Learning across business sectors: knowledge sharing between aerospace and construction

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Knowledge Sharing between Aerospace and Construction

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EPSRC
Engineering and Physical Sciences Research Council

IMRC
Innovative Manufacturing Research Centres

This report is based on a two-year research project funded by the Engineering and Physical Sciences Research Council (EPSRC). The research was conducted by The University of Reading in collaboration with seven industrial partners:

- BAE SYSTEMS
- Forticrete
- INBIS
- Mowlem Aqumen
- Mowlem Building
- N. G. Bailey & Co
- Scott Brownrigg

Foreword

In today's competitive marketplace it is too easy for managers to focus exclusively on short-term efficiency. Business survival depends upon the development of a long-term capacity to innovate. This means encouraging diversity of thought and making sure managers find time for reflection. Both of these are essential prerequisites to innovation. Firms must be committed to continuous investment in technology and process innovation. The latter is no less important than the former. Innovation requires a willingness to move beyond existing comfort zones. In an increasingly uncertain world, companies must innovate continuously if they are to remain competitive. It is not only sufficient simply to become efficient at what we already do. We must seek to develop new ways of working that are responsive to the demands of the future.

This report promotes innovation and knowledge sharing through 'learning across business sectors'. It is the product of a unique collaboration between The University of Reading and seven industrial partners drawn from the aerospace and construction sectors. The research challenges managers to think continuously about the wider business drivers that shape best practice. It also highlights the importance of continuously questioning currently accepted ways of thinking if firms are to adapt successfully to changing circumstances.

I am delighted to support the efforts of the team that has contributed to this research. The report deserves to be widely read and talked about. Our ability to cope with the future depends on a better understanding of the context within which we operate.

Sir John Gains
Group Chief Executive, Mowlem plc

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Executive Summary

This report addresses the extent that managerial practices can be shared between the aerospace and construction sectors. Current recipes for learning from other industries tend to be over-simplistic and often fail to recognise the embedded and contextual nature of managerial knowledge. Knowledge sharing between business sectors is best understood as an essential source of innovation. The process of comparison challenges assumptions and better equips managers to cope with future change. Comparisons between the aerospace and construction sectors are especially useful because they are so different. The two sectors differ hugely in terms of their institutional context, structure and technological intensity. The aerospace sector has experienced extensive consolidation and is dominated by a small number of global companies. Aerospace companies operate within complex networks of global interdependency such that collaborative working is a commercial imperative. In contrast, the construction sector remains highly fragmented and is characterised by a continued reliance on small firms. The vast majority of construction firms compete within localised markets that are too often characterised by opportunistic behaviour.

Comparing construction to aerospace highlights the unique characteristics of both sectors and helps explain how managerial practices are mediated by context. Detailed comparisons between the two sectors are made in a range of areas and guidance is provided for the implementation of knowledge sharing strategies within and across organisations. The commonly accepted notion of 'best practice' is exposed as a myth. Indeed, universal models of best practice can be detrimental to performance by deflecting from the need to adapt continuously to changing circumstances. Competitiveness in the construction sector too often rests on efficiency in managing contracts, with a particular emphasis on the allocation of risk. Innovation in construction tends to be problem-driven and is rarely shared from project to project. In aerospace, the dominant model of competitiveness means that firms have little choice other than to invest in continuous innovation, despite difficult trading conditions. Research and development (R&D) expenditure in aerospace continues to rise as a percentage of turnover. A sustained capacity for innovation within the aerospace sector depends crucially upon stability and continuity of work. In the construction sector, the emergence of the 'hollowed-out' firm has undermined the industry's capacity for innovation. Integrated procurement contexts such as prime contracting in construction potentially provide a more supportive climate for an innovation-based model of competitiveness. However, investment in new ways of working depends upon a shift in thinking not only amongst construction contractors, but also amongst the industry's major clients.

Learning across Business Sectors

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1.1 Background

1.1.1 This report describes the outcome of a two-year collaborative research project funded by the Engineering and Physical Sciences Research Council (EPSRC) as part of a wider initiative to promote 'learning across business sectors'. The research was a collaborative project between The University of Reading and seven industrial partners.

1.1.2 The research was born from a sense of unease regarding current exhortations to learn from other industries. Too often it is assumed that managerial practices can be simply transferred across sectors with markedly different structural characteristics. Different sectors frequently possess deeply ingrained 'industry recipes' that reflect and reinforce the way that the sector is organised. Such recipes provide unique cultures that encapsulate distinctive norms of behaviour.

1.1.3 Managerial practices are rarely universally applicable irrespective of context. Contextual influences are often so strong that 'best practice' recipes are manifested differently when implemented in different sectors. For example, it would be naïve to assume that collaborative working practices from a highly consolidated sector can simply be lifted and transferred to a sector characterised by fragmentation. Not only will the process of diffusion of such practices differ, but also their ultimate manifestation.

1.1.4 While it may not be possible to transfer managerial practices from one sector to another, this does not mean that invaluable learning cannot be derived from cross-sectoral comparisons. On the contrary, it will be argued that learning across business sectors is essential to innovation and continuous improvement. However, any attempt at knowledge sharing between industrial sectors must take into account contextual differences. Understanding the way that managerial practices are mediated by context is central to the learning process.

1.1.5 It must further be understood that no industrial context is ever static; industry sectors are constantly in a state of flux as they respond to external pressures. Any understanding of context must be predicated on an understanding of the dynamics of change. In this respect, universal prescriptions of 'best practice' are much less important than an ability to adapt successfully to changing circumstances.

1.1.6 The aerospace and construction sectors were not chosen because they are similar. They were chosen because they are so different. Whereas the construction industry is highly fragmented, the aerospace sector is highly consolidated. The two sectors differ hugely in terms of their structure and technological intensity. Aerospace is perhaps the ultimate of globalised industries. In contrast, the majority of construction projects remain rooted in local contexts. Comparing construction to aerospace highlights the unique characteristics of both sectors and helps explain how managerial practices are mediated by context.

1.2 Research aims and objectives

1.2.1 The research investigated the extent to which managerial practices can be shared between the aerospace and construction sectors. It also sought to develop an approach to knowledge sharing that could be implemented as part of a knowledge management initiative within individual companies.

1.2.2 More formally, the primary research objectives were originally stated as follows:

- To facilitate learning and knowledge sharing between aerospace and construction.
- To develop and evaluate a participative approach to knowledge sharing that recognises that business practices are inevitably rooted in a wider organisational context.
- To investigate the extent to which established practices within the aerospace sector can be successfully implemented in the context of prime contracting in construction.

1.2.3 Each of the above objectives is addressed in the conclusion to this report.

In common with many other exploratory research projects, the objectives evolved as the research progressed. The questions being asked at the end of the project were therefore rather different from those that were asked at the beginning. This was because the team's learning developed throughout the research. It is hoped that those reading this report will also treat it as a learning process. The intention is not to prescribe solutions or courses of action. Rather, it is hoped that the content of this report will encourage industry practitioners to challenge existing assumptions and to innovate in a way that is appropriate to the context within which they operate.

1.3 Research team

1.3.1 The principal investigator for the project was Professor Stuart Green of the School of Construction Management and Engineering (SCM&E) at The University of Reading. The co-investigators were Mr Robert Newcombe, also in the SCM&E and Dr Marylin Williams of the School of Psychology. The appointed researchers were Mr Scott Fernie and Ms Stephanie Weller. The research team was specifically chosen to encourage collaboration between social scientists and engineers, thereby meeting one of the key aims of the EPSRC 'Learning across Business Sectors' initiative.

1.3.2 The research team was guided and advised by a project steering committee comprising the following:

- Mr Martin Brown, Mowlem Aqumen (Chairman) [previously Mr John Lorimer]
- Mr Allan Day, BAE SYSTEMS
- Dr Simon Burtonshaw-Gunn, BAE SYSTEMS
- Mr Andrew Carpenter, Forticrete
- Mr Patrick Williams, INBIS [previously Mr Graham Thomson]
- Mr David Robertson, Mowlem Building [previously Mr John Barclay]
- Mr Terry Bilsbrough, N. G. Bailey & Co
- Mr Peter Caplehorn, Scott Brownrigg

1.3.3 The project steering committee was closely involved in setting the research agenda and priorities as the project unfolded. They also provided a significant input to the regular research workshops. Steering committee members further played a crucial role in facilitating access to specialists throughout their organisations and beyond. The authors are indebted to the steering committee for their invaluable support.

1.4 Structure of report

1.4.1 Chapter One outlines the background to the research project and details the industrial partners and the role of the project steering committee.

1.4.2 Chapter Two describes the importance of knowledge sharing and its link to competitive advantage. The problematic nature of knowledge is addressed and the crucial importance of understanding context is emphasised. Finally the adopted methodology for knowledge sharing between aerospace and construction is described.

1.4.3 Chapter Three compares the different contexts provided by the aerospace and construction sectors. Points of comparison include the structural characteristics of the two sectors and their respective relationships with government. Particular emphasis is given to global trends of consolidation in aerospace and the continued fragmentation of the construction sector.

1.4.4 Chapter Four addresses the way that supply chain management (SCM) is understood and enacted in the two sectors. The strategic and operational perspectives of SCM are compared and issues of confidence and trust are addressed. The current best practice agendas for SCM in both aerospace and construction are reviewed and critiqued. Particular attention is given to prime contracting in the construction sector.

1.4.5 Chapter Five examines requirements management as practised in the aerospace sector. The origins of requirements management are described and the key techniques are reviewed. Comparisons are made to the equivalent practices in construction. Consideration is also given to the extent that requirements management can be applied to construction.

1.4.6 Chapter Six focuses on the way that human resource management (HRM) is implemented in the two sectors. The concepts of 'high-performance HR' are introduced and the barriers to its implementation are addressed. Particular attention is given to how the mediating effects of context limit the scope for managerial action.

1.4.7 Chapter Seven addresses the topic of innovation and the way that it is understood and enacted in the aerospace and construction sectors. Different types of innovation are described and the need for a supportive climate is emphasised. Particular attention is given to the factors that encourage or impede the diffusion of innovation.

1.4.8 Chapter Eight concludes the report and presents the key lessons. Recommendations are made for practitioners in both sectors. Conclusions are presented in terms of the viability of codifying 'best practice' in isolation of any consideration of context. Guidance is provided for the implementation of knowledge sharing strategies within and across organisations.

1.5 Tables and use of margins

1.5.1 Each of the main chapters of this report contains numerous summary tables. These are intended as handrails, providing reminders of the structural characteristics of the two sectors throughout. The need to understand managerial practice in context is a recurring theme.

1.5.2 The report builds on the existing literature for each of the topic areas. Numerous references are provided in the margin for the benefit of the interested reader. Such published sources provide the platform upon which this research has been built. The use of these references reflects the philosophy that practitioners should continuously challenge accepted assumptions on the basis of a broader knowledge.

1.5.3 Also appearing in the margin throughout the report are numerous 'provocations', denoted by an exclamation mark. These are statements designed to provoke the reader into considering alternative views. They are deliberately provocative and do not necessarily reflect the opinion of the authors.

!

1.5.4 The final icon used in the margin is that of the 'talking head'. This is used to denote quotations taken from interviews with practitioners. These are used to reinforce the interview summaries provided in the main text.

2

2.1 Introduction

2.1.1 Effective mechanisms for knowledge sharing are increasingly viewed as essential to competitive advantage. An understanding of the underlying principles is an essential pre-requisite for 'learning across business sectors'. This chapter draws from the emerging discipline of knowledge management to develop a framework for knowledge sharing between the aerospace and construction sectors.

DTI (1998) **Competitive Futures: Building the Knowledge Driven Economy**, Department of Trade and Industry, London.

2.1.2 Knowledge management is subject to a multitude of interpretations and definitions. Most definitions are structured around the means and benefits of creating, sharing and using knowledge within organisations.

Abell, A. and Oxbrow, N. (2001) **Competing with Knowledge: The Information Professional in the Knowledge Management Age**, Library Association, London.

2.1.3 There are two dominant schools of thought in the knowledge management literature. The first focuses on the contribution of management information systems. The second sees knowledge management primarily as a human endeavour concerned with the development and retention of intellectual capital. Different approaches reflect different assumptions about the nature of 'knowledge'. For the purposes of this report, the second interpretation is most pertinent.

2.1.4 The focus on knowledge sharing is initially justified with reference to the knowledge-based economy. The benefits of participating in knowledge sharing are explained for both individuals and organisations. The problematic nature of knowledge is explored and the importance of context is established. Finally, the approach adopted for sharing knowledge between aerospace and construction is described.

! Knowledge is power!

2.2 Knowledge-based economy

2.2.1 The creation of a knowledge-based economy is a central part of Government strategy for trade and industry (DTI, 1998). An extensive literature links knowledge to competitive advantage (e.g. Abell and Oxbrow, 2001). Knowledge management is widely recognised as an essential part of best practice in both aerospace and construction.

2.2.2 The concept of the 'knowledge worker' has long been important to professional firms and high-technology organisations. In recent years, the growth of the service sector and the decline of traditional manufacturing have placed a wider emphasis on knowledge work. The provision of services is becoming ever more central to aerospace and construction. Contractors in both sectors are increasingly asked to provide a capital asset plus a guaranteed service over a fixed number of years. Continuous improvement in service provision is a commercial imperative; knowledge is the key resource.

2.2.3 Organisations are frequently characterised by silos of knowledge based around small groups of people. If organisations are to compete effectively in the knowledge-based economy they must mobilise knowledge in the cause of competitive advantage. Whilst such statements have strong rhetorical appeal, they are notoriously difficult to put into practice. Too often it is assumed that knowledge is an objective transferable commodity that can easily be captured, shared or transferred (Lanzara and Patriotta, 2001).

2.2.4 Individuals and companies are often unwilling to share their knowledge because they feel they are giving something away. Whilst trust is undoubtedly an essential pre-requisite, knowledge sharing is not a zero-sum game. Knowledge sharing is a creative activity from which all parties gain and an essential element of collaborative working.

2.2.5 Notwithstanding the challenges of knowledge sharing within and between organisations, the debate has recently extended to 'learning across business sectors'. The challenge of the research described in this report was to derive an approach that was theoretically defensible whilst being meaningful to the industrial participants.

2.3 The problematic nature of knowledge

2.3.1 Knowledge remains a heavily contested concept with opposing views regarding its definition and meaning. Significant confusion reigns regarding distinctions between data, information and knowledge. Data are objective facts presented in the absence of any categorisation. Data becomes information when they are structured and placed in context. Knowledge depends upon the interpretation of information from a particular perspective. Knowledge includes elements of judgement, intuition and values. Unlike information, knowledge is orientated towards action (Nonaka and Takeuchi, 1995).

2.3.2 There is a commonly accepted distinction between explicit and tacit knowledge (Goldblatt, 2000). Explicit knowledge describes knowledge that can easily be expressed and codified. In contrast, tacit knowledge is rooted in personal experience and cannot easily be expressed or codified. The distinction reflects longstanding philosophical debates about whether knowledge is essentially objective or subjective.

2.3.3 Too often, knowledge management is limited to the appropriation and exploitation of explicit knowledge. Tacit knowledge is either ignored or 'converted' to explicit knowledge. Unfortunately, knowledge relating to managerial practices is frequently rooted in the experience of individuals and is therefore tacit in nature; it cannot be packaged and transferred from one context to another. Such an understanding must be central to any attempt to learn across business sectors.

Lanzara, G.F. and Patriotta, G. (2001) Technology and the courtroom: an inquiry into knowledge making in organisations, **Journal of Management Studies**, **38**(7), 943-972.

! Competitive advantage lies in the process of knowledge creation. Those who refuse to participate on the basis of what they know already are gambling with a rapidly diminishing asset.

Nonaka, I., Takeuchi, H. (1995) **The Knowledge Creating Company**, Oxford University Press, Oxford.

Goldblatt, D. (Ed.) (2000) **Knowledge and the Social Sciences: Theory, Method and Practice**, Routledge, London.

! The problematic nature of knowledge has plagued philosophical debate since Plato and Aristotle's time and remains unresolved.

! Many managers do not know what it is that they know until such time as they need to know it.

2.3.4 Management information systems can be highly effective at storing, manipulating and transmitting explicit knowledge. However, as tacit knowledge is inseparable from individuals it can only be managed through the management of people (Baumard, 1999). Unfortunately, people are unpredictable and often unwilling to be programmed in accordance with a rationally designed system.

Baumard, P. (1999) **Tacit Knowledge in Organizations**, Sage, London.

2.3.5 Sharing tacit knowledge amongst individuals is highly dependant upon an ongoing process of socialisation (Turiel, 1983). Discussion and debate become the mechanisms by which people learn. To make sense of what a person is saying, it is necessary to understand the context within which they operate. Knowledge creation depends upon interactive and controversial social processes amongst individuals with different perspectives (Lanzara and Patriotta, 2001). Knowledge is created when individuals challenge the perspectives of others.

Turiel, E. (1983) **The Development of Social Knowledge: Morality and Convention**, Cambridge University Press, Cambridge.

Pettigrew, A. M. (1997) What is a processual analysis?, **Scandinavian Journal of Management**, **13**(4), 337-348.

McKinlay, A. (2000) The bearable lightness of control, in C. Pritchard, R. Hull, M. Chumer and H. Willmott (Eds.), **Managing Knowledge: Critical Investigations of Work and Learning**, MacMillan, London, pp. 107-121.

2.3.6 Knowledge can usefully be understood as a dynamic. Organisations are constantly in the process of creating it both consciously and subconsciously. Human knowledge is created and enhanced through a spiral of social interaction that engages with both explicit and tacit knowledge (Nonaka and Takeuchi, 1995).

! It is commonly accepted that taking an argument out of context can be dangerous and misleading. However, knowledge is invariably assumed to be universally applicable.

! Most popular management textbooks promote simplistic improvement recipes that are assumed to be applicable universally.

2.4 Knowledge in context

2.4.1 The aerospace and construction sectors comprise very different contexts, both in terms of industry structure and culture. Practitioners too easily take the context within which they operate entirely for granted. Managerial practices are frequently described with little recognition of the context within which they are enacted. A mutual understanding of the respective industry structures and traditions is an essential pre-requisite for 'sharing knowledge' amongst practitioners from different sectors. It is essential to understand the context within which practice is embedded (Pettigrew, 1997; McKinlay, 2000) *(see Figure 2.1).*

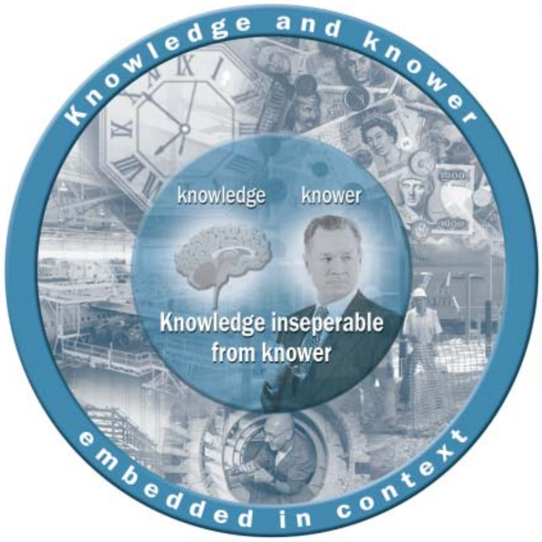

Figure 2.1: The importance of context

2.4.2 The aerospace and construction sectors have very different development paths that have been shaped over time by a complex array of economic, social and technological forces. The interaction of these forces provides the dynamic context within which firms operate. Managerial practices in different industries are governed by different 'industry recipes' of beliefs and rules (Spender, 1996). Such recipes of managerial practice are interwoven with the structural characteristics of the sector.

2.4.3 Of further relevance is Powell and DiMaggio's (1991) concept of 'institutionally embedded practices'. Organisations are seen to be subsumed under the broader category of institutions. The rules and norms that constitute institutions are reflected in organisational structures and processes. Changes in the latter cannot be understood in isolation from the broader sets of institutional norms and rules within which they are embedded.

2.4.4 When seeking to share managerial practices across business sectors it is the process of contextualision and re-contextualisation that generates understanding. Identifying common aspects and differences between the original context and intended context can in itself derive significant learning (Hull, 2000). It is the knowledge derived from this process that makes 'learning across business sectors' worthwhile. Assumptions are challenged and the capacity for innovation is enhanced *(see Figure 2.2).*

2.4.5 The 'best practice' literature displays little appreciation of the way in which practice is shaped by context. This explains in part why managerial 'fads and fashions' consistently fail to deliver what is promised. Managerial tools and techniques frequently lose their meaning once separated from the context within which they are embedded.

Spender, J.-C. (1996) Making knowledge the basis of a dynamic theory of the firm, **Strategic Management Journal**, **17**, 45-62.

Hull, R. (2000) Knowledge management and the conduct of expert labour, in C. Pritchard, R. Hull, M. Chumer and H. Willmott (Eds.), **Managing Knowledge: Critical Investigations of Work and Learning**, MacMillan, London, pp. 49-68.

Powell, W. W. and DiMaggio, P. (Eds.) (1991) **The New Institutionalism in Organizational Analysis**, University of Chicago Press, Chicago.

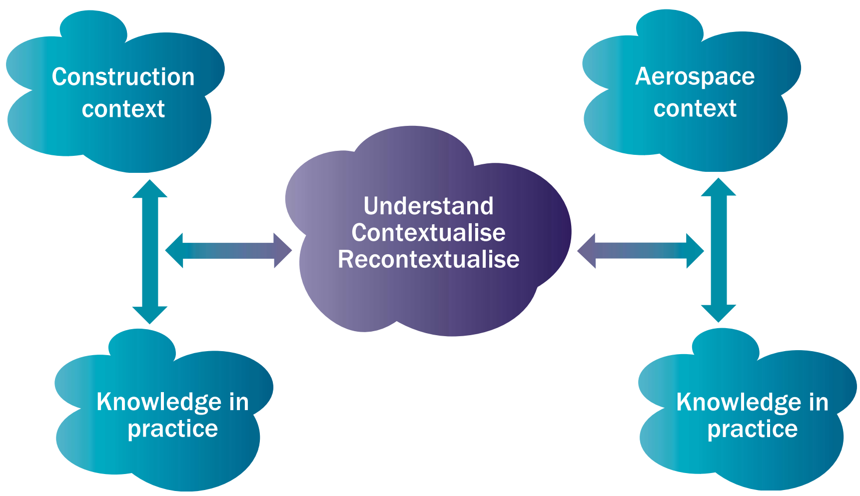

Figure 2.2: Learning across business sectors: understand, contextualise and re-contextualise.

! If the context within which you operate prevents you from implementing new practices, it might be better to think of ways the context can be changed.

2.5 Knowledge sharing: adopted methodology

2.5.1 The research summarised in this report was informed by the principles of knowledge sharing described previously. The project was structured around a series of three-month cycles each of which focused on a different topic.

2.5.2 Topics were identified by the research steering committee on the basis of inherent interest and topicality. Each cycle commenced with a broad literature review followed by a series of semi-structured interviews with domain experts from the participating companies and beyond. All cycles concluded with a one-day participative workshop involving practitioners from both sectors. The four topics chosen were supply chain management, requirements management, human resource management and innovation. An additional workshop was held on the topic of knowledge sharing. The adopted approach is summarised in *Figure 2.3.*

2.5.3 Each literature review sought to identify the dominant interpretations of the chosen topic. It was not the purpose to refute or endorse any of the existing interpretations, but to use them as the basis for generating debate and controversy. Understanding frequently comprises an appreciation of different interpretations. Knowledge is not necessarily uni-dimensional and accumulative.

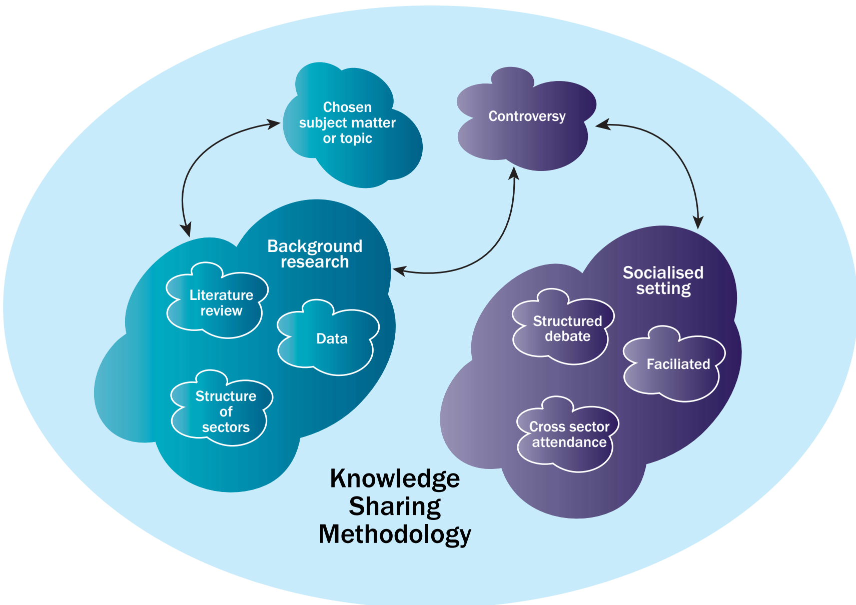

Figure 2.3: The adopted knowledge sharing methodology

Knowledge Sharing: Challenging Assumptions

2.5.4 In total, sixty-five semi-structured interviews were conducted with practitioners from the aerospace and construction sectors. The interviews provided the means of exploring the ascribed meanings of the chosen topics. Particular emphasis was given to issues relating to their practical implementation. The interview data were supplemented with a review and analysis of relevant documentation.

2.5.5 The interim results were presented for discussion at each workshop. Themes from the interviews were compared with different perspectives derived from the literature. The socialised setting allowed individuals to discuss and debate the variety of interpretations and controversies. The setting acted to 'socialise' the individuals involved and encourage knowledge sharing through facilitated debate.

2.5.6 Each cycle sought to benefit both sectors by sharing knowledge of managerial practices that interested all the research participants. However, an important additional objective was to develop and evaluate a 'knowledge sharing' methodology that could be replicated elsewhere.

2.5.7 Ongoing interaction between practitioners from both sectors contributed to their respective understanding of each other's assumptions and beliefs. The process also enabled the participants to reflect on their tacit assumptions about their own sector.

! The challenge was to make each stage of the research directly relevant to the concerns of the participating industry partners. The ultimate test of any collaborative research is whether or not the participants are still actively engaged at the end.

! Research projects are too often judged in terms of instrumental outputs. Challenging fixed ways of thinking is arguably much more important in promoting innovation.

3

3.1 Introduction

3.1.1 Managerial practices in the construction and aerospace sectors are shaped by significant contextual differences. Different pressures for change have shaped different development paths. Key differences can be identified in the structural characteristics of the two sectors. The construction industry is considerably more fragmented than aerospace with a much greater concentration of small firms.

3.1.2 The aerospace and construction sectors differ significantly in terms of their capital and technological intensity. They further differ in their relative extent of globalisation and in their respective relationships with government. Such contextual differences have an important influence in shaping business relationships and managerial practices in the two sectors.

3.1.3 Practitioners often take the defining characteristics of the sector within which they work for granted; knowledge relating to context is frequently tacit in nature. Cross-sector contextual comparisons are an essential part of 'learning across business sectors'. They are also important in making explicit practitioners' tacit understanding of their own sector. Comparisons between aerospace and construction are especially useful because the two sectors are so different.

3.1.4 Understanding the factors that have shaped the historical development paths of different industrial sectors is central to understanding the dynamics of change. Such an understanding is essential if practitioners are to adapt to future changes.

Structure and Change: Contrasting Contexts

Aerospace and Construction - contrasting contexts	
Aerospace	**Construction**
• 117,256 employees • £16.14bn turnover • 1000 SMEs • One firm accounts for 60% of supplier output • £1.74bn R&D spend	• 1,599,000 employees • Output £83.59bn • 122,220 SMEs • Top 30 firms account for 17% of supplier output • £270m R&D spend

3.2 Structural differences

3.2.1 The UK construction sector is significantly larger than the UK aerospace sector. On the basis of the latest available figures, the construction industry has an annual output of £83.59bn (DTI, 2003a). The DTI (2003b) figure for the turnover of the aerospace sector (Standard Industrial Classification D353) is £17.95bn. On the basis of a different boundary definition, the Society of British Aerospace Companies (SBAC, 2003) quote a UK aerospace turnover figure of £16.14bn.

3.2.2 Figures for the number of employees in the two sectors also differ in accordance with the way in which the sector boundaries are defined. The latest DTI (2003a) seasonally adjusted provisional employment figure for the construction industry is 1,599,000. On the basis of a different sampling methodology, the Small Business Service (DTI, 2003b) estimate that there are 1,778,000 employees in construction and 116,000 in aerospace. The corresponding SBAC (2003) figure for the aerospace sector is 117,256. Of 1,599,000 employees in the construction industry, 605,000 are self-employed (DTI, 2003a).

3.2.3 Although the construction sector is larger than aerospace, it is considerably more fragmented with a much greater concentration of small firms. According to the Small Business Service (DTI, 2003b) the UK construction sector comprises 122,220 SMEs (excluding sole traders). In conjunction with 'sole proprietors' (i.e. self-employed) these firms account for a remarkable 82.6% of the construction workforce.

3.2.4 In contrast, the DTI (2003b) list only 380 private sector SMEs (Small and Medium - Sized Enterprises) within the aerospace sector. In sharp contrast to the construction sector, these 380 firms account for only 9.6% of aerospace employees. The remaining 90.4% are employed by 50 large firms (DTI, 2003b). The figures from SBAC are different, but nevertheless tell the same story. SBAC (2003) estimates that there is a maximum of 1000 SMEs in the UK aerospace sector, with a significant reduction in the number of employees since 2001.

DTI (2003a) **Construction Annual Statistics**, Department of Trade and Industry, London.

DTI (2003b) **Small and Medium-sized Enterprise (SME) Statistics for the UK**, Department of Trade and Industry, London.

SBAC (2003) **UK Aerospace Facts and Figures 2002**, Society of British Aerospace Companies, London.

! Comparisons between aerospace and construction are useful because the two sectors are so different.

Aerospace and Construction - contrasting contexts	
Aerospace	**Construction**
• High trust economy	• Low trust economy
• Highly consolidated	• Highly fragmented
• Few customers	• Many customers
• High knowledge intensity	• Low knowledge intensity
• High barriers to entry	• Low barriers to entry
• Long time frames	• Short time frames
• Fixed locations	• Transient locations
• High inter-dependency	• Low inter-dependency
• Predominantly global markets	• Predominantly local markets

3.2.5 The relative extent of consolidation/fragmentation in the two sectors is illustrated by the fact that in the UK aerospace sector BAE SYSTEMS accounts for 60% of supplier output (A. T. Kearney, 1999). In the construction industry, the top 30 contracting firms routinely account for approximately 17% of output.

A. T. Kearney (1999) **The Impact of Global Aerospace Consolidation on UK Suppliers**, Society of British Aerospace Companies/A. T. Kearney Ltd.

3.2.6 Suppliers in aerospace are also more specialised than those in construction, with much higher levels of technological expertise. Furthermore, technological expertise is much more widely spread throughout the supply chain than tends to be the case in construction. Within the construction sector, suppliers tend to compete on cost efficiency rather than technical expertise. The knowledge-intensive nature of the aerospace sector is illustrated by an estimated annual research expenditure of £1.74bn (SBAC, 2003). The comparative figure for construction is a relatively modest £270m (NAO, 2001).

! The prevailing ethos amongst firms within the aerospace sector is based on mutual dependence. In contrast, most firms in construction are locked into a mindset of mutual competition.

NAO (2001) **Modernising Construction,** Report by the Comptroller and Auditor General of the National Audit Office, The Stationery Office, London.

3.2.7 The high technology content of the aerospace sector combines with a complex network of inter-dependency to present significant barriers to new entrants. In contrast, the construction industry has traditionally been characterised by low barriers to entry. This is especially true of the SMEs that comprise the industry's pool of sub-contractors.

3.2.8 Of further significance is the diversity of the construction industry's client base. Every domestic and commercial property owner in the UK is an occasional client of the construction industry. In this respect, the contrast with the clients of the aerospace sector could hardly be greater. Firms within aerospace tend to possess longstanding collaborative relationships with very few highly sophisticated clients. The fragmentation of the construction sector can be seen to reflect directly the fragmentation of its client base.

3.3 Relationship with Government

3.3.1 The structure of firms and relationships in the aerospace sector is a product of its unique history. Traditionally, the aerospace and defence sector has enjoyed a privileged relationship with government due to its strategic importance (Hayward, 1989). Government has in the past attempted to shelter the aerospace industry from fluctuations in the civil aircraft market through defence expenditure.

3.3.2 In contrast, various British governments since the Second World War have acted to exacerbate fluctuations in construction output through successive 'stop-go' policies. The public expenditure cuts of 1973 stand as a prime example. Likewise the sharp deflation induced by the Conservative government of the early 1980s stands as a further demonstration of the influence of periodic state expenditure cuts on the demand for construction work.

3.3.3 In recent years, Government policy towards the aerospace sector has tended to give primacy to value for money rather than strategic support. MoD agencies are increasingly willing to procure 'off-the-shelf' systems from overseas suppliers. The UK government has recently encouraged international collaboration in defence procurement to spread development costs.

3.3.4 The Defence Industrial Policy (DIP) published in October 2002 reaffirmed the need for an industrial dimension in UK procurement policy. SBAC was active in its development and is working closely with Government to ensure implementation.

3.3.5 The weakening of the UK government's traditional strategic relationship with the aerospace sector has introduced fresh competitive imperatives. The reliance on domestic government contracts has declined significantly over the last 10 years and currently stands at only 16% of turnover (SBAC, 2003).

Hayward, K. (1989) **The British Aircraft Industry**, Manchester University Press.

3.3.6 The decline in UK government contracts highlights the current importance of export contracts in sustaining the UK's aerospace expertise. The new climate of international competitiveness is evidenced by several best practice initiatives. Examples include the Lean Aerospace Initiative (LAI) and the Society of British Aerospace Companies' (SBAC) Competitiveness Challenge.

3.3.7 The welfare of the construction industry continues to be subservient to the government's broader policy objectives. The demand for construction remains extremely sensitive to government policy. Despite its relative decline over the last 25 years, the public sector continues to account for a significant percentage of construction output. Furthermore, the rate of interest continues to be used to control the economy with direct and indirect consequences for construction output.

The housing sector is especially sensitive to changes in interest rates.

3.3.8 The prevailing economic stability throughout the 1990s has undoubtedly alleviated the need for the crude interventions of the past. The result is that the construction industry's collective memory of previous 'stop-go' cycles has eased.

Harvey, M. (2003) Privatization, fragmentation and inflexible flexibilization in the UK construction industry, in **Building Chaos: A International Comparison of Deregulation in the Construction Industry** (Eds. G. Bosch and P. Philips), Routledge, London, pp. 188-209.

3.3.9 Twenty-five years of government vicissitude in taxation and insurance regimes has encouraged self-employment in the construction sector thereby directly contributing to labour casualisation (Harvey, 2003). The de-regulation of the construction labour market has eroded employment conditions and undermined investment in training.

3.4 Global trends in aerospace

3.4.1 Changes in the UK government's industrial policy towards aerospace must be understood alongside significant trends of consolidation and collaboration in international aerospace. Any understanding of the current structure of UK aerospace should be predicated on a broader knowledge of the intense rivalry between the European and US aerospace industries.

3.4.2 Since its launch in 1970 Airbus Industrie has been phenomenally successful in challenging the post-war US domination of the aerospace markets. In 1970 European manufacturers produced only 10% of commercial aircraft. They now claim a market share of 50% for new aircraft orders.

3.4.3 In order to meet the huge costs of aircraft development the members of the Airbus consortium were provided with launch aid by their respective governments. These loans later became highly contentious elements in a conflict between the EU and US over allegations of unfair competition. In response, EU representatives have pointed to hidden US subsidies provided by defence procurement and publicly funded R&D.

3.4.4 Extensive competition between the US and EU has been sharpened by the global reduction in defence spending following the end of the Cold War. The European industry remains disadvantaged by the need to serve the diverse defence requirements of different national governments.

3.4.5 The period from 1970 saw significant restructuring in the US aerospace industry, culminating in the merger of Boeing and McDonnell Douglas. Since 2001 three giant companies have dominated the US aerospace and defence industry: Raytheon, Lockheed Martin and Boeing.

3.4.6 In the face of extensive US consolidation, the European aerospace industry had little choice but to develop collaborative working practices. Despite significant political difficulties amongst national governments, the European

aerospace industry has in part followed the US trend towards consolidation. The Airbus consortium finally became a corporate entity in 2000. A further stream of mergers resulted in the European Aerospace, Defence and Space Company (EADS).

3.4.7 Consolidation in the UK aerospace sector culminated in the merger of British Aerospace with Marconi Electronic Systems in 1999. This resulted in the emergence of BAE SYSTEMS as the sole UK national aerospace champion. Further mergers are expected, possibly involving North American partners.

3.4.8 The current interests of BAE SYSTEMS reflect the UK's longstanding policy of facing simultaneously across the Channel and the Atlantic. BAE SYSTEMS combines a 20% stake in Airbus with extensive manufacturing facilities in North America. The company is engaged in a number of collaborative ventures with both European and US aerospace companies.

3.4.9 The end result of a prolonged period of extensive global consolidation in the aerospace industry is a realisation amongst UK suppliers that they have to collaborate in order to survive. In a highly competitive global market, BAE SYSTEMS and their suppliers are locked into a relationship of mutual dependency. This web of mutual dependency extends into a network of complex global relationships.

3.5 Structural change in the UK construction industry

3.5.1 While the construction industry has experienced degrees of globalisation and merger activity, these remain minuscule in comparison to the restructuring of the aerospace sector. Beyond specialist niche markets, the vast majority of construction projects remain rooted in local contexts.

3.5.2 Notwithstanding the above, the construction sector has experienced extensive structural change over the last three decades. Since the mid-1970s the UK has seen a significant reduction in directly employed labour. Similar trends are evident across many developed countries to such an extent that employment patterns are increasingly similar to the multi-layered ‘labour-only’ contracting systems typically found in developing countries.

! Globalisation and consolidation are to aerospace as localisation and fragmentation are to construction,

3.5.3 Official government statistics consistently underestimate the level of self-employment in the construction sector (Cannon, 1994). According to the ILO (2001) self-employed labour grew from 30% of the total workforce in 1977 to a high point of over 60% in 1995. These figures suggest a dramatic shift towards a greater degree of sub-contracting and reliance on self-employed labour. A tightening up of the self-employment tax regime in 1977 only partially reversed this trend. The latest indicators suggest that self-employment is once again on the increase.

ILO (2001) **The Construction Industry in the Twenty-first Century: Its Image, Employment Prospects and Skills Requirements,** International Labour Office, Geneva.

Cannon, J. (1994) Lies and construction statistics, **Construction Management and Economics, 12**(4), 306-313.

3.5.4 If outsourcing/subcontracting is taken as an essential measure of 'leanness', then construction is significantly ahead of manufacturing. This is especially ironic given repeated exhortations for construction to model itself on the automotive sector by adopting 'lean production' practices.

3.5.5 The UK construction sector is increasingly characterised by the 'hollowed-out' firm that retains only a small core of white-collar staff. Traditional contractors are progressively more removed from the physical work of construction, preferring to focus on management and coordination functions. Several major contractors of the 1970s have evolved into service companies.

3.5.6 The construction sector has been subject to increasing pressure to change from its clients over the last twenty years. Private sector clients have organised into groups and used their buying power to force contractors to lower costs and improve quality.

3.5.7 There has been a sustained proliferation of procurement methods to cater for the needs of different clients. The emergence of management forms offered clients a greater degree of engagement and resulting flexibility. At the same time, design and build offered single point responsibility for clients who were able to pre-articulate their requirements. Both of these procurement methods served to alleviate traditional process discontinuities and hence resulted in significant improvements in productivity.

3.5.8 More recently, procurement approaches have encouraged additional efficiencies by combining responsibility for design and construction with an ongoing responsibility for facilities management. PFI has become the government's preferred procurement route. Other significant developments include the adoption of prime contracting, which provides construction companies with the opportunity to work collaboratively with their clients and supply chains.

3.6 Conclusions

3.6.1 There are extensive structural differences between the aerospace and construction sectors. These reflect their different historical development paths and differing degrees of capital and technological intensity. The aerospace sector has experienced significant consolidation in the face of extensive global competition. In comparison, the UK construction industry remains highly fragmented and localised.

3.6.2 The aerospace sector has long been considered strategically important to the national interest; not only in terms of defence capability, but also in terms of maintaining technological expertise. As a result, aerospace has traditionally enjoyed a close relationship with government.

However, in recent years government has increasingly given primacy to value for money in defence acquisition, thereby providing the impetus for aerospace to adopt best manufacturing practice. The competitive situation has been exacerbated by global reductions in defence expenditure.

3.6.3 In contrast, the needs of the construction sector have always been subservient to broader government policies. The disengagement by government from construction industry development has been exacerbated by the decline of the public sector. Of particular significance has been the demise of public sector direct labour organisations (DLOs). Notwithstanding these changes, the public sector continues to account for approximately 40% of construction output. Construction demand is therefore highly sensitive to government policy.

3.6.4 The structure of the UK aerospace sector has much more in common with the automotive sector than with construction. Concepts originally formulated in the Japanese automotive industry are much more readily absorbed into aerospace than construction. Globalisation has had a similar impact on the aerospace and automotive sectors; this is especially evident in the degree of consolidation.

3.6.5 The imperatives of international competition have obliged the UK aerospace industry to operate in a highly collaborative manner. In recent years, prime contractors within the aerospace sector have positioned themselves as 'systems integrators'. This reflects the increasing use of 'off-the-shelf' systems in aerospace projects. The prime source of competitive advantage increasingly lies in systems integration with the supporting technological expertise being widely shared across the supply chain.

3.6.6 The primary source of competitive advantage in the construction sector continues to rest on cost competitiveness and the appropriation of value from sub-contractors. However, within the context of emerging procurement initiatives such as framework agreements and prime contracting there is much greater potential for collaborative working. Within the context of prime contracting in construction, there is considerable scope for knowledge sharing between aerospace and construction. There are also opportunities for commercial collaboration between firms with complementary expertise.

4

4.1 Introduction

4.1.1 Supply chain management is central to the accepted improvement agendas in both the aerospace and construction sectors. The 'best practice' literature tends to advocate standard principles that are applicable universally, irrespective of context.

! Given that so few of the big five global automotive groups are consistently profitable, it is strange that they are so often quoted as examples of best practice.

4.1.2 The automotive sector is consistently offered as the model of best practice for both aerospace and construction. The lean model of supply chain management, derived from the Toyota Manufacturing System (Womack *et al*, 1990), is equally influential in the literature directed at both sectors.

Womack, J.P., Jones, D.T. and Roos, D. (1990) **The Machine That Changed The World**, Rawson Associates, Macmillan, New York

4.1.3 A review of the supply chain management literature reveals a widespread absence of contextual awareness. In contrast, this chapter will explore the way in which the practice of supply chain management is inexorably shaped by context. Different approaches are necessary for different circumstances.

4.1.4 The longstanding use of prime contracting in the aerospace and defence sector means that supply chain management is much more established in this sector than in construction. However, changing circumstances in the global aerospace industry continuously require new responses.

4.1.5 In the construction industry, procurement approaches such as prime contracting and PFI transcend the process discontinuities of traditional procurement approaches. For those wishing to compete in these markets, the development of integrated supply chains arguably becomes increasingly central to commercial success.

Supply chain management **in aerospace** - A summary

Context	Practice
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• Focus on on-going business relationships • Supply chain management is a reality • Practice influenced by lean thinking • Collective commitment to change born of crisis • Supply chain management is a ‘philosophy’ • Aerospace ‘walks the walk’

4.2 What is supply chain management?

4.2.1 Despite the burgeoning body of literature, there is no universally accepted definition of supply chain management *(See Box 4.1)*. Some see it as a form of competition (Ellram, 1991), others view as a means of improving ‘optimisation and efficiency’ (Tan *et al*, 1998). Supply chain management is an evolving concept subject to multiple interpretations.

Definitions of supply chain management

‘Supply chain management is the integration of business processes from end user through original suppliers that provide products, services and information that add value for customers.’ Cooper *et al* (1997)	‘A way of thinking that is devoted to discovering tools and techniques that provide for increased operational effectiveness and efficiency throughout the delivery channels that must be created internally and externally to support and supply existing corporate product and service offerings to customers.’ Cox (1999)
‘A network of organisations that are invoked, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer.’ Christopher (1992)	‘The integration of activities’ associated with the flow of materials and information, through improved supply chain relationships, to achieve a sustainable competitive advantage.’ Handfield and Nichols (1999)

Box 4.1: Definitions of Supply Chain Management

Ellram, L.M. (1991) Supply chain management: The industrial organisations perspective, **International Journal of Physical Distribution & Logistics Management, 21**(1), 13-22.

Tan, K.C., Kannan, V.R. and Hadfield, R.B. (1998) Supply chain management: Supplier performance and firm performance, **International Journal of Purchasing and Materials Management, 34**(3), 2-9.

Cooper, M. C., Lambert, M. and Pagh, J. D., (1997) Supply chain management: More than a new name for logistics, **The International Journal Of Logistics Management, 8**(1), 1-13.

Cox, A. (1999) Power, value and supply chain management, **Supply Chain Management, 4**(4), 167-175.

Christopher, M. (1992) **Logistics and Supply Chain Management**, Pitman, London.

Handfield, R. B. and Nichols, E. L. (1999) **Introduction to Supply Chain Management**, Prentice Hall, New Jersey.

Supply chain management **in construction** - A summary

Context

- Highly fragmented
- Few large players
- Many customers
- 1,599,000 employees
- Output £83.59bn
- 122,220 SMEs
- £270m R&D spend
- Predominantly regional markets

Practice

- Focus on short-term project relationships
- Supply chain management is seen to be a ‘fad’
- Rhetoric influenced by lean thinking
- Little collective commitment to change
- Supply chain management is a ‘tool’
- Construction ‘talks the talk’

4.2.2 Despite the vagaries of the literature, supply chain management gurus consistently agree that it is no longer adequate for management to confine its attention to the limited domain of single organisations. To compete effectively in the modern world, management must extend across the whole supply chain.

! Is supply chain management just old wine in bigger bottles?

4.2.3 Traditional management focuses on the competitive advantage of single organisations. In contrast, supply chain management emphasises the competitive advantage of the ‘supply chain’. Beyond this distinction, the supply chain management literature frequently repeats familiar exhortations from the generic management literature.

4.2.4 The wide variety of definitions of supply chain management reflects the wide variety of definitions of management *per se*. In broad terms, the supply chain management literature can be classified into two schools of thought: strategic and operational.

4.2.5 A common imperative that distinguishes supply chain management from other approaches is the need to develop collaborative working arrangements with key suppliers. Collaborative working is an essential pre-requisite for integrated supply chains.

4.3 Supply chain management: *the strategic perspective*

4.3.1 The strategic view of supply chain management interprets the supply chain as a structure within which organisations position themselves. Part of this process is aligning other supply chain members to serve their needs. The strategic view is therefore primarily concerned with understanding markets and how best to competitively position the firm in the supply chain.

4.3.2 Organisations can also competitively position themselves through acquisition and mergers. While these may be seen as alternative strategies, they can also be used in combination with supply chain management. The central decision relates to which activities are considered 'core' and which are considered 'peripheral'.

4.3.3 Supply chain management can enable engagement with supplier organisations without the cost of outright acquisition. In turn, suppliers can retain their independence whilst acting to reduce market uncertainties. Such decisions are central to any process of competitive positioning and are highly dependent upon the prevailing market conditions.

! The strategic perspective sees organisations in a supply chain competing to collaborate.

! Behind the recent consolidation in aerospace lies a continual struggle of supply chain positioning.

4.4 Supply chain management: *the operational perspective*

4.4.1 The operational view of supply chain management focuses on improving efficiency through the implementation of logistics. The challenge is to realise more efficient ways of managing the flows of goods, services and information across the whole supply chain *(see Figure 4.1).*

! The operational perspective sees organisations in a supply chain collaborating to compete.

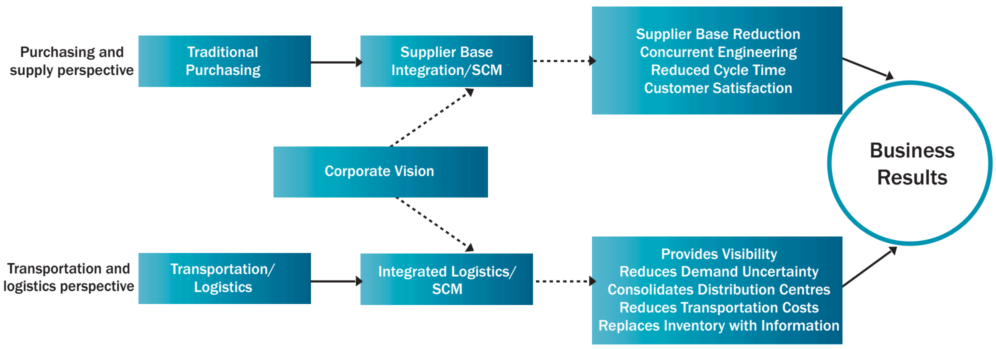

Figure 4.1: Operational view of supply chain management (adapted from Tan *et al*, 1998)

4.4.2 Traditionally, the purchasing function has focused on 'playing the market' to achieve short-term cost savings. The move from purchasing to supply chain management requires a fundamental shift in orientation towards long-term relationships with favoured suppliers.

! Despite past and present exhortations to develop long-term relationships in the construction sector, little progress has been made.

4.4.3 Supply chain management is less about buying a product and more about initiating and maintaining a collaborative working relationship with key suppliers. Sharing the benefits ensures a shared ethos of continuous improvement. Whilst improved efficiency depends upon an initial level of trust, the realisation of mutual benefits will lead in turn to a higher level of trust.

4.5 Confidence and trust

4.5.1 Whilst trust is widely held to be central to effective supply chain management, it is rarely considered in any great detail in the literature. Korczynski (2000) notes that trust is a consequence of the basic premise that one party has confidence that another will not exploit its vulnerabilities. This confidence is shaped and determined by many factors that are played out differently in different contexts. Such factors include the organisations' reputations, existing interpersonal relationships, the extent to which the organisations are perceived to be interdependent and the likely continuity of future workload.

4.5.2 The structural characteristics of the two sectors have a fundamental influence on the underlying level of trust *(see Box 4.2)*. Aerospace tends towards the characteristics of a high-trust economy. In contrast, construction displays many of the characteristics of a low-trust economy (cf. Korczynski, 2000).

4.5.3 No amount of 'best practice' initiatives advocating the need for greater trust can escape the consequences of industry structure. However, there are emerging niche markets within the construction sector that approximate towards the characteristics of a high-trust economy. Within these contexts, firms within integrated supply chains are highly interdependent. Hence collaborative working becomes a commercial necessity. The extent to which construction companies are adapting to these different circumstances remains unclear.

! Trust cannot be separated from structure. Advocates of supply chain management continually miss this point.

Aerospace - High trust economy	**Construction** - Low trust economy
• Highly consolidated	• Highly fragmented
• Few customers	• Many customers
• High knowledge intensity	• Low knowledge intensity
• High barriers to entry	• Low barriers to entry
• Long time frames	• Short time frames
• Fixed locations	• Transient locations
• High inter-dependency	• Low inter-dependency

Box 4.2: Political economies of trust

Korczynski, M. (2000), The political economy of trust, **Journal of Management Studies**, **37**(1), 1 -21.

! The construction industry will consist of two types of firm: those who qualify for prime contracting and those who don't.

4.6 Best practice initiatives

4.6.1 Despite the structural differences between aerospace and construction, the respective best practice agendas are remarkably similar. Both are heavily influenced by the collaborative managerial practices that have emerged from the automotive sector.

4.6.2 The Society of British Aerospace Companies (SBAC)'s Competitiveness Challenge embraces five key areas: Supply Chain Relationships in Action (SCRIA), Lean Aerospace Initiative (LAI), People Management, Winning Business and Knowledge Management.

4.6.3 The best practice agenda for the construction industry reflects identical themes to those found in Competitiveness Challenge (with the possible exception of 'Winning Business'). Neither of the best practice agendas shows any sensitivity to the importance of context. The overriding assumption seems to be that the principles of best practice are universally applicable.

4.6.4 The major clients of the construction industry have provided a significant impetus to the best practice programme in construction. Clients have long been dissatisfied with the perceived poor customer orientation of the construction industry. Clients are tired of dealing with a fragmented and adversarial industry.

4.6.5 Advocated 'best practice' solutions for the construction industry invariably play heavily on the concept of integration. Examples include: integrated design and construction, integrated team working and integrated supply chain management.

4.6.6 The model of supply chain management advocated by the Construction Best Practice Programme is primarily operational. Success is seen to be dependent on cooperation and collaboration across customer/supplier interfaces. Each company is seen as a link in a chain of activities designed to satisfy the end customer. Benefits include improvements in production effectiveness of up to 30% and a greater confidence for longer term planning. Companies are exhorted to appoint a champion. The advocated approach is in many respects inseparable from partnering.

4.6.7 The Building Down Barriers model of supply chain management has attracted considerable attention in the construction sector (see Holti *et al*, 2000). The approach has been embraced by the MoD and encouraged by HM Treasury. Key elements include a 'prime contractor' (see 4.7) and a 'pre-assembled supply chain'. The overall aim is to deliver optimal value to the client in terms of through-life performance, whilst maintaining the profit margins of all concerned.

! Practitioners in both sectors tend to look elsewhere for models of best practice. Is the grass always greener?

! Clients seem happy to engage with management panaceas but less willing to question and address issues of industry structure.

Holti, R., Nicolini D. and Smalley, M. (2000) **The Handbook of Supply Chain Management: The Essentials**, CIRIA, London.

! It is difficult to understand why management concepts such as supply chain management can be held in such high regard without a clear understanding of how they are played out in context.

4.6.8 Building Down Barriers mixes the language of defence procurement with established construction techniques and practices such as value management, through life costing, risk management and continuous improvement. The notion of collaborative working recurs throughout. The approach was seemingly developed in isolation from the broader supply chain management literature. The issue of trust is taken largely for granted. The extent to which the approach can be applied within the construction industry at large is highly questionable.

! The SCRIA approach to supply chain management reflects and reinforces the characteristics of a high trust economy.

4.6.9 In the aerospace sector, SCRIA promotes a code of practice to achieve a co-operative supply chain, where companies can work with customers and suppliers for mutual benefit. The aim is to promote better team working within supply chain relationships. The broader vision is to create value and sustainable competitive advantage.

4.6.10 In contrast to similar construction initiatives, SCRIA is played out against a backcloth of significant consolidation in the international aerospace sector. Firms within the UK aerospace sector are highly interdependent. Global competition makes collaboration a commercial imperative. The SCRIA approach is highly relevant in the context of a high-trust economy. However, the relevance of such approaches to low-trust economies such as construction is more contentious.

4.7 Prime contracting in construction

4.7.1 Procurement initiatives such as prime contracting and Procure 21 offer construction companies the opportunity to work collaboratively both with their clients and supply chains. Under these arrangements, contractors are commonly evaluated on the extent to which their supply chains are 'in place' and on their experience of collaborative working.

4.7.2 Although new to construction, prime contracting has a long history of application in the aerospace and defence sectors. The MoD has been influential in promoting the concept of prime contracting for the construction industry. The underlying principles reflect the MoD's SMART procurement initiative to realise better value for money in defence procurement.

4.7.3 Procurement routes such as prime contracting extend the contractor's obligations to include design, construction and operation of the built facility. They therefore replace the traditionally fragmented process with the opportunity for an integrated approach. Within such frameworks, facilities management expertise and life-cycle costing become central to commercial success.

4.7.4 Prime contracting has the potential to overcome the problems of fragmentation in construction project delivery. However, there has been some resistance within the

Supply chain management **in aerospace** - Interview summary

Context	Dominant Themes
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• The move towards new working practices is recognised as the consequence of an industry wide crisis • Supply chain management practice exists and is used extensively • Practice is rooted in a business-to-business approach • Widespread and in-depth understanding of supply chain management • Supply chain management thinking and practice extends beyond organisational boundaries

construction industry to the MoD's perceived policy of transferring unreasonable risks on to the private sector. The entry requirements to prime contracting are significant in terms of the additional expertise required from construction companies.

4.7.5 Raising the barriers to entry would seem to satisfy the need of the construction industry's large clients to deal with fewer, more sophisticated construction firms.

4.7.6 The construction sector has seen significant jockeying for position in recent years as firms attempt to integrate themselves into stable supply chains to take advantage of the emerging prime contracting market. Many firms have made a significant investment in training in order to develop the necessary skills of collaborative working.

4.7.7 The rewards for success are potentially high. The likely outcome is a polarisation in the market place between those players who meet the criteria for prime contracting and those who do not. The latter group is likely to form a significant rump that will continue to operate in traditional ways. It is debatable whether or not these trends will serve the interests of small occasional clients.

! The majority of firms in the construction industry are unable to invest in the necessary skills without the assurance that prime contracting is here to stay.

4.8 Supply chain management in practice

"I believe it is relationship management that we're into if you're really serious about it."

Aerospace interviewee on the definition of supply chain management.

4.8.1 To explore how supply chain management was enacted within the two sectors, interviews were conducted with representatives from construction and aerospace. The dominant themes are presented here to indicate both the current concerns of supply chain management practitioners, and the alignment of supply chain management practice with theory.

! A high level of interdependency between fewer firms in aerospace makes the diffusion of change easier than in construction.

4.8.2 Interviewees from the aerospace sector support the contention that the

Supply chain management **in construction** - Interview summary

Context	Dominant Themes
• Highly fragmented • Few large players • Many customers • 1,599,000 employees • Output £83.59bn • 122,220 SMEs • £270m R&D spend • Predominantly regional markets	• There appears to be no compelling argument for industry-wide adoption of new working practices • Supply chain management discussed extensively as a good initiative but appears to have had little impact on practice • Supply chain management is frequently discussed in the context of projects rarely in a business context • Limited understanding of supply chain management, restricted to certain individuals

! The concept of globalisation means little to the majority of those in the construction industry. It is much more relevant to talk of regional markets.

origins of collaborative supply chain management lie in the imperatives of global competition. Within BAE SYSTEMS, several interviewees referred to the way in which the share crisis of the 1990s provided the platform for a change. Collaborative working in the aerospace sector was born from a shared sense of mutual dependency in the face of global competition.

"I would hazard to say that we didn't actually use any formal supply chain relationship, it was very much we've got these guys we work with on the basis they're bloody good blokes to work with."

Construction interviewee on traditional methods of working.

4.8.3 The construction sector has yet to experience a comparative crisis and therefore feels little imperative to change its long established way of working. Whilst many interviewees cited client pressure, the need to change was considered less than compelling. No construction interviewees cited globalisation to be a significant issue for the UK construction industry.

! It is telling that supply chain management in aerospace has moved beyond the best practice discourse, whereas in construction it has not.

4.8.4 Within the aerospace sector, there was found to be a strong reliance on providing advice and support to first tier suppliers. This reflects the established ethos of mutual dependency. The Supplier Excellence Programme (SEP) would appear to be widely applied to both internal and external supply chains. Whilst the Supplier Excellence Programme provides the dominant view of supply chain management, aerospace interviewees are also focused on the issue of core competencies. Several cited the need for continual re-alignment in accordance with changes in the market place.

4.8.5 The Building Down Barriers model of supply chain management heavily influenced construction interviewees. However, in sharp contrast with the aerospace sector, they tended to describe the model they were working towards, rather than a model they had actually implemented. Phrases such as 'we recognise the need for a more integrated approach' were commonplace - even amongst alleged supply chain management experts. In stark contrast, accepted models of supply chain management in aerospace are commonplace. For example *Figure 4.2* and *Figure 4.3* represent well-established and mature supply chain management models used by aerospace practitioners.

approach that could be used on specific projects. Several of the firms interviewed had to reconcile the fact that whilst on some projects they would be required to demonstrate supply chain management, on

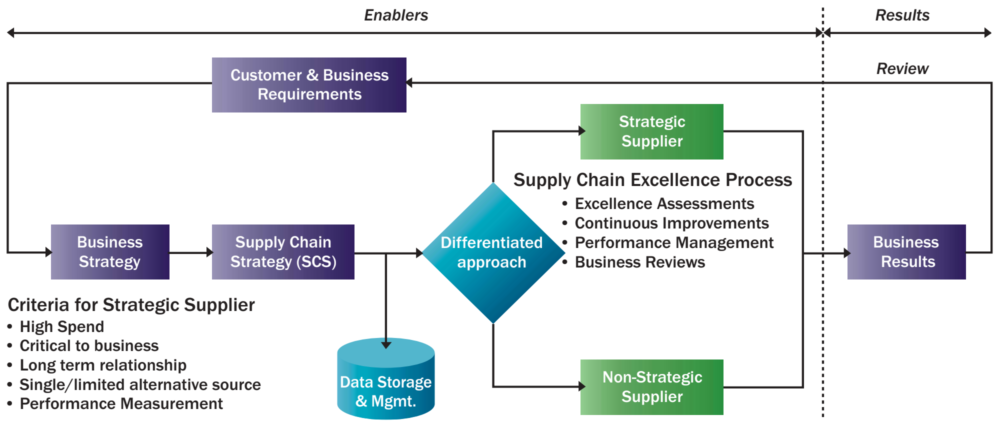

Figure 4.2: Supply Chain Development Architecture (Source: BAE SYSTEMS)

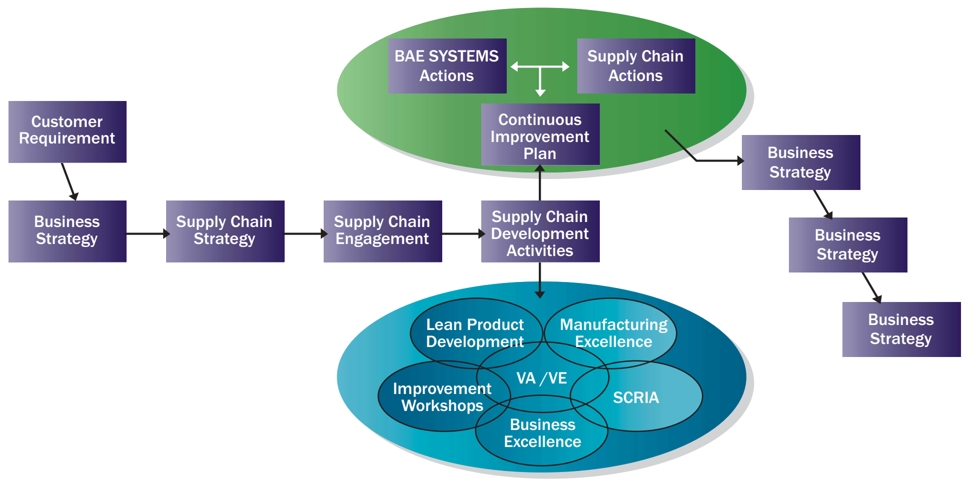

Figure 4.3: Supply Chain Strategy (Source: BAE SYSTEMS)

4.8.6 Aerospace interviewees tended to describe supply chain management on the corporate level as being central to the way in which the business operates. In contrast, construction interviewees tended to describe supply chain management as an

others they would operate in the traditional mode of contract management. Many referred to colleagues within the same company that continued to insist on competitive tendering for sub-contractors.

! The rhetoric of long-term relationships sits uneasily with the institutional context of construction that demands short-term returns.

"The reality of the situation is that the management of those interfaces and the need for on time delivery of quality goods is something that we are always striving for and it is not where we are."

Aerospace interviewee on the realities of supply chain management within the organisation.

"Some people like a good old-fashioned contractual punch-up or whatever; I guess there are a few around, but the culture is changing. But most people get a lot of satisfaction [from] making it work together. It makes life more enjoyable."

Construction interviewee on the benefits of supply chain management.

"I could point to areas in this organisation where we would have good practice but across the board the answer would be no. They are not an embedded part of this organisation."

Aerospace interviewee on the extent to which supply chain management practice and philosophy are integrated within the organisation.

4.8.7 There was an obvious pride in the end product and its technology amongst aerospace employees. This was less evident amongst construction employees who would appear to be more commercially orientated. It was notable that many aerospace interviewees had moved into 'management' with significant reluctance. They feared that their careers would be limited should they become isolated from technological advances. In contrast, construction interviewees invariably saw the move into management as a significant promotion.

4.8.8 Many construction companies are organised into quasi-independent regional business units. Such a structure has advantages in terms of flexibility, but seriously impedes information sharing and the implementation of supply chain management on a corporate basis. Some significant national contractors do not possess a centralised database of sub-contractors.

"Construction supply chains compete, not construction companies."

Construction interviewee on his perception of supply chain management.

4.8.9 The more traditional firms within construction see supply chain management to be synonymous with the purchasing function. The scope of the purchasing function is often limited to sourcing materials and services at minimum cost. This tends to be done as an independent exercise for each project.

4.8.10 Construction interviewees directly involved in prime contracting saw supply chain management as an essential means of ensuring their competitive position in the marketplace. Others were openly sceptical of what they saw to be the latest 'fad', preferring to emphasise the need to 'talk the talk' in accordance with the current improvement agenda. There was widespread concern that the MoD has yet to finalise the contractual basis of prime contracting, in the construction sector at least.

4.9 Conclusion

4.9.1 There is a widespread absence of contextual awareness amongst the advocates of supply chain management. This tendency is by no means unusual within the 'management improvement' literature. Concepts such as supply chain management are invariably presented as best practice tools that can be introduced irrespective of a broader contextual understanding.

4.9.2 The structure of the UK aerospace sector is much more consolidated than that of construction. Concepts originally formulated in the automotive industry can therefore be much more readily diffused across aerospace companies. The fragmented structure of the construction industry makes the diffusion of such ideas significantly more difficult.

4.9.3 In recent years, prime contractors within the aerospace sector have positioned themselves as 'systems integrators'. This reflects the increasing use of 'off-the-shelf' systems in aerospace projects. Skills of integration and supply chain management are therefore increasingly central to competitive advantage.

4.9.4 The imperatives of international competition have obliged the UK aerospace industry to operate in a highly collaborative manner. The reality of mutual dependency provides the platform for effective supply chain management. It is commonly accepted that this is the only way in which European firms can compete with the US giants. In contrast, the construction sector remains highly localised. Beyond specialised niche markets, the commercial imperative for change is much weaker.

4.9.5 Collaborative working with key suppliers across organisational boundaries depends upon an underlying climate of trust. The aerospace sector tends towards a high-trust economy, making trust a prevalent component of business relationships. This is much less true in the construction industry that approximates towards a low-trust economy.

4.9.6 The emergence of integrated procurement approaches in construction such as prime contracting and PFI is causing a polarisation in the construction market. Firms have strategically positioned themselves to take advantage of new markets. The competitive advantage of the leading players will increasingly be based on their skills of integration and supply chain management. These emerging niche markets already present significant barriers to new entrants.

4.9.7 Within the context of integrated procurement approaches in construction, the conditions of mutual dependency will prevail across integrated supply chains. This will provide a significant break with the rump of the construction industry. Clients may benefit through a more integrated service. Integrated supply chains potentially stand to benefit by competing primarily on the basis of innovation and expertise rather than cost.

4.9.8 Construction firms are currently investing in new skills and the development of integrated supply chains for the purposes of competitive positioning. However, such trends are highly dependent upon a continuous flow of work of this nature.

5

! The construction industry's obsession with cost efficiency misses the point. If you can't get the brief right you might as well pack up and go home. Building the wrong thing cost effectively does not provide value for money for anyone.

5.1 Introduction

5.1.1 The elicitation and delivery of client requirements has long been problematic in both the aerospace and construction sectors. The process of delivering the functional requirements of complex clients is widely misunderstood and frequently poorly managed.

5.1.2 Within the aerospace sector, the discipline of 'requirements management' is increasingly used to capture and manage client requirements. In construction, the language of 'requirements management' has yet to make any impact, despite longstanding concerns regarding the limitations of traditional approaches to briefing.

5.1.3 Whilst requirements management has no direct equivalent in construction, there has been a significant recognition that effective briefing is central to client satisfaction and an essential prerequisite to efficient construction.

5.1.4 Given similar concerns in both aerospace and construction, it is pertinent to investigate the extent to which the two sectors can learn from each other. Understanding points of commonality and difference between the two industries can provide fresh insights into long standing problems.

5.1.5 The Ministry of Defence (MoD) has adopted prime contracting as the preferred means of construction procurement. Prime contracting provides an integrated procurement context that combines design and construction with an ongoing responsibility for facilities management. It therefore provides an opportunity for a continuity of process that remains impossible with traditional construction procurement methods. This will require new skills from construction professionals. It will also provide new opportunities for requirements specialists from other sectors.

5.1.6 This chapter explores the theory and practice of requirements managements in the aerospace sector. The research methodology comprised an extensive literature review and a review of requirements management processes from a range of aerospace and defence organisations. These processes are compared with associated practices within the construction sector.

Requirements management **in aerospace** - A summary	
Context	**Practice**
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• Originally developed in software sector • Intellectual origins lie in systems engineering • Provides a controlled environment for capturing and managing requirements • Imposes a discipline and strives for a consistent language • Practitioners recognise both social and technical complexity • An essential component of product development • MoD push towards a common approach • Still in development

5.2 Origins of requirements management

5.2.1 Extensive literature exists on requirements management in the aerospace and software sectors. In contrast, the term 'requirements management' is rarely used in the construction industry. The intellectual roots of requirements management lie within the field of systems engineering. Influential authors include Hooks and Farry (2001), Finkelstein and Emmerich (2000) and Alexander and Stevens (2002).

5.2.2 Requirements management was originally established in the software sector. It then spread more widely into the defence and aerospace sectors. NASA is frequently cited as being influential in the application of requirements management to aerospace projects.

5.2.3 In addition to 'requirements management', the literature frequently refers to 'requirements engineering'. There is little consistency in usage in the literature. The distinction would further appear to be subject to multiple interpretations.

5.2.4 The MoD has championed the cause of requirements management through the *Acquisition Handbook*. Significant emphasis is given to the concept of smart requirements. The implication is that the MoD and its suppliers have not always been 'smart' in their definition and interpretation of requirements. The history of the aerospace industry is characterised by a number of high-profile 'requirements failures'. This makes any promised improvement especially attractive. It should also be noted that the track record of the software sector in respect of requirements failure is even more woeful (Standish Group, 1995).

5.2.5 It must also be stated that the systematic introduction of requirements

Hooks, I.F. and Farry, K.A. (2001) **Customer-Centered Products: Creating Successful Products Through SMART Requirements Management**, AMACOM, New York.

Finkelstein, A. and Emmerich, W. (2000) The future of requirements management tools, in **Information Systems in Public Administration and Law**, Quirchmayr, G., Wagner, R.R. and Wimmer, M. (Eds.s) Austrian Computer Society.

Alexander, I.F. and Stevens, R. (2002) **Writing Better Requirements**, Pearson Education Ltd, Harlow, UK.

The Standish Group (1995) **The Scope of Software Development Project Failures**, Standish Group, London.

Equivalent practices **in construction** - A summary	
Context	**Practice**
• Highly fragmented • Few large players • Many customers • 1,599,000 employees • Output £83.59bn • 122,220 SMEs • £270m R&D spend • Predominantly regional markets	• No direct equivalent; aspects of briefing, value management and change control • Systems engineering/integration means little to practitioners in the construction sector • Practitioners recognise both social and technical complexity • Briefing and design are seen to be iterative and interdependent • Increasing recognition of the need for facilitation skills and consensus building • Little consistency in implementation • Notable lack of supporting software

Checkland, P. (1981) **Systems Thinking, Systems Practice**, Wiley, Chichester.

! Given the importance attached to consistency of language, it is ironic that practitioners cannot agree on the distinction between requirements management and requirements engineering.

management in aerospace is still in its early stages. This is especially true when judged against development timeframes of 10-15 years when requirements management is presented as a task that should continue throughout the operational lifecycle. Despite the persuasive argument in support of requirements management, it must be conceded that the extent to which it can bring about substantive improvements has yet to be fully evaluated.

5.3 Systems engineering

! The validity of systems engineering is limited to the efficient means of production and not ends.

5.3.1 Requirements management is widely acknowledged to have developed from systems engineering, which peaked in the 1960s/70s. The literature is dominated by 'tools and techniques' and is noticeably short on theory. The emphasis lies on the need to adopt a systematic approach to the total task of 'conceiving, designing, evaluating and implementing a system to meet some defined need' (Checkland, 1981). Early accounts are clearly aimed at engineering projects and are careful to exclude the 'political' process of trading-off objectives.

5.3.2 Systems engineering has a long record of success in solving problems primarily concerned with the efficient means of achieving known ends. It has been less successful in situations where the required ends are themselves contested and subject to multiple interpretation. In essence, systems engineering seeks to address technical complexity. The extension of the underlying model of systematic rationality to social and political complexity is at best contentious (Schön, 1983).

Schön, D.A. (1983) **The Reflective Practitioner: How Professionals Think in Action**, Basic Books, USA.

5.3.3 More recent sources on systems engineering have certainly strayed beyond the limited domain of technical complexity. Indeed, practitioners have undoubtedly fed back the benefits of their experience. Modern sources often balance the implied rigour of systems engineering with the pragmatic need for flexible responses to dynamic problems (e.g. Goguen and Jirotka, 1994). Many sources have sacrificed the theoretical origins of systems engineering in favour of pragmatism. In some cases, it is questionable whether the approach advocated continues to justify the systems engineering label.

5.3.4 Systems engineering has always had a close relationship with engineering and engineering economics. Indeed, many have suggested that systems engineering is simply 'good engineering'. Traditionally, systems engineering has been intuitively appealing to engineers because it reflects their own internalised approach of systematic rationality.

5.3.5 Systems engineering has an equally long pedigree in both construction and aerospace. The underlying concepts remain inseparable from the protocols of engineering design. This is true not only for aeronautical engineering, but also for civil, mechanical and electrical engineering. The discipline of computer science owes an equal allegiance to systems engineering. Project management protocols in both sectors remain heavily influenced by systems engineering concepts.

5.3.6 In contrast to the engineering disciplines, the dictates of systems engineering have been less persuasive within the context of architectural design. The 1960s/70s saw a series of attempts to develop a 'systematic design method' for the purposes of economic optimisation. Such methods were characterised by false assumptions of process linearity. They also severely underplayed the social and aesthetic dimensions of architectural design. However, irrespective of any intellectual argument, the architectural profession continues to be criticised for its perceived absence of systematic rationality.

5.3.7 *Systems Engineering: Coping with Complexity* (Stevens *et al,* 1998) provides a useful bridge between systems engineering and requirements management. It is widely cited in the requirements management literature and was mentioned by several interviewees. The book is eminently practical and benefits from the consultancy experience of its authors. However, it is under-developed in terms of its theoretical underpinnings and has little recognition amongst academics working in the systems field. In essence, requirements management is a product of consultants rather than academics.

5.4 What is requirements management?

5.4.1 In essence requirements management is the process of capturing, engineering and managing requirements

! The trouble with systems engineering is that it assumes that people behave like cogwheels in an optimising system.

! Practitioners have a tacit understanding of the limitations of systems engineering when faced with complex problems.

Goguen, J. and Jirotka, M. (Eds.) (1994) **Requirements Engineering: Social and Technical Issues**, Academic Press, Boston, Massachusetts.

Stevens, R., Jackson, K., Brook, P. and Arnold, S. (1998) **Systems Engineering: Coping with Complexity**, Prentice Hall, London.

! The complexities of architectural design cannot be captured in the protocol of systematic design methods.

based on the principles of systems engineering. The need for requirements management is invariably justified with reference to longstanding problems: (i) failure to deliver projects within budget; (ii) late delivery of projects; (iii) failure to consider project decisions from a 'whole life cycle perspective'; (iv) poor customer satisfaction. Such problems are considered endemic in the software and aerospace sectors. They are also frequently cited in the construction industry where requirements management has also been offered as a potential solution (Kamara *et al,* 2002).

Kamara, J.M., Anumba, C.J. and Evbuomwan, F.O. (2002) **Capturing Client Requirements in Construction Projects**, Thomas Telford, London.

5.4.2 The requirements management literature repeatedly emphasises the need not to repeat the mistakes of the past. Requirements management in itself is not seen to be especially new, but rather something that has not been done well previously. A further consistent plea is for greater time and resources to be allocated to the process of 'requirements definition'. This reflects similar long-standing pleas in the construction industry vis-à-vis the briefing process.

MoD (2002) **The Acquisition Handbook: A Guide to Achieving "Faster, Cheaper, Better"** (4th Edn.) Ministry of Defence.

! Given that the aerospace sector has relatively few customers, the quest for a common language is a sensible aspiration. This is not the case for construction where the diversity of customers is unlimited.

5.4.3 Many of the seminal descriptions of requirements management draw from standard dictionary definitions of a 'requirement'. Typical examples include: 'something demanded or imposed as an obligation'; 'a thing needed or desired' and 'the act or an instance of requiring'. The first definition is suggestive of the key assumption of systems engineering that the ends are given and that the task is limited to technical complexity. The second definition raises the possibility that different users may 'need' or 'require' different things, thereby introducing the notion of social complexity. The third definition sees 'requirement' as a verb rather than a noun. In other words, 'requirement' is a process that must be managed rather than a 'thing'.

5.4.4 Of particular note in the requirements management literature is the importance attached to the consistency of language. The literature advocates that all parties involved in the procurement process should use the same terminology. Requirements management goes some way towards providing a common baseline of communication. The MoD (2002) *Acquisition Handbook* promotes the same commonality of terminology.

5.4.5 The requirements management literature consistently distinguishes between 'user requirements' and 'system requirements'. The former defines the required performance outputs, while the latter defines issues of technical performance. User requirements must be short and non-technical. Emphasis is given to the importance of not mixing user and system requirements.

5.4.6 Two factors combine to provide an explanation for past requirements management failures in the aerospace sector. The first concerns rapidly changing technology. Significant developments in technological systems invariably occur during product development. Inevitably, this can result in user requirements being led by technological development. Initial statements of requirements are frequently revisited once the users become aware of new technologies. Whilst understandable, such revisions obviously carry an associated cost in implementing late changes.

5.4.7 The second factor relates to the complex nature of the 'user group' for many aerospace projects. Collaborative European military projects are especially prone to users with different requirements. Different European defence agencies often emphasise different performance requirements, reflecting different strategic needs. In this respect, European aerospace consortia are undoubtedly disadvantaged in comparison to their North American competitors who have the luxury of serving one defence agency. Political pressures to allocate jobs to different countries add a further political complication to multi-national collaborative projects. It must also be acknowledged that national strategic defence requirements are often subject to rapid change in the face of unforeseen events. Export projects are faced with different political uncertainties as recipients change from 'desirable' to 'undesirable' in accordance with the demands of 'real politick'.

5.4.8 It follows that aerospace projects are often developed within the context of considerable political complexity. In comparison, the uncertainties surrounding the typical construction project pale into insignificance. (Construction projects such as the Millennium Dome provide obvious exceptions.) There is nothing within the theoretical heritage of requirements management that brings any confidence that the political complexities surrounding aerospace projects can be subject to an 'engineering fix'. In such circumstances, the contribution to be offered by any managerial algorithm will be limited.

! Claims made for requirements management often underestimate the technical and especially the political complexity of aerospace projects.

! If buildings had to fly, designers would be more careful about justifying and recording their decisions.

5.4.9 Aerospace projects often present a unique combination of technical and political complexity. In such circumstances, some of the more grandiose claims made by the requirements management literature seem far-fetched. This observation does not discount the importance of requirements management in maintaining a 'controlled and managed environment' for administrative purposes. It is further true that the traceability of design decisions has a particular poignancy in aerospace that is less evident in construction.

5.5 Techniques of requirements management

5.5.1 The requirements management literature is dominated by 'tools and techniques'. However, it is clear that an understanding of these techniques is not sufficient to perform effective requirements management, in the same way that an understanding of 'design methodology' is not sufficient to perform effective design.

user scenarios, capture of requirements, organisation of requirements, review of user requirements. Sources of user requirements include: interviews, existing documentation,

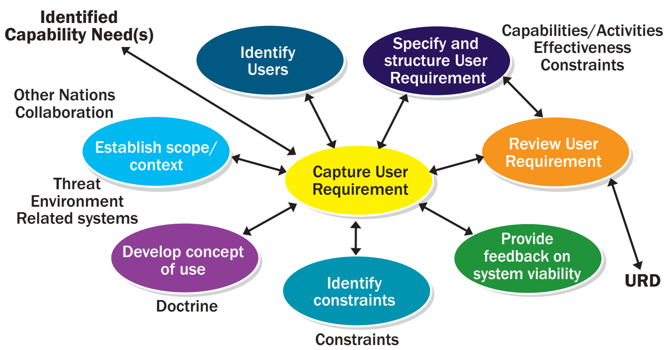

Figure 5.1: User requirement document (Source: MoD, 2002)

5.5.2 The user requirements document (URD) (*see Figure 5.1 above*) is central to the process of capturing user requirements. According to the MoD, the user requirements document should be 'an all embracing structured expression of the user needs for a bounded operational capability'. The process of producing the user requirements document would include numerous sub-activities such as: customer scoping, definition of user types, identification of constraints, definition of related products, prototyping and workshops (Stevens *et al*, 1998). Within the MoD context, the user requirements document is owned and prepared by the nominated Director of Equipment Capability (DEC). This is significant because it removes much of the political complexity of user requirements from the domain of external requirements management consultants.

5.5.3 The system requirement document (SRD) (*see Figure 5.2 below*) is the second

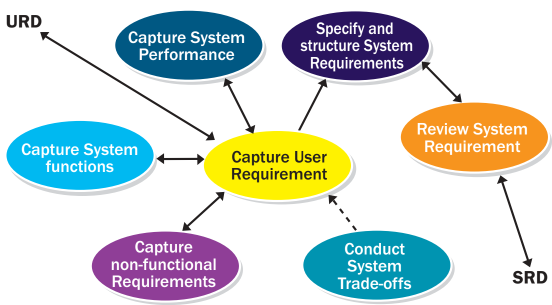

Figure 5.2: System requirement document (Source: MoD, 2002)

key document/database of requirements management. To follow the MoD definition, the system requirements document 'defines, in output terms, what the system must do to meet user needs as stated in the user requirements document'. Defining the system requirements is held to be a highly creative process. The purpose is to show what the system must do, but not how it must be done. The system requirements form a model of the system, acting as the intermediate step between the user requirements and design (Stevens *et al,* 1998).

is produced by the project delivery team, i.e. the 'Integrated Project Team' (IPT).

5.5.4 The administrative function of requirements management is heavily represented in the literature. The verification process is central to systems engineering and mirrors the traceability emphasis of requirements management (see *Figure 5.3*). The systems requirements model provides a dynamic knowledge repository that enables ongoing interrogation and verification throughout the project life-cycle.

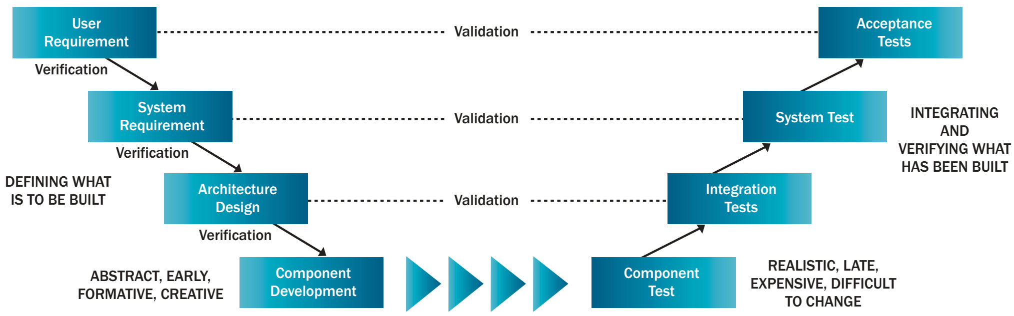

Figure 5.3: Requirements verification (Adapted from Stevens *et al*, 1998)

Diagrams are often used for expressing structure and relationships. The task of capturing system requirements is supported by activities such as the production of a functional diagram created through brainstorming, definition of non-functional requirements, system trade-offs and finally a review of system requirements. Core techniques for specifying system requirements include data flow diagrams, entity relationship diagrams and state transition diagrams. Within the MoD context, the system requirements document

5.5.5 Facilitated workshops are commonly used for requirements elicitation and consensus building. However, the literature gives scant attention to the necessary facilitation skills. Successful facilitators depend upon high-level behavioural skills that often do not come naturally to engineers. The requirements management literature severely underplays the importance of behavioural skills in comparison to systematic rationality.

! Engineers are not trained in the required behavioural skills to facilitate effective workshops.

Requirements management **in aerospace** - Interview summary	
Context	**Dominant Themes**
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• Tacit awareness of social complexity • Normative language still not adopted • Communication is vital • A flexible not 'purist' approach is more common • Vital to any project • No definitive proof of success • Software tools simply aid the process

5.6 Requirements management in practice

5.6.1 The requirements management practitioners interviewed provided points of agreement with the literature, but also significant points of departure. There were also considerable differences of emphasis amongst those interviewed.

"A glossary of terms has been produced...but [it] doesn't cover everything. RTM, DOORS, have differing terminologies that come with them. There is a stubbornness to adopt others' terminologies."

Defence interviewee on the problems of a common language.

5.6.2 In general, interviewees displayed a significantly greater awareness of the social complexity of the requirements process than is demonstrated in the literature. Much of this understanding was tacit in nature and rooted in experience.

5.6.3 The reasons given for the need for requirements management largely reflected the storylines in the literature, but with a greater emphasis on the necessary skills alongside the need for better systems.

"Issues of hierarchy are at play; weighted attention is common in workshops."

Defence interviewee on the issue of eliciting user requirements.

5.6.4 Interviewees confirmed the widespread use of interviews and workshops during requirements elicitation, and displayed a much greater awareness of the importance of group dynamics in workshop settings. There was a particular emphasis on consensus building and a widespread awareness of the dangers of 'groupthink'. Several interviewees also referred to the existence of hierarchical differences within workshops and the associated problems of 'weighted attention'.

5.6.5 The documented requirements process does not account for the complexity and inevitable conflict associated with 'people problems'. However, those immersed in the requirements management context would appear to be adept at recognising and addressing social complexity.

5.6.6 Despite the importance placed on consistent requirements management terminology in the literature, a normative language has yet to be fully adopted across the companies interviewed. Reasons cited include the necessary transition from traditional methods of working, the inability of employees at all levels of the organisation to write requirements, and the different terminologies present within different software tools. There was also some stubbornness to adopt the terminologies of others. This is prevalent where teams work together from different departments or where different companies have merged.

5.6.7 Several interviewees expressed definitional problems relating to the difference between ‘requirements management’ and ‘requirements engineering’. Some see the former as a sub-set of the latter, others see them as synonymous.

5.6.8 Considering the highly socialised process of requirements elicitation, it is not surprising that the importance of communication was much emphasised. The importance of ensuring clients and stakeholders express needs and not wants reflects similar debates in construction. The distinction between ‘hard’ and ‘soft’ problems was well summed up by the comment that “technical problems require an intellectual exercise”, whereas eliciting requirements calls for a “communications exercise”.

5.6.9 Interestingly, it was widely acknowledged that although requirements management is rooted in systems engineering, it is not a ‘purist’ approach that is being used. Indeed, in comparison to much of the requirements management literature, some interviewees remarked that the process does not always start with an identified need. Many ideas are said to develop from the bottom up. This implies a degree of flexibility in approach that is not reflected in the literature. All interviewees considered requirements management to be an evolutionary process, involving much iteration between stages.

5.6.10 When asked about the applicability of requirements management to other sectors, common responses were: “it must be used”; “I don’t understand how people can build anything before knowing what is required in the first place”. However, some aerospace companies that purport to use requirements management are never involved in upstream requirements identification. In many circumstances, questioning client stakeholders is not an option.

“I don’t understand how people can build anything without knowing what it is you want to do in the first place.”

Defence interviewee on the applicability of requirements management.

5.6.11 It was notable that none of the interviewees were able to offer any definitive proof of the success of their requirements management process due to lengthy project timescales. The requirements management process was quoted to take anything from 6 weeks to 6 years, depending on the project. None of the projects on which it had been used had yet reached final conclusion. However, it was claimed that the resulting modifications and upgrades occurring during the life of the product had so far been successful, indicating that the through-life policy of requirements management is being implemented.

“You can’t teach requirements engineering; you have to have the right mind set, be the right person.”

Defence interviewee on defining requirements management.

“Some call it management, some engineering: [it’s] all the same. Can’t manage the requirements without engineering, can’t engineer it without managing.”

Defence interviewee on the applicability of requirements management.

5.6.12 The most common requirements management software tools were cited as being DOORS® and RTM®. All the interviewees agreed that the software tools were simply to document and aid the process. Such tools cannot be used in the absence of an overriding process.

"You need the customer on board – so you [must] find a process they're happy with."

Defence interviewee on working with reluctant clients.

5.6.13 It was consistently emphasised that the requirements management process requires an investment of time and resources. Some frustration was expressed that clients are currently reluctant to allocate sufficient time and resources to the requirements management process. It was widely believed that clients need to be educated to appreciate the benefits. The top-down push from the MoD was seen as useful in this respect.

5.7 Equivalent practices in construction

5.7.1 Requirements management has no direct equivalent in construction. To describe how similar processes are achieved it is necessary to describe a bundle of different practices such as briefing, value management and change control. Even these have little consistency in the way they are implemented.

5.7.2 The nearest equivalent to the user requirements document in construction is known as the 'strategic brief'. The system requirements document relates in turn to the 'performance brief'. Neither practice in construction is especially influenced by systems engineering.

Fisher, N., Barlow, R., Garnett, N., Finch, E., and Newcombe, R. (1997) **Project Modelling in Construction...Seeing is Believing**, Thomas Telford, London.

5.7.3 Current practices of strategic briefing emphasise the iterative and inter-dependent nature of briefing and design. Construction clients are becoming increasingly multi-faceted, resulting in the need to negotiate a shared understanding of the client's requirements. The more recent literature refers to the need to develop and maintain a 'political constituency' throughout the project life-cycle.

! Value engineering draws heavily from the rhetoric of systems engineering.

5.7.4 In common with requirements management in the aerospace sector, strategic briefing has long been problematic. Part of the problem is the recognised tendency of construction professionals to rush into solutions without a clear understanding of problem. Communication between users and designers is made more difficult by the absence of any common language. Designers are repeatedly criticised for their failure to understand the business needs of the client.

5.7.5 The techniques commonly used in support of strategic briefing are directly equivalent to those used in aerospace to produce the user requirements document - with the notable exception of 'prototyping'. Interviews, documentary review, visits to similar buildings and facilitated workshops are all common practice. The potential use of virtual reality (VR) technology is also becoming more widely recognised amongst leading firms (Fisher *et al*, 1997).

5.7.6 Previous solutions to perceived poor value for money in construction include the adoption of 'value engineering', which draws from the logic of systems engineering. Value engineering seeks to 'achieve identified functions at least cost'. It includes techniques such as functional diagramming and brainstorming for the purposes of defining 'functional requirements'.

5.7.7 The functional models that serve value engineering tend to be less robust than those used in requirements management. In part, this is due to an unwillingness to invest the time and effort. However, the performance of buildings cannot be understood by breaking their components down into systems. Whilst engineering systems are increasingly important to building performance, the most important parts of buildings are arguably the defined spaces. The interaction between such spaces dictates the use of the building in a fundamental way. This inevitably introduces psychological and social factors into building performance appraisal. The existence of multiple stakeholders with different agendas also introduces political factors into the design process.

5.7.8 Aesthetic considerations are often of prime importance to building design. This relates not just to the 'image' desired by the client, but also the quality of the public environment. Designers are invariably constrained by planning regulations. It must be added that for the reasons described above, the implementation of value engineering is relatively unsophisticated. It is invariably implemented retrospectively in response to a projected cost overspend. In such circumstances, the frame of reference is predominantly technical, the task being to achieve the required functions at less cost. It normally consists of little other than the identification of alternative technical solutions by an assembled team.

5.7.9 Associated with value engineering is the more strategic practice of 'value management'. Value management tends to be implemented at key pinch-points during the briefing process. Rather than involving technical experts, value management seeks to involve the key project stakeholders. The objectives of value management are normally described in terms of 'collective learning' and 'consensus building'. Value management is therefore an aid to the briefing process and often plays an important role in maintaining the 'political constituency' for a construction project.

5.7.10 The expression 'Soft VM' is increasingly used to contrast the strategic approach with the more technical orientation of value engineering (otherwise labelled 'Hard VM'). Soft VM is essentially predicated on social science concepts. It is recognised that there are often several equally valid perceptions of 'reality' based on different worldviews. The models that support value management are therefore used to facilitate debate and the emergence of a shared understanding. The labels 'Hard' and 'Soft' are borrowed from systems thinking. The expression 'hard systems thinking' is used to characterise the tradition of systems engineering, the applicability of which is limited to technical problems. In contrast 'soft systems thinking' adopts an interpretive approach that is deemed more appropriate for social contexts where the definition of the 'problem' is in itself problematic.

! In contrast to value engineering an important emphasis in value management is given to facilitation skills.

! Political complexities that characterise the vast majority of construction projects are several magnitudes smaller than those that characterise large-scale aerospace projects.

! The overriding objective of value engineering is cost reduction.

5.8 Conclusion

5.8.1 Requirements management is advocated and increasingly implemented in the aerospace sector in response to a history of requirements failure. The approach was originally developed in the software sector whose track record is even more woeful. The construction industry also possesses similar long-standing problems in meeting client requirements.

5.8.2 The aerospace and software sectors are both characterised by rapid technological development with the result that requirements are frequently revisited once users become aware of new technologies. The problem of 'technology push' is less prevalent in construction. All three sectors are susceptible to political complexities caused by multi-faceted clients pursuing different agendas.

5.8.3 Aerospace products are much more intensively designed than their equivalents in construction. Furthermore, aerospace systems tend to be much closer to the leading edge of technology. Hence the need for the maintenance of a highly detailed database that provides traceability for a myriad of design decisions.

5.8.4 The level of political complexities surrounding aerospace projects is frequently of a different level of magnitude to those commonly encountered in construction. This is especially true for multi-national defence projects that endeavour to serve the need of several defence agencies. Such projects often involve high-level input from national governments seeking to balance strategic defence needs against support for national aerospace industries. In such conditions, stakeholders and user representatives are often beyond the reach of requirements management practitioners.

5.8.5 The literature consistently distinguishes 'user requirements' from 'system requirements'. Whilst the latter tends to be characterised by technical complexity, the former tends to be characterised by political complexity. Whilst the systems engineering approach is highly appropriate for technical problems, it remains contentious for problems that are subject to multiple interpretation.

5.8.6 The requirements management literature is dominated by the tradition of systems engineering. As such, it shows little sensitivity for social and political complexity. The tacit sensitivity demonstrated by practitioners presents a sharp contrast with the established literature. Recent research in requirements management is aimed at the development of a 'socio-technical' systems approach that seeks to embrace both 'hard' and 'soft' issues (Mumford, 2000; Galliers and Swan, 2000).

5.8.7 The modelling techniques of requirements management are significantly more sophisticated than their equivalents in construction. They also require significant investment of time and effort. Aerospace projects can be meaningfully modelled as integrated technological systems. In contrast, the performance of building projects is dependent upon the way the designed space facilitates complex social interactions.

Mumford, E. (2000) A socio-technical approach to system design, **Requirements Engineering**, **5**(2), 126-134.

Galliers, R.D. and Swan, J.A. (2000) There's more to information system development than structured approaches: Information requirements analysis as a socially mediated process, **Requirements Engineering**, **5**(2), 74-82.

Furthermore, the required use of buildings will inevitably evolve over time. Ongoing flexibility to adapt to changing and unforeseen patterns of use is often more important in building design than optimisation in accordance with pre-determined parameters. In short, whereas aerospace products can be modelled as 'systems' this is only partially true for buildings.

5.8.8 The explicit recognition of the need for advanced facilitation and behavioural skills appears to be more recognised amongst leading construction firms than their equivalents in aerospace. The construction industry tends to undersell its skills in these areas.

5.8.9 The requirements management literature assigns significant importance to the conformity of language amongst different stakeholders. Despite this emphasis in the literature, the existence of a 'normative language' in practice remains elusive. The articulation of requirements management in construction may alleviate the current diversity of language amongst highly disparate stakeholders. However, the hugely fragmented structure of the construction industry is likely to make the achievement of a normative language an elusive target.

5.8.10 The above notwithstanding, there would appear to be significant potential for the adaptation of requirements management for the construction industry. This is particularly true for procurement methods that approximate towards the concept of 'integrated project teams' (IPT). Further research is necessary to evaluate requirements management processes in the construction context. Development work may be necessary before existing requirements management software tools can be meaningfully piloted.

5.8.11 The fragmented process of construction continues to present barriers to new ways of working. The advent of 'Design and Build' resulted in significant productivity improvements, but its success requires a unitary client who can pre-articulate a detailed set of requirements. Traditionally, there has been no equivalent of the 'integrated project team' (IPT) in construction. More recent procurement methods such as prime contracting, Procure 21 and PFI combine design and construction with ongoing responsibility for facilities management. These new approaches provide a much richer context for the application of new ways of working such as requirements management.

5.8.12 The MoD *Acquisition Handbook* gives particular emphasis to the use of requirements management. There are opportunities for construction companies to increase penetration in the MoD prime contracting market by adopting the language and logic of requirements management. Such opportunities are dependent upon the flow of work being sufficiently large to justify the necessary investment.

6

6.1 Introduction

6.1.1 Human resource management (HRM) is widely recognised to be an essential ingredient of business success. This is equally true for both the aerospace and construction sectors. Firms within both sectors frequently claim that their 'people are their greatest asset'.

6.1.2 The increasing importance attached to HRM is evidenced in the construction industry by the 'Respect for People' initiative launched in 1999. The equivalent within the aerospace sector is the 'People Management' theme of SBAC's Competitiveness Challenge, initially launched in 1998.

6.1.3 The comparison between HRM practice in the two sectors is useful because the two sectors are different. The construction industry is highly fragmented and has a reputation for its dominant culture of command and control. Current calls for enhanced teamwork and collaborative working must be understood in the broader structural context.

6.1.4 The aerospace sector has undergone significant consolidation and is highly integrated. It therefore arguably provides a more supportive context for the espoused team culture and the associated emphasis on commitment and long-term partnerships. However, any such superficial analysis conceals as many complexities as it reveals.

6.1.5 Any discussion on HRM is immediately faced with problems of definition and scope. Of further concern to commentators is the frequently observed distinction between rhetoric and reality.

Human resource management **in aerospace** - A summary

Context	Practice
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• Technological intensity and rate of change demand continuous training to maintain competitiveness. • Concept of the 'high performance work organisation' is central to the quest to link people management to business performance. • Efforts to introduce high performance HR practices are frequently disrupted by mergers and consolidation. • High levels of direct employment amongst manual workers sustains collective bargaining between employers and trade unions. • Longstanding concerns regarding skills shortages. Engineering is not attracting sufficient new entrants to maintain necessary skills base.

6.2 What is Human Resource Management?

6.2.1 The last twenty years have seen a widespread shift in terminology from 'personnel management' to 'human resource management' (HRM). Traditionally, personnel management was an administrative function that struggled for recognition in the boardroom. Whilst it could be argued the shift in terminology is largely a re-branding exercise, HRM has undoubtedly been influential in encouraging a much more strategic orientation towards the management of people. The literature on HRM repeatedly emphasises the need to treat people as a key resource. The aim is to integrate human resources policy into strategic management whilst seeking behavioural commitment to organisational goals (Guest, 1987).

6.2.2 There is an established dichotomy in the literature between 'hard' HRM and 'soft' HRM. The former treats people as a resource to be provided and deployed as necessary to achieve organisational objectives. In contrast, the latter sees people as valued assets who offer a source of competitive advantage (Legge, 1995). Whereas hard HRM comprises 'command and control', soft HRM comprises 'empowerment and commitment'. In many respects, the two models of HRM are direct descendants of McGregor's (1960) Theory X and Theory Y.

6.2.3 The above dichotomy is clearly an over-simplification of a complex field where rhetoric and reality are difficult to separate (Legge, 1995). Many organisations undoubtedly apply elements of both. Companies are also often fond of dressing

! The hard and soft approaches to HRM are incompatible because they are based on diametrically opposed assumptions.

Guest, D. (1987) Human resource management and industrial relations, **Journal of Management Studies**, **24**(5), 503 – 521.

Legge, K. (1995) **Human Resource Management: Rhetorics and Realities**, MacMillan, London.

McGregor, D. (1960) **The Human Side of Enterprise**, McGraw-Hill, New York.

! Many companies have relabelled their Personnel Departments as HRM functions without understanding or changing the role they perform.

Human resource management **in construction** - A summary

Context

- Highly fragmented
- Few large players
- Many customers
- 1,599,000 employees
- Output £83.59bn
- 122,220 SMEs
- £270m R&D spend
- Predominantly local markets

Practice

- Collective bargaining has never been strong and has weakened significantly over last 25 years
- Institutionalised regressive approach to HRM. Dominant culture of 'command and control'
- HRM practices are heavily mediated by industry structure. High levels of sub-contracting mean that firms often have no HRM policy for manual workers
- Casualisation of workforce has significant implications for job security, training and health & safety
- HRM policies based on empowerment and commitment are more prevalent within professional firms and design consultancies

up hard HRM in soft rhetoric (Truss *et al,* 1997). Espoused policy is frequently more coherent than operational practice, which by necessity tends to be pragmatic and opportunistic (Brewster *et al,* 1983).

6.2.4 Soft HRM is increasingly operationalised through the concept of high commitment management, otherwise labelled high performance HR. The approach is characterised by a number of mutually reinforcing practices (*see Box 6.1).* The high commitment model is widely accepted as best practice, but its level of implementation in UK workplaces remains low (Wood and de Menezes, 1998).

6.2.5 A range of factors act to constrain and influence the adopted model of HRM. These include the size and history of the

- Trainability and commitment as key criteria in employee recruitment, selection and promotion
- Extensive use of systems in communication
- Teamworking with flexible job design
- Emphasis on training and learning
- Involvement in operational decision-making with responsibility
- Performance appraisal with tight links to contingent rewards, including promotion
- Job security/no compulsory redundancies

Box 6.1: Mutually reinforcing practices of HRM. (Adapted from Legge, 2000.)

Truss, C., Gratton, L., Hope-Hailey, V., and McGovern, P. (1997) Soft and hard models of human resource management, **Journal of Management Studies, 34**(1), 53-73.

Brewster, C., Gill, C. and Richbell, S. (1983) Industrial relations policy: a framework for analysis, in K. Thurley and S. Woods (Eds.) **Industrial Relations and Management Strategy**, Cambridge University Press, Cambridge, pp. 67-72.

Wood, S. and de Menezes, L. (1998) High commitment management in the UK: evidence from the WIRS and EMSPS, **Human Relations, 51**, 485-515.

! Soft HRM is more of an aspiration than a policy that can ever be fully implemented in practice.

Legge, K. (2000) Personnel management in the 'lean organisation' in S. Bach and K. Sisson (Eds.) **Personnel Management: A Comprehensive Guide to Theory and Practice**, Blackwell, Oxford, pp. 43-69.

organisation, prevailing market pressure, the nature of the product (or service), employee behaviour and level of trade union activity (Marchington and Parker, 1990). Management is not always able to exercise independent choice. Different policies tend to be applied to staff perceived to be 'core' and those perceived to be 'peripheral'.

6.2.6 Two current trends may particularly affect the way in which HRM is exercised in an organisation: the devolution of HR responsibilities to line managers and the shift from collectivism to individual contracts. The demise of collectivism means individual employees are increasingly expected to be personally responsible for their own career development.

6.2.7 Trends towards the individualisation of the employment relationship have focused attention on the 'psychological contract' between the employee and the organisation (Rosseau, 1995). The concept is useful in that in considers the implicit mutual obligations and expectations that exist between the two parties. High commitment HR practices are often correlated with a more positive psychological contract, i.e. both parties feel that the other is maintaining their part of the bargain (Guest, 1999).

6.3 HRM in the construction context

6.3.1 Construction project managers have always had significant discretion over employment issues such as recruitment, training, and health & safety. There is a long-established tradition of devolved HRM responsibilities within the construction sector. Collective bargaining on behalf of manual workers by trade unions has never been strong in the construction industry and has weakened significantly over the last 25 years.

6.3.2 HRM practices in the construction sector are heavily mediated by industry structure. Contractors frequently offload the risks and responsibilities of direct employment to subcontractors. Many projects are characterised by articulated chains of sub-contracting that culminate in a workforce that is notionally self-employed. It follows that most contracting firms have no HRM policy for manual employees. HRM personnel within main contractors are largely confined to dealing with core professional/managerial staff.

6.3.3 Several previous studies contend that the dominant culture of the construction sector consistently emphasises the hard model of HRM. The *Work Employee Relations Survey* (Cully *et al,* 1999) investigated three measures of employee participation across twelve

Marchington, M. and Parker, P. (1990) **Changing Patterns of Employee Relations,** Harvester Wheatsheaf, Brighton.

! There is a mismatch in the construction industry between the requirements of the construction process and the culture of the industry.

! The structure and culture of the construction industry dictates the HRM strategies adopted.

! Senior managers talk soft HRM but practice hard HRM.

Rosseau, D. (1995) **Psychological Contracts in Organisations**, Sage, Thousand Oaks, CA.

Guest, D. (1999) Human resource management: the workers' verdict, **Human Resource Management Journal, 9**(3), 5-25.

Cully, M., Woodland, S., O'Reilly, A. and Dix, G. (1999) **Britain at Work**, Routledge, London.

sectors: (i) non-managerial participation in problem-solving groups, (ii) operation of suggestion schemes and (iii) formal survey of employee attitudes during the last five years. In the construction industry, participation in problem-solving groups occurred in only 21% of workplaces. This was lower than any other sector with the exception of 'other community services' (17%). The construction industry was bottom in the other two categories by a significant margin.

6.3.4 Whilst the high degree of sub-contracting in the construction industry may account in part for these results, research by Druker *et al,* (1996) concludes that the hard model of HRM dominates not only for the construction labour force, but also for professional and managerial staff. Coffey and Langford (1998) further observe a low level of employee participation in construction, whilst concluding that there are no inherent reasons that prevent effective participation, even at trade level.

6.3.5 The European survey conducted by Price Waterhouse/Cranfield (Brewster and Hegewisch, 1994) showed that the status and influence of HRM on corporate decision-making was lower in the UK construction industry than in other European construction industries. These results confirm Hillebrandt and Cannon's (1990) previous findings on the low status of the personnel function within UK contractors. Recent research into career opportunities for women in construction companies has further pointed to a widespread discriminatory culture in the UK construction industry (Dainty *et al*, 2000).

6.3.6 The dominant model of hard HRM sits uncomfortably with the oft-cited need for creative processes, integrated teamwork and technical innovation. The industry's regressive HRM culture also presents a significant barrier to organisational learning and knowledge management.

6.3.7 Sub-contracting and self-employment have always played an important role in construction. They offer significant advantages in terms of flexibility. One of the key strengths of the UK construction sector has been its ability to expand and contract in response to fluctuations in demand. The real concern is the level of unjustified casualisation of the core workforce through *bogus* self-employment (Harvey, 2001).

6.3.8 The continued casualisation of the construction workforce has significant implications for job security, training and health & safety. The apprentice system lies in tatters and craft skills are in serious decline. CITB (2002) estimates that the industry currently requires 76,000 new entrants per year. On the basis of current trends, there is a question mark over the industry's long-term capacity to deliver high-quality construction.

Druker, J., White, G., Hegewisch, A. and Mayne, L. (1996) Between hard and soft HRM: human resource management in the construction industry, **Construction Management and Economics, 14**, 405-416.

Coffey, M. and Langford, D. (1998) The propensity for employee participation by electrical and mechanical trades in the construction industry, **Construction Management and Economics, 16**, 543-552.

Brewster, C. and Hegewisch, A. (1994) **Policy and Practice in European Human Resource Management: The Pricewaterhouse Coopers/Cranfield Survey**, Routledge, London.

Hillebrandt, P. and Cannon, J. (1990) **The Modern Construction Firm**, Macmillan, London.

Dainty, A.R.J., Bagilhole, B.M. and Neale, R.H. (2000), A grounded theory of women's career under-achievement in large UK construction companies, **Construction Management and Economics, 18**, 239-250.

Harvey, M. (2001) **Undermining Construction: The Corrosive Effects of False Self-Employment**, Institute of Employment Rights, London.

CITB (2002) **Skills Foresight Report February 2002**, Construction Industry Training Board, Bircham Newton.

6.3.9 Notwithstanding the above, there are parts of the construction sector that depart from the default recipe of Hard HRM. This is especially true for professional firms, design practices and engineering consultancies. Many compete very successfully internationally and have invested heavily in knowledge-based services. The competitive advantage of these firms is based on the expertise of their employees and their capacity for innovation. Such firms seek to recruit and retain highly capable people by providing them with rewarding and challenging careers. Soft HRM policies based on empowerment and commitment are much more prevalent within organisations orientated towards creativity and innovation.

6.4 HRM in the aerospace context

6.4.1 Aerospace is a technologically intensive, high-skills industry. This is especially true for systems integration activities that are undoubtedly at the forefront of the acclaimed knowledge economy. More than a third of employees possess a degree or equivalent qualification and over 11% are involved in R&D (AeIGT, 2003). Whilst aerospace still employs a large proportion of manual workers, recent years have seen a move towards high skill work of a non-manual type. 53% of employees are currently classified as manual and 25% as technical and professional (SBAC, 2002) (see *Table 6.2*).

Aerospace Innovation and Growth Team (AeIGT) (2003) **An Independent Report on the Future of the UK Aerospace Industry**, DTI, UK.

SBAC (2002) **High Performance Work Organisation in UK Aerospace: The SBAC Human Capital Audit 2002**, SBAC, London.

6.4.2 The majority of manual workers are engaged in manufacturing activities in fixed locations with relatively high levels of trade union membership. Such workplaces continue to be subject to collective bargaining agreements. Aerospace establishments have experienced significant redundancies over recent years. Some followed the post Cold War reduction in defence expenditure in the early 1990s. Others followed as a result of ever increasing levels of global competition and progressive waves of rationalisation following sector consolidation. More recently, the uncertainties following September 11th 2001 have had a major impact.

OCCUPATION	1997 (%)	1999 (%)	2002 (%)
Managers	10	10	10
Technical and professional	20	25	25
Administrative and technical	11	12	12
Manual	59	53	53

Table 6.2: Occupational Profile 1997-2002. (Source: SBAC, 2002 with acknowledgements to Templeton College.)

6.4.3 Redundancies in the aerospace and defence sectors consistently attract media headlines. Aerospace establishments tend to be located in geographical clusters. Job losses therefore frequently impact significantly on local economies. Despite falling levels of employment, recruitment and retention problems remain. A recent survey revealed that 42% of establishments continue to have difficulty filling vacancies (SBAC, 2002).

6.4.4 The high levels of direct employment amongst manual workers continues to sustain collective bargaining between employers and trade unions. This in turn facilitates partnership arrangements between employers and trade unions in support of training and skills development. Salaries in aerospace are 25% higher than the manufacturing average.

6.4.6 There are longstanding concerns within the aerospace sector concerning skills shortages. Engineering is not attracting sufficient new entrants to maintain the necessary skills base. The rate of technology change makes training and skills development especially important to the competitiveness of UK aerospace.

6.4.7 The people management theme of the DTI/SBAC Competitiveness Challenge has championed the need for firms to develop a strategic approach to people management that includes investment in skills (SBAC, 1998). A range of factors was found to influence expenditure on training for non-management employees (see *Figure 6.1*).

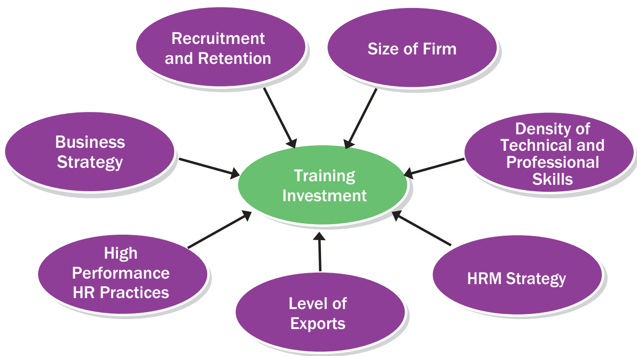

Figure 6.1: Factors influencing training investment in UK Aerospace (Source: SBAC, 1998)

6.4.5 Many aerospace firms have always relied on agency staff for key positions within project teams. Technical and professional staff are routinely seconded to major projects for prolonged durations. As a result, they acquire experience of working for several different prime contractors, thereby serving to share best practices across the sector. The use of seconded staff provides obvious advantages in terms of flexibility and frequently provides highly specialist expertise.

SBAC (1998), **The Competitiveness Challenge: People Management in Aerospace**, SBAC, London.

6.4.8 The concept of the ‘high performance work organisation’ (HPWO) has emerged as a central component of the quest to link people management to business performance. HPWOs combine a range of complementary practices: high involvement practices, human resource practices for building skills levels and employee relations practices for building trust and loyalty (*see Table 6.3*).

High Performance Work Organisation (HPWO)

High Involvement Practices	Human Resource Practices	Employee Relations Practices
• Semi-autonomous team working • Continuous improvement teams • Responsibility for own work quality • Job rotation • Information sharing programmes • Briefing groups	• Appraisal • Personal development plans • Performance based rewards (skill and performance related pay) • High levels of training on and off-the-job • Sophisticated recruitment techniques • Broad job grading structures	• Harmonised terms and conditions of employment (pensions, leave etc) • Formal grievance procedures (sex, race discrimination etc) • Induction programmes • Joint consultative committees • Regular social gatherings for employees • Same canteen and eating arrangements

Table 6.3: HPWO and interrelated groups of practice. (Source: SBAC, 2002.)

6.4.9 On the basis of the SBAC (2002) *Human Capital Audit*, there is still a long way to go before the full range of high performance practices are adopted across aerospace. Only 11% of establishments use two-thirds of them, and 45% use less than half. The overall picture is one of slow but steady uptake. The highest level of penetration relates to employee relations practices. 83% of establishments implement a common pension scheme and 77% have a common pay scheme for more than two-thirds of the non-management workforce.

6.4.10 Of further note is the relatively high reported percentage of establishments that involve more than two thirds of the non-management workforce in on-the-job training (46%) and share ownership schemes (30%). Whilst the use of high involvement work practices is also increasing, many aerospace establishments still fall short of HPWO on several key criteria. Only 15% of establishments involve more than two thirds of the workforce in problem-solving teams. The equivalent figure for the use of continuous improvement teams is 21% (SBAC, 2002).

! High performing firms spend three times as much developing people management skills as low performing firms.

Human resource management in **aerospace** - Interview summary

Context	Dominant Themes
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• Distinction between hard and soft HRM considered too idealistic. In the real world it is necessary to make difficult choices • Different styles appropriate for different parts of the company • Managers frequently heavily constrained in the extent to which they can implement high performance HR in practice • Need to project a 'tough' image frequently felt to be in conflict with trends towards HR practices based on empowerment and commitment

6.5 HRM in practice

6.5.1 To investigate how HRM is enacted in practice, interviews were conducted with practitioners from the two sectors. The sample included both HRM specialists and line managers. Given the wide scope of HRM and the diversity of both sectors, caution must be expressed about the generalisability of the views expressed. The emergent themes are primarily presented to encourage further research and reflection on the way HRM practice is mediated by context.

6.5.2 Many interviewees from both sectors considered that HRM practice frequently departed from the theory. Whilst many supported the aspirations of high performance HRM, they felt themselves to be heavily constrained in the extent to which it could be implemented in practice. Those responsible for implementing HRM practices often have limited choice in the approaches that could be adopted.

6.5.3 Several considered the distinction between hard and soft HRM far too idealistic. Whilst all the HR practitioners liked to think of themselves as enlightened, they frequently emphasised that in the real world it is necessary to make difficult choices. Some project managers from construction were openly antagonistic about HR practitioners. They saw themselves as "having to get a job done in a tough world". Many construction interviewees expressed reservations about the 'Respect for People' initiative, but there was nevertheless a general consensus that construction is moving towards a softer approach based on teamwork.

6.5.4 In many construction organisations, project managers have such a high level of autonomy that the role of HRM

"Now given that we have a huge engineering requirement rolling forward, even if we recruited every single engineer that came out of university this year, we'd still be short. We sponsor some university courses and are actually physically paying people to go and do software technology. Now that's been reasonably successful, but it's how you retain them thereafter."

Aerospace interviewee on the role of HR in addressing recruitment and retention.

Human resource management in construction - Interview summary

Context	Dominant Themes
• Highly fragmented • Few large players • Many customers • 1,599,000 employees • Output £83.59bn • 122,220 SMEs • £270m R&D spend • Predominantly local market	• Some degree of overt antagonism towards HRM and its practitioners • Many project managers are concerned with 'having to get a job done in a tough world'. HRM is seen to be an irrelevance • Perception of a general move towards a softer HRM approach, at least for professional and managerial staff • HR staff involved in facilities management aspects of PFI projects currently preoccupied with TUPE transfers

departments is often limited to the administrative and quasi-legal aspects of recruitment and redundancies. They also take responsibility for developing policies on issues such as equal opportunities. On-site project managers frequently view such policies as bureaucratic constraints on their autonomy. Within the construction sector, it would seem that the responsibility for training and career development is increasingly delegated to individuals. This tends to apply both to professional staff and manual operatives.

6.5.5 Interviewees consistently resisted any attempt to characterise the HRM style of the organisation for which they worked. Different styles were considered appropriate for different activities and for different parts of the company. Many expressed the view that for manual workers involved in routine production activities there is little alternative to an approach based on 'command and control'. This applied equally to both aerospace and construction, thereby confirming the limited penetration of high performance HR practices.

6.5.6 Whilst construction claims to be moving towards a softer approach, many within aerospace appear to be experiencing a state of tension. Some practitioners wished to implement a softer style, others claimed that they were already too soft, and a harder approach was needed. Considering the size of many aerospace organisations, it is perhaps unsurprising that considerable differences exist within a single company. Some differences in HR strategy can be traced back to mergers between different companies. It can take years to re-establish a consistent HRM approach following a merger between

"HRM doesn't have a place on the board. I don't think they should have a place on the board. I think our board has too many people now!"

Construction interviewee on board representation of HRM.

"We have been looking to harmonise the terms and conditions [from all the takeovers] but are coming across numerous hurdles trying to do that."

Aerospace interviewee on the HRM problems of mergers.

"I think soft HRM has become the norm now. You don't have to beat people with a stick."

Construction interviewee on the dominant HRM style.

"I think because it's a profession, people pursue their interests individually rather than collectively. Most employees feel they can deal with any issues they have directly with their employer."

Construction interviewee elaborating on the lack of trade union membership in their profession.

companies with significantly different cultures. Subsequent attempts to instil a unified approach are often overtaken by further mergers. Most mergers inevitably result in some degree of rationalisation, often involving redundancies. HRM initiatives are continuously disrupted by such discontinuities. This is especially true for the aerospace sector.

6.5.7 Some within the aerospace sector considered that senior management would prefer to be seen to be implementing hard HRM. Such a view suggests the existence of counter-cultures within companies and sits uneasily with the supposed shift towards HPWO. It further suggests that the need to focus on short-term efficiency and productivity frequently impinges upon longer-term developmental HRM strategies. It was even suggested that occasional 'blood-letting' is necessary to keep the City happy. The need to project a 'tough' image can be vital to some companies, and this may be reflected in the adopted HRM style.

"It seems to be one of the things that creates an us-and-them mentality".

Construction interviewee on the role of trade unions.

6.5.8 Many interviewees representing management felt there is little need for trade union representation. This was especially true for the construction sector where many considered trade unions to be an irrelevance. This reflects the decline of collectivism with an increasing emphasis on the 'psychological contract' between individuals and their employers.

6.5.9 TUPE transfers were of particular concern for construction sector practitioners involved in PFI projects. HR managers in this context are heavily involved in negotiations with trade unions on the employment conditions of operatives transferred from public to private sector. The issue is highly topical and receives considerable publicity. Unison continues to campaign against PFI on the basis that it downgrades employment conditions for those who deliver support services. Despite tentative moves towards 'retention of employment' clauses, trade unions continue to be concerned about the development of a two-tier workforce.

6.6 Conclusions

6.6.1 HRM practice in both aerospace and construction is heavily mediated by context and cannot be divorced from the structural characteristics of change and continuity in the two sectors. Managers within both sectors are heavily constrained by economic exigencies in the extent to which they can implement innovative HRM strategies. This is especially true for construction where short-term competitive pressures combine with deeply embedded institutionalised practices to limit the scope for management initiative.

6.6.2 Any understanding of HRM in the construction or aerospace sectors must be predicated on a wider knowledge of HRM practice across the spectrum of British manufacturing. Few UK companies possess coherent HRM strategies. Furthermore, despite the reported benefits of high commitment HR practices, the general level of take-up remains low.

6.6.3 In common with British industry as a whole, both the aerospace and construction sectors have seen a decline of collectivism in employee relations. Technical and professional staff are increasingly seen as 'knowledge workers' who warrant an individual 'psychological contract' with their employers.

6.6.4 Within the construction sector, individualism in employee relations has extended to include many manual operatives who have been encouraged towards self-employment. Trade union density has declined in both sectors, but has been especially marked in construction. Many manufacturing establishments within aerospace remain highly unionised facilitating a partnership approach towards training and skills development. In the construction sector, with some exceptions, trade unions are increasingly marginalised and emasculated.

6.6.5 Attempts to propagate high commitment HR practices in the aerospace sector have to be judged against the low levels of adoption elsewhere. The diffusion of these practices within aerospace remains limited, but there is evidence of increasing take up. Sustained improvement initiatives such as the people management theme of SBAC's Competitive Challenge have had an impact, aided by various 'culture change' programmes within the sector's leading companies. The level of technology-push within aerospace places an especially high premium on training.

6.6.6 The fragmented structure of the construction sector presents a significant barrier to the implementation of coherent HRM strategies. The culture of sub-contracting and self-employment marginalises the importance of people management and thereby reflects and reinforces the dominant industry recipe of hard HRM. The Respect for People initiative has had little impact on the prevailing low status of HRM in construction companies. With few exceptions, main contractors delegate responsibilities for employment issues down the supply chain.

! The extensive use of sub-contracting in the construction industry devolves responsibility for HRM down the supply chain to those least able to deal with it.

6.6.7 The construction sector is increasingly characterised by the 'hollowed-out' firm that retains only a small core of white-collar staff. The industry relies heavily on a casualised workforce sourced through employment agencies and labour-only sub-contractors. There is therefore little incentive for firms to invest in training and career development. The apprentice system is in terminal decline with little prospect of an end to the current skills crisis. The need for flexibility in the face of market volatility has dissolved into damaging endemic short-termism.

6.6.8 HRM culture within many professional firms in the construction sector aligns more closely with the essential tenets of soft HRM. However, relatively few firms have coherent HRM strategies that reflect the characteristics of high performance HR. The level of autonomy in professional firms often results in little attention being paid to HRM issues beyond the legal minimum. The dominant culture remains one of devolved professionalism, whereby employees take personal responsibility for training and continuous professional development.

6.6.9 Ongoing attempts to implement coherent HRM policies within aerospace are frequently disrupted by mergers and acquisitions. Whilst the consolidated structure of the sector should aid the diffusion of new managerial practices, the ongoing process of consolidation acts to disrupt the implementation of high commitment HR practices. Intense global competition has required progressive waves of rationalisation, thereby further serving to undermine progressive HRM policies. The ongoing volatility of demand also serves to deny management the stable environment necessary to implement real change. Nevertheless, the language of high performance HR has played an important role in persuading managers that they can influence change.

6.6.10 Whilst the evidence in support of high commitment HR is compelling, its success is highly path dependent. Changing the HRM culture within companies cannot be achieved overnight. Individual firms are frequently constrained by the dominant industry recipe. Furthermore, management must be capable of implementing high commitment HR as a coherent bundle of mutually reinforcing techniques. Success stories from elsewhere cannot always be replicated. The possibility of employee intransigence as a result of previous poorly implemented management initiatives must also be recognised.

Learning across Business Sectors

7

DTI (2001) **Enterprise Skills and Innovation: Opportunity for All in a World of Change**, The Stationery Office Ltd., Norwich.

7.1 Introduction

7.1.1 The DTI (2001) White Paper *Enterprise Skills and Innovation: Opportunity for all in a World of Change* exemplifies a sustained government directed push towards innovation in British industry. Initiatives such as SBAC's *Aerospace Innovation and Growth Team (AeIGT) and the Movement for Innovation* (M4I) reflect and reinforce the government focus on innovation.

7.1.2 Innovation is undoubtedly an essential component of a successful industry. It is also central to the lexicon of best practice. Unfortunately, it is notoriously difficult to define and proceduralise.

7.1.3 In this chapter, the literature on innovation will be explored to identify how current dominant definitions reflect and reinforce attitudes to innovation. Different typologies of innovation will be considered together with some of the claimed dependent variables. Particular attention will be given to the way in which innovation is diffused across technological and social boundaries. Finally, views of innovation are presented from those who are involved in creating it whilst struggling to make sense of it.

Innovation

Innovation **in aerospace** - A summary

Context	Practice
• Highly consolidated • One major player • Few customers • 117,256 employees • £16.14bn turnover • 1000 SMEs • £1.74bn R&D spend • Predominantly global markets	• Innovation is important, but ill-defined as a concept • Radical technological innovations are common and highly regarded • Innovation is integral to the business • The industry's ability to risk encourages continuous innovation • There is a gap between top-level encouragement of innovation and lower level diffusion

7.2 What is Innovation ?

7.2.1 The problematic nature of innovation is immediately apparent when attempts are made to define it. Historically, the expression 'innovation' has been used to signify change, invention (16th Century), an upheaval or rebellion (17th century), and, in Scots Law, the substitution of a new obligation for the old (19th century).

7.2.2 Innovation as a business concept dates from Schumpeter's (1939) clarification that "Innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation". This distinction between innovation and invention is important, especially the suggestion that one is not necessarily a precursor of the other.

7.2.3 Current debates about the definition of innovation continue to raise further questions (*see box 7.1*). The concept of innovation is invariably intertwined with issues of knowledge creation, continuous improvement, and organisational change. Such terms are frequently used interchangeably. Economists, psychologists, change consultants and knowledge management gurus all bring different perspectives to the innovation debate. However, within academia the understanding of innovation is still considered under-developed and highly fragmented (e.g. Wolfe, 1994; Tidd, 1997).

The act that endows resources with a new capacity to create wealth (Drucker, 1985)	Novel changes and the introduction of something new (Davenport, 1993)
Invention plus exploitation (Schumpeter, 1934)	The creation of something new (Sonfield and Lussier, 2000)

Box 7.1: Conflicting definitions of innovation

Schumpeter, J.A. (1939) Business Cycles: **A Theoretical, Historical, and Statistical Analysis of the Capitalist Process** (2 vols.), McGraw-Hill, New York.

Wolfe, R. (1994) Organizational innovation: review, critique and suggested research directions, **Journal of Management Studies, 31**(3), 405-431.

Tidd, J. (1997) Complexity, networks and learning: integrative themes for research on innovation management, **International Journal of Innovation Management, 1**(1), 1-21.

Drucker, P. F. (1985) **Innovation and Entrepreneurship: Practice and Principles**, Harper and Row, New York.

Davenport, T. (1993) Process Innovation: **Reengineering Work Through Information Technology**, Harvard Business School Press, Boston.

Schumpeter, J.A. (1934) **The Theory of Economic Development**, Harvard University Press, Massachusetts.

Sonfield, M.C. and Lussier, R.N. (2000) Innovation, risk and entrepreneurial strategy, **International Journal of Entrepreneurship and Innovation**, **1**(2), 91-99.

Innovation **in construction** - A summary

Context	Practice
• Highly fragmented • Few large players • Many customers • 1,599,000 employees • Output £83.59bn • 122,220 SMEs • £270m R&D spend • Predominantly local markets	• Innovation is important, but ill-defined as a concept • Incremental process innovations are common and highly regarded • Incremental innovation is essential for culture change • The industry's attitude to risk inhibits innovation • Prolonged imposition of process innovations by clients has led to initiative overload

7.2.4 Despite the disparities between current popular definitions (*see Box 7.1*), there is a general agreement that innovation involves the introduction of something new or novel. Arguably, an innovation can be a new product, a new process, or even a new way of thinking. Some would even argue that the term innovation is justified when an old idea is used in a new context (King and Anderson, 2002)

King, N. and Anderson, N. (2002) **Managing Innovation and Change: A Critical Guide for Organizations (2nd Ed.)**, Thomson, London.

7.2.5 It is often argued that the scale of innovation ranges from incremental to radical (e.g. Davenport, 1993; King and Anderson, 2002). Incremental innovations are small-scale changes based on current knowledge. Their impact is minimal and predictable, and they emanate from within the organisation. Radical innovations are characterised by breakthroughs and large-scale change, unpredictable in appearance and impact. They tend to emanate outside of the current industry, and provide a new way of understanding a phenomenon and formulating approaches to problem solving. Because of the scale of radical innovations they are very rare, and by their very nature they frequently result in significant change.

7.2.6 Innovation can be found at every organisational level (King and Anderson, 2002). Vacancies are frequently advertised for an innovative individual, without clear criteria by which the person will be judged as innovative. Conversely, other advertisements require someone to join an innovative group. Here the focus moves from the individual to the characteristics of the group as a whole. Individuals themselves do not need to be innovative, but they need to cohere with others to form an innovative whole. An organisation might describe itself as innovative, either in recognition of its products or for marketing purposes. These tacitly recognised, but subtly different, levels of innovation raise questions as to the optimum industrial climate for promoting organisational innovation.

7.3 Characteristics of innovation

7.3.1 The literature on innovation can be grouped into three typologies:

- The source of innovation: emergent, imported or imposed (e.g. Sauer and Anderson, 1992)
- The characteristics of innovation: programmed vs. non programmed, instrumental vs. ultimate, and degree of 'radicalness' (e.g. Zaltman *et al*, 1973)
- Product and process innovations (e.g. Damanpour and Gopalakrishnan, 2001)

These typologies are by no means independent. For example, a process innovation can be both emergent and radical.

7.3.2 Building on Sauer and Anderson, Breschi *et al,* (2000) argue for another source of information stating that innovations are often dictated by technology available to the industry in which firms operate. They contend there is a dichotomy between the different industrial contexts for innovation. The pattern of 'widening' is where small new firms can enter the industry and disrupt the established models of production, wiping out the profits associated with previous innovations. Conversely, the pattern of 'deepening' is where large established firms innovate persistently and tend to dominate their industries for a very long time.

7.3.3 Construction can be viewed as an example of widening, with its low barriers to entry, project-by-project timeframes and plethora of small firms. Conversely, with its high barriers to entry, large firms and lengthy product time frames, aerospace is a prime example of deepening.

7.3.4 Furthermore, the level of technology applied within aerospace is more advanced than that applied within construction. The differing technologies undoubtedly account in part for the difference in structure. At the same time, the difference in structure accounts for the propensity towards innovation. Hence there is an iterative relationship between innovation and industrial context. The context will dictate the innovations that can occur, whilst the innovations will impact upon the context.

7.3.5 It follows from the above that innovation is at least partly dependent on the surrounding environment. Dependent variables include: organisation size, organisational structure, and the culture within the company.

7.3.6 In terms of the size of firm that is most conducive to innovation, small really is beautiful (Quinn, 1985; Schumacher, 1973). Innovation clearly involves an

Sauer J. and Anderson N. R. (1992) Have we misread the psychology of innovation? A case study from two NHS hospitals, **Leadership and Organization Development Journal, 13**(2), 17-21.

Zaltman, G., Duncan, R. and Holbeck J. (1973) **Innovations and Organizations**, Wiley, New York.

Damanpour, F. and Gopalakrishnan, S. (2001) The dynamics of the adoption of product and process innovation in organizations, **Journal of Management Studies, 38**(1), 45-65.

Breschi, S., Malerba, F. and Orsenigo, L. (2000) Technological regimes and schumpeterian patterns of innovation, **The Economic Journal, 110**(463), 388-410.

Quinn, J. B. (1985) Managing innovation: controlled chaos, **Harvard Business Review**, May-June.

Schumacher, E. F. (1973) **Small is Beautiful: Economics as if People Mattered**, Blond & Briggs, London.

element of risk. Employees in small firms bear greater personal risk and incentive; therefore there is less organisational restriction on innovation. The risk-avoidance strategies and high levels of corporate risk of large firms are widely held to restrict their employees' opportunity to innovate.

7.3.7 The close relationships within small firms provide more opportunity for implementable innovations than the isolated top management structure of large firms. The relatively low start-up costs provide extra opportunity for small firms. Large organisations often suffer from what can be called bureaucratic constipation, resulting in a slow moving, static entity. Flexibility and speed are the essence of small firms. They allow them greater opportunities to innovate.

7.3.8 Generally, large firms frequently seek to overcome bureaucratic constipation by arranging themselves into loosely connected networks of small business units built around tightly knit teams. The majority of teams are multi-disciplinary and multi-level, enabling them to draw on – and draw together – the wide range of knowledge within the organisation (e.g. Gerstner, 2002). Arguably, this allows large firms a far greater opportunity for interactive learning with clients, universities and even competitors.

7.3.9 Burns and Stalker's (1961) seminal study of the management of innovation distinguishes between organic and mechanistic organisations. An organic organisation, as often found within small firms, provides a dynamic environment for innovation. Conversely, a mechanistic organisation as traditionally typified by large bureaucracies can stifle innovation. Current structural theories of innovation build on this theory, conceding the role of context in dictating organisational type (e.g. Miles and Snow, 1978; Miller, 1986).

7.3.10 Organisational culture is commonly discussed as both the cause and the result of many organisational practices (e.g. Brown, 1995). In contrast, Salaman and Storey (2002) argue that organisations do not simply have cultures they are cultures. They further build on the definition of culture as "*a manifestation of, and a constraint on, organisational cognition, values and action*" (Meyerson and Martin, 1987). This 'shared cognition' results in the shared social norms that pervade any social structure.

7.3.11 It is the shared social norms that determine an organisation's orientation towards innovation. The organisational memory will ensure these attitudes prevail and are maintained through each generation of employees (Weick, 2001). Previous engagements with innovation (be they positive or negative) will contribute to

Gerstner Jr, L.V. (2002) **Who Says Elephants Can't Dance? How I Turned Around IBM**, HarperCollins, New York.

Miles, R. E. and Snow, C. C (1978) **Organizational Strategy, Structure and Process**, McGraw-Hill, New York.

Miller, D. (1986) Configurations of strategy and structure: towards a synthesis, **Strategic Management Journal, 7**, 233-249.

Brown, A. (1995) **Organisational Culture**, Pitman Publishing, London.

Salaman, G. and Storey, J. (2002) Managers theories about the process of innovation, **Journal of Management Studies, 39**(2), 147-165.

Meyerson, D. and Martin, J. (1987) Cultural change: an integration of the different reviews, **Journal of Management Studies, 24**(6), 623-647.

Burns, T. and Stalker, G. M. (1961) **The Management of Innovation**, Tavistock, London.

Weick, K. (2001) **Making Sense of the Organization**, Blackwell, Oxford.

the shared reality as the encounters are remembered and learnt from (Salaman and Storey, 2002). It is within these constraints that organisational innovation is bound.

7.3.12 Other variables that are frequently held to impact upon innovation are leadership, corporate behaviour and strategy. The impact of these variables is determined by the extent to which they each encourage or inhibit innovation. Peters (1998) presents a checklist of keys to fast innovation: invest in small starts; pilot everything; practice "creative swiping"; encourage mixed teams; support committed champions and past failures; and set quantitative innovation goals. However, the opportunity to practice these initiatives is often restricted by institutional barriers.

7.4 Diffusion of innovation

7.4.1 The diffusion of innovation is central to the current discourse of knowledge sharing. Diffusion can be defined as *"the process by which an innovation is communicated through certain channels over time among the members of a social system"* (Rogers, 1995). There are therefore four factors that influence the diffusion of innovation: the innovation itself; communication channels; time; and the social system.

7.4.2 The innovation itself must be perceived as novel to the individual or environment. This 'newness' "may be expressed in terms of knowledge, persuasion or a decision to adopt [it]" (Rogers, 1995). Its rate of adoption is dependent on:

- The perceived relative advantage of the innovation;
- Its compatibility with existing values, past experiences, and current needs;
- Its complexity in understanding and use;
- Its trialability;
- Its visibility to others.

7.4.3 A level of understanding or similarity between the change agent and the change receivers enhances diffusion (see *Box 7.2*). This understanding is known as 'homophily' and is the degree to which interacting individuals are similar in certain attributes. Whilst this could arguably be viewed as a reason for employing like-minded individuals, it is ironic that innovations are usually introduced by individuals seen as outside of the norm, comprising 'heterophilous' (differing or contrasting) attitudes (Rogers, 1995).

Peters, T. J. (1988) **Thriving on Chaos: Handbook for Management Revolution,** Macmillan, London.

Rogers, E. M. (1995) **Diffusion of Innovation** (4th Ed), The Free Press, New York.

! Experts and fanatics are the backbone of a small company, but are risky prospects in larger organisations, and so are discouraged.

Homophily	Individuals who interact share similar attributes such as beliefs, education, and social status. Innovation is diffused more quickly amongst homophilous individuals.
Heterophily	Individuals who interact have contrasting attributes. Innovation is diffused more slowly amongst heterophilous individuals.

Box 7.2: The impact of attitudes on the diffusion of innovation.

7.4.4 The time dimension of diffusion relates to three distinct parts of the process:

- The time it takes an individual to accept or reject the innovation (innovation-decision).
- The early or lateness of adoption by the individual in comparison to other members of the system.
- The rate of adoption in a system.

! There is no spirit of the pioneer: companies do not encourage innovation for innovation's sake. Only commercially viable innovations are considered worthy of development and implementation.

7.4.5 Another contrast can be found here between the aerospace and construction sectors. As construction is characterised by shorter project time frames, there will be limited time to evaluate innovations. Hence the likely result is not only fewer innovations, but also more innovation failures. In contrast, the time frame of aerospace projects may enable more time for evaluation, with the result that more innovations are adopted. A greater degree of evaluation will also mean less innovation failures, thereby promoting an embracing attitude to future innovations.

Bresnen, M. and Marshall, N. (2001) Understanding the diffusion and application of new management ideas in construction, **Engineering, Construction and Architectural Management,** **8**(5-6), 335-345.

7.4.6 Diffusion is affected by many facets of the social system that transcend individual organisations:

- Social and communication structure: the extent to which it is well developed, it has a pattern, and it provides regularity and stability to the human behaviour within.
- System norms: the established behaviour patterns of those in the system.
- Opinion leaders: those who have the most influence over individuals within the system.
- Change agents: these influence clients' innovation-decisions in a desired direction, and can sometimes even prohibit the spread of innovations if desired by the change agency.
- Decision-making: the extent to which the decision to adopt an innovation is an individual choice, a system consensus, or an authoritative demand.
- Consequences of an innovation: these can be desirable or undesirable, direct or indirect, anticipated or unanticipated.

! Companies aren't any more innovative now than in the past: innovation is simply another term used to attract customers.

7.4.7 Although innovations are generally introduced with the expectation they will be desirable, direct and anticipated, it is hard to predict the potential meaning of an innovation to those within a social system, possibly resulting in unanticipated, indirect and undesirable consequences (see Bresnen and Marshall, 2001).

7.4.8 Innovation needs a 'champion' to ensure and facilitate diffusion. This champion will preferably be of recognised status and expertise, and will be homophilous with the group. Being recognised as experts in their specialist field and a trusted source of information may be reasons why aerospace practitioners are seen as great innovators. Their ideas are quickly disseminated, enabling swifter diffusion of innovations, which in turn allows for the creation and development of further innovations. Conversely, construction innovations are slow to catch on, and generally ignored, as it is not usually viewed as an innovative sector. This creates a problem for future innovations. The cycle is perpetuated. However, the varying degrees of consolidation and fragmentation within the industries undoubtedly also has an impact.

7.5 An innovation framework

7.5.1 Taking account of the differing definitions afforded by the literature, and the different environments in which innovation is deemed to occur, an innovation framework (*Figure 7.1*) can be proposed that incorporates the notions of innovative ideas, invention and diffusion.

7.6 Innovation in practice

7.6.1 Interviewees from the aerospace and construction sectors mirrored the confusion of the literature when defining innovation, and in particular the split between innovation and invention. Whilst all stated that 'invention' involved technical products 'innovation' was often used as a default term to cover everything else. However, innovation was also deemed to cover technical products, adding to the confusion over definitions.

7.6.2 Within aerospace, only technological innovations were considered radical, with changes in process and practice viewed as incremental and very common. There were differing views as to the level of importance attached to each. Those involved in engineering would only consider step-changes as innovative, and thus the most

"Innovation isn't doing things better, it's doing better things."

Construction interviewee on the definition of innovation.

"A process or procedure that was new and unknown, and could give a competitive edge to the people employing it; a new idea or concept."

Construction interviewee on the definition of innovation.

"I think they're equally innovative."

Construction interviewee on the differences between incremental and radical innovation.

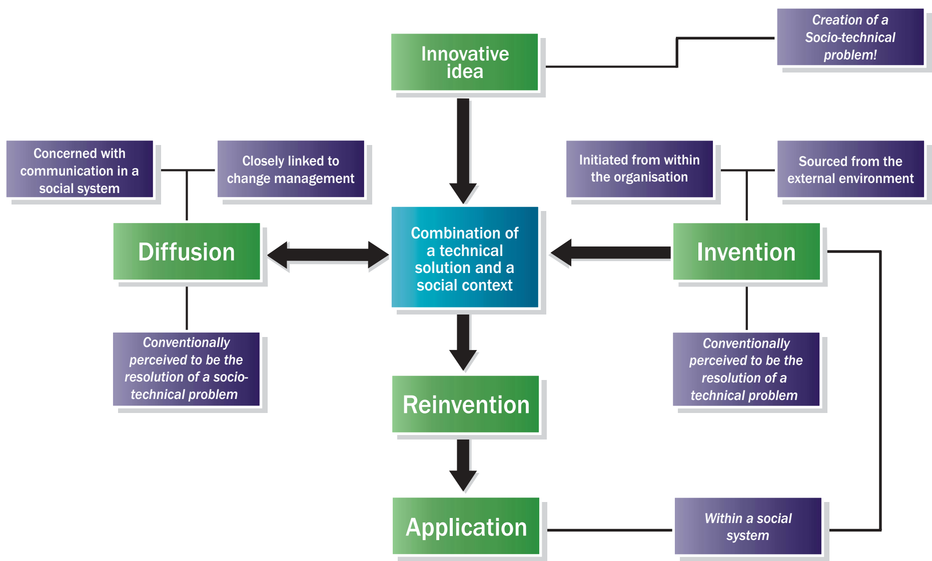

Figure 7.1: A framework of innovation

Innovation **in aerospace** - Interview summary

Context

- Highly consolidated
- One major player
- Few customers
- 117,256 employees
- £16.14bn turnover
- 1000 SMEs
- £1.74bn R&D spend
- Predominantly global markets

Dominant Themes

- Technical innovations are seen to be radical, process innovations are seen to be incremental
- Continuous re-structuring within the sector impedes innovation diffusion
- The tendency for executives to rotate positions often hinders innovation
- There is frequently a gap between the recognition of innovations and their implementation
- There are conflicting opinions on whether innovation is pushed from below or pulled from above
- The blame-free culture enhances innovation

important. However, other interviewees felt incremental change and radical change were both of value.

7.6.3 In construction, incremental innovation is viewed as the most common (innovations are “rarely earth shattering” in construction), but interestingly these small-scale changes were viewed as equally, if not more, important than any radical innovations that might occur. This was partly attributed to the rarity of radical innovations in construction, and partly to the belief that culture change occurs through small-scale changes.

> “It’s rarely basic R&D, coming up with something earth-shattering and new.”
>
> *Construction interviewee on what innovation means in construction.*

7.6.4 Risk proved to be an equally problematic issue for the interviewees. Construction interviewees acknowledged that they tended to be risk averse, and noted that promotion tended to increase risk adversity. Although aerospace interviewees did not consider themselves risk averse (being “risk aware” and even “risk embracing”) it was acknowledged that the transient nature of its executive workforce encouraged a risk-averse attitude at the top level. As senior executives are moved around every eighteen months to two years, they are often unwilling to take on risky propositions with long pay-back periods.

> “Innovation has a strong survival instinct in our business.”
>
> *Construction interviewee on innovation within their sector.*

7.6.5 When asked about levels of diffusion within their companies, the interviewees in both sectors found that poor communication was prohibitive. Within aerospace, there was felt to be a significant gap between top-down encouragement and recognition of innovations, and actual implementation throughout the company. A similar problem was highlighted within construction, where the constant cascade of ‘innovative’ initiatives has resulted in a feeling of saturation.

7.6.6 The sheer volume of new initiatives passed down often means that few are

Innovation **in construction** - Interview summary

Context	Dominant Themes
• Highly fragmented • Few large players • Many customers • 1,599,000 employees • Output £83.59bn • 122,220 SMEs • £270m R&D spend • Predominantly local markets	• Incremental innovation is seen to be more common than radical innovation • Volatility of workload discourages innovation • The 'not invented here' syndrome impedes innovation diffusion • Many complain of 'initiative overload' • Too many firms see innovation as an unnecessary cost • The absence of a blame-free culture impedes innovation

properly implemented. It was commented that top-level encouragement was not enough. There has to be top-level involvement to ensure the successful implementation of new practices.

7.6.7 The Chairman's Award was a topic that provoked considerable debate from those within BAE SYSTEMS. The Chairman's Award seeks to acknowledge and promote innovations devised by its employees. Whilst the initiative was recognised by all the interviewees, they displayed differing attitudes towards it. Some stated that it was there simply to reward naturally occurring innovations, whilst others felt the company was forcibly 'pulling' innovation from its employees. Some even found it offensive, claiming that they would do it anyway, simply as part of their job.

7.6.8 In contrast, innovation in construction is more likely to be 'pulled through' by the client, than pushed through by the supply chain. This implies that there is still a perception within construction that innovation is an unwanted cost.

7.6.9 In aerospace, inhibitors of innovation were cited as instability, size, current technology, organisational culture, legal and business laws, budgets and time. Interestingly, size was said to be an enhancer of innovation, as large organisations are seen to have a greater pool of people from which to glean ideas. If innovation is part of a company's product or image, it was felt that it is much more likely to occur.

7.6.10 Innovation is more likely to thrive in a blame-free culture. The organisational memory provides an understanding of what will and will not be accepted and implemented within the company. This notion of 'bounded' innovation suggests that rather than limiting the intellectual

"The idea of innovation tends to come from the high levels, and it's not perhaps communicated down throughout the lines to the staff down below. Yes, they want to be innovative, yes they probably try to define the word innovation, but there's a difference between the practical and the theoretical."

Aerospace interviewee on the diffusion of innovation.

"There is a recognition in [this company] that we can't get away from it, and we're beginning to think we ought to take on more risk."

Aerospace interviewee on risk.

"Tales of innovations are swapped through socialisation – [you] hear about product innovations through word-of-mouth."

Construction interviewee on the diffusion of innovation.

"[It's] bound by the constraints of current technology; culture – people are frightened of change... and to an extent, I would say, business and legal issues all combined."

Aerospace interviewee on the inhibitors of innovation.

"You have to allow innovation but within a controlled environment."

Aerospace interviewee on innovation within their organisation.

opportunities, considering innovations within the boundaries of an organisation might increase implementation.

7.6.11 For construction, inhibitors of innovation were focussed around fear of the unknown and territorialism: the "not invented here" syndrome. Interestingly, there was no mention of instability, presumably because of the unstable climate of the sector: instability is stability for construction. Enhancers included notions of the 'right' environment. The creation of a blame-free culture was felt to be especially important. Managerial and organisational support was also cited as being crucial for thriving innovation.

"There's certainly an element of "not invented here" syndrome – if we haven't actually evolved it, it's not very good."

Construction interviewee on the introduction of new innovations.

7.6.12 The impact of environment on innovation was highlighted when talking with the infrastructure arm of BAE SYSTEMS. Interviewees acknowledged that the department is not seen to be as innovative as the rest of the company. Nevertheless they felt they had more opportunities for innovation than the rest of the construction sector. They attributed these opportunities to the unique challenges provided by the aerospace environment, for which bespoke and innovative solutions are often required.

"The implementation of landfill tax has made us look at how much stuff we send off our sites to get put in the ground."

Construction interviewee on the impact of government standards.

7.6.13 Both sectors experience pressure to innovate from clients, although construction interviewees concede that if the client does not want innovation in their product, the industry will not push for it. Government policies affect innovation in both sectors. For example, the introduction of landfill tax has forced construction to think of 'innovative' ways to dispose of rubbish. The aerospace sector is similarly motivated to innovate to accommodate increasingly stringent environmental and noise pollution laws.

7.6.14 A paradox of innovation appears to be reflected within the construction industry. The introduction of modular construction is in itself an innovation. However, the very nature of this standardisation prevents further innovations from taking place, either on site or in design.

7.7 Conclusion

7.7.1 Definitions of innovation are problematic. This is clearly demonstrated by both the literature and by the empirical research. The confusion of definition is partly due to the diverse linguistic heritage of the word 'innovation'. Although innovation has been identified as separate from invention, boundaries between the two are hazy at best.

7.7.2 The label of innovation is often used interchangeably with invention, knowledge creation, continuous improvement and continuous change. A possible reason for the inconsistency of terminology is the current preference for 'innovation' as marketing currency. An 'innovative' company is likely to attract more customers.

7.7.3 Innovation ranges from incremental to radical. Aerospace tends to consider radical innovations to be the most significant, whilst construction relies more on incremental innovation to assist cultural change. Definitional problems abound. If incremental innovation encompasses all small-scale changes occurring on a regular basis, it is hard to distinguish between incremental innovation and continuous improvement. Furthermore, if incremental innovation and continuous improvement are the same, this raises further questions as to how innovation should be managed, and what it means for an organisation to be ‘innovative’.

7.7.4 The emphasis on the technical in radical innovations may be attributable to the fact that products are tangible. In contrast, new processes are much less tangible and are hence subject to multiple interpretations. As such, it is much more difficult to measure their impact.

7.7.5 The apparent bias towards technical innovations is perhaps partly responsible for the noticeable divide between the supposedly ‘innovative’ industries, such as aerospace and IT, and supposedly less ‘sophisticated’ sectors such as construction, where the opportunities for product innovation are more limited.

7.7.6 Context dictates innovation. Variables such as organisational size, structure, culture and attitude to risk all have a significant impact. The received wisdom is that smaller companies have more motivation, opportunity and encouragement to innovate. However, larger firms frequently have greater opportunities (and resources) for interactive learning with universities, clients and even competitors.

7.7.7 Within the context of an ongoing struggle to define innovation, both industries are continually striving to become more innovative. However, there will always be disparity between a sector that primarily innovates in process and one that primarily innovates in product. The enhanced status afforded to technical innovation reinforces perceptions of a technologically sophisticated aerospace sector and a ‘primitive’ construction sector. The experienced reality is much more complex.

8

8.1 Introduction

8.1.1 This chapter presents a summary of the overall findings and suggests some general conclusions. Separate summaries are provided of each of the preceding chapters to reiterate the main themes.

8.1.2 The general conclusions are offered more in the style of provocations rather than definitive statements. Perhaps the biggest lesson of the research is that both the aerospace and construction sectors are so large and diverse that almost any generalised statement will be untrue in part. In accordance with the overall philosophy of the report, readers are therefore encouraged to derive their own conclusions by applying the arguments presented to the context within which they operate.

8.2 Knowledge sharing

8.2.1 Knowledge management resonates with the discourse of the knowledge-based economy. Effective knowledge management is increasingly seen to be a central component of competitiveness. Nevertheless, knowledge is not a commodity that can be acquired, stored and distributed as if it were a manufactured product. Managerial knowledge is frequently tacit in nature and uniquely rooted in the experience of individuals.

8.2.2 Sharing managerial knowledge within and across companies depends upon an ongoing process of socialisation. The processes of de-contextualisation and re-contextualisation are of principal importance. Knowledge sharing is essentially a process of knowledge creation; all those who actively engage learn as a result of their participation.

8.2.3 Day-to-day interactions between individuals with different perspectives are a vital component of knowledge creation. Diversity in thought and a willingness to challenge accepted assumptions are essential prerequisites to innovation. It is equally important to keep up to date with the latest thinking published in the literature. However, the views of remote experts must be challenged and re-contextualised before they can contribute to the knowledge of individuals.

8.2.4 The research described in this report developed a participatory approach to knowledge sharing across business sectors. It combined a rigorous review of the literature with a series of interactive workshops involving senior practitioners drawn from the aerospace and construction sectors. Each workshop was directed at a different topic. The discussions were always predicated on an analysis of the different characteristics of the two sectors.

8.3 Structure and change: contrasting contexts

8.3.1 A relative contextual understanding of the aerospace and construction sectors is essential to any comparison of managerial practices. Comparisons between the construction and aerospace sectors are especially pertinent because they are so different. The construction industry is highly fragmented and dominated by small firms. In contrast, the aerospace sector is highly consolidated and dominated by a small number of large firms. Suppliers in aerospace are more specialised than those in construction, with much higher levels of technological intensity.

8.3.2 Structural change in the aerospace sector has been driven by global trends of consolidation. Aerospace is a highly globalised industry with extensive international networks of collaboration. In contrast, the vast majority of construction projects are embedded in localised contexts. The enduring legacy of low-cost tendering and associated process discontinuities makes the construction sector especially resistant to change.

8.3.3 Within the construction sector, firms frequently compete on cost efficiency rather than innovation and technical expertise. In contrast, the aerospace sector invests heavily in R&D and is characterised by highly integrated processes. Despite pockets of excellence, the construction sector is characterised by a ‘low road’ development path. Competitive advantage in construction too often depends upon extracting value from sub-contractors rather than investing in innovation.

8.3.4 The differing structures of the two sectors are reflected in their respective client bases. There are a limited number of global procurers of aerospace systems. Such clients tend to be highly sophisticated with longstanding relationships with the aerospace sector. In contrast, the client base of the construction sector is hugely fragmented and is dominated by once-in-a-generation clients who have no specialist knowledge of the construction sector.

8.3.5 The two sectors have traditionally had very different relationships with government. Government has in the past supported the aerospace sector for strategic defence reasons, although in recent years value for money in defence procurement has increasingly taken priority. Aerospace is important to the UK economy because of its position at the apex of the technology triangle. R&D in aerospace frequently provides trickle-down benefits for other high-technology sectors. Relatively few countries possess the range of aerospace capabilities of the UK. Maintaining this technological capacity depends crucially upon continuity of work.

8.4 Supply chain management

8.4.1 Supply chain management (SCM) is currently central to the best practice agendas of both sectors, despite the lack of any universally accepted definition. A common theme in the literature is the need for management to extend control across the whole supply chain. A commitment to collaborative working is seen to be an essential prerequisite of successful SCM.

8.4.2 The SCM literature further distinguishes between strategic and operational perspectives. The former emphasises the need for firms to position themselves to best advantage while aligning others to serve their needs. The latter focuses on improving efficiency through better logistics.

8.4.3 Effective SCM depends on confidence and trust between supply chain members. The aerospace and construction sectors comprise very different contexts within which such issues are played out. The extent of confidence and trust between firms cannot be separated from a broader understanding of the structural characteristics of the sector within which they operate. The characteristics of the aerospace sector are those of a high-trust economy. In contrast, the construction sector tends towards the characteristics of a low-trust economy.

8.4.4 SCM in the aerospace sector is played out against a backcloth of significant global consolidation coupled with complex international networks of interdependency. Global competition and spiralling development costs makes collaboration a commercial necessity. Within aerospace, firms have little choice other than to compete as part of an integrated supply chain. In contrast, the fragmentation of the construction sector provides an environment where confidence and trust cannot be taken for granted. In consequence, opportunistic behaviour remains more prevalent than any genuine commitment to collaborative working.

8.4.5 The emergence of integrated procurement routes such as prime contracting potentially provide a more supportive context for collaborative working within construction. Firms competing within the embryonic prime contracting market succeed or fail on the strength of their integrated supply chain. However, behavioural change remains dependent upon continuity of work and a willingness to invest in new skills.

8.5 Requirements management

8.5.1 The elicitation and delivery of client requirements has long been problematic in both sectors. Within the aerospace sector, the discipline of requirements management is widely advocated as a potential solution. Construction lacks a similar integrated approach, with different parties frequently taking responsibility for the disparate processes of briefing, value management and change control.

8.5.2 Requirements management draws heavily from the tradition of systems engineering. It provides a framework for verifying requirements and ensuring traceability of decisions. However, the practice of requirements management has been found to differ significantly from the theory. Practitioners demonstrate a greater awareness of social complexities than the majority of published sources. Requirements practitioners repeatedly emphasise the importance of advanced facilitation skills, thereby echoing established trends amongst briefing and value management practitioners in construction.

8.5.3 The modelling capabilities of requirements management are significantly more refined than their equivalents in construction. However, it must be recognised that whereas aerospace systems can usefully be modelled as an integrated set of technical sub-systems, this is not usually the case for the products of the construction industry. Building performance is dependent upon a complex interaction between technical and social sub-systems. Architectural designers frequently combine a commitment to client requirements with a wider social responsibility for maintaining the quality of the public built environment.

8.5.4 In addition to its administrative functions, an important feature of requirements management is the quest to implement a consistent language for the elicitation and delivery of client requirements. Despite the consolidated nature of the aerospace sector, significant differences in terminology remain. Given the hugely fragmented nature of the construction sector's client base, any similar quest for a common language would seem unrealistic.

8.5.5 The requirements management process requires an investment of time and resources. Some frustration was expressed that clients are often unwilling to allocate sufficient resources to the process. Many construction designers involved in the strategic briefing process express similar frustrations. Client requirements are frequently tacit in nature and can only be understood through a prolonged process of socialisation. Eliciting requirements is a knowledge sharing process; all parties must be equally committed to participation.

8.6 Human resource management

8.6.1 The best practice agendas of both sectors place a particular emphasis on human resource management (HRM) and the need to adopt a more strategic approach to the management of people. However, espoused HRM policies are frequently more coherent than those implemented in practice.

8.6.2 The UK construction industry possesses an institutionally embedded regressive approach to HRM and compares badly to all other sectors. The high degree of sub-contracting means that firms too often avoid responsibility for investing in the employment relationship. While sub-contracting has obvious advantages in terms of flexibility, the downside is a casualised workforce with significant implications for job security, health & safety and training.

8.6.3 There are exceptions to the above, especially amongst the UK's design practices and engineering consultancies. There are a few notable firms that compete very successfully internationally and have invested heavily in knowledge-based services. Such firms seek to recruit and retain highly capable people by providing them with rewarding and challenging careers. Central to the attraction of such organisations is the extent of job variation and the associated opportunities for continuous personal development.

8.6.4 Employment patterns in the aerospace sector are markedly different to those in construction. Most manual workers are engaged in manufacturing activities in fixed locations with high levels of trade union membership. Collective bargaining arrangements are much more prevalent than in construction.

8.6.5 The concept of the 'high performance work organisation' (HPWO) is increasingly recognised within the aerospace sector as the key to business improvement. Implementation is growing, but overall progress remains slow. Such initiatives frequently sit ill at ease with enforced redundancies due to market fluctuations and inherited overcapacity. Continuity of work and a stable environment are vital if progressive HRM strategies are to be implemented successfully. Corporate mergers and acquisitions also often interrupt HRM initiatives with aerospace companies.

8.6.6 HRM practice in both sectors is heavily shaped by context. Managers are invariably constrained by the structural characteristics and traditional practices of the sector within which they operate. Whilst dramatic change is likely to remain an aspiration for both sectors, commitment to training and people development is much more prevalent in aerospace than construction.

8.7 Innovation

8.7.1 Innovation has been a recurring theme throughout this report. Innovation is widely recognised as a source of competitive advantage, despite difficulties of definition. Innovations range from the radical to the incremental. Process innovations are no less important than technological innovations.

8.7.2 Innovation depends upon a range of variables. Size of firm, flexibility in structure and attitudes towards risk all affect the organisational capacity for innovation. The aerospace sector tends to emphasise technological innovation, process innovation is held to be more important in construction. Process innovation tends to be incremental in nature and is often indistinguishable from continuous improvement. A propensity towards knowledge sharing is an essential prerequisite of innovation.

8.7.3 The impact of any innovation will ultimately depend upon the ease with which it can be diffused across complex social systems. Technological innovations are usually much easier to diffuse than process innovations, which are subject to reinterpretation by the recipients. The extent of reinterpretation will depend upon the cohesiveness of the social system. The diffusion of some innovations may well result in indirect and undesirable consequences.

8.7.4 The consolidated structure of the aerospace sector provides for more stable patterns of innovation diffusion than the highly fragmented construction sector. This is well illustrated by the case of supply chain management, which is much more coherently understood and implemented within aerospace than in construction. However, paradoxically, the ongoing process of consolidation in aerospace frequently interrupts innovation programmes.

8.7.5 Of greatest concern for the construction sector is the erosion of the industry's capacity for innovation. The emergence of the hollowed-out firm and widespread reliance on outsourcing means a capacity for innovation is often seen to be an unnecessary overhead. The underlying model of competitiveness based on low cost therefore becomes a self-fulfilling prophecy. The UK construction sector is seemingly locked into a self-perpetuating low-skill, low-technology development path. In contrast, the UK aerospace sector strives towards an innovation-based model of competitiveness that requires continuous investment in its capacity for innovation.

8.8 Conclusions

8.8.1 Knowledge sharing across business sectors

The research has demonstrated the benefits of knowledge sharing across business sectors. Furthermore, the adopted method has significant implications for the way that the aerospace and construction sectors should seek to learn from other industries. The approach described is much richer than the majority of 'benchmarking' exercises because it does not ignore contextual differences.

8.8.2 Best practice recipes are not universally applicable

The adopted knowledge sharing methodology makes explicit the assumptions that practitioners have about their own sector. The process generates an understanding of the way that managerial practices are mediated by context, thereby exposing the myth that best practice recipes are universally applicable. An understanding of the dynamic relationship between best practice and the broader business environment better equips managers to cope with future change. In an increasingly turbulent world, the flexibility to foresee and adjust to future scenarios is an essential managerial capability. This applies equally to construction and aerospace.

8.8.3 Knowledge sharing within companies

The research has significant implications for knowledge sharing within companies. IT systems are extremely effective at distributing information. They also have a role to play in the dissemination of codified technical knowledge that is independent of context. However, they are unlikely to be effective at sharing managerial knowledge within companies. Any company that has aspirations to be a learning organisation could replicate the approach described in this report. In this way, knowledge managers could play a significant role in generating a company's capacity for innovation. The approach is by no means limited to learning across business sectors.

8.8.4 Multiple interpretations

All four managerial practices described in this report are subject to multiple interpretations. Vagueness of definition is a recurring theme. Furthermore, implementation of managerial practices is significantly shaped by context. Practices of the same name are often radically different when implemented in different sectors. For example, SCM in construction bears little resemblance to SCM in aerospace. This observation has significant implications for management training and education. Too much prescription is likely to be counter-productive.

8.8.5 Industry recipes

The way that managerial practices are implemented in the two sectors depends upon the dominant industry recipe. The concept of institutionally embedded practices is of particular importance in understanding the mediating effects of context and the complex interplay between structural and cultural factors. An awareness of a sector's historical development path is an essential pre-requisite to any change agenda. In the absence of any such understanding, the promoters of change are doomed to repeat the mistakes of the past.

8.8.6 Models of competitiveness

Numerous sources distinguish between 'low road' and 'high road' industry development paths. The first equates to a productivity-based model of competitiveness and the second to an innovation-based model of competitiveness. The construction sector has undoubtedly taken the low road. Indeed, the competitiveness of the UK construction sector rests more on efficiency in contract trading than on improving productivity. In contrast, the aerospace sector continuously strives for the high road, seeking to compete on the basis of innovation wherever possible. The rate of technological development in aerospace systems demands continuous innovation.

8.8.7 Capacity for innovation

The emergence of the hollowed-out construction firm has seriously threatened the sector's capacity for innovation. While many design firms are highly innovative, this is the exception rather than the norm. The fragmentation of the sector, coupled with a model of competitiveness based on efficiency in contract trading, presents significant barriers to innovative practices such as supply chain management and requirements management. Within the aerospace sector, spiralling R&D costs have been one of the main drivers behind the trend towards global consolidation and the increasing reliance on integrated supply chains and joint ventures. The need for continuous investment in innovation has driven structural change in aerospace. Similar trends in construction remain at best embryonic.

8.8.8 Prime contracting in construction

The emergence of integrated procurement contexts such as prime contracting in the construction sector potentially provides a much more supportive climate for collaborative ways of working than has traditionally prevailed. Providing that a regular workflow can be achieved, prime contractors may well be able to form stable relationships with key suppliers that approximate towards established practice within aerospace. Similar opportunities exist within the PFI market. Within these frameworks, there is an opportunity for firms to compete on the basis of innovation rather than short-term cost efficiency. However, such a shift depends crucially upon a willingness to invest in new skills and a decisive break with the industry's default model of human resource management. If such investment is to be forthcoming, clients must provide continuity of work if they are to promote any lasting change. Such developments are likely to be limited to an elite group of firms that serve the needs of major repeat clients. Notwithstanding the unlikely occurrence of widespread 'culture change', the prospects for a general shift to collaborative working are limited by the structural characteristics of the sector.

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