacturing capabilities of all the companies examined, as detailed in the empirical chapters, have been extensively modified, with the period from 1989-95 witnessing the largest and most rapid changes in the organization of manufacturing since the Second World War. These organizational changes were primarily market driven. The Levene reforms of the mid-1980's and the
reduction in demand following the end of the Cold War resulted in a much greater emphasis being placed on cost management than had previously existed in these markets. The stereotypical view that this lack of emphasis on cost control had profoundly influenced the capabilities of companies operating in defence equipment markets (see Dunne & Willett 1992; p6, for example) was true for all the large companies examined. The lack of emphasis on cost control during this period affected all aspects of organizational behaviour, not only manufacturing (Maddock 1983, Schofield et al 1992; p67), but the focus here will only be on manufacturing.

As outlined, one common characteristic of companies from all tiers and sectors was the low volume, batch nature of production. At the top two tiers in particular the number of items manufactured was extremely low, with annual production volumes unlikely to exceed a few hundred items. Production for these companies was also highly labour and capital intensive, which acted as a barrier to the routinization of jobs and the deskilling of manufacturing workers (Lovering 1990). While these general characteristics of manufacturing have remained unchanged the greater prioritization of cost management in procurement has resulted in significant changes being introduced by most companies to the organization of their manufacturing systems. The result of the traditional lack of emphasis on cost reduction for manufacturing was that systems to effectively control and reduce costs were poorly developed (Frensborg & Wallensteen 1980, Willett 1990; p473). As indicated by one interviewee, cost accounting systems during the Cold War period were primarily concerned with adding up costs, rather than controlling or reducing them. In all the companies examined from the top tiers similar priorities had predominated, with the same effect on their manufacturing systems. Thus cost reduction was a priority which never influenced the organization of manufacturing. This allowed all the large companies examined to develop large over-capacities in both capital and labour.
resources without experiencing any negative economic consequences, as productivity etc. was not governed by any market cost mechanism (Lock 1995).

As indicated, the Levene reforms in the UK, combined with the general reduction in demand following the end of the Cold War, resulted in cost control becoming much more important in defence procurement. The response of the companies examined to this situation was to introduce a large number of changes to their internal operating practices in order to reduce their operating costs and increase their cost efficiency. While both the scale and type of change introduced varied greatly, all but two of the thirteen large companies examined (Land Rover and GEC Sensors) implemented significant changes to their manufacturing systems (summarized in Table 7.1).

<table>
<thead>
<tr>
<th>Company</th>
<th>Manufacturing workforce reduced</th>
<th>Manufacturing floorspace reduced</th>
<th>Increased flexibility in manufacturing operations</th>
<th>Change to quality-project mgmt system</th>
<th>Sub-contract systems changed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nortel IN</td>
<td>no</td>
<td>?</td>
<td>no</td>
<td>yes</td>
<td>?</td>
</tr>
<tr>
<td>SPS</td>
<td>yes</td>
<td>?</td>
<td>?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>SMS</td>
<td>yes</td>
<td>?</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Racal Radar</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Cossor</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>BAe Dynamics</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>BAe MAD</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Smiths Industries</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>GEC NSD</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Alvis Vehicles</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Vickers Defence</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table 7.1 Changes to internal organization of production
The two most common changes were the reduction in employment levels, and the introduction of different project management or quality systems. Of the eleven companies introducing changes Nortel was the only one not reducing its workforce levels and GEC's NSD the only one not introducing any changes in its project management systems. The most common change to project management and quality systems was the partial adoption of JIT manufacturing and inventory control systems, with Alvis, VDS, BAe's MAD and Dynamics divisions and SMS all adopting these practices in different forms.\(^93\) The adoption of JIT manufacturing systems and other 'Japanese' operating practices in the UK developed out of the debate on post fordism and organizational flexibility.

It has been argued (see Piore & Sabel 1984), that future competitive advantages for industrial enterprises would be dependent on their degree of flexibility to adjust to varying market demands.\(^94\) This flexibility was argued to require particular manufacturing systems, employment conditions and subcontractor relations and is closely related to the theory of the 'flexible firm' (Atkinson 1984). Despite the prominence of these ideas however they have not been widely adopted by UK industry, with the motor vehicle industry providing the most prominent example (Turnbull et al 1992, Oliver & Williamson 1988). In the defence equipment manufacturers examined these systems were not fully implemented, with a 'pick and mix' approach being adopted, where only selective aspects were implemented. For example, while there was a move towards more flexible manufacturing work practices through increased functional flexibility,\(^95\) none of the companies examined had fully implemented

\(^{93}\) Similar changes to internal operating practices are also being adopted in a significant number of the largest US defence contractors, including Lockheed-Martin and McDonnell Douglas (JDW 1995b).

\(^{94}\) These ideas have not gone unchallenged, with the foundation assumptions of this thesis being criticized (Pollert 1988, Wood 1989).

\(^{95}\) This was focused primarily on manufacturing, where demarcations between trades were reduced with a move towards multi-skilling.
core-periphery employment practices. In all six cases where this was done, these changes were accompanied by an overall reduction in employment levels, with cost reduction rather than flexibility being the main goal behind the adoption of these practices.96 Similarly, while sub-contract relations have been changed, through reducing the absolute size of their supply base and in some cases adopted preferred supplier schemes, full flexibility in these practices has not been undertaken (see later).97 This was again similar to the partial way that these systems were implemented in commercial industry (Rainnie 1991, Imrie & Morris 1992), where the aspiration of moving away from conflictual supply relations has not been achieved.

A sectoral comparison across each of the three tiers shows that the similarities between manufacturing capabilities were much more significant than any differences, never-the-less important differences still existed. Focusing on the prime contractors a number of these differences become apparent, with the range and type of technologies required varying substantially between sectors. Prime contracting in both the vehicles and aerospace sectors required greater mechanical engineering capabilities than in the electronics sector. In both these sectors there was a greater requirement to both manufacture large component parts and to manipulate and assemble large metal assemblies. This was most pronounced in the vehicles sector, where the core manufacturing capability of the prime contractors was in the manipulation and assembly of large mechanical systems (Hartley & Hooper 1990; p10-11). In both these sectors, therefore large machine shops and assembly areas were required. In the electronics sector manufacturing was more concerned with the production of micro-electronics.

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96 There is also evidence from commercial industry that cost reduction rather than flexibility was the main motivation behind the adoption of these practices (Bresnen 1996; p126, Imrie & Morris 1992; p642)
97 Many of the largest US defence contractors are also shrinking their supply base as a way to reduce their costs, with the Douglas Aircraft Company and Lockheed at its Fort Worth site reducing their number of suppliers by over 70% (Velocci 1994a)
components and sub-assemblies, such as printed circuit boards, with a much smaller need for large scale mechanical engineering capabilities. But even in this sector there was some need for mechanical assembly skills, as the prime contractors all retained the task of finally assembling their products internally.

At the level of component suppliers the main differences in manufacturing capabilities were not across sectors, but between companies making different types of components. At this level in the industry the range and type of components being designed and manufactured was far greater than at higher tiers, however it was possible to group companies into two main categories, those producing standardized, generic components and those producing specific, custom designed components (Walker et al 1988). The main difference between these categories in terms of manufacturing capabilities was in the volume of production. For companies producing standardized components, such as Analog Devices (integrated circuits), Spectrum Hose (Hydraulic hosing), Twiflex (clutches and driveshafts) and Hypertac (electrical connectors), production volumes were significantly higher than for those producing specific components such as Roband (power supplies), Pilkington Optronics (electro-optics products) and Westair (lighting systems). From the three supply base surveys conducted and the eleven suppliers examined the vast majority of companies produced specific components. Therefore, even at the lowest tiers of the defence industries manufacturing for most companies concerned the low volume production of small batches of components.

At all tiers and in all sectors, with the exception of those component suppliers producing standard components, the manufacturing capabilities of the companies examined were extremely specific in nature, with relevance to only a limited range of market environments. The manufacturing systems in these

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98 Of the eleven suppliers interviewed only four (one third) were mass producing standardized components.
companies were not adaptable to markets requiring higher volume production, as this would require a complete transformation of their existing systems. For example, using two particular cases, both Hypertac and Cossor had potential diversification opportunities into larger volume markets, and, in terms of their products, had the technical capabilities to do so. What prevented them from entering these markets were their production capabilities, which were totally unsuited to the requirements of higher volume production. For these companies to have entered these markets would have therefore required a total transformation in their manufacturing systems. Their capabilities were not specific to only defence markets, but they were specific to markets requiring similar manufacturing volumes. Therefore the particular character of their manufacturing capabilities limited substantially the range of markets which they could enter.

7.3.3 Sales & Marketing Capabilities

Simplistically, sales and marketing activities are primarily concerned with: identifying potential customers; determining market 'needs' (both the level and type of demand); and selling the company's capabilities and products to potential customers. The way in which this is done, and the extent to which these tasks can be achieved is highly variable, and is primarily related to the particular characteristics of the market environment. Comparing the sales and marketing capabilities of companies at the different tiers of defence markets large differences were found, due to the variation in the character of the market at each tier. The sales and marketing capabilities of the third tier component suppliers were so different from those of the first and second tier companies that they are examined separately. In both sections these capabilities will be
shown to be closely related to the character of the market, with no significant differences existing across the three sectors.

(a) Prime Contractors and Second Tier Suppliers

Of the contingent factors which characterize the defence market environment the most significant ones shaping the sales and marketing capabilities were the structure of the market, the nature of competition, and the particular way in which demand is identified. Firstly, the monopsonistic-oligopolistic structure of the top tier of these industries both endows the main customer (domestic government) with a large amount of power to define the contract relationship and requires the prime contractors to have a very direct and close relationship with it, thus resulting in the prime contractors developing very particular sales and marketing capabilities. Secondly, both the 'all or nothing' nature of competition and the fact that competition occurs prior to the design and manufacture of the end product, also affects the nature of the prime contractors' sales and marketing capabilities. Finally, the fact that demand emanates from a small number of easily identifiable customers who define their requirements explicitly results in the 'needs' of these markets, and the level of demand being easily identified, which therefore affects the type of marketing required.

Due to this last point there is no requirement for speculative market research aimed at identifying the potential level of demand or the potential requirements of customers. The monopsonistic structure of these markets also means that customers have the power to control the contract relationship, defining the way in which contracts are awarded, the desired technical requirements and the

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99The second tier suppliers considered are only those from the aerospace and electronics sector. The second tier of the vehicle sector is considered to be equivalent to the third tier of these sectors, and is included in the following section.
level of demand. Most of this information is publicly available and is stated explicitly by the customer, therefore sales and marketing for prime contractors consists of determining the timing and requirements of potential future competitions and lobbying customers for the award of these contracts (Gansler 1991, Berkovitz 1994). This was the situation in all three sectors, where the prime contractors marketing efforts were focused around competing for specific large contracts. For example, in mid-1996, BAe Dynamics was competing for three major missile contracts with the UK MOD (Morrocco 1996, Gray 1996a), Nortel IN and SPS were both competing for the BOWMAN radio contract and both Vickers and Alvis were competing for a pan-European contract for armoured vehicles (Financial Times 25th June 1996; p7). These contracts were all large, and therefore had significant implications for the future of all these companies, which meant that the competition for these contracts was extremely intense. Another aspect of the prime contractor's sales and marketing capabilities was that all had long term relations with a relatively small number of customers, with whom they had been doing business over extended periods. Thus the vast majority of BAe MAD's business was with less than five governments, while over 95% of Vicker's business since the 1960's has been with only five governments (Table 5.2). The long term nature of the relationship between these companies and their main customers has resulted in very close relations being built between defence companies and both the procurement functions and military services of their customers (Gummett & Reppy 1990). This often resulted in informal personal networks being established between sales staff and government representatives. Thus, a large component of their sales and marketing was concerned with maintaining good relations with existing customers.

At the second tier of the aerospace and electronics sectors there was less direct contact with governments, with the immediate customers of these companies
being the prime contractors. However, the similarities between their relationship with the prime contractors, and the prime contractors relationship with government, were large. For second tier companies, such as Racal Radar, Cossor, GEC and Smiths, sales and marketing were concerned with building and maintaining long term relations with a relatively small amount of powerful customers. Also, again similar to the prime contractors, the level and technical requirements of their customer are also defined for them, thus eliminating the need to do speculative market research. Thus even though they are dealing with a different customer, and have fewer direct relations with the national government, their sales and marketing capabilities were similar to those of the prime contractors.

Of the three categories of organizational capabilities examined, sales and marketing were the most specific to defence markets, with very little relevance to any other market environment. This was illustrated by the case of Land Rover, where the only organizational function divided into specific military and commercial departments was sales and marketing. Even though the products being sold to their military customers were largely based on their commercial products, and could be manufactured using their commercial facilities, they had a separate sales and marketing department for their military business. This was due to the extremely different structure of these markets, thus requiring very different sales and marketing capabilities. In a number of diversification studies (Gilmore & Coddington 1966, NEDC 1991, Schofield et al 1992) it was concluded that one of the main limitations to diversification faced by large defence companies was the unsuitability of their sales and marketing practices to commercial markets, which is a conclusion supported by the findings of this research. The unique aspects of these markets were the particular nature of the customer supplier relationship, and the dominant role that governments play in these markets, which will be explored more fully later.
(b) Component Suppliers

As outlined above, the market environment at this tier was very different from that of higher tiers in defence markets, although its character was similar in all three sectors considered. These differences changed the nature of the company-customer relationship thus resulting in companies at this level of the industry possessing very different sales and marketing capabilities from the prime contractors and second tier suppliers. At this level of the industry the number of competitors was larger, producing greater levels of competition, and the number of potential customers was also greater, so there was no single dominant customer with a position as powerful as that of government at the top tier of the industry. Competition was also different, and did not have the 'all or nothing' character of the top tiers. At the top two tiers of defence markets contracts tended to be extremely large in size, but few in number, whereas for component suppliers there was a much greater number of potential customers and a greater number of contracts to compete for. These market characteristics were the main factor shaping the sales and marketing capabilities of companies in the supply base.

While the number of potential customers was large for the component suppliers, in reality, the vast majority were dependent on a relatively small number of customers for most of their business. This was the case in all three sectors, with most component suppliers having approximately 60-70% of their business with only four or five customers. Customer relations tended to be long term, often extending over decades, with most component suppliers winning

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100 This refers to companies in the second tier of the vehicle sector, and the third tier in the aerospace and electronics sectors.
101 In defence markets their potential customer base included all first and second tier companies, but most had business in other sectors as well, which further increased their actual and potential customer base.
repeat contracts with the same constant small group of customers. For these companies, sales and marketing activities were primarily concerned with building and maintaining contacts with existing customers. This was achieved by either personally visiting or telephoning their customers on a regular basis. Due to the pyramidal structure of the markets these companies competed in, which was typical for their defence and non-defence business, identifying customers was not a problem, as they tended to be large industrial enterprises. This, combined with the stability in their customer base, meant that the companies examined had not developed pro-active, speculative marketing capabilities, as they had never been necessary in the type of markets they operated in. Another factor affecting the relationship between component suppliers and their customers was the large disparity in size. Typically most component suppliers were small enterprises with less than 250 employees and annual turnovers of less than £10 million, while their customers were much larger corporate enterprises.

The disparity in size between the suppliers and their customers, combined with their dependence on a small number of these corporate customers for the majority of their business endowed these large corporate customers with the power to control the contract relationship, which is typical for all markets with a similar structure (Bresnen 1996; p127, Stinchcombe 1990). This was significant as six of the 13 large companies examined (table 7.2) had introduced changes to the way they managed their supply base, which changed the relationship between these companies and their suppliers. Even those large companies which had not substantively changed their sub-contracting practices had still put greater cost pressures on their suppliers. The large dependence that the

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102 In approximately half of the companies examined from the supply base, senior managers had built up personal friendships with staff from their customers.

103 The supply base surveys conducted in both the electronics and vehicles sectors found that more than 75% of the companies who returned the questionnaire had less than 250 employees.
component suppliers had on these companies meant that they had little power to resist or influence these changes.

The main changes in sub-contract relations introduced by the large defence companies, as outlined earlier, were to substantially reduce the size of their supply base and to put a greater emphasis on cost when awarding contracts. While the benefits of adopting JIT inventory control systems are argued to be in providing companies with greater quality control and higher levels of flexibility, as was found in commercial industry when these systems were adopted, the main motivation was to pass risk and cost down to their suppliers (Rainnie 1991; p356). The adoption of JIT and preferred supplier schemes was intended to transform contract relations from being conflictual to supportive and concensual, as under these systems the interests of both companies have greater commonality, resulting in a more trust based relationship (Baxter et al 1989). However, from the sub-contractors examined, this was not the case, with contract relations still being conflictual, with cost rather than quality, reliability or flexibility still being the most important factor in the allocation of contracts.104 Thus contract relations between the large defence companies and the component suppliers examined had not fundamentally changed. The only major difference experienced by the suppliers was a greater pressure on cost when competing for contacts. The adoption of different sub-contract relations by the largest defence companies has therefore not required the suppliers to substantially modify their sales and marketing practices, but it did require them to reduce their operating costs.

Virtually all of the companies from the supply base examined had a large dependence on a small number of important customers, which was the primary factor shaping their sales and marketing capabilities. However, these

104 Imrie & Morris (1992; p644) reached similar conclusion from research in other industrial sectors.
capabilities were not specific to defence markets alone, as there are commercial markets with similar structures, where the market power and dominance of the largest companies influences customer relations at all levels of the industry. Two other industries which are similar, and where the sales and marketing capabilities required by suppliers are largely similar are the car and commercial aircraft industries (Tighe 1996, Moreland 1993, Thompson & McHugh 1995; p64). At the level of component suppliers, the characteristics of defence markets were not as distinctive and unique as at the higher tiers, therefore operating at this level in defence markets does not require capabilities specific to defence markets alone. Thus component suppliers generally possess organizational capabilities which are more broadly relevant beyond defence markets than the prime contractors or second tier suppliers. This was certainly the case in terms of their sales and marketing capabilities.

7.3.4 Technological Capabilities

While the technological capabilities of companies encompass more than the artefacts they produce, the focus in this section will be on their products alone.\textsuperscript{105} Focusing on three main themes it will show how the market and technological environment in defence procurement has shaped the characteristics of military equipment. Firstly, the very distinct character of military products will be shown to be the result of a particular technical trajectory which had predominated in these markets since the Second World War. Secondly, a sectoral comparison of the relationship between technical change in military and non-military markets will show that the interplay between these environments varies greatly between sectors. Finally a comparison of the

\textsuperscript{105} Other aspects of the technological capabilities of the companies examined have been covered in the sections on their system and manufacturing capabilities.
artefacts produced at each tier will show that the lower a company’s position in the product hierarchy, the less likely its products are to being specific to military requirements only.

(a) The Cold War Trajectory of Technological Development

The products of all the first and second tier companies examined were specific in nature with very limited, if any, applicability to non-defence markets. In all of these companies military and civil products were designed and developed separately, and possessed very different technical characteristics. In virtually every case these products were fundamentally different in terms of their size, weight, cost, range of technical functions performed or level of technical performance. As one interviewee said, ‘you can never take a military system and .... sell it as a commercial system.’ The only significant exception to this was in the area of communications products, where the overlap between military and non-military systems was extensive (see later). The very specific character of military products is due to both the unique conditions this equipment must be designed to operate in and the trajectory of technological development which has operated continuously since World War Two (see chapter 2 for details of this trajectory).

Detailed studies of technical change in military equipment has shown that this trajectory was shaped by particular social, political and economic factors as much as technological ones (MacKenzie 1990, Enserink 1993, Elzen et al 1996). While technological constraints do limit the opportunities for technical

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106 In a number of the companies examined, for example BAe, SPS, GEC and Smiths Industries, military and civil business was separated into distinct operating units, organizationally remote from each other.

107 Dosi (1982) and Sahal (1981) both studied the long term evolution of a wide range of products and concluded that processes of technical change developed an inherent momentum or logic, which explained why persistent patterns of technical change had occurred.
change social choices still exist, which are equally as important in shaping the direction of technical development (MacKenzie 1992, Grin 1990). In the design and production of defence equipment choices were found to exist at four different levels, where political, economic and social factors all shaped the broad technological priorities being addressed and defined the specific technical requirements of weapons systems. These four levels are;

(i) Definition of Broad Defence Strategy
(ii) Particular Defence Policies adopted to fulfill defence strategy
(iii) Competition between different technical systems
(iv) development and production of particular equipment systems

Beginning with level (i), two major commitments in the UK during the Cold War period (see chapter 3) shaped the technological environment of defence markets. Firstly there was a commitment to maintain a broad range of industrial capabilities including the ability to design and manufacture aircraft, tanks, electronic systems and missiles. Secondly, it also pursued a strategy where military advantage was based on technical superiority. Both these commitments played an important role shaping the defence procurement environment and were the result of particular political and economic choices. Both these commitments affected the companies examined, with the commitment to retain capabilities resulting in them being provided with adequate levels of work to sustain themselves. The commitment to a trajectory of technical development was also shown to shape the technical character of their products in very specific ways. Level (ii) is where these defence commitments are turned into

108 Contemporary sociological approaches to the study of technical change attempt to overcome the limitations of previous models of weapons development dynamics (for example the bureaucratic politics or technical imperative model) by considering the role of both technical and social factors without a priori privileging either as being more important. See for example Spinardi (1994) MacKenzie (1990) and Elzen et al (1990,1996).
particular defence policies, where again important choices shaped the technological environment. At this level choices exist over the way in which defence strategy is to be carried out, the balance of force levels and the range and type of equipment required. In the UK defence policy has been shaped by a commitment to NATO, requiring it to possess large land and air force capabilities, which has been an important factor behind the development of the UK’s fleet of tanks and aircraft.

Level (iii) represents the competition which occurs when procurement contracts are specified, which is the most visible level at which choice exists. Detailed studies of specific procurement decisions such as for the TSR2 aircraft (Law & Callon 1992) or EFA radar contract (Elzen et al 1990, 1996) as well as the contemporary cases outlined previously, show the heterogeneous networks of institutions involved in these decisions where the lobbying of government by industry is at its most intense. During these processes, even though detailed technical specifications are outlined, the characteristics of weapons systems are not fixed, and are open to negotiation and change as part of the competitive process. Therefore, the particular choices pursued at this level also have implications for the technical characteristics of weapons systems. The final stage at which choice occurs is during the development process, after one company has won a procurement contact. By this stage, the shape and technical characteristics of equipment are largely fixed, but if there are technical problems during development, or fiscal crises within government projects can be cancelled, the number of systems bought could be changed, or the technical specification may be modified. Therefore, even at this level in the equipment development process the final form of weapons systems are open to change.109

109 A good example of change and choice at this level is provided by the EFA (Elzen et al 1996). Since development began on this project there have been a number of changes in the technical performance requirements and the number of systems to be bought. For example, Germany pushed to have its specification downgraded in order to reduce the cost of development, resulting in the EFA being renamed
One of the most important ways in which the capabilities of the organizations examined were shaped by these factors was in the particular way that equipment procurement was managed. Thus, prior to the Levene reforms the lack of emphasis on cost control resulted in them having poorly developed organizational systems to control and minimize their costs. The greater focus on cost control which followed these reforms also required the companies examined to adjust their operating practices, which was illustrated very vividly with relation to their manufacturing systems.

At all four levels particular choices are made which influence the technical characteristics of military equipment. The political, economic and technical priorities which predominate within this environment are very particular and result in these systems generally having little relevance to other non-defence applications.

As outlined above, the very specific character of military equipment, which was the case for the prime contractors in all three sectors examined, was also the result of the unique operating requirements of the defence environment. These requirements, where equipment must be designed to be rugged, withstand extremes of vibration, temperature and humidity places further technical requirements on weapons systems, which are unnecessary for operation in more benign commercial operating environments. Harbor (1991) found that during the development of the System X radio system the military requirement for ruggedness and portability shaped the design in ways which made the equipment totally unsuited to non-defence operating environments. Similarly, Rice & Sammes (1989) show how the extreme demands of the battlefield...

\[ \text{EFA 2000. The number of systems to be bought have also been revised, dropping from initial estimates of over 800 systems to approximately 500.} \]
environment produce very particular design requirements, which result in military equipment have very particular technical characteristics. For example, they show how battlefield temperature and screening requirements make the use of standard electrical cabling impossible, requiring the use of specifically designed cable.

Both the unique requirements of the military operating environment and the extremely particular technological priorities pursued therefore combine to result in weapons systems having very little relevance to non-defence operating environments. However, the degree of synergy between military and civil products was not constant, varying greatly between sectors, which is the next issue to be addressed.

(b) The Relations between military and civil products and technologies\textsuperscript{110} - a sectoral comparison

In each of the sectors examined the relationship between developments in the military environment with products and general technical developments in non-defence markets varied substantially. Therefore the source and rate of technical innovation varied greatly between sectors. For the vehicle and aerospace sector, at the top tier of the product hierarchy, there was little synergy between the military and commercial sectors, with the companies, markets and products in these sectors being separate and distinct. In both of these sectors the

\textsuperscript{110} While it is possible to identify specific military and commercial products distinguishing between military and civil technologies is more difficult (but not always impossible). While technologies are not a priori military or civil (Smit 1995; p627), it is still possible to see how military or civil priorities have shaped the direction in which technologies are developed. For example, MacKenzie (1990) showed how the technical requirements of nuclear missile guidance systems resulted in a trajectory of increased accuracy being pursued. Similarly, the influence of military priorities visibly shaped the development of transistor technology in the 1950's along a trajectory of improving technical performance at virtually any cost (Misa 1985, DeGrasse 1984).
characteristics of military and non-military products, and the trajectory of technological development were very different. For example, at the level of complete systems, technical developments in the civil sector had little relevance or impact on the companies examined. In aerospace markets the military and commercial sectors were populated by distinct and separate divisions,\textsuperscript{111} had products with very different technical performance characteristics and pursued distinctly different trajectories of technical development.\textsuperscript{112} In the electronics sector, while the performance characteristics of military and commercial products varied the overall level of synergy and overlap between companies and technical developments was much greater than in the vehicle or aerospace sectors. This was not always the case, and is a relatively recent change, resulting from the rapid expansion which occurred in commercial electronics markets since approximately the late 1970's (Chapter 6). As will be seen, this overlap was particularly noticeable in the area of telecommunications. These differences were significant, as they affected the source and direction of technical change in military markets while also influencing the ability of companies to diversify.

In vehicle and aerospace markets, the separation between the military and civil sectors meant that, at the top of the product hierarchy, the source of technical change in the military sector was internal. Thus technical developments in the commercial vehicle and aerospace sectors have little impact or influence. In electronics markets, however, technical innovations in the commercial sector have had an impact on the development of military equipment. The large technological developments which occurred in commercial electronics during

\textsuperscript{111}While most aerospace companies, including BAe, Aerospatiale and Daimler Benz, are involved in both military and commercial markets these activities are managed within separate businesses which have little interaction or overlap.

\textsuperscript{112}In the military aerospace sector technical development efforts are focused on improving speed, agility, radar invisibility, while the dominant technical issues in the commercial environment are focused round safety, comfort, reliability and cost.
the 1980's had a significant impact in the military sector (Molas 1994, Molas & Walker 1992, Lock 1995). The growth in commercial electronics during this period, particularly in the information technology, communications and computing sectors, was so significant that the rate of technical development was extremely rapid. This reduced the difference in the technical standards between the military and commercial sectors so extensively that it became possible to use a wide range of commercial products in military equipment. Historically this had not been possible as the technical requirements placed on military equipment had traditionally exceeded the technical standards common in commercial markets (Todd 1990). It was this rapid development in commercial electronics which made it possible in the 1980's for a company such as Northern Telecom, which had no prior experience of defence markets, to enter and successfully compete in the military environment (see chapter 6).

These sectoral patterns of technical change (Pavitt 1984) are likely to continue into the foreseeable future. In electronics, the commercial sector is likely to remain at the forefront of technical development as the levels of investment there are higher and the life cycle of innovation shorter than in military markets (Lock 1995, Molas & Walker 1992). While the growth and technological development of commercial electronics are likely to result in a greater proportion of standard commercial components being used in the military vehicle and aerospace sectors the separation between military and commercial markets at the system level is likely to remain as the technical requirements of products are so different in the military and commercial environment. This lack of synergy at the system level will reduce the diversification opportunities of the vehicle and aerospace prime contractors as their products are much less relevant to technical requirements of commercial markets than the products of the electronics sector prime contractors (Dussauge 1987).
(c) The product hierarchy and product specificity

As outlined previously the character of products vary greatly between the different tiers of the product hierarchy. At the lowest tiers the products are typically individual components such as electrical connectors, micro-electronic devices or vehicle engine parts. As the hierarchy is ascended the products become more systemic in nature, consisting of complex assemblies of varying size and scale. Thus, at the top of the product hierarchy complete equipment platforms such as tanks, aircraft or communications networks can be considered as complex systems as they involve the integration of a massive range of components and sub-systems (Walker et al 1992, Schofield 1992). Making general statements about the nature of the products at each tier is difficult, particularly at the lower tiers as the range and type of components is wide. However it was found that the higher a company’s position in the product hierarchy, the more specific and limited in nature its products will be (Smit 1995; p623, Walker et al 1988; p29). Thus complete equipment platforms, at the apex of the product hierarchy are uniquely relevant to the very specific environment they have been designed for. In the case of Vickers, for example, the Challenger 2 tank is a product with extremely limited and specific applicability. Conversely, at component level products were more generic and relevant to a wider range of environments. For example, the products sold to their defence customers by the suppliers examined (such as Hypertac with its connectors or Spectrum Hose and their hydraulic hose assemblies) were also sold in other markets. Thus at this level in defence markets, as seen from the supply base surveys and interviews, companies are likely to be less dependent on defence markets, as their products are relevant to a wider range of environments. The only exception to this at the supply base comes from companies producing custom designed components (Walker et al 1988). Even though these companies are operating at the lower tiers of defence markets their products are
specially designed and built to the specific requirements of their defence customers. Thus the supply base can be crudely divided into two categories of company, those producing specific, custom designed items and those producing more generic items, with the second type being by far the most common.

This section brought together and compared the empirical findings on the character of organizational capabilities from all three sectors. This showed how the capabilities of all the companies examined were related to the character of their market and technological environment. The significant differences in the character of the operating environment in each sector resulted in their being sectoral differences in the capabilities of the companies examined. Thus, for example, while the broad character of the prime contractor's capabilities in each sector had many similarities there were also distinct sectoral differences in them due largely to the differences which existed in their market and technological environments.
7.4 Evolutionary Economics, Organizational Capabilities and the Operating Environment

The focus of the chapter now shifts to a more theoretical perspective, as the research findings are related directly to a number of the ideas developed in evolutionary economics.

Evolutionary economics is extremely relevant to this research as it is fundamentally concerned with the relationship between organizations and their environment. As a body of theory it was developed as a challenge to neoclassical economics, which was argued to be based on a number of flawed assumptions concerning market and organizational behaviour (see chapter 2 for details). This section will relate the empirical findings on the relationship between the companies examined and their environment (see section 7.3) with the arguments and ideas proposed by evolutionary economics. The capabilities possessed by the companies examined were shown to be closely related to the characteristics of their external environment, which supports certain aspects of the model of organizational-environment relations suggested by evolutionary economics. However, its assumption that organizations are separate and independent from, rather than being integral to, their environment, which has important implications for the relationship between the two, was not supported. The section is structured such that each of these arguments is developed separately.

7.4.1 Organizational Capabilities and the environment

One of the central ideas in evolutionary economics is that organizational capabilities and behaviour evolve incrementally through interaction with their
external selection environment\textsuperscript{113} (Blauwhof 1995; p101-2). That change tends to be incremental is due to two main factors. Firstly, the neo-classical assumption that firms are continually searching for ways to maximize their economic performance is challenged. Rather, organizations, under normal conditions, follow routines and patterns which have been shaped by past experience, as long as this provides \textit{satisfactory} economic performance (Nelson & Winter 1982; Ch5). Thus organizational behaviour tends to be limited within a range of established and accepted practices, which constrain the options for change immediately open to an organization (Metcalfe & Boden 1992; p54). The second factor which limits change is the inherent uncertainty which exists when implementing change, which tends to increase the more significant the change undertaken (Coombs et al 1987; p115, Nelson & Winter 1982; Ch5).\textsuperscript{114} Freeman (1982) also acknowledged that organizational and technical change unavoidably involved uncertainty, categorizing uncertainty into three main categories; market, technical and business. However, the type and level of uncertainty varies greatly between market sectors dependent upon the character of the selection environment. For example, if an organization is selling products to a diffuse mass market the level and type of uncertainty will be different than if it was selling to a market with a smaller number of larger customers. The assumed relationship between the character of the selection environment and the capabilities possessed by an organization results in the selection environment being a critical factor shaping the nature of an organizations' capabilities.

\textsuperscript{113}Nelson and Winter's definition of selection environment refers narrowly to the market, technological and regulatory environment of an organization and not to a broader definition including factors such as labour market characteristics or labour relations (1982; p262-266). This definition, however, encompasses all the environmental dimensions being considered in this research project.

\textsuperscript{114} Two examples of uncertainty were that the full character of any change implemented could not be known in advance, as the process of implementation will result in modifications being made to the change undertaken. The second example of uncertainty occurs in the market place, where the reaction of competitors and customer to any change can never be fully anticipated.
These ideas were supported by the research in two main ways. Firstly the capabilities of the companies examined did reflect the character of their selection environment, with large differences existing in the character of the selection environment at each tier. Secondly, the organizational changes implemented since the end of the Cold War also largely reflected the changes which had occurred in the selection environment.

Prior to the end of the Cold War defence markets had very distinctive characteristics and priorities which were reflected in the capabilities and behaviour of the companies operating in this environment. In evolutionary economics competition is one of the most important elements of the selection environment (Metcalfe & Boden 1992; p51), as it is through competition that a companies' 'routines are exposed to the selection pressures of the environment' (van den Belt & Rip 1988; p137). From the large companies interviewed it was apparent that effective competition in Cold War defence markets was limited, and took a very particular form, where the emphasis was on technical innovation rather than equipment cost. The lack of competition was also due to the pyramidal structure of these markets, where the number of competitors for the prime contractorship of contracts was limited. The character of competition was the most distinguishing element of the Cold War selection environment and was the single most important factor influencing the capabilities and internal operating practices developed by the companies examined. The lack of effective competitive pressure on operating and equipment costs, as illustrated above and in the empirical chapters, affected all aspects of company organization. Firstly, in their internal operating systems, whether for organizing manufacturing, controlling quality, project management or managing their sub-contract relations cost control mechanisms were under-developed. This resulted in the development of operating practices which were relatively inefficient at controlling or reducing costs ultimately producing an over-capacity in labour and
capital resources. The peculiar nature of competition, combined with the monopsonistic-oligopolistic market structure also resulted in these companies developing very specific sales and marketing capabilities. The relatively benign nature of this environment, combined with the extended period over which these priorities predominated resulted in these systems and priorities becoming routinized, and to some extent ossified (Kaldor 1983). During the Cold War period therefore no radical changes were made to internal operating practices, with any changes being incremental and small scale, the result of which was the over-capacity and cost inefficiencies described above. Thus the characteristics of their selection environment had a very definite effect on the capabilities developed by the companies examined.

Similarly at the lowest tier of defence markets where individual components are produced the capabilities of the companies examined were shaped by the character of their selection environment. However, the selection environment at this level in defence markets, as shown, was very different from that at the top tiers. At this level the market structure was not oligopolistic, with a greater number of competitors each having little market power. Buyer-supplier relations were also shown to be different, with the component suppliers having relatively little power to control or influence the terms of competition. At this level competition was also greater and was more focused on cost. All these characteristics were reflected in the capabilities of the component suppliers examined, therefore confirming the closeness of the relationship which exists between organizational capabilities and environmental characteristics.

This relationship was further confirmed by the organizational changes implemented by all the companies examined in the post Cold War period, which closely mirrored the changing priorities which occurred in their selection environment. Between the mid-1980's and 1990's there was a significant
increase in the prioritization of cost management in the UK’s defence procurement environment due to both the Levene reforms and the absolute reduction in demand for equipment which occurred following the end of the Cold War. These changes represented a significant break from the traditional Cold War market priorities described above. The response to these changes in the selection environment by all the large companies examined was to modify their internal operating practices in order to both reduce their operating costs and introduce stricter cost management practices. In many of the companies examined this was primarily achieved through 'downsizing', where employment levels were drastically reduced. Thus the changes introduced largely reflected the character of change occurring in the selection environment. However, due to both the pace at which these changes were introduced and the extent of the changes, the internal re-organization undertaken cannot be described as incremental in nature. In many of the companies examined, for example BAe's Military Aircraft and Dynamics divisions, Shorts Missile Systems or Alvis Vehicles some relatively fundamental changes in operating practices were introduced within a relatively short time period. This does not however challenge the assumption in evolutionary economics that organizational change in general tends to be incremental in nature. This was because the period during which these changes were implemented, was one characterized by rapid and fundamental change and great uncertainty, which was untypical of these markets and which the companies examined had never experienced before.

7.4.2 Organization-Environment Relations

In evolutionary economics there is an inherent assumption that the selection environment is independent of and separate from organizations and that the relationship is primarily uni-directional, with the environment having 'effects' on organizations (Schot 1992, Belt & Rip 1988). Neither of these assumptions were
supported by the empirical evidence, where the companies examined, particularly the prime contractors and large sub-contractors, themselves constituted an important component of their environment. Thus, rather than being independent from it, they represent a fundamental part of it. Due to the considerable economic power of many of these companies, they were able to exert an influence on the shape and character of their environment. Organizations, particularly large economically powerful ones, therefore have the ability to partially shape their environment (Mercer 1994).\textsuperscript{115} Schot (1992; p188) argues this influence can only be partial, as there will always be a 'hard, structured' element to the selection environment which constrains the degree of influence individual organizations can exert,\textsuperscript{116} which was the case for the environments studied. While the companies examined were able to partially influence the character of their operating environment they did not possess the ability to fundamentally transform it. In defence markets the influence of the largest companies on the selection environment was exerted through their relationship with government and through changing the supply sided character of their markets by mergers and acquisitions. The most visible signs of this organizational pressure occur during the lobbying of government for the award of particular contracts or through attempts to modify and change contract procurement rules. For example, when Vickers was competing for the Challenger 2 tank contract it used a large amount of political lobbying to persuade the UK government of its case. This involved commissioning a report on the industrial consequences of the contract not being awarded to them (Hartley & Hooper 1990) and included an extensive amount of political lobbying (Adams 1990; chs9-11).

\textsuperscript{115} This 'manipulation' of social, political and economic as well as technological factors has been termed heterogeneous engineering due to the diverse range of interest group this requires organizations to interact with (Law 1987, Sorensen & Levold 1992).

\textsuperscript{116} Schot used the term quasi-evolutionary economics to describe this variation on evolutionary economics.
The case of GEC can be used to illustrate the ability of large companies to reshape their environment through mergers and acquisitions. Of all the companies examined it was one of the most active in such activities. Thus the acquisition of Ferranti, the joint acquisition of Plessey and its acquisition of VSEL all illustrate GEC’s efforts in this regard.

Conclusion - Organization Capabilities and the Operating Environment
The empirical evidence presented shows that the organizational capabilities of all the companies examined were shaped to a large extent by the character of their selection environment. This was illustrated by showing how the technological and market characteristics of the defence procurement environment shaped the organizational and technical capabilities of the companies examined. The lack of emphasis on controlling equipment costs, which was a priority which predominated in defence markets throughout the Cold War period, resulted in the development of organizational practices which did not effectively control or reduce operating and equipment costs. The technical requirements of system integration which existed at the top tiers of these markets were also shown to be a significant factor shaping the capabilities of the companies examined. This relationship was further reinforced when it was shown that the organizational changes introduced in the 1990’s by the majority of the companies examined closely reflected the greater emphasis on cost control which had developed in these markets from the mid-1980’s onwards.
7.5 Strategy and Environment

In this section the focus of analysis is shifted to the strategies pursued by the companies examined. The largest part of the section will show the ways in which the strategies of the companies examined were constrained by various environmental factors, limiting the degree of strategic choice they possessed. While the capabilities of the companies examined have been shown to be specific and limited in nature, being shaped by the character of their operating environment these were not the only environmental factors shaping their strategy.

From the interviews conducted two other major factors were found which constrained the strategic behaviour of the companies examined, each of which was as significant a constraint as the nature of their capabilities. This will be done in two major sub-sections. Firstly sub-section 7.5.2 considers the way in which the policies adopted by the UK government acted as a constraint on the strategies of the companies examined. Due to the powerful influence of government in these markets, the policies adopted by the UK government have been a major factor shaping the selection environment and constraining the strategic opportunities open to industry. For example, the lack of support for diversification policies by the UK government was an important factor partly explaining why none of the companies examined had attempted to diversify organically. Secondly, in sub-section 7.5.3 the relationship between the companies examined and their corporate owners is examined. All of the large companies examined, and a few of the smaller ones, were divisions of larger corporate groups, thus the strategies adopted by the divisions examined were shaped by the broad strategy of their corporate owners. These factors were equally as important as other environmental constraints in shaping the exact form that their strategies took, with the short term economic focus of their
corporate owners, for example, being an important factor shaping the strategies pursued by the companies examined.

While the environmental constraints were extremely significant in shaping the strategies of the companies examined it will be argued that they still possess an element of discretion to pursue particular strategic goals. It is concluded that the environmental determinism of contingency theory supports too deterministic a model of organizational behaviour, which inadequately acknowledges the elements of choice available to organizations, however constrained, in controlling their strategy. These ideas however will be addressed in section 7.6, once the constraints imposed on the organizations examined by the UK government and their corporate owners are considered. Before all of this a brief summary of the strategies adopted by all the large companies examined will be given in sub-section 7.5.1.

**Capabilities as a Constraint on Strategy**

The previous section, and all three empirical chapters, showed in detail how the capabilities of the companies examined were closely related to the character of their selection environment. Both the technological and market characteristics of the defence procurement environment resulted in the companies examined possessing capabilities which were of limited general relevance. The closeness of the relationship between the character of an organization's capabilities and the nature of its operating environment was such that they had only limited relevance to operating environments with different characteristics. For example the technical requirements of being a prime contractor were onerous, which resulted in design and manufacturing systems which were relevant to an extremely limited range of other environments. Similarly, the particular nature of customer relations, especially at the higher tiers of defence markets resulted in sales and marketing capabilities which were also of limited relevance to other
markets. Thus the specific character of these capabilities acted as a constraint on the strategic freedom of the companies examined to enter and compete in other markets. Their capabilities were therefore only applicable to operating environments with broadly similar characteristics. This has implications for the ability of the organizations examined to diversify organically as for most of the companies examined this would require a substantial degree of change.

While it is difficult to make general statements on the character of companies in the supply base due to the diversity of company types which operate at this level, their capabilities were more generic than those of the prime contractors. The fact that the primes had the most specific capabilities meant that organic diversification for them would be extremely difficult. For the prime contractors and second tier suppliers the character of their capabilities restricted them to operating environments with the following broad characteristics and requirements; monopsonistic markets where customers are easily identifiable and few in number; markets with low volumes of demand, where the requirement is for the production of low volumes of goods; the design and development of complex technical systems involving the integration of large numbers of components and sub-assemblies. The range of markets where all of these characteristics are required is extremely limited, therefore the specific nature of their capabilities was a major constraint on the strategic freedom of these companies.

The above, combined with a number of other factors, tend to make substantial change difficult for any organization. This can be explained by making comparisons with research on the nature of technical change within organizations. This research shows that as well as the technological knowledge possessed by organizations being specific in nature (Pavitt 1984, 1987; Faulkner & Senker 1995; Dosi 1988) that this knowledge is also developed
cumulatively, being built up over time in relatively small incremental steps (Rosenberg 1982, Sahal 1981, Gilfillan 1935). If these ideas are extended to cover all aspects of organizational capabilities then organizational change of any form therefore tends to be incremental in nature.

These findings, combined with the uncertainty inherent in organizational change (see section 7.4, and 7.6.1a) and the resistance to change which can occur when radical change is implemented within any organization (see section 7.6.1b) make radical organizational change difficult to successfully achieve. Therefore due to the specificity of the capabilities possessed by the prime contractors organic diversification would require the implementation of radical organizational change and would therefore be a high risk strategy for these companies. However, as outlined, this is not the only factor which explains the lack of attempts by the prime contractors to diversify. Equally as significant in explaining this absence were the role of the UK government and the corporate owners of the companies examined, both of which acted in ways likely to inhibit diversification strategies being adopted. Thus, these are the two issues which the remains of this chapter focuses on.

7.5.1 Supply Side Changes in the UK’s defence Markets - Industrial strategies

The strategies adopted by the companies in the top two tiers of all three industrial sectors examined were, in general terms, remarkably similar. Surprisingly, given the decline in business levels, the substantial uncertainty over contracts and the reductions in employment, none of the divisions examined attempted to diversify out of defence markets to any significant extent. Instead their strategies were focused on remaining within defence markets, and restructuring their businesses to the changes which had occurred in these markets. This was achieved in two main ways. Firstly, the vast majority
were involved in, or affected by, some form of corporate restructuring, with Europe's defence markets going through a period of substantial concentration. Secondly, in virtually every case some form of internal restructuring and 'downsizing' was also undertaken, although the form this took varied greatly. Further, the financial performance of the vast majority examined was healthy, however, this will be shown to reflect the particular performance priorities adopted.

In the aerospace and electronics sectors the decade following the mid-1980's was a period of significant concentration (Smith 1990). By the late 1980's Walker & Gummett (1989) identified the 'triangular cartelization' of Europe's defence industries involving the largest defence companies in France, Germany and the UK. The further concentration which occurred in the early 1990's only served to reinforce this situation (Walker & Willett 1993). However there was a noticeable difference between the two sectors in the level of concentration achieved and the methods used to do so. The electronics sector experienced the most substantial concentration, noticeable by the fact that every electronics company examined either acquired other businesses or undertook some form of ownership change. In the aerospace sector on the other hand, at the level of prime contracting, there was less in the way of permanent mergers and more temporary, project bases alliances such as on EFA, the EH101 helicopter or BAe's production and marketing agreement with Saab (Shifrin 1995b). However, the 1996 cuts in French military procurement (Sparaco 1996a), may prompt more permanent mergers to be made, with Dassault and Aerospatiale likely to merge (Covault 1996). The vehicle sector was the only market examined where

117 As well as an increase in concentration through permanent mergers and acquisitions the 1980's saw a large increase in the number of strategic alliances undertaken on a contract by contract basis. In a study on strategic alliances undertaken in the defence and aerospace sector between 1950-90 almost 70% had occurred in the 1980’s (Dussauge & Garrette 1993; p50)
118 The three corners of the triangle were BAE and GEC in the UK, Aerospatiale and Thomson-CSF in France and Daimler Benz in Germany.
there had been little corporate restructuring and which was still relatively fragmented.

The second similarity across the companies examined was that the vast majority undertook some form of internal restructuring, usually accompanied by a shrinkage in their workforce. Of the 13 companies examined in the top two tiers, 11 had undertaken significant internal restructuring, and in nine there had been a reduction in total workforce levels of over 10% (Table 7.2). However, as was shown in the empirical chapters, the particular form that the reorganization took varied greatly between companies. For example; in Siemens Plessey the reorganization was primarily restricted to the introduction of new project and cost management systems; in Shorts Missiles the emphasis was on manufacturing, with a completely new manufacturing site being built; in Alvis there was a general downsizing of the whole company and the redesign of it's manufacturing facility; and in BAe's Military Aircraft and Dynamics Divisions there was a large reduction in employment levels accompanied by the modification of manufacturing and project management systems.
Table 7.2: Major Changes in Companies Examined, 1990-95

What was apparent though was that the shift in procurement to fixed price contracts had resulted in every company experiencing a noticeable increase in the emphasis placed on issues of technical risk and cost management, which was one of the motivations for the internal changes introduced. The similarity in the strategies pursued by the companies examined suggests that either the
degree of autonomy and choice open to organizations was limited or that all the firms examined had independently decided to pursue the same strategies. This relates to the degree of 'strategic choice' (Child 1972) companies possess and the degree to which their capabilities and strategy are constrained and shaped by external, environmental factors, which is one of the main issues addressed in the research. Ultimately it is concluded that the constraints placed on the companies by the nature of their capabilities, the political-economic environment defined by government, and by their corporate owners result in them having very little autonomy. In most cases the extent of their strategic freedom was limited to controlling the exact way in which corporately defined strategies were implemented. These arguments will be developed more fully in section 7.6

7.5.2 Government-Industry Relations and Environmental constraints

The focus in this section is on the experiences of companies from the top two tiers of defence markets, as it is only at these levels that direct government intervention occurs. At the third tier in these markets there was no direct government involvement. While the greatest level of government involvement undoubtedly occurred at the top tier, with the prime contractors, there was also evidence of substantial direct government involvement at the second tier, especially with the largest companies such as GEC.

The level of government involvement at the top tiers of these markets was such that it provided the single largest influence on the prime contractors (Taylor 1992, Dunne & Smith 1992). Much of the UK government's influence in these markets comes from its bargaining power as one of the most important customers. This power is based not only on its ability to allocate contracts, but to also control the basis of which equipment competitions occurs. Its influence in
these markets, however, is also exerted in other, equally significant ways, through its ability to control and support export efforts and through a range of industrial policy mechanisms. In these markets the customer-supplier relationship was very particular, as the prime contractors and large second tier companies also had an element of power to influence customer decisions. This supplier power exists for a number of reasons (HC61/62; pviii). Firstly, the government has interests in supporting domestic companies in order to retain certain indigenous capabilities for the design and production of defence equipment. Secondly, these industries also provide significant levels of employment. Finally, due to the technical sophistication of military equipment the companies in these industries possess high technology capabilities deemed important as a national capability. The power of industry in its relationship with government is most directly exerted through lobbying efforts, attempting to influence the procurement rules on which contracts are awarded, or in support of bids for specific competitions. The relationship between government and defence industry prime contractors is therefore one of mutual dependence.

This section will begin by summarizing the UK government's general policies towards the defence industry between 1985-95, before looking in more detail at the specific ways in which these policies were implemented. Finally a comparison will be made with the policies adopted in France and the USA to illustrate different ways that governments have adapted to the post Cold War environment.

(a) The UK Government's Policy Position

In the decade from 1985-95 the UK government's policies in relation to its domestic defence industry can be summarized as follows. To shed excess fat in the industry spending levels were reduced and a substantially greater emphasis
was placed on controlling and reducing procurement costs (Lovering 1992, Taylor 1992). Despite the government's public position on defence industry restructuring being to leave it to 'market forces' and 'competitive pressures' (HC218, Dunne & Smith 1992), through the allocation of various domestic contracts and in support of export efforts, it acted to maintain capabilities in a number of specific industrial sectors (Lovering 1995). The details of how these policies were implemented, and how they affected the sectors examined, will be detailed below. However, before this it is necessary to comment on the source and quality of data in this area.

The data used in this section was from secondary sources only, as no government representatives were interviewed, with the main sources being from parliamentary reports or the specialized defence press. It was also not possible to obtain detailed data on the financial relationship between government and the individual companies examined as companies were unwilling to provide what was deemed financially sensitive information. In the interviews conducted it was only possible to obtain general, non specific data on company-government relations. Therefore, much of the financial data used, for example on export credit spending, is general in nature and is not dis-aggregated to the level of individual companies. Thus the discussion of these issues is conducted at a general level, only referring to specific companies when the data permits. However, using this type of data it is still possible to establish the extent and character of government-industry relations.

(b) Spending Levels and Domestic Procurement

While the total defence budget in the UK was reduced from 5.6% to 3.9% of GDP between 1985-86 and 1992-93 (Cm2501), spending on defence equipment in 1992-93 still exceeded £10.5 billion (DS 1994; table 1.2). This
therefore gave the government enough economic power to both influence the structure of defence markets and the operation of companies operating within them. The main changes to procurement practices have been outlined above and will not need repeated, except to emphasize the greater focus on cost control which was implemented. This was achieved by increasing the number of competitors for contracts and prioritizing 'value for money' criterion as the deciding factor. While greater cost controls were implemented through an increased use of fixed price contracts, in major procurement decisions, as illustrated previously, procurement decisions were not made on strict value for money grounds. In the Challenger 2 case, for example, the lobbying efforts of Vickers, which emphasized the importance of maintaining industrial capabilities and jobs in the UK, was a significant factor in them winning the contract. Thus, in this and other contracts, the government has not allowed restructuring to occur by the hands off, market led ideology articulated.\footnote{Other examples where procurement appeared to be made on the basis of industrial rather than value for money factors include the EH101 helicopter decision and the Apache helicopter decision.}

The significance of the government's economic power means that its procurement decisions always have implications for the structure of the defence industry in the UK. This can be seen in relation to equipment competitions in each of the three sectors examined. In the aerospace sector the decision on the Nimrod replacement aircraft, a contract worth over £2 billion, was fought over by BAe and GEC, with the award of the contract to BAe preventing GEC from getting into a prime contracting role in the aerospace sector, which was an important decision for the future structure of the sector (\textit{Guardian} 9th July 1996; p1). In the vehicle sector the competitions for three new types of armoured vehicle, worth £3bn in total, have significant implications for the vehicle sector, with all the prime contractors interviewed competing for at least one of these vehicles (Gray 1996d). Similarly, in the missile sector the MoD's
decision on the allocation of three missile contracts will be a significant factor shaping the future structure of this sector (Gray 1996a). Thus in all these cases the UK government has adequate economic power to have a substantial influence on the future structure of these industrial sectors. The significance of these contracts to all the companies competing for them has increased the intensity of the lobbying process, which is one of the most important, and public arenas in which the relationship between industry and government is negotiated, where competing companies use a wide range of arguments to convince the government their bid is the most suitable.

(c) Industrial Policy

As shown, through domestic procurement decisions the UK government has pursued an industrial policy to support certain domestic capabilities, even though its public position was that value for money considerations were more critical. Due to the level of government spending, whether acknowledged or not, all large procurement decisions have implications for industry and can therefore be considered to be a form of industrial policy. Over the decade considered growing pressure has been put on the government to develop a more explicit and coherent industrial policy towards its domestic defence industry. Thus, in 1993 the trade and industry committee recommended that;

'... the MoD's procurement officials be instructed to take into account in their planning and recommendations not only value for money in defence terms but the consequences of their decisions for the long term strength of the UK's defence industries and related industries such as civil aerospace' (HC 563; p42-43)

Similar arguments have also been made by industrial interest groups such as the SBAC and DMA, and by industrial representatives giving evidence to select committee's (HC 333, Financial Times 4th June 1996; p7). At the end of 1995
the defence and trade and industry select committee also made similar recommendations (HC 61/62). From public statements in early 1996 (Morrocco 1996a) it appears the government has accepted the importance of these considerations and will give greater explicit consideration to the industrial implications of its procurement decisions.

As outlined previously, procurement is not the only area where the government has powers of influence. Industrial policies can also be adopted to support (or not) diversification efforts, or in support of exports. The UK government's position in both of these areas will now be examined. As will be seen, promoting and supporting exports has been one of the main methods used by the British government to support defence contractors (Lovering 1992, Taylor 1992).

The UK government's position to defence industry diversification has consistently been that it is the responsibility of industry itself, and not government, to develop strategies for adjusting to reduced levels of defence spending (HC 61/62, HC 218). Therefore, no policies were adopted supporting or encouraging diversification.\(^\text{120}\) This is extremely important, as organic diversification is unlikely to occur without some form of government support.\(^\text{121}\) Such diversification would involve considerable organizational change and adaptation by any company attempting it due to the specific nature of their capabilities and operating practices. Therefore substantial levels of long term investment would be required. Such investment is unlikely to be made by private industry on its own, particularly as the ultimate goal of such a strategy is the

\(^{120}\) Udis (1987) showed that during the 1970's and early 1980's governments in the UK, France, Germany and Sweden had not developed policies in support of diversification, with all taking the position that adjusting to changes in levels of defence spending was the responsibility of industry itself.

\(^{121}\) Diversification here does not refer to corporate diversification, where large corporations acquire non-defence companies to dilute the corporation dependence on defence. Rather, what is referred to is organic diversification, where capabilities and facilities currently used for defence are adapted for other applications.
maintenance of employment levels rather than a narrower economic goal (Quigley 1991). This position was confirmed in all of the large companies interviewed, none of which had pursued organic diversification strategies to any significant extent. In all cases such a strategy was not considered feasible due to the high levels and long term nature of investment required and the risks involved in making such an investment.

In the UK the only organizations supporting an agenda of diversification have been trade unions and local authorities, where the preservation of jobs and industrial capabilities in defence dependent regions was the main issue. However, the awareness of different local authorities of this issue has been variable, with only a few authorities having developed detailed strategies in support of their local defence industries (Quigley & Selby 1994). In those regions where local authorities had developed strategies to combat reductions in defence spending, for example, Fife, Lothian, Lancashire and Wiltshire, policies had been focused on: producing surveys detailing the level of dependency and character of regional defence industries (FRC 1991, WCC 1992, 1993); providing training and support for redundant workers; and setting up small business start up initiatives. Trade union initiatives have either been general campaigns advocating the importance of diversification (IPMS et al 1991) or local campaigns organized to resist cuts and closures in particular locations (for example at VSEL in Barrow and GEC Marconi in Edinburgh). However these campaigns have only succeeded in raising diversification as an issue and have not resulted in diversification efforts being undertaken to any significant extent (Schofield & Davis 1995). In all the large companies examined, without exception, even those which had experienced the largest reductions in workforce levels, the trade unions had not developed diversification initiatives to challenge the strategies pursued by management.
Thus those organizations which were supportive of a diversification agenda were unsuccessful in having it effectively addressed by the largest companies.

(d) Government Policy on the Export of Defence Equipment

The influence of government on the export of defence equipment involves both controlling which countries equipment is sold to and supporting those export efforts which are approved. This section will focus only on the support given to approved export efforts, as this has been one of the main industrial policy mechanisms used by the UK government to support defence companies in a period when it has been cutting its own expenditure levels. This support has been focused on very large contracts such as the two Al Yamamah contracts to Saudi Arabia and is mainly concentrated on a small number of countries including Malaysia, Indonesia and Saudi Arabia. While the absolute level of the UK's defence exports did not increase during the 1990's, fluctuating between £1.5-1.9 billion (Hartley & Hooper 1995; p39) as global arms sales have been declining this represents an increased share of the world's arms export trade. Thus by 1993 UK arms exports accounted for between 16-20% of world arms exports (HC61/62, Cm2270), and by 1995 the UK had become the world's second largest arms exporter, after the USA (Beaver 1996). The export of military equipment is very much dominated by aerospace products, which accounted for 87% of all defence exports between 1990-93 (Hartley & Hooper 1995; p38).122

The involvement of the government in supporting exports increases the intimacy of its relationship with industry. The mutual dependence between government

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122 In 1993 the total value of aerospace related exports amounted to over £2350 million, while armoured vehicle exports accounted for only £147 million.
and defence prime contractors is made explicit here as both have a common interest in winning export orders. Exports are attractive to companies as they provide an extra source of business and revenue, which reduces their dependence on orders from the UK government. The UK government is also supportive of exports as they provide an alternative way of supporting and maintaining indigenous capabilities. Thus, both parties have an interest in increasing the levels of defence equipment exports. In all the prime contractors examined, the respondents interviewed were extremely positive about receiving government support, and argued that it was necessary in these markets. A typical comment was that there was no such thing as a 'level playing field' in defence export competitions, and that the role of government was to make them as uneven as possible through whatever means available.

For the UK government there were three main mechanisms for supporting defence exports. Firstly, through DESO (Defence Export Service Organization), the government provides sales and marketing support to the export efforts of the UK's largest defence manufacturers.\textsuperscript{123} This support tends to be focused on very large contracts, often involving a wide range of equipment and companies (DESO 1985). Secondly, through the ECGS (Export Credit Guarantee scheme) the government provides insurance to underwrite the cost of equipment exports and thus encourage foreign governments to buy equipment. In 1993 over £4 billion of cover was provided (Taylor 1994), with 48% of this being for defence equipment (HC 61/62; pxxxv).\textsuperscript{124} Offset deals provide the third policy mechanism

\textsuperscript{123} DESO was officially set up in the mid 1960's to provide government support for the export of defence equipment at a time when Britain was facing significant balance of payment problems (Sampson 1977; Ch8). Increasing the level of defence exports was seen as a way of both reducing this problem while also providing support for domestic defence manufacturers such as Hawker Siddley. However, there is evidence (Noel-Baker 1936; p65-80) of government sales and marketing support in export competitions from a much earlier period.

\textsuperscript{124} Substantial losses have been made on a number of export credit deals due to problems of non-payment. Two of the largest debtor countries are Iraq, which in 1990 had over £1 billion of unpaid credit, and Nigeria, who in the early 1990's had outstanding credits of approximately £125 million per year (HC 333; p90-91).
used by government in support of exports. Offset deals are where part payment for equipment is provided in the form of services or goods rather than money. This requires the company selling the equipment to either accept goods instead of money, or to guarantee that a certain proportion of the equipment will be produced within the country purchasing the equipment (Matthews 1991). There has been a tremendous growth in offset contracts since the 1970's due to the increasingly competitive nature of export competitions, which provides the purchasing country with a significant element of control in deciding the details of a contract (Udis & Maskus 1991, Matthews 1991). The complex nature of these contracts, which often involve a wide range of companies and products, requires the involvement of government to co-ordinate the overall deal. For example, the UK government was centrally involved in negotiating both the Al Yamamah contracts with Saudi Arabia. These contracts involved the supply of a wide range of equipment including Tornado and Hawk aircraft, helicopters, missiles, mine sweepers, communication systems and the construction of two airbases, with the government incurring over £1.5 billion of offset obligations (Allen 1995). Evidence indicates that a significant proportion of the largest UK defence equipment manufacturers have been involved in offset contracts of various types, with a high proportion of their export deals involving some form of offset obligation (Matthews 1991, Martin & Hartley 1995).

Thus while it has not been possible to show the specific export commitments of individual companies the extent of government involvement has been shown to be massive, and is probably the single most important factor explaining the improved export performance of UK companies in global defence markets. This

125 For Saudi Arabia offset deals for arms purchases are obligatory (JDW 1995a)
126 This single contract involved a large proportion of the UK’s most significant defence manufacturers including BAe, Vosper Thornycroft, Westland, GEC, Plessey and Rolls Royce (Aburish 1994; p204)
127 Martin & Hartley (1995) in a survey of the UK’s largest defence contractors, found that in 1991 over 80% of the companies returning the survey (19 from 24) had signed export contracts involving some form of offset obligation.
section has illustrated the enormous influence that the UK government has in defence markets and the various way in which its behaviour has influenced the strategy and behaviour of the companies examined. Its various involvements in defence equipment markets are such that its behaviour and priorities are a significant influence on all companies operating within these markets. The range of policies adopted by the UK government such as the lack of support for diversification initiatives, the changes to procurement and the support for export efforts have been significant in shaping the strategies adopted by the companies examined. Thus, if these policies had been significantly different, it is possible that the strategies adopted by the companies examined may have been different.

(e) Government policy - An international comparison

The purpose of this section is to show how the policies adopted by the UK government could have been different, by examining the policies adopted by the French and U.S. governments. The reason for using France and the USA for comparative purposes is the great similarity between their Cold War defence policies and those adopted by the UK government. For example, all three placed a great emphasis on maintaining and developing their indigenous defence industries and used similar policies to do so, in general always favouring domestic companies in procurement competitions. The comparison will be made by looking at three particular areas: changes in levels of domestic spending levels; procurement and industrial policies; and export policies. From this the differences in their post Cold War policies will emerge, as the French government in particular has adopted substantially different policies to those implemented in the UK.
While all three countries have historically spent similarly high proportions on weapons, the greater size of the USA means that in absolute terms its spending has been much higher. Thus while France and Britain spent $21 billion and $19 billion on defence in 1993, spending in the USA for the same year was $229 billion (Ball et al 1994). The first difference in government policy emerges when comparing changes in procurement levels. While spending levels in the USA and the UK have varied in a very similar way, being cut substantially after 1989, there has been no such reduction in France. While spending in the USA began to decline after 1985 (Adams & Kosiak 1993), it was only after 1989 that it dramatically reduced, falling by 14% between 1989-93 (Ball et al 1994). This reduction affected the equipment procurement budget, with a number of projects either being either cancelled or reduced in size (George et al 1995, Adams & Kosiak 1993). In the same period French defence spending has remained relatively constant, and was not significantly reduced following the end of the Cold War (Ball et al 1995), however due to large cost increases cuts were still required in many equipment programmes, though none were cancelled outright.128 The main purpose of maintaining spending levels in France was to help maintain the country's indigenous defence industry capabilities, which will be seen to be a common theme running through the French government's policies in the post Cold War period. While both the UK and U.S. governments also pursued similar objectives spending levels were cut with the expectation that the efficiency of their procurement practices could be improved.

Significant differences existed with regard to changes in procurement methods and industrial policy. In this section procurement methods and broader industrial policies are considered together, as in all three countries they are closely related. One of the most stark difference between defence industries in France

128 For example, the number of Rafale aircraft for the navy was reduced from 86 to 60, the army is only to get 400 Leclerc tanks instead of 650 and the number of Tiger helicopter bought will probably halve (Buchan 1996).
and those in both the UK and USA, is that in France they are still largely state owned, with 80% of the largest companies being in government ownership or control. This reflects the close involvement of the French government in the management and running of their defence industries, which is done through the DGA (Walker & Gummett 1993; p321-323). In France the level of government intervention in their defence industries has been substantially higher than in either the UK or USA, with loss making government owned companies such as SNecaM being given direct subsidies to underwrite their losses (Lewis 1995a). The level of job losses from defence industries in the period following 1989 has also been significantly lower in France than in either the UK or USA, as the French government have intervened to prevent excessive job losses (Anthony et al 1994). For example, French defence spending increased between 1995 and 1996 specifically to minimize the number of industrial jobs lost (Lewis 1995b).

In all three countries procurement policies, even in the post Cold War period, have emphasized the maintenance of domestic defence industries, but the methods used to achieve this have been markedly different. In France this was largely achieved through the continuation of overtly interventionist policies, where the government has provided contracts or finance to the domestic companies it wishes to support. In this way France has been able to maintain capabilities in the design and production of the full range of military equipment including nuclear weapons (Anthony et al 1994), and is the only Western country, apart from the USA, still independently designing and manufacturing its own combat aircraft (Chesnais et al 1994). There is no evidence to suggest

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129 The French government announced in 1993 that 21 defence companies, including three of the largest; Aerospatiale, Snecma and Thomson-CSF, were to be privatized, however by mid 1996 this has not been achieved (Anthony et al 1994).
130 Delegation Generale pour L'Armament.
131 Maintaining absolute independence in all areas of equipment production has not been possible due to cost considerations. This has resulted in French companies being involved in a greater number of
that there has been any significant liberalization in procurement practices like those adopted in the UK, and to a lesser extent the USA. As shown, while maintaining a wide broad range of indigenous defence capabilities has also been a large factor in the UK government's procurement practices, this has been done against a background of more liberal, competitive and cost conscious procurement practices. In the USA procurement practices were also reformed in order to reduce costs, through a wide range of mechanisms, including a greater use of fixed price contracts (Anthony et al 1994; p478). But, the full range of reforms that were proposed have not been implemented, largely because of resistance from industry (Reppy 1993). There is also no evidence to suggest that the US government has moved away from its 'buy American' procurement practices (Vogel 1989), making it extremely difficult for foreign companies to win defence equipment contracts in the USA. Thus the procurement reforms introduced in the UK have been the most far reaching in terms of increasing the levels of competition, increasing the access of foreign companies to domestic programmes and driving though cost reduction measures, which has resulted in the restructuring which has occurred in the UK being the most extensive.

The other area of industrial policy mechanism discussed above was diversification, where it was shown that there was a complete lack of support for such policies from the UK government. This was also the situation in France, with a similar absence of any diversification policy mechanisms. Thus the only one of the three countries with any specific diversification policies was the USA. However, even there the main policy mechanism in this area, the Technology Reinvestment Programme (TRP), has been the subject of significant funding cuts, and has been criticized for being ineffective. When the TRP was initiated it

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collaborative, international programmes, such as the Tiger Helicopter, Future Large Aircraft and the next generation of European armoured vehicles.
was presented as a dual use programme intended to encourage conversion and improve the connections between innovations and technical developments in military and civil markets (Anthony et al 1994). However, by the time it had been implemented the conversion element had been greatly reduced (Evans-Klock & Bischak 1995), the funding for the project had been drastically cut (Bridgman 1995), and the emphasis in the project had shifted towards the benefits commercial innovations offered to military projects (ARPA 1995).\footnote{132} Therefore the reality is that in the UK, France and the USA there has not been any significant levels of support for conversion or diversification initiatives. The unwillingness of all three governments to invest in such policies reflects their greater concern over maintaining defence industrial capabilities than defence industry jobs.

One policy area where all three countries have adopted similar policies was in support of defence exports. In all three countries there has been a large amount of government support for the export efforts of their domestic defence manufacturers (Nordwall 1994, Fulghum 1994). In absolute terms the USA dominates the international arms markets, winning a relatively constant 50% share of the total world export market throughout the 1990’s (Anthony et al 1994; p493). While the French government has also vigorously supported the export efforts of its companies, its share of the world arms export trade declined drastically between 1990-94, reducing from 7% to just over 3% (Anthony et al 1994; table 14.1). The type of support given by the French and US governments is similar to that given by the UK government and includes government sales and marketing efforts as well as a range of financial support measures.\footnote{133}

\footnote{132}This shift of emphasis in the project is identifiable in the title of the main project report which talked of 'dual-use innovation for a stronger defence.'

\footnote{133}Offsets, as for UK companies, are an increasingly used by US companies to win defence contracts. For example, when McDonnell Douglas sold F/A-18 aircraft to Thailand it accepted a 'lucky dip' of locally produced goods worth approximately $93 million which included rubber, ceramics, furniture and fruit (Financial Times 31st May 1996; p6).
Conclusion - Government-Industry Relations

While the post Cold War policies of the UK, French and US governments have been broadly similar, focused around ways of retaining their indigenous capabilities, important differences existed as to how this was actually achieved. This difference in approach has been a significant factor shaping the restructuring strategies of each countries domestic defence companies. In the UK, and to a lesser extent in the USA, a more liberal, laissez faire approach was taken to defence industry restructuring. This shaped the strategies of the companies examined and was a significant factor explaining their focus on introducing cost cutting measures while remaining within defence markets. While the UK government has undoubtedly supported domestic companies through its procurement decisions, the changes implemented in procurement practices and its 'hands off' policy to the exact form that restructuring should take has been an important factor shaping the cost cutting measures implemented by virtually all of the large companies examined. The negative consequences of the UK's restructuring, however, fell disproportionately on defence workers, where large proportions of jobs have been lost at the same time as the companies making them redundant have been performing well financially. In France, where greater state support has been given to industry, and where state involvement in the control and management of defence industries was greater the industrial restructuring undertaken has not been as significant or far reaching, but the proportion of workers losing their jobs has been substantially less. However, whether this strategy is sustainable in the long term is questionable. Due to the poor economic performance of many French defence companies an extensive privatization program was announced in mid-1996, while simultaneously 11,000 job losses were announced (Sparaco 1996b).
The other major factor which influenced the strategies pursued by the companies examined came from their corporate owners. All of the companies in the top tiers of all three sectors, and a number of the component suppliers, were divisions of larger corporate groups, which exerted a significant influence on the strategies of their divisions. In fact, it is not possible to fully understand the strategies of the companies examined outwith the context of the strategy being pursued by their corporate owners. This section will therefore examine the relationship between the companies examined and their corporate owners, showing how significantly divisional autonomy was constrained.

(a) Corporate Strategies - an empirical summary

As shown in the empirical chapters, the strategies pursued by the companies examined were remarkably similar. Primarily they had all developed strategies which consolidated or improved their position within their existing markets. In general this involved either merging with or acquiring other defence manufacturers and undertaking some form of internal restructuring. In none of the companies examined had there been any significant attempts to diversify organically. The strategies adopted by their corporate owners were also very similar, which is an important factor explaining the similarity in divisional behaviour. The strategies adopted by the corporate groups examined can be summarized as follows.

While organic diversification was not a strategy pursued by the divisions examined most of their corporate owners had undertaken diversification at the

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134 Analog Devices, Hypertac, Marshall SPV and Pilkington Optronics.
corporate level through the acquisition of completely new businesses or the expansion of existing non-defence businesses, again primarily through acquisition. The largest example of this was BAe's acquisition of Rover cars, which dramatically reduced the corporation's dependence on military work. This was part of a deliberate strategy by BAe to diversify its business interests into new markets. Smiths Industries also pursued a corporate diversification strategy, although in their case this was done through the expansion of their existing industrial and medical divisions. This was one of the core parts in Smiths' strategy in the mid-1990's with the proportion of aerospace work in the corporation declining from 54 to 41% between 1993-95 (see chapter 4). During the late 1980's both the Alvis and Vickers corporate groups also diversified through acquisitions, successfully reducing their dependence on military vehicle work. While this resulted in these corporations successfully reducing their dependence on defence work, these strategies did not benefit their defence divisions, whose dependence on defence work remained relatively constant. These corporate priorities have thus been important in shaping the strategies of the companies examined, putting a greater emphasis on cost cutting and rationalization than on organic diversification.

Another core aspect to the strategies of corporations involved in defence work was to reinforce their position within their defence markets through mergers and acquisitions or inter-company arrangements such as joint ventures. Virtually every company examined had been involved in this form of consolidation. BAe developed joint ventures in aerospace with SAAB and US companies such as McDonnell Douglas and in missiles through its merger with Matra. Alvis and Vickers both bought other military vehicle companies to consolidate their positions within military vehicle markets. Bombardier sold half of its missile business to Thomson, creating Shorts Missile Systems. Similar changes have also been undertaken by the largest second tier companies. GEC consolidated
its position in defence electronics markets through its joint acquisition of Plessey and its sole acquisition of Ferranti's defence business. While finally, both Cossor, through its acquisition of Northern Telecom's GPS business and Racal Radar, through its acquisition of Thorn-EMI's Electronic Warfare division, reinforced their positions within their own niche defence markets. The result of this inter-company activity has been to reduce the number of separate companies competing in most of the UK's defence markets, substantially increasing the level of concentration in these markets.135

The third and final core component to the strategies of the corporations examined was the stringent short term financial goals placed on all their divisions. In all the large companies examined it was apparent, both from their positive financial performance, and from those interviewed, that pressure to produce positive annual financial returns was a significant factor shaping their strategies. Given the level of reduction in demand in these markets and the general turbulence and uncertainty which has occurred since 1989 the positive financial performance of virtually all thirteen large companies is surprising. While most experienced some decline in business, virtually all were able to maintain positive profit levels and relatively stable profitability ratios. By looking in detail at the situation of three companies (Smiths Industries, BAe Defence and Vickers Defence), the emphasis on short term financial performance becomes even more visible. The reason for using these three companies was not because they represented extreme cases, as they did not, but because the best levels of data were available in their cases.136 In other surveys of the financial performance of defence equipment manufacturers from this period the positive

135 A similar process of concentration through mergers and acquisitions has also been occurring in the USA, with the merger between Lockheed and Martin Marietta being the most significant (Velocci 1994c)
136 In the case of GEC, Nortel and Siemens it was not possible to disaggregate either employment or financial data to an adequate level to establish the performance of their defence divisions. In the case of other companies such as Racal, Cossor and Alvis either financial or employment information was not available.
economic performance of most companies is apparent (Shifrin 1995a, Velocci 1994b, Skons & Goncher 1995). Velocci (1995; p36-38), when examining the financial performance of the largest US aerospace and defence corporation in 1995 talked of a 'golden era in profits', where, 'net income and earnings per share are at all time highs.' Therefore, the positive financial performance of the UK companies examined (see below), does not appear to be an untypical aberration.

For British Aerospace's military aircraft and missile businesses137 the post Cold War period was shown to be one of great uncertainty with many contracts being cancelled, reduced in size, or under threat of cancellation. For BAe Dynamics in particular the period from 1989-95 was one in which its business levels and employment declined substantially. But, due partly to the emphasis on cost cutting in its restructuring program the company was able to return a profit on its defence business in every year between 1989-95, with projected profits for the late 1990's also being optimistic (Gray 1995f). Reducing labour costs and increasing organizational efficiency were two of the companies primary goals in its reorganization, and between 1990-95 labour costs were reduced by 45% (Weston 1993), with employment declining by over 18,000. The companies policy of improving competitiveness through reducing labour costs was articulated by John Weston, the managing director of BAe Defence, when he talked of the necessity of 'stripping out percent-by-percent excess cost' (Weston 1993; p41). While the absolute levels of BAe Defence's profits and sales were relatively stable, the reductions in employment achieved, combined with the changed operating practices introduced, meant that its profits/employment and sales/employment ratios increased substantially (Table 7.3, Fig 7.1). Thus the internal changes made to the structure and organization of the company were

137 While only the military Aircraft and Dynamics businesses were examined in detail, the financial data on the company represents all of its defence divisions including Royal Ordnance and the Systems and Services Division.
not simply driven by external changes to its markets, they were also shaped by the company’s pursuit of short term financial performance goals. The importance of short term financial performance to the company was made explicit in the Military Aircraft Division’s 1994 business plan when it described how, ‘labour costs exceeded our targets in some areas.... (which) had an adverse effect on both our profitability and cash flow’ (BAe 1994; p16).

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</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>48,500</td>
<td>42,700</td>
<td>37,400</td>
<td>33,500</td>
<td>31,500</td>
<td>30,800</td>
</tr>
<tr>
<td>Sales (£m)</td>
<td>4,635</td>
<td>4,266</td>
<td>4,003</td>
<td>3,963</td>
<td>4,587</td>
<td>4,256</td>
</tr>
<tr>
<td>Profit (£m)</td>
<td>-</td>
<td>371</td>
<td>352</td>
<td>345</td>
<td>412</td>
<td>487</td>
</tr>
<tr>
<td>Sales/Employment (£)</td>
<td>95,600</td>
<td>99,900</td>
<td>107,000</td>
<td>118,300</td>
<td>150,400</td>
<td>138,000</td>
</tr>
<tr>
<td>Profit/Employment (£)</td>
<td>-</td>
<td>8,600</td>
<td>9,400</td>
<td>10,300</td>
<td>13,500</td>
<td>15,800</td>
</tr>
<tr>
<td>Profit/Sales (%)</td>
<td>-</td>
<td>8.7</td>
<td>8.8</td>
<td>8.7</td>
<td>9.0</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Table 7.3 BAe Defence's Business Performance

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138 Figures taken from BAe Annual Reports and are unadjusted for inflation.
A broadly similar situation was found with Smiths Industries' defence business. While the level of business in its aerospace division declined by 17% between 1990-95 its employment levels were reduced by over 43%, with its profit/turnover ratio never dropping below 10%. Thus, as with BAe Defence its profit-employment and sales-employment ratios increased substantially (Table 7.4, Fig 7.2). This was achieved by an internal reorganization aimed at drastically reducing its operating costs (Lex 1996). Therefore while its level of business declined, in terms of short term economic indicators the period between 1990-95 represented one of relative success, which did not go unnoticed by the city (Lex 1996, Financial Times 26th October 1991; p2).

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139 For Smiths Industries it was not possible to separate the financial data of its military and civil aerospace businesses, therefore the data shown represent their combined totals. It was estimated by a company representative that the reduction in military and civil business had been relatively equal, which is the assumption made in the text.
Therefore, the strategy adopted by Smiths industries was also driven by short term financial goals.

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<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>8,772</td>
<td>7,771.7</td>
<td>7,073</td>
<td>6,173</td>
<td>5,442</td>
<td>4,945</td>
</tr>
<tr>
<td>Turnover (£m)</td>
<td>455</td>
<td>431</td>
<td>390</td>
<td>393</td>
<td>374</td>
<td>374</td>
</tr>
<tr>
<td>Profit (£m)</td>
<td>58</td>
<td>60</td>
<td>43</td>
<td>40</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>Turnover/Emp'm'ent (£)</td>
<td>52,200</td>
<td>55,900</td>
<td>55,100</td>
<td>63,600</td>
<td>68,700</td>
<td>75,600</td>
</tr>
<tr>
<td>Profit/Emp'm'ent (£)</td>
<td>6,600</td>
<td>7,800</td>
<td>6,100</td>
<td>6,600</td>
<td>7,200</td>
<td>8,100</td>
</tr>
<tr>
<td>Profit/Sales (%)</td>
<td>12.7</td>
<td>13.9</td>
<td>11.1</td>
<td>10.3</td>
<td>10.4</td>
<td>10.8</td>
</tr>
</tbody>
</table>

Table 7.4 Smiths Industries Aerospace Division Business Performance

Fig 7.2 Smiths Industries Aerospace division: Financial Performance 1990-94

Finally, Vickers Defence, even after it won the second Challenger 2 production contract, boosting its order book to over £1.5 billion and guaranteeing

\(^{40}\) Figures are taken from annual reports and are unadjusted for inflation.
production work well into the next century, announced 'a modest reduction in the workforce to make the business more competitive.' (Vickers Annual Report 1994; p4). Therefore the drive to cut costs was not directly related to the health of the company's order book, being more related to the company's aim of achieving short term financial goals such as annual profitability ratios.

The prioritization of short term economic goals has been as significant a factor as the environment changes which have occurred in shaping the restructuring strategies adopted by the divisions examined. These priorities will be argued not to be the result of any environmental constraints, but particular organizational choices, being one of the main areas in which organizations possess a degree of 'strategic choice.'

Having outlined the strategies pursued by those corporations involved in defence work, the following section will relate these findings to a number of separate issues including; the power of large corporations to shape their environment; the constraint placed on divisional autonomy from the corporate centre; and the variance (or lack of variance) in the priorities and behaviour of different corporate groups.

(b) Corporate Groups and the Market Environment

The relationship between the corporations examined and their operating environment was not uni-directional, with the environment simply having effects on corporations. The size of the major corporations involved in the UK's defence markets (Table 7.5) was such that they had the ability to shape and change their environment, not just react to it. This is true not only for defence markets,

<table>
<thead>
<tr>
<th>Company</th>
<th>Corporate Owner</th>
<th>Corporate Turnover (£m)</th>
<th>Range of Corporate interests</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAe MAD</td>
<td>British A'space</td>
<td>7153</td>
<td>Aerospace and defence</td>
</tr>
<tr>
<td>BAe Dynamics</td>
<td>British A'space</td>
<td>7153</td>
<td>(as above)</td>
</tr>
<tr>
<td>SI Aerospace</td>
<td>Smiths Industries</td>
<td>766</td>
<td>Diversified engineering group - medical, industrial &amp; a'space</td>
</tr>
<tr>
<td>GEC Sensors</td>
<td>GEC</td>
<td>9701</td>
<td>Diversified engineering group - electronics, power supply, telecoms, consumer goods..</td>
</tr>
<tr>
<td>GEC NSD</td>
<td>GEC</td>
<td>9701</td>
<td>(as above)</td>
</tr>
<tr>
<td>SPS</td>
<td>Siemens</td>
<td>(Dm) 84,500</td>
<td>Diversified engineering group - energy, telecoms, industrial, transportation</td>
</tr>
<tr>
<td>SMS</td>
<td>Bombardier-Thomson CSF</td>
<td>84,500</td>
<td>Bombardier - transportation &amp; engineering. Thomson - def. electronics</td>
</tr>
<tr>
<td>Nortel IN</td>
<td>Northern Telecom</td>
<td>($) 8,874</td>
<td>telecommunications</td>
</tr>
<tr>
<td>Racal Radar</td>
<td>Racal Electronics</td>
<td>880</td>
<td>Diversified engineering group - communications, defence electronics</td>
</tr>
<tr>
<td>Cossor</td>
<td>Raytheon</td>
<td>($) 4,500</td>
<td>Diversified Engineering group - defence electronics &amp; aerospace</td>
</tr>
<tr>
<td>VDS</td>
<td>Vickers</td>
<td>727</td>
<td>Diversified engineering group involved in automotive, medical and propulsion</td>
</tr>
<tr>
<td>Alvis Vehicles</td>
<td>Alvis</td>
<td>80</td>
<td>Diversified engineering group involved in vehicle, aerospace and electro-optics.</td>
</tr>
<tr>
<td>Land Rover</td>
<td>BMW</td>
<td></td>
<td>Vehicle Manufacture</td>
</tr>
</tbody>
</table>

Table 7.5 Patterns of Corporate Ownership

For the corporations examined there were three particular ways in which they were able to reshape their environment. Firstly, as outlined, through their

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141 This argument was first made by Galbraith (1977), in relation to the growing economic power of US multi-nationals in the 1960's.
relationship with the UK government corporations were able to lobby and exert pressure both for the award of particular contracts and in general over the methods by which procurement decisions are made. Due to the mutually dependent relationship that exists between government and the largest defence companies this influence is not inconsiderable. Secondly, through the sorts of mergers and acquisitions outlined previously they were able to influence the structure of their markets. In all three sectors examined there has been a reduction in the number of separate companies competing, with the largest corporations becoming more and more dominant. Often such changes were made in the face of opposition, as was in the case of the GEC-Siemens takeover of Plessey, which was vigorously opposed by Plessey. However, largely due to their brute economic strength, GEC and Siemens were able to complete the acquisition. This, therefore is another method by which corporations can substantially change the structure of their market environment. Finally, as was outlined by the experiences of all the component suppliers examined, corporate groups have the ability to change the character of their sub-contract relations, with their suppliers having very limited powers to resist such moves.

All these methods have been used by the corporate owners of the companies examined, influencing both the pace and character of the changes which have occurred within defence markets during the post Cold War period. This ability of corporations to shape their own environment results in the boundary between organizations and their environment becoming unclear (Whitely 1987; p127). While the corporate centre is an intrinsic part of the companies studied, simultaneously it constitutes a significant part of its own environment, with the ability to shape the milieu in which it operates. However, analytically it is still possible to conceptualize organizations as distinct, identifiable entities, while
simultaneously considering them to be an important part of their own operating environment.

(c) Corporate Strategy as a divisional constraint

The responses of the corporate groups to the decline in business experienced by their defence divisions limited the range of strategic options available to these divisions, and was therefore a major factor influencing the strategies they pursued. The strategies adopted by the corporate groups examined had considerable similarities with the responses of other defence companies (DeGrasse 1987, Lall & Tepper-Marlin 1992, Adams & Spann 1995) and non-defence companies (Massey & Meegan 1982, Spencer et al 1986) to reductions in business. In all of these studies and in the research conducted the strategies and priorities of the corporate centre have been similar, allowing a general model of corporate behaviour to be developed.

In response to declining business levels in particular divisions the strategy of the corporate centre has two main components, which are often developed in parallel (Spencer et al 1986; ch5). The first component of their strategy is rationalization, where the market focus of the corporation is changed through the acquisition of new businesses or the selling off of declining ones. As outlined, this was a strategy pursued by a considerable number of the corporate groups examined, where diversification through acquisition had been pursued. While only a small number of corporations have sold their defence businesses,142 a significant number did acquire new businesses to reduce the corporate dependence on defence. The second general component of corporate strategy is to implement a programme of cost cuts in the division experiencing a

142 None of the corporations examined pursued a strategy of selling their defence businesses. The most prominent corporate group in the UK which has done this is Thorn-EMI, who have completely removed themselves from defence markets.
reduction in business, in an attempt to increase its competitiveness. This strategy was pursued by the vast majority of the companies examined, and represents the most typical corporate response to declining levels of business in their defence divisions. What is extremely unlikely is that a strategy of organic diversification will be supported. In none of the companies examined, or in the studies described above, had organic diversification been pursued to any significant extent.

These corporate priorities reflect the extremely narrow prioritization of economic performance which the corporate groups examined used to control their divisions (see above). Absolute employment levels in a division or its' degree of dependence on particular markets were not factors which shaped the strategy of the corporations examined to any significant extent. These priorities and strategies therefore did little to reduce the dependence of the companies examined on defence markets. For example, while the acquisition of Rover Cars significantly reduced BAe's dependence on defence work, both its Military Aircraft and Dynamics divisions remained totally dependent on defence work. The lack of support for organic diversification in BAe, and all the corporate groups examined, has therefore contributed to the shrinkage experienced by most of the companies examined. These priorities constrain the strategic freedom of companies, as without corporate support organic diversification is unlikely to be successful, due to the high levels of investment required. Thus while corporations focus narrowly on the economic performance of their divisions the strategies they adopt to reductions in business are always likely to be conservative in nature, focusing on cost reducing measures.
(d) Variation in corporate Strategy

While the previous section argued that the priorities and strategies of the corporations examined showed little variance, Goold and Campbell (1987a,b) found significant differences in the priorities and methods used by corporate groups to control their divisions. They found evidence to suggest that both the level of strategic autonomy and the strictness of financial controls used by corporations to control their divisions varied greatly, using data from a wide range of different corporate groups. It was also argued that there was no single best style of control, with the most suitable control mechanism varying dependent upon the technical and market requirements of their divisions business. However, for the companies examined no such variation was found in the control mechanisms used by their corporate owners. GEC is often characterized as a corporation which places a greater emphasis on financial control mechanisms than other similar corporations (see Williams 1983). While undoubtedly GEC did place a large emphasis on controlling its divisions through short term financial control mechanisms there was no evidence from any of the other companies examined that they operated in a substantially different way. In all the large companies examined it was apparent that there were corporate demands to produce positive annual financial results, even during periods of significant restructuring. This lack of variation is explained by both the similarity in the type of corporate groups examined (table 7.5), all of which were diversified engineering groups, and the similar character of defence markets in all three sectors examined. The lack of variance in corporate control mechanisms is therefore not surprising considering the homogeneity of both the markets and corporate types studied.

143 In Goold, Campbell & Luchs (1993) updated evidence is given on the performance of the companies originally studied.
144 Their research involved holding companies such as the Hanson group to engineering conglomerates such as GEC.
The influence of the corporate centre in shaping the strategies adopted by the divisions examined has been very significant. For all the companies examined which were part of a larger corporate group it was apparent that their strategy was co-ordinated from the centre, and that divisional autonomy over strategic issues was constrained. To fully understand the strategies adopted by these companies it is therefore necessary to consider them within the context of the strategies of their corporate owners. Many of these corporate groups, such as GEC, BAe, Siemens, BMW, Thomson-CSF or Raytheon are so large that they constitute a significant element of these markets, with the ability to shape and influence its character. The importance placed on short term economic indicators by the corporate groups examined, combined with the emphasis on growth through acquisition substantially constrained the strategic freedom of their companies. These priorities are important as they influence and limit the strategies open to companies, ultimately encouraging them to pursue conservative, risk avoiding strategies. For the divisions examined this was an important factor explaining the emphasis on cost cutting rather than diversification strategies. With the corporate priorities outlined organic diversification was a strategy unlikely to be pursued due to high levels of long term investment that would be required. The strategic autonomy of the companies examined was therefore significantly constrained, limiting company management to controlling the exact methods by which a strategy was to be implemented rather than having control over what strategy was to be pursued.
7.6. **Company Strategy: Constraint and Choice**

This final section examines the extent to which the strategies pursued by the companies examined were shaped and constrained by their environment. While the previous sections have shown that the characteristics of a company's operating environment does play an important role in both shaping their capabilities and constraining its strategic choices, it will be argued that this does not result in their behaviour and capabilities being purely determined by environmental factors. However, the primary question is: if companies possess an element of choice, why did all the companies examined pursue such similar strategies? (see section 7.5.1) It will be shown that even though the companies examined did pursue similar strategies this was the result of them choosing to do so, and was not due only to environmental constraints. Using the concept of sectoral recipes it will be argued that as well as being competitors, companies operating within defence markets in some respects also represent a community, with shared conventions and methods of operating, and it is because of these shared perceptions and values that their strategies were so similar.

*Environmental Constraints*

All companies operating in a market environment are to some extent constrained in their operating practice and strategic decisions. The law of value, or the 'determinism of economic forces' (Hyman 1987; p22-23) makes it necessary for companies to produce some financial return, which places a significant constraint on their behaviour (Kochan et al 1984). Crudely, the requirement on companies operating in a capitalist economy to make money shapes the way they operate. However, the way this is achieved is not the same in all situations, being dependent upon the particular structural character of a company's operating environment (Scherer 1980, Smith & Child 1987). Thus the specificities of a company's operating environment place further constraints on
its strategic freedom and shape both the character of its capabilities and the strategies it pursues. In all three empirical chapters, and in the earlier sections of the analysis chapter the effect of the market and technological characteristics of the defence procurement environment on the companies examined was shown to be considerable.

As outlined in the methodology chapter these ideas are central to Contingency theory, which in its strongest form assumes that direct causal relations can be established between a company's internal structures and operating practices and needs or imperatives which exist in its operating environment (Reed 1985). Thus contingency theory fundamentally supports assumptions of environmental determinism. These ideas however, have been heavily criticized, with a number of their basic assumptions being brought into question (Reed 1992, Clegg & Dunkerely 1980). Primarily, contingency theory proposes a functionalist view of organizations, where an internal consensus over organizational goals is assumed (Wood 1979, Child 1988). There is also an assumption that organizations possess adequate knowledge of their environment, allowing them to make fully informed choices over strategy. In defence of these ideas its supporters argue that organization studies should be primarily concerned with the design of 'efficient organizations', which is a technical operation simply requiring the adjustment of an organizations structures and operating practices to the relevant environmental contingencies (Hinings 1988; p2), thus representing a separate discipline from sociology (Donaldson 1985, 1988). It will be shown that neither of these assumptions is accurate and that contingency theory proposes too deterministic a model of organization-environment relations. Following this the elements of choice open to the companies examined will be illustrated, where it will be shown that the particular priorities pursued have been important in shaping the strategies adopted. Specifically,
the short term economic goals of the corporate groups examined were important in shaping the restructuring strategies pursued.

7.6.1 The limits of Environmental Determinism

(a) Uncertainty of environmental knowledge

Choice in organizational behaviour emerges when it is acknowledged that companies do not possess complete or certain information (Aldrich 1979; ch 5). As argued earlier (section 3.2.2), uncertainty of knowledge on the external environment is inherent to all organizations. Organizational decision making thus has to be made on the basis of uncertain information (Whitley 1987, Kay 1984). For example, when implementing any form of change companies can never possess full knowledge of how their customers or their competitors will respond. Such uncertainty in company information therefore results in an element of subjectivity existing as to how companies interpret environmental contingencies and their implications for the structure and performance of their companies (Metcalfe & Boden 1992, Dawson 1992; p123-131). The move towards more cost sensitive procurement practices in the UK's defence markets provided the companies examined with only a general indication of a change in their customer's procurement practices. A degree of interpretation was thus required by each company to consider their implications, raising questions such as how significant a change did the Levene reforms represent from previous practices, what prospect would they have of winning future contracts without any internal reorganization, how much was demand for defence equipment in their particular market sector going to change or what type of internal reforms should be undertaken? Due to the ad-hoc and piecemeal nature of the UK government's reforms in the period following 1985, which were driven by short term fiscal concerns as much as long term changes in defence policy (Lovering
1995, McIntosh 1990), complete or certain information was not available to companies on the government's future defence policy intentions. One of the most frequent complaints made by the interviewees in the companies examined was that they had to make important strategic decisions with inadequate and uncertain information from the UK government on future intentions with regards to defence procurement. How each company interpreted this uncertainty, and the uncertainty of not knowing exactly how their competitors would respond, is an important factor explaining the variance which was apparent in both the extent and type on internal reorganization implemented.

The environmentally deterministic model of organization-environment relations results in the assumption that there is only 'one best way' to structure and manage organizations in any market situation being challenged (Aldrich 1979; p139-144, Hyman 1987; p30). Evidence suggests that organizational structures can be varied with little detrimental impact on organizational performance, and that companies with different organizational structures and operating practices can compete and survive within the same market (Woods 1979). In relation to the companies examined a range of responses were possible to the increased cost sensitivity which occurred in their defence markets. The 'strategic choice' available to organizations exists in their ability to pursue particular performance goals over others and in the levels at which these performance goals are set (Child 1972, Brown 1992; p121). The pursuance of short term economic goals by the corporations examined shaped the character of their internal reorganizations as much as the environmental changes which occurred, and it will be argued this was an area in which these corporations had an element of choice. Through the pursuance of different financial targets it is possible that the character of the internal reorganizations undertaken could have been substantially different.
(b) Internal Organizational Dynamics

A further problem with some contingency theory research is that it inadequately deals with issues of power or conflict within organizations, assuming an internal consensus over organizational goals (Clegg 1988).\textsuperscript{145} This functionalist assumption results in issues such as efficiency or rationality being treated as neutral terms. However, this doesn't acknowledge the often conflictual nature of organizational decision making, illustrated by detailed sociological studies of organizations (Cyert & March 1963, Burns & Stalker 1968, Beynon 1984). In these studies organizations were shown to consist of different interest groups such as departments, functions, sites or even levels of management, which often did not share a consensus on either the goals of the organization or the methods by which goals were pursued. Organizational power was based on the ability to control limited resources, whether people, money or time, and to control strategic decision making processes. In these conditions efficiency and rationality are not terms which can be regarded as neutral as they can be used by specific interest groups as ideological tools to legitimate particular goals and strategies (Salaman 1979).

The internal dynamics of decision making and change implementation thus contradict functionalist assumptions of internal consensus and can influence the strategies pursued by management (Thompson & Ackroyd 1995). The objectives and character of organizational changes are mediated through processes of resistance, often resulting in the alteration of management objectives. These ideas will be discussed in relation to one company, BAe's Military Aircraft Division, which was studied in greater detail than the others, allowing a fuller examination of the processes involved in the implementation of organizational change. The focus will primarily be on the introduction of the

\textsuperscript{145} Penrose (1959) provides a good illustration of these assumptions.
company's new project management system, which did not go uncontested, and which provides a good illustration of the conflicts which can occur between different interest groups when substantial changes are introduced.

The changes introduced to the project management system in BAe's Military Aircraft Division in the early 1990's represented a substantial break from traditional operating practices. During this period many of the organizational practices and priorities, which had predominated for decades, were changed. However, the strategy pursued by the company, to adopt more cost conscious operating practices, did not go unchallenged, with the main source of resistance coming from those areas experiencing the most detrimental impact, the technical functions. During the period of the Cold War the structure and organizational practices of the company were dominated by technical issues and the technical-engineering functions within the company were the 'dominant coalition' (Cyert & March 1963) who had the greatest power and influence over both the organization of the company and the running of its contracts. As one interviewee said, the technical director was one of the 'key guys in terms of the organization.\footnote{The other 'key guy', of equal power and significance as the technical director was the site manager. The site manager had organizational power and control. This power was due to the autonomy with which each site of the military aircraft division operated.} This was due to the nature of cost plus military contracts, which emphasized technical issues over those of cost, and resulted in the company being organized around the same principles. Therefore the company's organizational structure and operating practices were shaped by technical issues, such as compliance with technical specifications, more than they were by issues of strict cost control. While the other case studies were not conducted to the same level of detail, it was apparent that similar priorities had dominated in the first and second tier companies in all three sectors.
The implementation of a new project management system was the primary way that BAe’s Military Aircraft Division intended to introduce stricter cost control practices. The new project boards which were set up adopted a matrix management system, where control over projects was intended to be divided equally between the technical functions and project control functions. The consequence of these changes was to remove substantial organizational power from the technical functions passing much of it to the newly empowered project functions who were responsible for project costs and delivery timetables. This, and all the other changes introduced, was partly made possible by the recruitment of senior management staff with more experience of commercial business practices to a number of significant positions within the organization. For example, in the early 1990’s the company recruited a new managing director, and new directors for both the personnel and finance functions (interview source). All the changes introduced by the company were ideologically justified by management as being necessary adjustments to the more cost sensitive nature of their market, thus being unavoidable. Smith et al (1990; p323), based on their study of Cadbury’s, argued that the introduction of change within an organization is likely to be in dynamic tension with continuity, which was the case in BAe. Change to the established order within any organization is likely to be resisted by any interest group being adversely affected, which was the case with ICI (Pettigrew 1985), and a number of the companies studied by Burns & Stalker (1968). Due to this tension the greatest resistance and challenge to the proposed changes within BAe came from the technical-engineering functions.

The adoption of a matrix management system for project control resulted in the technical functions losing a substantial element of control over both the general organization of the company and specifically over the management of individual projects. However, they did not lose total control, retaining a substantial element
of influence over the management of projects. Due to the complexity of the systems being designed there is a large element of technical content to the company's work, resulting in the technical functions retaining significant, though substantially reduced organizational power. This was reflected within the new project boards where the chief engineer had the same level of authority as the project director. It was through this element of power and control, combined with the continuity of technical staff in middle management positions, which allowed the technical functions to resist the implementation of change.

While the technical functions did not challenge the argument that change to the company's organization was necessary, they did disagree with the character of the changes introduced, but this did not prevent senior management from introducing the new organizational structure. However, once implemented what has been described as a 'battle' occurred between the relatively disempowered technical functions and the newly empowered project functions, over the ultimate control of project management. This conflict divided the whole organization from senior management level, down to relatively low levels of middle management. The two main effects of this conflict were to retard the rate at which the rationale for the changes was being accepted by the workforce and to create confusion amongst the white collar\textsuperscript{147} workforce over which function was ultimately in control of projects.

From a number of the interviews conducted it was apparent that while there was much physical evidence supporting the introduction of change, there were fewer signs of 'people change', i.e. the acceptance of the company's changed priorities. As Smith et al (1990) and Pettigrew (1985) found, the full acceptance and implementation of significant changes within industrial organizations is likely

\textsuperscript{147} This refers primarily to 'professional' staff such as engineering designers and the quality and project management staff.
to occur over extended periods such as decades. The 'battle' between the project and technical functions over ultimate project control also confused many of the white collar workforce over which function was in control, as its effect was to give workers the perception that they had two separate bosses whose demands were incompatible. For example, the annual appraisal of white collar staff at which their future responsibilities were defined involved both their project and technical managers, often resulting in staff ultimately being unclear over their work objectives and priorities. While the confusion of apparently having 'two bosses' is a problem partly inherent to matrix management systems (Knight 1977, Kingdon 1973), it is a problem which became significantly larger in the case of BAe, due to the conflict between each function over organizational and project control.

In conclusion, the case of BAe's Military Aircraft Division illustrates how internal politics and conflict affected the process of change begun by management. In this case the main effect of this resistance was not to alter the fundamental character of the changes being implemented, but to produce delays in the rate with which change was implemented and accepted by the workforce. The functionalist assumptions of contingency theory, where organizational goals are assumed to be consensually agreed does not acknowledge the inherently conflict ridden nature of power relations and decision making processes within organizations. The similarity of BAe's experience of implementing change with that of other secondary accounts of organizational change suggests that any organizational change likely to challenge existing operating practices will face some form of internal resistance and challenge. Thus in the other companies examined where significant changes were also introduced, for example BAe's Dynamics Division, Shorts Missile Systems, Alvis Vehicles or Racal Radar, similar processes of organizational conflict are likely to have occurred.
7.6.2 Elements of Choice

The various changes to the demand side of UK's defence markets which have occurred since 1985, as illustrated, represent a substantial change to the objective conditions of these markets and have provided a significant break from the traditional Cold War priorities which operated for over 40 years. Thus, as in the case of Cadbury's in the early 1980's (Smith et al 1988), when competition in its confectionery markets substantially intensified, the changes introduced by the companies examined were primarily environment driven, being adopted in response to the environment changes outlined. Fundamentally, the operating practices and structures developed in the Cold War period were largely inappropriate to the more cost sensitive market environment which has developed. However, the form that these reorganizations took was as much influenced by the focus on short term economic objectives as by any market change and could have taken different forms.

In the following section it will be argued that the strategic priorities of organizations are not purely environmentally determined and that organizations do possess a significant element of control to shape their strategic priorities. However, the choices available vary greatly at different levels within organizations. For the organizations considered, the two levels examined were firstly at the level of individual divisions and secondly at the level of the corporate group. Each of these levels will be examined separately to show the differing types of choice available.

Prior to this the choices available to government will be considered, as they have an important role in constraining the choice available to organizations operating within defence markets. The role of government in defence markets
was shown to be extremely significant, being the single largest factor determining the character of these markets. However, from the international comparison it is apparent that if the UK government had supported more interventionist policies, similar to France, the reorganization undertaken by the UK's defence companies could have been substantially different. The significance of the government's role in shaping the character of defence markets is thus critical. Primarily, the non-interventionist, liberal policies supported by the UK government are important in explaining the lack of any efforts at organic diversification. Given the levels of investment required to achieve this, and the long term nature of these investments it is unlikely that such investments would have been made by private industry alone. Thus the policies adopted by the UK government toward defence markets have been an important factor constraining the strategy options available to industry.

(a) Corporate and Divisional Level Choice

For all the companies examined major strategy decisions such as the level of financial return expected from a division or whether a division should remain within or withdraw from particular markets were made at the corporate level, with individual divisions having extremely limited power to influence or change these priorities. For example, from the interviews conducted it was apparent that the pursuit of short term financial goals in the restructuring strategies adopted was a decision made at corporate rather than divisional level. This resulted in the corporate centre having control over the most significant strategic choices, while the divisions had substantially less autonomy. Chandler, in his study of the growth of multi-divisional corporations in the USA defined strategy as, 'the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for

148 Southwood (1991) systematically lists the range of government policy mechanisms required to encourage diversification, such as a commitment to direct intervention, compensating for reduced defence spending through other investments and direct support for diversification.
carrying out these goals' (1962; p13). In the companies examined, the corporate centre had control over determining the basic long-term goals and objectives, while the strategic freedom of individual divisions was limited to the second part, controlling and implementing courses of action to achieve these goals. However, at both corporate and divisional level important choices were still available, giving management at both levels significant choices in their strategy decisions. At the corporate level the prioritization of short term economic goals will be shown to offer corporations an element of choice. At divisional level the choices available to management will be shown to be more limited.

Even if the necessity of pursuing financial goals is accepted a range of choices still existed for the corporations examined. For the three companies detailed above the importance of their annual financial performance targets was apparent from the dramatic financial performance achieved. Such significant financial performance during so turbulent a period in these markets and during a period of substantial organizational change, could only be possible through the prioritization of these goals as the primary target of organizational performance. However, the particular financial performance indicators pursued, the level of performance expected and payback period for investment are all, to some extent, set arbitrarily. It appears that for all three companies the primary financial goal was to achieve consistent annual profits or a particular profit-to-sales ratio. However if lower profit targets had been accepted, or if short term profits had been sacrificed for longer term investments the reorganizations undertaken could have taken a different form. For example BAe Defence and Smith's Aerospace Division both made significant profits every year between 1990-95, with the profit/sales ratio in BAe Defence never falling below 8% and the profit/turnover ratio in Smiths Aerospace Division never falling below 10% (Tables 7.3, 7.4). In both cases this was achieved by ruthless reductions in their operating costs. As the tables of their financial performance show, while profits
and profit ratios were being maintained, employment was cut drastically, by 37% in BAe Defence and 43% in Smiths. Thus if lower financial targets had been set, or if annual profits for one or two years had been sacrificed for longer term investment, the reorganization introduced could have been different, with employment not being so drastically reduced.

At divisional level organizational control over strategy was substantially constrained, with management at this level controlling only the methods by which corporately defined strategies should be implemented. However this still provided management at these levels with an element of choice, which is visible in the range of ways internal restructuring was undertaken (Table 7.2). Thus while the financial requirements and strategy decisions placed on these companies by their corporate owners were very similar, the particular methods chosen to achieve them varied. In five of the 13 companies from the top two tiers a major component of their reorganization was to adopt Japanese type manufacturing practices, aimed at reducing both inventory costs and, through adopting more flexible working practices, labour costs.\(^{149}\) In the remaining eight companies, for example Cossor, Racal, Smiths Industries or Siemens Plessey, manufacturing and management systems was less radically changed, with reorganization in these cases being focused on the reduction of workforce levels, both direct and indirect and through the introduction of stricter cost management systems. As there was no obvious correlation between the form the reorganizations took and the financial performance of these companies this suggests that a range of options was available to each company over the particular character of their internal reorganization. Thus while the strategic freedom of corporate divisions is extensively constrained, management at this levels still possess an element of choice which has important implications for the way corporate level strategy decisions are implemented.

\(^{149}\) The five companies were BAe’s Military Aircraft and Dynamics Divisions, SMS, Alvis and VDS.
(b) Sectoral Recipes

One of the most notable findings from the research was the broad similarity in the strategies adopted by the companies examined. Rather than this being purely due to environmental constraints it is suggested that because of shared or collective experiences companies in the defence sector have developed similar conventions and perceptions of their environment, which results in them pursuing similar strategies. The idea of a sectoral or industrial 'recipe' explains the similarities found in the behaviour of companies competing in the same market sectors by arguing that while companies operating in the same markets are competitors, simultaneously they also represent a community, operating under similar constraints and producing similar products (Child & Smith 1897, Child 1988, Whitley 1987; p 134). This acknowledges both the potential to collaborate and share experiences and perceptions which exists (Shearman & Burrell 1987) and the social nature of the normative pressures which may influence organizations operating in the same sector to adopt similar operating practices and priorities (DiMaggio & Powell 1983). The relative closed nature of defence markets, which present large entry and exit barriers to companies has created a stable community of organizations. Over the period of the Cold war, when this stability in industrial structure predominated, the range of companies operating in the UK's defence industrial base remained virtually static thus creating the ideal conditions in which a sense of identity could be generated amongst these companies.

The sharing of information in market sectors can occur through a number of mechanisms including: participation in sectoral lobbying groups; formal contractual collaborative agreements; the movement of staff between companies; or through newspaper and journal publications. From the research
conducted no primary data was gathered on the links between companies, however it seems likely that through all four mechanisms described information and perceptions have been shared. The most important sectoral lobbying groups in defence markets are the SBAC (Society of British Aerospace Companies) and the DMA (Defence Manufacturers Association). Both these organizations involve all the most significant companies from these markets, the primary function of which is to represent the collective interests of their members. Thus through both groups senior company representatives share information on their experiences and perceived business levels. The marked increase in formal collaborative agreements between defence companies has also resulted in this being a vehicle where companies share information and work together. These mechanisms result in companies developing similar conventions and perceptions over the 'best' operating practices required in their sector. It is thus suggested that the similarity in the strategies adopted by the companies examined to the environmental changes which have followed the end of the Cold War can be partially explained by the sharing of information and perceptions through such collective and collaborative mechanisms.

Conclusion - Company Strategy: Constraints and Choices
The previous two sections considered the extent to which the strategies adopted by the companies examined were constrained by environmental factors. While environmental factors did constrain their strategic freedom, the companies examined still possessed an element of choice and control over their strategy decisions. The major constraints on their strategic freedom originated in the specific nature of their capabilities, the policies adopted by government and the strategy decisions of their corporate owners. The capabilities of the companies examined were extremely specific in character, being largely shaped by the particular requirements of their operating environment. This limited the strategic freedom of the companies as their capabilities were relevant to only a
limited range of markets with similar environmental requirements. However, the role of government and their corporate owners were equally significant in constraining their strategic freedom. The role of government in defence markets was so extensive that it had a significant degree of power to shape the character of the defence equipment procurement environment. This influence was exerted through a number of different mechanisms, including the award of procurement contracts, controlling the procurement process and through supporting the export efforts of UK companies. The policies of the UK government have been relatively non-interventionist with regard to how the companies examined reorganized and reduced in size, which was an important factor influencing the restructuring strategies adopted by the companies examined. Finally, through controlling the most important strategy decisions the corporate owners of the companies examined exerted a large influence over their strategy. Their pursuance of short term economic goals and support for diversification through acquisition resulted in the companies examined having extremely limited control over their overall strategies. Their autonomy was limited to controlling the exact form in which the corporately defined strategy was implemented.

However, while acknowledging the significance of all the above environmental constraints the environmental determinism of contingency theory implies too deterministic a relationship between the operating environment and a companies strategic freedom. Important elements of choice still existed at both corporate and divisional level. The significance of the corporate groups examined made them an important component of their own operating environment and gave them the ability to influence it through their strategic decision making. Their strategies were not totally constrained by environmental factors as they possess an element of control over the type of financial targets pursued and the level of financial return required from their divisions. The
Prioritization of short term economic targets was therefore a choice made by the corporations and was not the result of any specific environmental constraints. However, these priorities had important implications for the strategies pursued by the companies examined, which were constrained to adopt strategies which would provide the required financial returns. This was an extremely significant factor in shaping the strategies adopted, which were not to pursue diversification but to reorganize internal operating practices and remain competing within defence equipment markets, even when this resulted in the companies examined shrinking massively.

Thus the autonomy of the companies examined was substantially limited by their corporate owners and extended to controlling the exact way in which the corporate strategy was implemented. The similarity in the strategies of the corporate groups examined was not solely due to the environmental constraints they faced but was also due to the shared perspectives which they possessed on the character of their operating environment. This sharing of outlooks develops due to the collaborative as well as competitive character of operating in any market sector.
The primary intention of this chapter is to briefly conclude on the main findings of the research. Therefore rather than providing a summary on all the empirical and theoretical issues examined the chapter will instead focus on the most important findings which emerged from the research. Firstly conclusions will be made regarding the relationship between the capabilities of the organizations examined to the character of their operating environment and also to the general nature of organizational capabilities. This will be followed by a section focusing on the strategies pursued by the companies examined, which will be shown to be constrained by both the character of their capabilities as well as other environmental factors such as the particular policies pursued by government and their corporate owners.

As outlined in the introduction (section 1.1.2), the research was initially intended to be a study of the conversion (or organic diversification) practices of the UK’s defence industrial base following the end of the Cold War. However, the fact that no companies had made any substantial attempts to do so obviously meant that the focus of the research had to change. Thus the research therefore examined the strategies that had been adopted by companies from the UK’s defence industrial base, considering the question of why no significant attempts had been made to convert defence capabilities to non-defence applications. As already noted, much research into defence industries and defence markets concluded that the character of defence equipment markets were extremely particular, which resulted in the capabilities of any companies operating in these markets being shaped in ways which made them virtually irrelevant to non-defence markets. Thus the conversion of such specific capabilities to non-defence applications is likely
to be extremely difficult to achieve. I therefore decided to investigate these assumptions and examine the capabilities of companies operating in defence markets, to see how they were related to the character of their operating environment, and to examine how this affected the strategies they pursued. The two theories utilized to analyse the empirical findings, evolutionary economics and contingency theory, were chosen because they were both centrally concerned with the relationship between organizations and their environment.

The main conclusion concerning the capabilities of the companies examined was that their character was closely related to the nature of their operating environment. A large element of the research was concerned with identifying the character of the organizational capabilities of the companies examined and relating them to the character of their operating environment. For all the companies examined it was apparent that their organizational and technological capabilities had been substantially shaped by the character of their market and technological environment. As suggested by some research into defence industries, the character of the UK's defence operating environment, particularly during the Cold War, was found to be extremely distinctive in character, which, as was shown, resulted in the companies examined possessing capabilities which had limited relevance beyond defence markets. Rather than attempting to summarize all the empirical data which has been used to illustrate this argument one specific example will be given before other more general conclusions are made which further reinforce the argument. To provide a specific illustration of the relationship between the character of an organization's capabilities and the nature of its operating environment the manufacturing capabilities of the prime contractors will be considered. This shows how both market and technological factors shaped organizational capabilities as well as illustrating how the internal changes in the organization of manufacturing systems
adopted by most of the prime contractors examined were stimulated by, and related to, changes in the character of their operating environment.

The technological requirements of being a military prime contractor were extensive, requiring all the companies examined to possess specific capabilities and organizational systems. One of the main technological requirements was to co-ordinate the assembly and integration of complete equipment systems. The complexity of these systems, and the large number of diverse components involved required the prime contractors to possess extensive system integration capabilities. These capabilities were primarily logistical in nature, requiring the prime contractors to manage large and diverse supplier bases. Another requirement which shaped the manufacturing capabilities of the prime contractors was the demand for relatively low volumes of high quality, technologically sophisticated products. This required the prime contractors to develop manufacturing capabilities which were suitable to these requirements.

Finally, the characteristics of their market environment also shaped their manufacturing capabilities. During the Cold War the UK government's procurement priorities on defence equipment placed very little emphasis on minimizing or reducing equipment costs. Therefore within all the prime contractors examined systems to control and reduce costs were poorly developed during this period, which resulted in virtually all of the prime contractors examined developing large over-capacities in both capital and labour resources. Thus these priorities had a significant impact on the manufacturing capabilities of the prime contractors. However the market environment of the prime contractors was transformed following both the changes in procurement priorities ushered in by the Levene reforms and the end of the Cold War. These events dramatically altered the character of the UK's defence markets with levels of demand declining and substantially greater pressure being passed to equipment manufacturers to control and
reduce equipment costs. These environmental changes were the primary stimulus to the internal restructuring adopted by the vast majority of the prime contractors examined, thus further illustrating how the character of their operating environment shaped their capabilities.

As the UK's defence industrial base is extremely diverse and heterogeneous the research methodology was designed to account for this by examining a wide range of organizations from different parts of the defence industrial base. From the three empirical chapters and the analysis chapter it is apparent that the operating environment was extremely heterogeneous. Thus the operating environment of the prime contractors varied across the three sectors examined, and the operating environment of component suppliers was found to be very different to that of the prime contractors. What was consistent for all the different organizations examined was that their organizational and technological capabilities were shaped by the particular character of their immediate operating environment.

Another conclusion regarding the capabilities of the organizations examined was that they were generally specific in nature, having limited relevance in operating environments with substantially different characteristics. The operating environment in defence markets during the Cold War, particularly for the prime contractors, was distinctive, with a number of characteristics virtually unique to defence markets. For example, a very particular trajectory of technological development was pursued, the market structure and customer relations were also distinctive, and as outlined above, there was little emphasis on cost control. This combination of distinctive characteristics in the defence operating environment therefore resulted in the companies which operated under these conditions developing extremely specific capabilities. This specificity of organizational capabilities, when combined with the inherent uncertainty in organizational change and the resistance to change which can develop within any organization (see section 7.6.1 on the
case of BAe's Military Aircraft Division) made radical organizational change for the companies examined difficult to achieve. The main implication of this for most of the companies examined, but particularly the prime contractors (because of the particularly specific nature of their capabilities), was that organic diversification would have been a difficult strategy to pursue as it would have involved the large scale adaptation of existing capabilities and operating practices. The specificity of organizational capabilities was therefore a constraint on organizational behaviour.

The above conclusions about the character of the capabilities possessed by the companies examined generally supported a number of the central arguments of evolutionary economics. Firstly, the assertion that the character of the capabilities possessed by an organization are formed through the interaction between the organization and its environment was supported by the empirical data collected. The capabilities of the companies examined were found to be closely related to the character of their operating environment. The empirical data gathered also sowed that the capabilities of the companies were specific in nature, and that organizational change was likely to be incremental in nature. This supports the arguments in evolutionary economics that the adaptability of organizations is limited (due to the character of their capabilities), and that the implementation of radical change for any organization is difficult to achieve. This partly explains the lack of attempts by any of the companies examined to diversify organically, as the particular character of their operating environment, and the specific nature of their capabilities meant that organic diversification, in general, would have been difficult to achieve, due to the large scale of the adaptation that would be required. However, for all the companies examined, including the prime contractors, opportunities existed to diversify into 'adjacent markets', which had similar market and technological requirements to their defence markets, and which would thus have not required the large scale adaptation of their capabilities and operating practices. Thus the lack of
attempts to diversify into even these markets cannot be explained purely by reference to the character of their organizational capabilities.

Two other environmental factors which were equally as important in shaping the strategies pursued by the companies examined were, firstly, the role of the UK government, and secondly, the influence of a divisions corporate owner. Therefore, the following section on organizational strategy will primarily consider the role of these two elements in shaping and constraining company behaviour. Specifically it will be shown that the lack of government support for diversification and the short term economic focus of the companies examined both partly explain the lack of organic diversification that was found.

One of the most interesting findings of the research was the broad similarity of the strategies pursued by virtually all of the companies examined. Thus in general terms the response of most of the companies examined, even those which had experienced a large decline in business following the end of the Cold War, was to remain centrally focused on defence markets while simultaneously restructuring their internal operating practices. In none of the companies examined was organic diversification pursued to any significant extent. As outlined above, however, while the specific nature of their capabilities would have made such a strategy difficult to achieve, due to the high level of adaptation involved, the similarities in the strategies they pursued is not explained purely by the constraints imposed on them by the specific character of their capabilities.

The research showed the significance of the UK government's role in domestic defence markets, which gave it the ability to influence the behaviour of the companies operating in these markets. Thus through this role the behaviour and priorities of the UK government influenced the strategies adopted by the companies examined. The significance of its
influence in these markets not only emanated from its power as a customer, which was significant, but also from the role it played in shaping the procurement system, thus giving it the ability to influence the nature of competition, and from its broader industrial policies, such as providing support for the export efforts of defence manufacturers. The strategies pursued by the companies examined, which were focused on remaining within defence markets and not diversifying out of them, were therefore influenced by the lack of support from the UK government for any diversification initiatives.

As outlined, the Levene reforms did significantly change the character of the UK's defence markets through passing greater technical and cost risk to industry and generally placing more of an emphasis on cost control. Therefore it is suggested that these changes were one of the primary catalysts to the internal restructuring adopted by most of the companies examined. However, while the Levene reforms changed the way defence equipment procurement was organized in the UK, there was greater continuity in the broader industrial policies adopted by the UK government. Primarily, the UK government is still concerned with retaining a significant indigenous defence industrial base. This was one of the most consistent aspects of the UK government's priorities during the Cold War (see chapter 3) and the industrial policy reforms it introduced in the 1980's and early 1990's have not changed this. Thus while more cost focused procurement policies were adopted evidence suggests (see chapter 7) that UK companies were favoured in procurement decisions which had important implications for the UK's defence industrial base. Similarly, the high level of support given to the export efforts of the UK's defence equipment manufacturers can also be seen as providing a means to support the UK's indigenous industrial capabilities. In short, as argued by Lovering (1992; p112), these policies were more concerned to 'shed the 'fat' and find new ways of propping up the remaining core' of the UK's defence industrial base than with letting 'market
forces' decide its structure. Thus, because of these priorities the UK government has not encouraged its indigenous defence equipment manufacturers to diversify organically out of their existing markets. These priorities are therefore argued to be an important factor explaining the lack of organic diversification pursued by the companies examined.

That the UK government's policies could have been different can be illustrated by examining the policies adopted by the U.S. and French governments (see chapter 7). In terms of policies to support diversification, and to encourage the full utilization of the dual use potential of the capabilities possessed by companies examined, a programme such as the USA's Technology Reinvestment Program (TRP) could have been developed. The purpose of such an initiative would be to provide funding to encourage the utilization of their capabilities in non-defence markets. However, the UK government instead argued that undertaking any such initiatives was the prerogative of industry alone, and therefore, on ideological grounds it did not support such an initiative. While the capabilities of the companies examined were specific in nature, there was an element of dual use potential in many aspects of their capabilities, especially in relation to their 'adjacent markets.' Another policy option which could have encouraged defence equipment manufacturers to fully exploit the dual use potential of their existing capabilities, but which was not supported by any of the governments examined, would be to make it a condition of winning a defence contract that companies invest a certain proportion of this funding on developing potential non-defence applications. One of the problems of having a privately owned defence industrial base is that the profit motive is one of the most dominant factors shaping organizational behaviour (see below), with governments having limited powers to encourage companies to address other issues such as maintaining jobs (as occurred in France), or apply skills and capabilities developed in defence markets to non-defence markets. I believe the best way for the UK government to gain control over
the behaviour of the companies making defence equipment for them would be to own them. However, in practical terms, the likelihood of such a re-nationalization programme occurring in the political climate which exists in the UK in the late 1990's is extremely low.

Following on from the previous point concerning the narrow profit focus of private industry this section of the conclusion examines how the short-term cost focus of the companies examined was a significant factor shaping their strategic behaviour. The other major influence on the strategies of the companies examined was provided by their corporate owners. Basically the pursuit of short term economic goals by their corporate owners constrained and shaped the strategies pursued by the companies examined. These priorities were apparent from the fact that between 1989 and 1995, when most of the companies experienced a decline in demand and during which they also adopted substantial changes to their operating practices, the vast majority still maintained consistently high profitability ratios. To achieve this during a period of intense uncertainty and change could only be possible if these economic goals had been prioritized. The requirement placed on the companies examined by their corporate owners to provide consistent short term economic returns therefore acted to inhibit them from diversifying.

The above evidence suggests that the environmental constraints on the behaviour of the companies examined were substantial. However the similarity in strategies they pursued is not interpreted as suggesting that their behaviour was wholly constrained by environmental contingencies. While objective market conditions and pressures did have an impact on the companies examined, and did constrain and shape their behaviour, they still possessed an element of 'strategic choice' to pursue a range of strategies. Thus the 'one best way' logic which argues that organizational behaviour is purely environmentally determined is rejected. The strategies adopted by the companies examined, while being partially shaped by environmental factors,
were therefore not the inevitable result of environmental factors. In relation to contingency theory the strategic choice argument of Child was supported, and the extreme environmental determinism of 'strong' contingency theory was rejected. Child (1972; p2) argued that the strategic choices available to an organization's management extended from the standards of economic performance that they defined to the way they designed their organizational structures. In this research the economic goals of the companies examined provided the best illustration of the strategic choices available.

The organizations examined possessed a significant element of 'strategic choice' to define the particular economic goals that they pursued. Thus this provided an illustration of one area in which the organizations examined possessed a large element of control. As outlined, the strategies they pursued were shaped by the pursuit of strict short term economic goals. Thus if less onerous or more long term economic goals had been adopted that it would have been possible for the companies examined to have pursued different strategies.

A further argument, which also challenged the 'one best way' logic of environmental determinism was in the ability of the larger organizations examined to influence the character and structure of their environment. For example, the many acquisitions by both GEC and BAe during the period considered influenced the character of their own environment through increasing the level of concentration on the supply side of the UK's defence markets. Thus the relationship between these organizations and their environment was not unidirectional, with companies simply responding to environmental factors, but was a two way relationship with both mutually influencing each other.

The importance of recognizing that organizations do possess an element of strategic choice in this area is that if different economic targets had been
pursued a wider range of strategy options would have been available to the companies examined, which might have made the pursuit of other strategies such as organic diversification more feasible. This may have meant that the workforces in the companies examined would not have had to bear such a large part of the cost for the market changes the companies they worked for experienced.

To end I will make a number of suggestions about potential future research directions which could fruitfully build on the empirical and theoretical findings outlined. Firstly, to provide comparisons to these findings further research into the relationship between an organization's capabilities and its environment in non-defence sectors could be carried out. The benefits of such research would be to allow generalizations to be made on the character of an organization's relationship with its environment. Another potentially interesting research project would be to further investigate the significance of the inter-firm communication in developing 'sectoral recipes.' The research conducted suggested that such mechanisms played an important part in explaining the similarity of the strategies that were found. However, the empirical data on this was limited. Further research in this area would throw light on this potentially important inter-organizational communication mechanism.
APPENDICES
Appendix 1

- Defence Statistics (which lists all defence contractors paid over £5m in the previous financial year),

- the DTI Quality Register (DTI 1990),

- academic reports on the supply sided structure of the UK's Defence industrial base (See Wulf 1993c, Southwood 1985)

- Defence industry and business journals (Such as the Financial Times, Defence Industry Digest, Jane's Defence Weekly)
## Appendix 2

### Prime Contractors

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<thead>
<tr>
<th>Aerospace</th>
<th>Electronics</th>
<th>Vehicle</th>
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<tbody>
<tr>
<td>BAe Military Aircraft</td>
<td>Siemens Plessey</td>
<td>Alvis Vehicles</td>
</tr>
<tr>
<td>BAe Dynamics</td>
<td>Shorts Missile Systems</td>
<td>Vickers Defence</td>
</tr>
<tr>
<td></td>
<td>Nortel (Formerly STC)</td>
<td>GKN Vehicles</td>
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<td>Land Rover</td>
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### Second Tier Sub-system Suppliers

<table>
<thead>
<tr>
<th>Aerospace</th>
<th>Electronics</th>
</tr>
</thead>
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<tr>
<td>Page Aerospace</td>
<td>Racal Radar</td>
</tr>
<tr>
<td>Hunting Engineering</td>
<td>Cossor Electronics</td>
</tr>
<tr>
<td>Lucas Aerospace (actuation)</td>
<td>GEC Marconi Communications</td>
</tr>
<tr>
<td>Lucas Aerospace (power systems)</td>
<td>GEC Marconi Radar &amp; Control</td>
</tr>
<tr>
<td>Racal Avionics</td>
<td>GEC Marconi Naval Systems</td>
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<tr>
<td>GEC Marconi Avionics (Flight Systems)</td>
<td>GEC Dynamics</td>
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<td>GEC Marconi Avionics (Display Div'n)</td>
<td>Marconi Underwater Systems</td>
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<tr>
<td>GEC Marconi Avionics (Navigation Sys)</td>
<td>Marconi Command &amp; Control</td>
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<td>GEC Marconi Avionics (Radar Sys)</td>
<td>Graesby Dynamics</td>
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<td>BAeSEMA</td>
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<td>Dowty Aerospace (Landing Systems)</td>
<td>GPT</td>
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</table>
Appendix 3

DEFENCE ELECTRONICS- SUPPLY CHAIN SURVEY

BACKGROUND DATA: COMPANY AND MARKETS

1) Company name:
2) Name and position of respondent:
3) Brief description of company's products/services:

4) Is the company part of a larger parent group/holding company? If so, what functions/resources (if any) are shared with other divisions or central group, for example marketing, R&D, sales?

5) What is the annual turnover of your company? (as distinct from group turnover, if relevant) Please circle the appropriate choice

- Under £1M
- £1 - £10M
- £10 - 25M
- £25 - 50M
- £50 - 100M
- £100M+

6) How many employees work at your local site?

- Under 20
- 20-50
- 50-100
- 100-250
- 250-500
- 500+

7) Approximately what share of turnover is currently accounted for by defence related business?

- <20%
- 20-40%
- 40-60%
- 60-80%
- 80%+

8) How many customers account for the majority of the company's business?

- 1-5
- 5-10
- 10-25
- 25-50
- 50-100
- 100+
RECENT CHANGES IN BUSINESS AND PRODUCT MIX

9) Approximately, how does the company's current turnover compare with that of 5 years ago?
   Higher          Slightly higher          Same
   Slightly lower          Lower

10) Approximately, how does the company's current employment level compare with that of 5 years ago?
    Higher          Slightly higher          Same
    Slightly lower          Lower

11) Approximately, how does the company's proportion of defence work compare with that of 5 years ago?
    Higher          Slightly higher          Same
    Slightly lower          Lower

12) If the answer to any of the three previous questions shows a significant change over the last 5 years, can this difference be attributed mainly to contracting defence markets? (please highlight appropriate answer)
    Y/N

13) Are there other factors which are responsible for any change in the company's business mix or size? Briefly state these, if any.

14) How would you estimate the company's future (approximately 5-10 years) proportion of defence work compared with existing mix?
    Higher          Slightly higher          Same
    Slightly lower          Lower          Unknown
FUTURE STRATEGY

15) Is a reduction in your existing levels of defence related work seen as a significant component of the company's future strategy?

Priority Important Neutral Not important

16) Evaluate the following possible (future) strategy options with respect to your own company. Respond to both criteria for each strategy option by circling the most appropriate responses.

(a) Find new defence markets for existing defence products/services

(1) IMPORTANCE Priority Important Neutral Unimportant

(2) CHANCE OF SUCCESS V. Good Achievable Unlikely V. Low

(b) Adapt existing defence products/services for non-defence markets

(1) IMPORTANCE Priority Important Neutral Unimportant

(2) CHANCE OF SUCCESS V. Good Achievable Unlikely V. Low

(c) Diversify into (or develop) new defence products/services

(1) IMPORTANCE Priority Important Neutral Unimportant

(2) CHANCE OF SUCCESS V. Good Achievable Unlikely V. Low

(d) Diversify into (or develop) new non-defence products/services

(1) IMPORTANCE Priority Important Neutral Unimportant

(2) CHANCE OF SUCCESS V. Good Achievable Unlikely V. Low

17) What, if any, attempts have been made to reduce existing levels of defence related work?

18) The intention of the research is to follow up a selection of the companies surveyed to develop some more detailed case studies, examining a representative range of some of the most interesting responses. Would you company be prepared to take part in this work if requested? (This would simply
involve a half day visit to the company to talk to one or two people in more detail about the issues covered here)

Yes

No
Capabilities, Strategy and Environment: The Adaptation of the UK Military Aircraft Industry to the Post-Cold War Environment

DONALD HISLOP

ABSTRACT  This paper examines how companies in the UK’s military aircraft industry have responded to the post-Cold War environment of reduced defence budgets. Given the substantial decline in levels of global defence spending since 1989, it is perhaps surprising that few companies have attempted to diversify out of defence markets. This paper considers the extent to which the defence market environment has influenced the organizational capabilities possessed by companies potentially limiting their relevance to other markets, thus constraining the diversification opportunities available. The explanation suggested here is largely neo-Schumpeterian, where a company’s interaction with, and interpretation of, its market environment results in it possessing rather specific and non-general capabilities. However, the nature of organizational capabilities was not found to be an adequate explanation on its own for the company strategy observed. Rather, strategy was as much influenced by the corporate focus on short-term economic considerations and the policy of central government towards both defence procurement changes and the lack of support given to diversification.

Introduction

Following the end of the Cold War, there has been a significant decline in worldwide spending on the development and procurement of weaponry, with military spending in Britain not being excluded from this downward trend. The effect of this reduction on the UK’s defence aerospace industry has been substantial, impacting at all levels of the industry. From the prime contractor down to the broad base of component suppliers, there are few companies which have not experienced some adverse effects of this reduction in spending. In light of this, it may be surprising that there have been few concerted attempts to diversify organically. This refers to what is often called conversion, where resources previously dedicated to military work are adapted for alternative non-military applications. This paper, based on empirical work conducted between late 1994 and mid-1995, will examine a range of companies, looking at how they had been affected by the spending cuts and the strategies they adopted as a response. The research focused on two issues: first, the nature and specificity of their technological and organizational capabilities; second, the factors which had influenced any changes in strategy. This allowed questions concerning the uniqueness of military industries capabilities and skills to be addressed.

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It was found that the capabilities and behaviour of these companies had been shaped by the characteristics of the UK's military aircraft sector. However, their capabilities were also influenced by other factors, such as the technical requirements of the work undertaken and the dynamics of customer relations. It is suggested that, by relating these findings to more general, neo-Schumpeterian theories on the relationship between a company and its market environment, and on the specificity of company knowledge and capabilities, that all companies, not just those in defence markets, have rather narrow and specific skills and capabilities. These findings suggest that this is a constraint on company behaviour and thus provides a partial explanation for the lack of diversification found. But this is inadequate on its own for explaining the strategies adopted by the companies. Rather than being concerned with reducing levels of defence work through diversification, the strategies adopted ranged from reducing company size through 'downsizing', restructuring internal practices while still focusing on defence markets and putting a greater emphasis on exports of defence equipment. To understand this behaviour more readily, it is necessary to look at broader factors which shape their behaviour, the most important of which include the short-term economic focus of companies and the influence of government through its multiple role in these markets as customer, controller of procurement policy and supporter of export efforts.

Methodology and Industry Structure

Characterizing all companies involved in military work as part of a homogeneous group misrepresents the diversity of company type which exists; for example, in terms of company size, product type, etc. This diversity needs to be considered when one is examining the experiences and capabilities of companies involved in defence work, as existing empirical evidence suggests that the experiences of companies at different levels of the industry can vary considerably. The military aerospace sector is considered to be primarily structured around a hierarchy of components and subsystems based on the technical requirements of the weapons platform. In the case of the military aircraft sector, this produces a pyramidal shaped structure, with three separate tiers. The apex represents the prime contractor, responsible for the design, manufacture, integration and supply of complete aircraft systems. At the second tier are the major subcontractors, with responsibility for the design and supply of large subsystems, such as radars, navigation systems, displays or radios. Finally, the third tier is made up of companies which supply individual components or materials to the first or second tier companies. The importance of examining the third tier is reinforced by the fact that it is a part of the defence industrial base often ignored in research owing to the methodological difficulties in obtaining a typical sample of companies.

Companies at all three levels of the industry were examined, with the selection methods adopted varying to suit the differing characteristics of each tier. However, in all cases, the same range of empirical sources was used. The primary source of information was semi-structured interviews with management representatives from each company examined. Secondary data were also obtained from public sources, such as company reports, news and journal articles, and parliamentary papers, but owing to the small size of the third tier companies, no secondary material was available, except for that provided by the companies themselves.

At the level of the prime contractor, selecting the companies to be approached was not an issue, as there is only one company involved, British Aerospace's Military Aircraft Division. However, its management proved helpful and gave extensive access to company representatives. At the second tier of the industry, where avionics and major sub-systems are designed and manufactured, a number of companies were identified,
Adaptation of the UK’s Military Aircraft Industry

with three typical examples being examined. At the third tier, different methods were used to identify companies owing to the large number of companies involved and the lack of any particular regional focus. There are divergent estimates of the number of companies involved at this level, but in a study of the supply chain for Eurofighter, over 500 companies were identified. For this research, 19 small companies from Lancashire’s defence industrial base were surveyed by a questionnaire, and three cases were followed up with site visits and interviews.

Company Capabilities and Experiences: 1989–Present

This section is divided into three parts, with the first examining how the companies have been affected by the decline in defence spending, the second considering the nature of their organizational and technological capabilities, and the third focusing on the different strategies adopted by the companies.

Effects of Spending Reductions

In general terms, none of the companies examined came through the past 6 years unchanged. A virtually constant experience for companies at all three tiers of the industry was a reduction in business and simultaneous decline in employment levels, although a substantial diversity of experiences was found in terms of degree. For British Aerospace’s Military Aircraft Division, 1990–1993 in particular was a period of great uncertainty and turbulent change as the core of its development and production contracts were subject to delay, uncertainty, reduction or outright cancellation. For example, throughout this period the scale and future of the European Fighter Aircraft (EFA) development and production contract was subject to substantial doubt, the RAF cancelled orders for Tornado aircraft following the ‘Options for Change’ review, a major export order to Saudi Arabia was in doubt, and further exports to Oman, Malaysia and Jordan were cancelled. This turbulence, however, was not reflected in the company’s annual financial statistics, as its turnover actually remained relatively stable between 1989 and 1995. During the same period, however, there was a substantial reduction in is employment levels, producing the closure of two of its most historic sites at Kingston and Preston. Since 1990, for example, Military Aircraft Division employment declined from approximately 25,000 to 16,000 (interview source).

At the second and third tiers, similar experiences of declining employment and turnover were found. Of the three second tier companies interviewed, only one had maintained its 1990 levels of turnover and employment, while the other two had both experienced an approximate decline in employment of 40%, accompanied by a less severe reduction in turnover. Of the 19 third tier companies surveyed, 47% had experienced a substantial decline in both turnover and employment, while 30% estimated their levels of business to have been unaffected over the past 6 years. Of the three third tier companies interviewed, all had experienced an approximate 40% decline in turnover and employment between 1990 and 1995, with two actually having gone into liquidation and being bought back out of receivership. For example, one had gone from employing 200 people on four sites to 90 employees on a single site in the space of 10 years.

This reduction in business for second and third tier companies was the indirect effect of the cancellation and delays of contracts that British Aerospace’s Military Aircraft Division experienced first-hand. The third tier companies, which tended to be manufacturing entities rather than design companies, all experienced a substantial and very
sudden loss of business when the RAF Tornado production contract was cancelled following the ‘Options for Change’ review. The third tier companies had also experienced changes in subcontract relations with the prime contractors and second tier companies, another factor contributing to the decline in turnover they experienced. At the third tier, companies were more vulnerable to closure than the larger first and second tier companies, owing to their relative lack of financial resources, which meant they had very little to cushion themselves with when their business declined.

However, despite this decline in their levels of defence work, only one of the companies examined (at the third tier) was attempting to enter civil markets to any significant extent. Before we consider the strategies actually pursued by the companies examined, it is necessary to outline the capabilities they possessed, as they are likely to influence the strategies adopted.

Company Capabilities

Organizational capabilities. From the interview material, it became apparent that the organizational structures and capabilities of the first and second tier companies were very similar; therefore they will be discussed together in this section. Three separate factors were found which effectively described their distinctive characteristics, but these were not found to be particular to defence markets alone, having relevance to a range of non-defence markets.

First, it was apparent that these companies were concerned primarily with undertaking large-scale development projects, which shaped their organizations in particular ways, requiring them to have: large design and development functions requiring a high proportion of professional staff; manufacturing and test facilities suitable for small-batch, high-quality production runs of elaborate components/assemblies, which also must be adequate to satisfy the requirements of the development phase of contracts; large administration, quality and contract departments, in order both to monitor the development of design progress and to control the large amount of subcontract work required. Undertaking large-scale technical development contracts could be described as the main characteristic of these companies. The ‘core competence’ of these companies was being a ‘system integrator’, a phrase repeated by a number of managers. This capability is not unique to defence companies and defence markets, but is potentially relevant to a range of non-defence markets; for example, civil aerospace or civil air traffic control. Yet entry into even these markets has not been attempted by the companies studied.

The second distinctive factor of companies in the top two tiers of the industry was that their production capabilities and systems have developed particular characteristics, related to the emphasis in manufacturing on supplying equipment, where there was a greater emphasis on compliance with technical requirements rather than meeting cost parameters. Interviewees acknowledged that this had resulted in organizational efforts being focused on developing manufacturing systems which could produce equipment and components to the required technical standard rather than to cost targets. Interview evidence also suggested that operating under these priorities resulted in an underdevelopment of effective management systems for monitoring and complying with cost requirements. Historically, in defence markets, there was little incentive or requirement for first or second tier companies to invest in reducing their manufacturing costs; therefore, they have been more concerned with product rather than process innovation.

However, recent experience in these companies has shown that such priorities are far from static or unchangeable, as these are areas in which they have introduced substantial changes (see pp. 9–10). The extent of their historic blindness to cost-driven manufacturing
systems is illustrated by the rapidity and relative ease with which they have been able to reorganize extensively their manufacturing systems over the past few years. Again, while often seen as unique to defence markets, similar priorities are operated in a range of non-defence markets, also typically government sponsored, where manufacturing is driven by similar priorities; for example nuclear power stations, commercial ground radar equipment for airports.

Finally, there were a number of distinctive characteristics to company–customer relations in the defence procurement environment which influenced the operation of the sales and marketing functions in first and second tier companies. In military markets, unlike the majority of similar civil markets, the primary customer (UK government) pays for a significant proportion of development work, which gives it a substantial element of power and control. This was found to be exerted through the procurement process, where government dictates the (almost exact) specification of equipment, when competitions occur and the methods by which competition is conducted. In export sales, the role of government support is also apparent, taking the form of financially underwriting sales, agreeing offset deals and more informal government marketing support. In all areas of defence markets, customers explicitly define their requirements in specifications, against which companies compete; therefore, ‘customer’ requirements are known, making it unnecessary to conduct commercial, inquisitive-type market research. This results in sales and marketing processes being done in very different ways from most civil markets. Typically, military sales and marketing is done through informal relationships and networks with a small and relatively constant range of interest groups, such as MOD procurement, the relevant service personnel and other industrial interests.

The organizational structures and behaviour of the third tier companies were shaped more by the requirements of aerospace markets than any particular requirement of military markets. At this level, all the interviewees noted that, for subcontract manufacturing at least, the key requirements of military and civil aerospace work were similar. This was for the batch manufacture of low-volume, high-quality components. The organizational requirement this placed on them was to operate extensive and thorough quality systems for all work, involving a substantial administrative aspect, which produced an overhead cost burden. This was necessary for both military and civil aerospace work, but prevented these companies from competing in higher-volume, lower-quality markets owing to the overhead cost penalty. One company had previously attempted, unsuccessfully, to diversify into the manufacture of agricultural machinery such as slurry injectors, but found that the operation of its existing quality requirements meant that it could not compete effectively on cost.

Another element of the organizational characteristics of the third tier companies, which can be attributed to the particular operation of defence markets, was the general underdevelopment (or complete absence in one case) of proactive sales and marketing functions. In these markets, until approximately the mid to late 1980s, these companies operated with a small, but remarkably constant group of customers, winning contracts mostly on a repeat basis. Business had traditionally depended more on establishing a reputation as an effective supplier, than on active sales and marketing; thus, such functions were never required. The senior personnel within these companies tended to undertake these responsibilities without them ever being formalized into a general system. In all three of these companies, which had successfully built up their businesses in this manner, such functions were seen as unnecessary. This made entry into other markets difficult, and the development of these systems has been the main focus of effort for the one company which was attempting to diversify.
Technological capabilities. When one is considering technology, it is important to acknowledge that it represents much more than simply physical artefacts, and can also be thought of in terms of abstract knowledge and human skills. Therefore, in examination of the technological capabilities of companies, these definitions should be incorporated to describe company capabilities in their fullest sense. As indicated previously, the third tier companies examined were only manufacturing entities; therefore, the capabilities discussed will be in terms of the skills and knowledge of their personnel alone.

The prime contractors and the second tier companies will be examined together in this section, but discussion of their technological capabilities will be separated into two sections, considering the nature of their products first and their generic knowledge and skills second. For both the prime contractors and the second tier companies, it was felt by the interviewees that the products they developed for military applications were not suitable for use in other, non-military environments, even if substantial modifications were to be undertaken. For example, two of the interviewees from avionics companies argued that there were such substantial differences in the design and functional capabilities between their military and civil products that the military systems simply were not adaptable (the particular products being referred to were radars and display systems). These differences were attributed by the interviewees to the unique and specific functional requirements of military systems, which have to be incorporated at the design stage; for example, low weight requirements, limited space requirements or the requirement for unique military functions, such as weapons control. This acknowledges the specific nature of the design process, which must incorporate the differing needs of each particular situation from the beginning. Therefore, the particular design requirements of military equipment result in military and civil equipment being substantially different from the early stages of the development process.

In the general technological capabilities and skills of the first and second tier companies, a significant difference was noticeable, with the capabilities and skills of the second tier companies being less specific and more generic than those of the prime contractors. For prime contracting in military aerospace, the skills and capabilities of a company are focused around the design and assembly of large, complex mechanical structures and their integration with sophisticated electronics systems. It can therefore be categorized as a large-scale systems design and assembly company, which has very limited generalizability to other applications. The capabilities of the second tier avionics companies, on the other hand, are focused on designing complex electronics systems. While this also requires system management and integration skill, the capabilities of being an electronics system designer are more generic, with a wider range of applications than for simply military equipment. But the assertion that the lower the position of a company within the product hierarchy, the more general its technological capabilities are likely to be, is not supported by the evidence for the third tier companies.

The technological capabilities of the third tier companies, like their organizational capabilities, were constrained less by the requirements of defence markets than by the requirements of being a precision, high-quality manufacturer. The level of precision and accuracy which needs to be built into components in this environment is much higher than in many other environments. Using the example of the company which attempted to move into the manufacture of agricultural products, the machine operators found adjustment to reduced levels of accuracy difficult. The result was that they tended to take longer than was required and made components of a greater accuracy than was necessary, thus pushing up their cost. This, however, was not felt to be an insurmountable problem, and it was argued by the interviewees that after a period of transition the workers could adapt to manufacturing for lower accuracy environments.
Company Strategies

In the following section, each tier of the industry is examined separately, with strategy being separated into two components, internal reorganization and external changes in market, product or customer focus.

Prime contractor changes. British Aerospace’s Military Aircraft Division undertook the most significant internal restructuring of all the companies examined. The beginnings of this change became apparent in late 1992, with the circulation of the company’s first mass, public business plan. This plan has been updated every year since then, but has remained focused on the same core changes. The 1993 plan talked ambitiously of a ‘culture change in a new market environment’, highlighting the extent of the changes the company intended to implement. The historical priorities, which the company was attempting to replace, were described by one respondent as follows: “the organization was traditionally dominated by engineering ... it was never an incentive, price driven corporation”. Its stated intention was to move from being predominantly driven by technical issues and run by technical people, to being more financially aware and commercially efficient in both its project management and manufacturing tasks.

These changes were focused on three areas: the introduction of new project management systems, the adoption of new manufacturing practices and changed subcontract relations. The new project management systems gave greater financial control and autonomy to individual projects, with the intention of improving their commercial efficiency through giving greater visibility and importance to these issues. Interview evidence suggests that historically projects were controlled by engineering functions, with the technical aspects of projects being given precedence over other issues, with the result that there had been a general negligence and underdevelopment of cost-effective project management practices. This transition was being managed through the introduction of new, multi-disciplinary project boards which were intended to provide a better balance in project management between technical, cost and delivery issues. The new manufacturing systems, which have been focused on one site (Salmesbury), have adopted cellular manufacturing techniques requiring much greater flexibility and multi-skilling among the workforce. As a result, many traditional demarcation barriers between individual craft trades have been eliminated. The stated motivation behind these changes focused on reducing the cost of manufacturing through the implementation of more cost-efficient practices, but they also allowed the company to implement sweeping changes to work practices and employment conditions, which had the effect of eroding trade union power. Both of these changes have been accompanied by significant levels of redundancies for manufacturing and design staff. The final element of the changes was the adoption of a preferred supplier scheme, with the intention of reducing the company’s supplier base and improving the efficiency of its subcontracting work. Over the past 5 years the company supply base has shrunk from approximately 11 000 to less than 4000 companies (interview source).

The external market focus of the Military Aircraft Division also changed in the early 1990s, giving much greater priority to export markets, which appears to be driven by declining levels of domestic orders. Exporting is now such a significant proportion of the Military Aircraft Division business that between 1992 and 1995, export orders have accounted for at least 80% of British Aerospace’s defence sales. As will be discussed in the analysis section, however, this has been achieved through substantial government support. The company did not make any substantial efforts to diversify out of defence markets in the early 1990s, with
management seeing such a strategy as risky and unlikely to succeed due to the particularity of the divisions capabilities.

**Second tier strategies.** The level of internal and external restructuring undertaken by these companies varied substantially, increasing almost in direct proportion to the reduction they had experienced in their defence business. There was little visible change in the strategic focus of the company which had suffered least from declining defence orders. Conversely, the company most affected had introduced extensive changes by separating its military and civil business into two distinct divisions, in order to achieve a greater sensitivity to what was perceived to be the diverging needs of each market and customer (this company had historically been organized around product groups rather than markets). Simultaneously, it also pursued an aggressive downsizing strategy, which resulted in profit ratios remaining constant and productivity increasing substantially, while its employment levels and turnover almost halved over the same time period (1989–1993). The third second tier company, which had experienced significant employment reductions, did not undertake any substantial internal restructuring, with redundancies being more a reaction to declining orders than part of a coherent longer-term strategy.

With regard to external market and product focus, there were similarities and differences as to how the companies have evolved and changed over the past 6 years. The similarity was found in the lack of importance and support given to organic diversification. Only one company was supporting any diversification, and this was acknowledged by the interviewees to be peripheral rather than central to the company’s future, with the diversified business not intended to replace the existing defence work. All interviewees expressed the opinion that they were confident they could survive in defence markets as niche suppliers, even if their turnover and employment were significantly down on historical levels. There was a general confidence that defence procurement was currently as low as it was likely to get, and that if anything it was likely to go up in the future.

The substantive difference between the second tier companies was found in the extent to which they had attempted to change the geographic focus of their business, but it is only possible to make broad, not absolute, statements on this subject. One of the companies was content with its current, predominantly UK-based, market focus, while another was making efforts to penetrate Asian export markets more effectively. The third company had shifted its focus to entering US markets, through the acquisition of a number of similar American aerospace companies. However, this policy started in the mid-1980s, and therefore cannot be seen as a response to declining defence markets. In general the change in external focus, and particularly looking at export markets, was seen as less important for the second tier companies than it was for British Aerospace’s Military Aircraft Division.

**Third tier strategies.** The most significant change for these companies was their reduction in employment, which, in all cases, was in direct response to declining levels of business. In only one of the companies had there been any internal restructuring, which involved the reorganization of management structures to make them slimmer and thus reduce overhead costs. Simultaneously, different working practices for manual operators were introduced, with the intention of reducing manufacturing costs. These changes were intended to reduce demarcation boundaries and introduce greater flexibility, with an operator inspection system also being implemented. For the other two companies, no substantial organizational restructuring had been undertaken.
In a similar vein to the second tier companies, management in the third tier companies was confident that levels of defence work would not drop below current orders, and that the company could continue operating in these markets, although with significantly reduced levels of business. Therefore, only one of the three companies was actively pursuing a diversification strategy, aimed at moving from defence and aerospace markets into other, similar, high-quality, low-volume markets. These efforts were in their embryonic stages, focusing on the development and application of new sales and marketing skills to other markets. The other two companies, while not trying to diversify out of defence or aerospace work, were making efforts to broaden their customer base, in order to reduce their dependence on one particular customer. At this level in the industry these companies are very vulnerable to changes in the procurement policies of their dominant customers. For example, British Aerospace's change to a reduced supply base of preferred suppliers had a dramatic effect at this level of the industry.

Analysis

This section examines three separate issues and begins by relating the conclusions of the research to existing theory on the uniqueness of the defence market environment and defence company capabilities. While it is concluded that the capabilities of the companies examined are narrow and specific, they are relevant to a range of non-defence markets and were by no means found to be unique. Large differences were also found between the three tiers examined, which leads to the second subject of analysis: whether the capabilities and skills of all companies are actually very specific, with a narrow applicability in other market sectors. Finally, the third section will consider the main factors which have influenced the strategy of the companies examined.

Organizational and Technological Capabilities

As stated previously, there is a range of material which characterizes companies involved in defence work as possessing a range of skills and capabilities which have little relevance to non-defence markets. This section will address a number of these ideas, comparing them to the findings of the research.

Organizational capabilities

(1) Defence markets are excessively bureaucratic compared to other markets in terms of quality and traceability requirements.23

While it can be concluded that there are substantial administrative and quality requirements on companies at all three levels of the product hierarchy, there is no conclusive evidence that these requirements were particular to, or more excessive in, defence markets. For the first and second tier companies, it was argued by all interviewees that equivalent, comparable civil markets (for the design, development and manufacture of large, non-defence technological systems) were no less demanding in terms of such requirements. The third tier companies considered that there were also no significant differences in terms of administrative requirements between military and non-military markets.

(2) Defence companies give priority to technical rather than cost considerations, which results in organizational practices which are uncompetitive in comparison to those found in commercial markets.24
While this may have been true historically, it is much less so now, owing to the substantial changes the majority of the companies have introduced, particularly with regard to their manufacturing systems. Among the first and second tier companies, broad-ranging changes to production have been introduced, resulting in significantly more cost-effective manufacturing systems. However, these systems are still only appropriate for the small-scale, batch production of high-quality products and are totally inappropriate for mass production markets, for example. These capabilities, while substantially restricting the markets the companies could enter, were not found to be specific to military markets alone, having applicability in a number of non-defence markets.

(3) In defence markets the relationship between the customer and the supplier is very particular, which results in these companies possessing unique sales and marketing capabilities.25

It is concluded from this research that claims about the uniqueness of defence company capabilities have most resonance in this area of company activity. However, these conclusions have most relevance to prime contractors, who are closest in the market to the final customer of complete weapons systems, and who are therefore most directly affected by the particularities of defence markets. What separates defence markets from all others26 is in the relationship between industry and government, which has substantial effects on the type of sales and marketing activities the prime contractors conduct. The point made by Dunne and Smith,27 that “the most important skill for a defence producer is the ability to persuade governments to give it money”, is generally accurate. At the risk of making too obvious a point, the products of defence industries—military weapons—are of immense strategic importance to governments. Thus governments have more strategic and political interests in these industries, in terms of the functional characteristics of the products and in maintaining certain domestic capabilities, than in virtually any other area of industry. The effect of this government involvement is to bias the sales and marketing activities of prime contractors (and to a lesser extent second tier companies) towards complying with government requirements to such an extent that they have limited applicability to other market environments. This proximity of interest was apparent not just from interview sources, but also from recent secondary sources outlining government procurement changes (see following section) and from historic accounts of how the military aerospace industry has developed.28

Technological capabilities. Broadly, these capabilities were more specific to defence markets than the organizational capabilities. However, as described, substantial differences exist between each tier as to the character of its technological capabilities. The military products designed by these companies had no direct commercial applicability, as they were designed either for unique military requirements or to cope with a more demanding physical environment. This supports other evidence,29 which has shown that the technological trajectories defined by military requirements differ from those in other markets, resulting in the ‘separation’ of military design and development projects from other projects within companies. This distinct trajectory for military technological development is the result of an iterative weapons acquisition process driven more by a military demand for continually improving certain product characteristics than by any cost constraint.30 The general technological capabilities of the companies, however, are concluded to have applicability and relevance beyond military markets. The most specific capabilities, in this respect, were found in British Aerospace’s Military Aircraft Division, and have relevance in only a narrow range of other areas requiring large-scale system integration. The general technological capabilities of the second and third tier companies
were seen to have relevance in a broader range of non-military markets, presenting greater opportunities for diversification and technology transfer, but their relevance was still restricted to a rather narrow range of parallel, non-military markets.

Specificity of Company Capabilities

While it was concluded that the capabilities of all the companies considered did have relevance outside defence market, they were seen to be specific and non-general in nature, with applicability in a rather narrow range of different environments. This, combined with the finding that there were substantial differences in capabilities between each tier, suggests that the capabilities of the companies are contingent on the character and priorities of the specific market environment they operate in. These conclusions support a neo-Schumpeterian model of firm behaviour, where it is argued that a firm’s capabilities are the result of its interaction with and interpretation of its particular market environment. In this model, it is argued that in general the capabilities of any company are thus likely to be specific and non-general owing to the different priorities and dynamics which exist in each company’s immediate environment.

Referring to the contingent nature of company capabilities, however, does not imply a simple causal relationship between a firm and its market, with firms being shaped by unambiguous market signals, as market ‘signals’ and priorities are extremely subjective and open to interpretation. Further, the number of contingent factors which influence a firm’s operating practices, skills and capabilities is extremely large, which makes it impossible to compare and weight contingent factors in any strict quantitative way. The range of such factors includes the range and type of technologies required for design or manufacturing, the pace, trajectory and origins of technological change, the volume and quality of products manufactured, the relative power of a company compared to other competitors or customers, the number of competitors and customers, the degree of regulation in the market, etc. To appreciate fully the dynamics of each company’s environment, therefore, requires a close examination of its circumstances. Within the relatively small sector examined, for example, substantial differences were found between the three tiers considered in terms of the type of company, the product output and the relevance of their skill to other markets.

One implication of the foregoing is that other sectors of the defence industrial base may have very different experiences and capabilities, as the characteristics of their sector may be very different. (This research is part of a broader study, where the changes in this sector and its companies are compared with those in the vehicle and electronics sectors of the UK’s defence industrial base.)

Company Strategy and Its Shaping Factors

The previous sections have shown that the technological and organizational capabilities of all the companies interviewed were rather narrow and specific, with only limited relevance to other market environments. However, this does not provide an adequate explanation on its own for the strategies they adopted. This section will examine two other relevant factors, argued to play an important role in shaping the strategy of the companies: first, the narrow, financially driven behaviour of the companies will be shown to have constrained their strategy options; second, the role of government policy will also be seen to have constrained the possibilities for diversification.

The short-term financial motivation of companies provides a rather effective barrier to organic diversification, as in purely economic terms it does not give the most attractive
or efficient short-term economic solution. Quigley argued that factory-based organic diversification, where existing capabilities and skill were adapted for other applications, was unlikely to occur, as long as company policies were driven by narrow economic objectives. Such a strategy would require long-term investment and careful planning, and is primarily a social rather than economic issue; therefore, it is unlikely to be in the economic interests of private capital to pursue.

On the evidence from all levels of the aerospace sector, this analysis is verified. It was apparent from virtually all the interviews conducted that changes in strategy were driven primarily by short-term economic goals rather than longer-term investment considerations. The predominant response and core strategy of all the companies involved has been to downsize in terms of employment to a small core workforce, to maintain a focus on defence products as the core business and to pursue defence sales in alternative (predominantly export) markets. For the first and second tier companies, in terms of financial indicators such as profit ratios, sales ratios and productivity, these strategies can be deemed successful, even though in many cases they were achieved by vast reductions in the size and employment levels of the companies. The shrinkage in size of the companies was argued to be a necessary response to changed market conditions. Diversification was argued by most of the managers interviewed to be an unsuitable strategy, which would involve high risks and uncertain investment decisions that were not felt to be justifiable. Diversification, if attempted, is likely to be at the corporate level, through the acquisition of non-defence companies, rather than organically by the adaptation of defence capabilities. Therefore, while companies are driven purely by narrow economic objectives, organic diversification is unlikely to be pursued. To encourage organic diversification among companies, some form of government intervention would be necessary. This, however, has not occurred, and is the issue to be addressed next.

During the past 10 years, since approximately the mid-1980s, the explicit policy of the UK government with regard to defence industry restructuring has been to argue that 'market forces' and 'competitive pressures' should direct company policy. It has therefore done little to oppose the massive job losses which this restructuring has produced. This ideology, however, denies the fundamental nature of these markets, which in no respect are 'free' markets, as the UK government, to a large extent, creates and controls these markets by its policy mechanisms. Support from government in encouraging any form of diversification for defence-dependent companies has therefore not been forthcoming, making such moves by industry alone extremely unlikely. However, in contradiction to its free market ideology, even though it has not opposed the redundancies which have occurred, the government has implemented decisions and policies to support companies in the defence industries. Through its encouragement for defence equipment exports, the government has found a way of supporting industry while at the same time encouraging the 'shedding of fat' by these companies.

The government's support for exports has been achieved both directly, through government lobbying and negotiation with foreign governments, and indirectly, through financial support for these exports. In three recent contracts for defence aerospace exports (to Saudi Arabia, Indonesia and Malaysia), the government has played a pivotal role in helping to win contracts. In the case of the Al Yamamah contract to Saudi Arabia, Mrs Thatcher played an active role in encouraging the Saudi government to purchase British equipment. One interview source described this contract as "basically a government to government deal". The formalization of this government marketing role in support of defence industry equipment sales is achieved through the Defence Export Support Organization (DESO), which provides a support network of contacts and
information to these companies. The indirect financial support for defence equipment sales is achieved through the Export Credit Guarantee Scheme (ECGS), which underwrites the funding of equipment exports to less industrialized countries. This is not used purely in support of defence exports, but there is evidence that it is very much biased in this direction.  

The effect of these policies on the export performance of the UK's defence industries has been substantial, with Britain's share of world arms exports increasing to 20%, making it the world's second largest arms exporter in 1995.  

The effects of these policies on companies in the aerospace sector are most apparent when one looks at the prime contractor, which, as noted previously, now has a high proportion of export orders. While these policies are directed very much towards the large prime contracting companies, they do have a 'trickle down' benefit to those second and third tier companies which have equipment on the systems exported.

In sum, owing to the ubiquitous influence of government, direct or otherwise, it is not going too far to say that, in this sector, the government is the major market force.

Conclusions
The end of the Cold War has produced in Britain the most dramatic downturn in defence spending since the end of World War II, creating a large amount of uncertainty in defence industries, which has produced an equally dramatic response on the part of most companies. The strategy adopted by most, however, has been driven by narrow economic considerations, aimed at reducing their costs and improving their operating efficiency within defence markets. There have been no significant efforts by any of the largest defence aerospace companies to diversify out of defence through the adaptation of existing defence capabilities. The result of these reorganization strategies has been to produce companies which are substantially smaller in terms of employment, but which have substantially reduced their operating costs. The research concluded that the strategic behaviour of the companies, in relation to declining levels of defence work and the lack of diversification that was found, was as much influenced by the particular economic goals pursued by the companies and the role of government policy as it was by the nature of their organizational or technological capabilities.

At all three levels of the product hierarchy, both the organizational and technological capabilities of companies were shaped by both the requirements of defence markets and the nature of the tasks undertaken. However, the effect of the defence market environment and the nature of capabilities varied tremendously between each level of the hierarchy. The most distinct aspect of defence markets is related to the close relationship that the largest companies have to government. This is owing to the government’s triple role as customer, creator of the domestic procurement environment and supporter of export efforts. The result is that the sales and marketing capabilities of these companies are unsuited and unadaptable to the different customer dynamics of other markets.

The technical and organizational requirements of developing and manufacturing defence equipment were also found to constrain the capabilities of the companies examined. The capabilities of the prime contractor were found to be the most specific, in terms of both organizational structures and technological capabilities, as they are shaped by the requirements of designing and managing large-scale, complex engineering projects within an environment where the central government plays a very powerful role in defining priorities. The technical requirements which dominate the development of military equipment and the lack of experience defence prime contractors have in dealing with non-governmental customers results in company structures and organizational
behaviour which are suited to a narrow range of environments. Of the three company
types considered, it is the prime contractor which has the least potential for di-
versification. In a similar way, the organizational and technological capabilities of the
second tier companies are also constrained by the requirements of conducting large-scale
R&D projects in a defence environment with very particular technical and organizational
requirements. However, these companies have more generic technological capabilities
based on developing complex electronic systems, with relevance to a wider range of
environments than those of the prime contractor; for example, in civil information
technology and communications markets. For the third tier companies, the most
significant effect of defence markets was organizational: they had poorly developed
marketing skills, which were regarded as historically unnecessary to operate in defence
markets.

Diversification, in order to maintain employment levels, was seen to be more a social
goal than an economic one, and was therefore a strategy unlikely to be pursued by the
companies researched, which were found to be driven by wholly economic motivations.
Moreover, effective diversification would require large-scale investment, long-term plan-
ing and very substantial adaptation, which appeared to those interviewed to be too
uncertain and risky a strategy to be pursued. As stated, the role of government, which
has been non-interventionist with regard to job losses, but supportive in terms of defence
equipment exports, has also appeared to have a substantial effect in persuading
companies to pursue strategies where they remain within defence markets. In conclusion,
organic diversification is a strategy unlikely to be pursued by these companies, no matter
what the nature of their organizational and technological capabilities.

Notes and References

1. In GDP terms, Britain’s defence budget has declined from its mid-1980s high of 5.6% to 3.9% in
(London, HMSO, 1994)). In financial terms, using fixed prices, the total defence budget has
dropped from £27.23 billion in 1985–1986 to £23.76 billion in 1992–1993 (UK Defence Statistics,

2. There is a body of literature on the defence industries and defence companies which argues that
defence markets are unique environments, which result in the companies operating in these
markets possessing extremely specific capabilities, with limited relevance to other markets. Diversi-
fying into non-defence markets by such a company is therefore likely to be a difficult process. For
example, see B. Berkovitz, ‘Why Defence Reinvestment Won’t Work’, Technology Review, July 1994,
pp. 53–60; P. Dunne & S. Willett, Disarming the UK: The Economics of Defence (Leeds, University of
Leeds, 1992); S. Schofield, M. Dando & M. Ridge, Conversion of the British Defence Industries (Bradford,
Department of Peace Studies, 1992).

3. J. Finch, ‘Company Led Strategies in Defence Sector Restructuring: Implications for Local
the Future: Converting the St Louis Economy (Rutgers, NJ, Department of Urban Planning and Policy
Development, State University of New Jersey, 1993).

4. P. Gummett, ‘Issues for STS Raised by Defence Science and Technology’, Social Studies of Science,

5. The number of interviews conducted in each company varied from one to five, being dependent
upon the amount of access and time granted. The intention was to conduct at least two interviews
in each company with managers from different functions, but this was not always possible.

6. The list of companies was developed from publicly available government procurement sources, and
represents the most significant companies at this level in the industry. Over 20 separate operating
divisions were identified, but in reality this sector of the industry is dominated by a small number.
of companies, the largest and most significant of which is GEC. The large companies operate in these markets with a number of separate, semi-autonomous divisions. The three companies examined were selected to take account of these factors.

8. The survey was sent to 45 companies, from which 24 replies were received, but five of the companies had no military work, reducing the number of useful returns to 19. The three companies examined were selected to represent the range of experiences found within the questionnaire. The companies examined at the second and third tier level are not statistically representative of their population, but they were selected to reflect the most typical characteristics and experiences from their sectors. The consistency of the findings with information in the public domain allows a significant level of confidence to be put in the data.

11. Since approximately the mid-1980s, civil aerospace markets have also been in recession, with there being a substantial over-capacity in aircraft and avionics production, which would make entry into these markets difficult to achieve.
12. The primary customer is defined as the organization which proposes, stimulates and funds development programmes. While export sales to foreign governments are significant, this sales process is secondary to development and does not result in the fundamental redesign of equipment.
13. In the interviews with the first and second tier company representatives, the role of government was explicitly acknowledged. They stated that in international defence markets there is no such thing as a level playing field, with most interviewees arguing that the role of domestic government was to make them as uneven as possible.
14. There are a number of non-military markets which operate in a similar way; for example, air traffic control products specified and bought by the Civil Aviation Authority. But in civil aerospace markets, R&D must be funded by the company and not the customer, without the benefit of precise specifications to define customers needs. In all the first and second tier companies which had civil and military aerospace work, this was done in separate divisions owing to these very different customer relation dynamics.
15. Similar conclusions were reached in a study of the supply base of small companies in California’s aerospace industry. See G. Vernez, M. Dardia, K. McCarthy, J. Malkin & R. Nordyke, California’s Shrinking Defense Contractors: Effects on Small Suppliers (USA, RAND, 1996).
16. Similar conclusions about the relative lack of sales and marketing capabilities can also be found in other supplier surveys. For example, see Vernez et al., op. cit., Ref. 15; A. Hankinson, ‘In the Firing Line: Small Firms in Defence’, Certified Accountant, February 1993, pp. 14–17.
21. The company had set up, at the development stage, an industrial product group, with the intention of exploiting generic capabilities in non-defence markets. But the amount of resources and personnel allocated to these projects was low.
22. It was not possible for any of these companies to obtain numerical data, either current or historic, on the geographic distribution of their business, as this information was not broken down to the required level in the available company sources, and was a subject over which most interviewees would not give explicit details.
26. With the possible exception of the nuclear power industry.
34. In the late 1980s, British Aerospace adopted this strategy through the acquisition of a number of companies, the most significant of which was the Rover car group, and succeeded in diluting the corporation’s levels of defence work substantially.
37. In 1991–1992 the UK government spent £2267 million on defence-related R&D, while in 1992–1993 over £3.1 million was spent on equipment in the aerospace sector (UK Defense Statistics, 1994, Table 1.2; Annual Review of Government Funded R&D (London, HMSO, 1993), p. 27, which illustrates the power it possesses as the largest ‘market force’ in the industry.
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