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To cite this article: Stuart D. Green , Scott Fernie & Stephanie Weller (2005) Making sense of supply chain management: a comparative study of aerospace and construction, *Construction Management and Economics*, 23:6, 579-593, DOI: [10.1080/01446190500126882](https://doi.org/10.1080/01446190500126882)

To link to this article: <https://doi.org/10.1080/01446190500126882>



Published online: 12 Apr 2011.



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Making sense of supply chain management: a comparative study of aerospace and construction

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Received 18 July 2003; accepted 17 January 2005

Current recipes for learning across business sectors too often fail to recognize the embedded and contextual nature of management practice. The existing literature gives little emphasis to the symbiotic relationship between supply chain management and the broader dynamics of context. The aerospace and construction sectors are selected for comparison on the basis that they are so different. The UK aerospace sector has undergone extensive consolidation as a result of the imperatives of global competitive pressures. In contrast, the construction industry has experienced decades of fragmentation and remains highly localized. An increasing proportion of output in the aerospace sector occurs within a small number of large, globally orientated firms. In contrast, construction output is dominated by a plethora of small firms with high levels of subcontracting and a widespread reliance on self-employment. These differences have fundamental implications for the way that supply chain management is understood and implemented in the two sectors. Semi-structured interviews with practitioners from both sectors support the contention that supply chain management is more established in aerospace than construction. The introduction of prime contracting and the increasing use of framework agreements within the construction sector potentially provide a much more supportive climate for supply chain management than has traditionally prevailed. However, progress depends upon an improved continuity of workload under such arrangements.

Keywords: Consolidation, context, industry structure, sense-making, supply chain management

Introduction

Supply chain management (SCM) continues to attract significant attention among construction researchers. The dominant fixation of the academic literature is the extent to which the generic principles of SCM can be adapted to the allegedly unique context of construction. A recurring tendency is to conceptualize the fragmented structure of the construction sector as a 'barrier' to effective implementation. The less scholarly 'best practice' literature frequently ignores the structural barriers to SCM, preferring to concentrate on the need for 'culture change'. This tendency is by no means unusual within the prescriptive management-improvement literature. Concepts such as SCM are repeatedly presented as best practice tools that can be introduced at project level irrespective of a broader contextual understanding. Unfortunately, the

persuasive discourse of SCM too easily camouflages its essential vagueness. SCM continues to defy universal definition and is perhaps best understood as a sub-theme within a broader discourse that promotes 'new ways of working' to a seemingly backward construction industry (cf. Vrijhoef and Koskela, 2000; Cain, 2003; Childerhouse *et al.*, 2003). Despite this recurring ambiguity, the overriding focus of the continuing debate lies on the degree to which techniques developed in other sectors can be adapted for implementation in the construction sector. What seems to be absent is any critical appraisal of the extent that the ascribed meanings of SCM are embedded within the dynamics of the wider industrial context.

This paper contributes new insights by comparing the way that SCM is enacted and conceptualized in two sharply contrasting industrial contexts. The research was predicated on a sense of unease regarding repeated exhortations for construction to learn from other sectors (cf. Gann, 1996; DETR, 1998; Flanagan *et al.*, 1998). Too often, such exhortations give scant

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attention to the contextual differences that shape the implementation of 'new ways of working' in different sectors. Even less frequently is attention given to the symbiotic relationship between managerial practice and the context within which managers operate. The underlying contention is that SCM cannot be understood as a substantive 'improvement technique' in isolation of an understanding of the interaction between human agency and the broader institutional context.

The research was initially made relevant to the industrial participants as a means of supporting the implementation of 'prime contracting' in the construction sector. Although new to construction, prime contracting has a long history of application in the aerospace and defence sectors. This provided the context within which the construction sector participants were keen to learn from aerospace. In contrast, the initial motivation for the aerospace participants had more to do with finding new markets for consultancy services. However, as the research progressed it was increasingly recognized that the approach provided equally rich learning opportunities for both sectors.

The paper is structured into four sections. First, the adopted methodological position is justified with reference to Pettigrew's (1997) concept of processual analysis and Weick's (1995) notion of sense-making. These sources combine to provide the theoretical justification for the argument that the conceptualization and enactment of SCM cannot be understood in isolation from the broader sectoral dynamics of change. Secondly, the contrasting contexts of the UK construction and aerospace sectors are explored with reference to their respective structural characteristics, differing relationships with government and relative degrees of global consolidation. Particular attention is given to the way in which these factors have unfolded over time to provide very different contexts for collaborative working between organisations. Thirdly, a selection of the existing literature on SCM is reviewed to determine the extent to which these broader trends are taken into account. Although the review is by necessity selective, attention is given to both the generic SCM literature and that which addresses the implementation of SCM in construction. Coverage includes the associated concepts of confidence and trust as applied to inter-organizational relationships. The literature review also extends to the key SCM 'best practice' initiatives that have shaped the debate amongst informed practitioners. The fourth section of the paper reports empirical research that sought to access practitioners' interpretations of SCM in the two sectors. Finally, a summarizing discussion pulls together the key conclusions.

Methodological justification

Prior to comparing the contrasting contexts of aerospace and construction, or to engaging with the SCM literature, it is appropriate to describe the underlying methodological position. This is important not only because it shaped the approach to the empirical research, but also to establish the relevance of a broader understanding of the dynamics of sectoral change to the enactment of managerial concepts such as SCM. The adopted research approach was shaped primarily by the work of Pettigrew (1985, 1997) and Weick (1979, 1995). At risk of over-simplifying a complex literature, it is necessary to provide a brief overview of their respective contributions. Weick (1979) has long advocated that researchers should focus on dynamic organizational processes rather than static forms of organization. Pettigrew (1997) is especially notable for the development of 'processual analysis' as a distinctive research approach, where a process is defined as:

...a sequence of individual and collective events, actions, and activities unfolding over time in context.

The research described in this paper sought to understand SCM as a 'process' in accordance with the above definition. The guiding assumption is that managerial practices are embedded in context and can only be studied as such. Furthermore, there is seen to be complex interplay between human action and the context within which it occurs. Context is therefore dynamic and must be conceptualized as an active part of any analysis. But context is not only *shaping*, it is also *shaped* by action (Pettigrew, 1997). The mutual interaction between action and context over time is central to the concept of process analysis. The point is well made by Pettigrew (1985) in the preamble to his study of change and continuity in ICI:

...by conceptualising structure and context not just as a barrier to action but as essentially involved in its production.

Any consideration of the interaction between action and context must be informed by an understanding of the structure-agency debate that has long characterized the broader domain of social theory. Issues of consideration include the relationship between language and action, the way that human agency relates to structural aspects of society and the way that action is structured in everyday contexts. While any attempted resolution of such issues will always be subject to criticism from alternative theoretical perspectives, an essential touchstone is provided by Giddens' (1984) 'theory of structuration'. Giddens has been influential in challenging the dichotomist thinking enshrined

within Burrell and Morgan's (1979) paradigmatic typology (see Pozzebon, 2004). Perhaps the most important contribution of structuration theory is the rejection of the view that structure necessarily has a fixed form:

The structural properties of social systems are both the medium and the outcome of the practices that constitute those systems.

It follows that SCM cannot be understood in isolation from the dynamics of industry change. Structure and context must be conceptualized as active components in the way that SCM is interpreted and implemented. This clearly has important implications for any attempt to learn across business sectors. It also casts doubts on the validity of extracting 'production paradigms' from one context and then applying them in another. Indeed, the most useful aim of any cross-sectoral study should be to understand the inter-relationship between practice and context. From this perspective, the comparison between construction and aerospace is useful because the two sectors are so different.

It is further possible to interpret the adopted approach in terms of Weick's (1995) notion of 'sense-making', whereby a group of researchers and practitioners set out to 'make sense' of SCM. The adopted research methodology can therefore be explained as a process of sense-making that included a series of six interactive workshops involving the research team and collaborating practitioners from both sectors. The workshops were informed by an ongoing interrogation of the literature together with an unfolding analysis of the dynamics of change in the two sectors. The process was further informed by 65 semi-structured interviews with practitioners from both sectors, including 20 interviews with supply chain specialists from both sectors. These activities unfolded over a 2-year period and were punctuated by periods of analysis and reflection. This paper therefore presents an interpretation of SCM that is based upon a 2-year process of sense-making. But it is more than an interpretation; sense-making is about authoring as well as reading (Weick, 1995).

Finally, it must be conceded that the methodological justification for the adopted approach developed, at least in part, in response to the emergent findings. While the research team was certainly aware of the above concepts before the research commenced, they only become prominent as the research progressed. In this respect, the research accords with 'iterative grounded theory' (Orton, 1997) whereby researchers iterate between theory and data to generate new knowledge. As such, the research occupies the middle ground between deductive theory generation and inductive theory verification.

Contrasting contexts: aerospace vs. construction

The different contexts provided by the aerospace and construction sectors provided a constant source of debate throughout the research project. Insights into the dimensions of differences between the two sectors were gained primarily from published sources. However, the selected emphasis was influenced by the participating practitioners in terms of perceived relevance to SCM.

Structural differences

The UK construction sector is notably 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 aerospace sector (Standard Industrial Classification D353) is £17.95 billion. On the basis of a different boundary definition, the Society of British Aerospace Companies (SBAC, 2003) quote a UK aerospace turnover figure of £16.14 billion. 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). It should be noted that the official construction statistics consistently underestimate the level of self-employment (Cannon, 1994; Harvey, 2003). Figures from ILO (2001) suggest significantly higher levels of self-employment in the UK construction industry than recorded by government statistics. According to the ILO, self-employed labour grew from 30% of the total workforce in 1977 to a high point of over 60 % in 1995.

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 82.6% of private sector turnover. In comparison, the DTI (2003b) list only 380 private sector SMEs within the aerospace sector (Standard Industrial Classification D353). 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. The relative extent of consolidation/fragmentation in the two sectors is further illustrated by the fact that in the UK aerospace sector, BAE Systems (formerly British Aerospace) accounts for approximately 60% of supplier output (A. T. Kearney, 1999). In the construction industry, the top 30 contracting firms routinely account for only 17% of output. The structure of the construction sector is that of a broad-based pyramid dominated by small firms. In contrast, the aerospace sector is dominated by large firms. Suppliers in aerospace are also more specialized 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 £1.74 billion (SBAC, 2003). The comparative figure for construction is a relatively modest £270 million (NAO, 2001). The high technology content of the aerospace sector combines with a complex network of inter-dependency to present considerable barriers to new entrants. In contrast, the construction industry has traditionally been characterized by low barriers to entry. This is especially true of the SMEs that comprise the industry's pool of subcontractors.

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 long-standing 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. It is contended that this sharp distinction in industry structure has fundamental implications for the way that SCM is implemented in the two sectors.

Relationship with government

The structure of firms and relationships in the aerospace sector is a product of its unique history. It is

widely recognized that the aerospace and defence sector has traditionally enjoyed a privileged relationship with government due to its strategic importance (Hartley, 1974; Hayward, 1989; A. T. Kearney, 1999). Government has, in the past, attempted to shelter the aerospace industry from fluctuations in the civil aircraft market through defence expenditure (Todd, 1988; Hayward, 1989). The need to ensure continuity of work to maintain a national aerospace capability has shaped government policy towards the aerospace sector since its inception. In contrast, government policy towards construction has at best tended towards *laissez-faire*. Various British governments since the Second World War have acted to exacerbate the economic cycle through successive 'Stop-go' policies. Hillebrandt (1988) cites the public expenditure cuts of 1973 as a prime example. Ball (1988) refers to the sharp deflation induced by the Conservative governments of the 1980s as a further demonstration of the influence of periodic state expenditure cuts on the demand for construction work.

One of the most notable characteristics of the UK construction industry is its ability to expand and contract in response to severe fluctuations in demand. The Egan Report (DETR, 1998) cites the flexibility of the industry as a key strength. However, flexibility has been achieved at a price. Low barriers to entry and the dominance of localized markets perpetuate the fragmented structure of the UK construction industry. Twenty-five years of government vicissitude in taxation and insurance regimes has encouraged self-employment thereby directly contributing to labour casualization (Harvey, 2003). The deregulation of the construction labour market has eroded employment conditions and undermined investment in training. The apprentice system is seemingly in terminal decline with widespread reported skills shortages. Government continues to show a lack of willingness to intervene, preferring the supposed benefits of 'flexibility'.

Recent trends

Notwithstanding the comments above, the latter 1990s saw government policy towards the aerospace sector tend towards value for money rather than strategic support (A. T. Kearney, 1999). Ministry of Defence (MoD) agencies became increasingly willing to procure 'off-the-shelf' systems from overseas suppliers. The UK government deliberately encouraged international collaboration in defence procurement to spread development costs. Although the Defence Industrial Policy (DIP) published in October 2002 (MoD, 2002a) reaffirmed the need for an industrial dimension in UK procurement policy, this was only a partial correction to the trend towards international procurement.

This weakening of the government's traditional strategic relationship with the aerospace sector has introduced fresh competitive imperatives. The aerospace sector's reliance on domestic government contracts has declined over the last 10 years and currently stands at only 16% of turnover (SBAC, 2003). 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 further evidenced by several best practice initiatives. Examples include the Lean Aerospace Initiative (LAI) and the Society of British Aerospace Companies' (SBAC) Competitiveness Challenge.

The waning of the aerospace sector's privileged relationship with government is reflective of a general retreat from direct intervention by policy makers over the last 20 years. This is due in part to an ideological shift in favour of the alleged benefits of unregulated markets (Hillebrandt, 2000). However, despite the increasing emphasis on competitiveness, there is still a strong element of strategic support in the government's relationship with the aerospace sector. In contrast, 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. The prevailing economic stability throughout the 1990s has undoubtedly alleviated the need for the crude interventions of the past. It is therefore the current relatively stable trading environment that provides the context for the construction industry's recent interest in integrated SCM. The prolonged steady expansion of construction output since 1993 provides the context for the current desire of main contractors to form long-term relationships with their supply chains. The advent of the next recession could see a rapid return to overtly competitive behaviour and less emphasis on collaborative SCM practices.

Global consolidation in aerospace

Changes in the UK government's industrial policy towards aerospace must be understood alongside major 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. Since its launch in 1970 Airbus Industrie has been phenomenally successful in challenging US post-war domination of the aerospace markets. In 1970 European manufacturers produced only 10% of commercial aircraft. They now claim a market share of 50% for recent new aircraft orders. 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 (Aris, 2002). 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 (Lawrence, 1999). 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.

The period from 1970 saw extensive restructuring in the US aerospace industry, culminating in the merger of Boeing and McDonnell Douglas. By 2001, three giant companies dominated the US aerospace and defence industry: Raytheon, Lockheed Martin and Boeing. In the face of extensive US consolidation, the European aerospace industry had little choice but to develop collaborative working practices. Despite significant political difficulties among 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 formation of the European Aerospace, Defence and Space Company (EADS).

The merger of British Aerospace with Marconi Electronic Systems in 1999 significantly enhanced consolidation in the UK aerospace sector. This resulted in the emergence of BAE Systems as the sole UK national aerospace champion. The current interests of BAE Systems reflect the UK's longstanding policy of facing simultaneously across the Channel and the Atlantic (Lawrence, 1999). BAE Systems combines a 20% stake in Airbus with extensive manufacturing facilities in North America. The company is also engaged in a number of collaborative ventures with US aerospace companies. Of further significance is the way that 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 main source of competitive advantage for prime contractors arguably lies in their skills of integration and SCM.

The end result of a prolonged period of extensive global consolidation in the aerospace industry is a realization among 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. The unique history of the UK aerospace industry combines with global megatrends of consolidation and collaboration to provide an exceptional context for the enactment of SCM. While the construction industry has experienced an increasing degree of globalization and mergers (Carrillo, 1998), these remain minuscule in comparison to the restructuring of the aerospace sector. With few exceptions, firms within the construction industry remain locked in a mindset of mutual competition.

Supply chain management

The preceding analysis provides a radically different starting point from which to understand SCM. It also serves to challenge the assumption that 'supply chain management' means anything in isolation of a broader contextual awareness. The debate about the meaning of SCM continued throughout the research project and was informed by the both the generic SCM literature and that which is specific to construction. While a full review of the relevant literature lies beyond the scope of this paper, the following is sufficient to demonstrate that the shaping effects of context over time is rarely given prominence.

Generic storylines

The core literature on SCM displays the same definitional vagueness and lack of internal coherence displayed by many so-called 'new management approaches' (cf. Bresnen and Marshall, 2001). London and Kenley (2001) have previously noted the

extensive debate within the research community regarding interpretations of the supply chain concept. The confusion is well illustrated by the selection of definitions of SCM shown in Table 1. Beyond the managerialist clichés, the key message would seem to be that it is no longer adequate for management to confine its attention to the limited domain of the single organisation. The task of management is now defined in terms of ensuring 'competitive advantage' for the 'integrated supply chain'. Much of the substantive content of the SCM literature is drawn from the associated fields of logistics and operations management. The discourse of SCM is frequently interwoven with that of lean manufacturing. Recurring exhortations of customer responsiveness illustrate the uncritical absorption of the 'cult of the customer' (cf. du Gay and Salaman, 1992).

There is little in the current mainstream literature to suggest that the ascribed meaning of SCM may be shaped by the competitive dynamics of different industrial sectors. While it is true that several sources suggest a contingency approach to SCM, rarely is context an active part of the analysis. For example, the contingency approach advocated by Fisher (1997) depends primarily on the nature of the product. In contrast, Christopher and Towell (2000) distinguish between 'lean' and 'agile' supply chains, arguing that different paradigms are appropriate for different market-place requirements. Towell and Christopher (2002) subsequently seek to reconcile the two paradigms, arguing that they can be used separately or in conjunction subject to the demands of the market-place (see also Aitken *et al.*, 2002). While such sources have undoubtedly made a valid contribution to the field, they nevertheless give scant attention to the way that the meaning of SCM is embedded in localized contexts.

Cox *et al.* (2001) provide a refreshingly different view of supply chains, focusing on markets and buyer/supplier power relationships. But there is again little emphasis on the conflicting interpretations of SCM within organizations and way that the ascribed meanings are shaped by the dynamics of industry change.

Table 1 Definitions of supply chain management

<p>'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 <i>et al.</i>, 1997)</p>	<p>'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)</p>
<p>'Supply chain management covers the flow of goods from supplier through manufacturing and distribution chains to the end user.' (Christopher, 1998)</p>	<p>'[Supply chain management] is the integration of activities... associated with the flow of materials and information... through improved supply chain relationships, to achieve sustainable competitive advantage.' (Handfield and Nichols, 1999)</p>

Strategic vs. operational perspectives

Several authors distinguish between strategic and operational perspectives on SCM (Fuchs, 1998; Tan *et al.*, 1998; Cox, 1999). The strategic view interprets the supply chain as a structure within which firms position themselves. Part of this process is concerned with the alignment of other supply-chain members to serve their needs. Organizations can also position themselves competitively through acquisitions and mergers. The central decision relates to which activities are considered 'core' and which are considered 'peripheral'. SCM can further be viewed as a means of controlling supplier organizations without the cost of outright acquisition. In turn, suppliers may retain a degree of independence while the sourcing organization reduces market uncertainty. Cox and Ireland (2002) argue that SCM must be understood within the context of a firm's power position within the supply chain. From this perspective, firms enter into relationships to appropriate value. Large clients with regular workloads have greater leverage to extract value from contractors. Similarly, contractors may position themselves strategically to take advantage of inexperienced clients.

Any interpretation of SCM from a strategic perspective is clearly inseparable from a broader understanding of the dynamics of competitive positioning. Furthermore, competitive positioning is undoubtedly a dynamic process that unfolds over time. Nevertheless, the processual perspective as advocated by Pettigrew (1997) has attracted little interest within the mainstream SCM literature.

The operational view of SCM focuses on improving efficiency through the implementation of logistics (cf. Goldratt, 1990; Christopher 1998; Handfield and Nichols, 1999). It is this perspective that dominates the literature. The challenge is to realize more efficient ways of managing the flow of goods, services and information across the whole supply chain. The point is not to denigrate the contribution of logistics, but rather to observe that the development of collaborative working relationships with key suppliers is widely seen to be an imperative irrespective of context. Sharing the benefits of any realized efficiency gains is invariably perceived to be essential in maintaining the necessary ethos of continuous improvement. The existence of the necessary level of trust is too often taken for granted on the assumption that both parties are locked into a relationship of mutual interdependence. While such conditions frequently exist with highly consolidated sectors such as aerospace and automotive, they are by no means prevalent within the construction sector. Following on from Cox and Ireland's (2002) power perspective, it must also be recognized that the rhetoric of collaborative working is frequently imposed on the

supply chain while the dominant party continues to behave opportunistically.

Supply chain management in construction

Much of the construction-specific literature on SCM is dominated by the extent to which the 'generic theory of supply chain management' can be applied to construction (cf. Vrijhoef and Koskela, 2000). A common argument is that SCM is difficult to implement in construction because the sector is so fragmented. Notwithstanding the contribution of Cox and Ireland (2002), there is a recurring tendency among construction supply chain researchers to conceptualize context as an independent variable. Akintoye *et al.* (2000) are typical in their aspiration for construction to emulate other industries. Identified 'barriers to implementation' include: work-place culture, lack of management commitment, inappropriate support structures and a lack of knowledge of SCM philosophy. Given this diagnosis, the recommended solution is for more training and education in the 'philosophy' of SCM. Repeated prescriptions to follow the lead of other industries rarely include any comparison of the respective industrial contexts. Even more rarely do any such comparisons adopt an inter-temporal perspective on the dynamics of sectoral change.

Vrijhoef and Koskela (2000) are representative of many sources in arguing that the emergence of SCM is due to the same shift in 'theoretical concepts' that initiated just-in-time (JIT) and lean production. Their case studies are typical in adopting a top-down perspective focusing on 'waste and problems'. The cause of such problems is attributed to 'myopic control' and 'deficiencies in conceptualization'. The overriding assumption is that managers in the construction sector are in some way misinformed. What is seemingly absent is any recognition that any implementation of SCM is the outcome of human *agency* involving processes of interpretation and intra-organizational conflict. Furthermore, there is little acknowledgment that managerial actions are shaped by (and in turn, shape) the broader structural context, including market conditions and power relations between firms. Rather than condemn construction practitioners for being uninformed or deficient, an alternative basis for understanding would be to adopt Giddens's (1984) notion of social competence, based on the assumption that human actors have the capacity to be reflexive; to think about their situation and to take action to change it.

A separate strand of construction-specific literature follows the lead of Towell and Christopher (2002) by considering the competing merits of the lean and agile paradigms and the extent to which they can be combined (cf. Barlow *et al.*, 2003; Naim and Barlow,

2003). According to Naim and Barlow (2003), the former focuses on efficiency whereas the latter focuses on effectiveness; i.e. 'the ability to give customers exactly what they want, when they want it'. Such statements are once again evocative of the extent to which the 'cult of the customer' permeates current thinking. Political models of management that involve balancing the interests of diverse stakeholders have seemingly been cast aside in favour of the remorseless rhetoric of customer responsiveness. Naim and Barlow (2003) further suggest that the lean and agile paradigms are synonymous with the functional and innovative product strategies proposed by Fisher (1997). They are very clear that one size does not fit all: 'the right solution has to be applied to the right problem'. Naim and Barlow (2003) go on to combine aspects of the lean and agile paradigms to recommend a way forward for the UK house-building industry. There is much within their diagnosis to provoke thought and reflection, but the overall message is one of prescription. Once again, the characteristics of the house-building industry are seen as barriers that impede the implementation of supply chain approaches developed in other industries. In a similar vein, Childerhouse *et al.* (2003) propose the application of business process re-engineering (BPR) to the construction supply chain. They follow Naim and Barlow (2003) in arguing that SCM should be customized to suit different circumstances. They also contend that product delivery 'best practice' is transferable across market sectors. However, as previously, there is little emphasis on the symbiotic relationship between SCM and the broader dynamics of industry change.

The final strand of construction-specific literature on supply chains that warrants mention is that which focuses on the use of 'work clusters' (Nicolini *et al.*, 2001). The work cluster approach was developed in the course of an action-research project known as 'Building Down Barriers'. The underlying concepts owe more to the tradition of semi-autonomous work groups (e.g. Miller and Rice, 1967) and team-based organization (e.g. Neumann *et al.*, 1995) than they do to the generic SCM literature. The rationale is based on breaking projects down into semi-independent clusters to propagate collaborative working among designers and suppliers (Nicolini *et al.*, 2001). It is notable that clusters are determined on a project-by-project basis; there is seemingly little emphasis on strategic relationships that span across projects. As such, the orientation of the work cluster approach is overwhelmingly operational. There is no consideration of the way that firms jockey for preferential positions in the supply chain.

'Building Down Barriers' remains closely associated with the procurement approach known as 'prime contracting', as developed originally in the aerospace

and defence sectors. The underlying principles of prime contracting reflect the MoD's 'Smart Acquisition' initiative to realize better value for money in defence procurement (MoD, 2002b). According to Defence Estates (2000) a prime contractor can be defined:

...as having overall responsibility for the management and delivery of a project, including co-ordinating, integrating the activities of a number of sub-contractors to meet the overall specification efficiently, economically and on time.

Potential prime contractors are evaluated on the extent to which their supply chains are 'in place' and on their experience of collaborative working. The prime contractor will further be required to operate an 'open-book' accounting regime. Prime contracting extends the contractor's obligations to include design, construction and maintenance of the built facility. It therefore seeks to replace the traditionally fragmented process with the opportunity for an integrated approach. Within such frameworks, facilities management expertise and whole-life costing supposedly become central to commercial success. Elsewhere, Nicolini *et al.* (2000) describe the use of 'target costing' as a means of involving the whole supply chain in achieving the best balance between through-life cost and functionality. However, while clusters are best implemented on a project-by-project basis (Nicolini *et al.*, 2001), target costing requires the establishment of long-standing supply relationships (Nicolini *et al.*, 2000). The implementation of target costing on the two described pilot prime contracting projects was reportedly impeded by a lack of trust that drove participants to revert to 'established, non-collaborative practices'. The tendency to 'price in' risk apparently stems from a lack of confidence in the actions of others. It is further argued that the tendency to revert to such behaviours is 'very deep-seated within the industry's culture' (Nicolini *et al.*, 2000).

Confidence and trust

While trust is widely held to be central to effective SCM, 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 the other will not exploit its vulnerabilities. This confidence is shaped and determined by many factors that play out differently in different contexts. Such factors include the respective organizations' reputations, existing interpersonal relationships that transcend organizational boundaries, the extent to which the firms are perceived to be interdependent and the adjudged likelihood of continuity of work.

It follows that the structural characteristics and development paths of the two sectors will have a fundamental influence on the underlying level of trust. At risk of simplification, it could be argued the aerospace sector tends towards the characteristics of a high-trust economy (cf. Korczynski, 2000). In contrast, the construction industry tends towards the characteristics of a low-trust economy (see Table 2). Dainty *et al.* (2001) cite lack of trust and ingrained adversarial practices as key barriers to the implementation of SCM in construction. It must further be recognized that any attempt to introduce 'new ways of working' will inevitably be shaped by institutionally embedded practices (cf. Powell and DiMaggio, 1991). The barriers to collaborative working in the construction sector are therefore unlikely to be overcome by vague notions of 'culture change'. Prescriptions of best practice are inexorably filtered and played out differently in accordance with the experienced reality of industry practitioners. This would be true even if there were a universally accepted definition of SCM. Rather than arguing that SCM provides a radical model for overcoming the industry's 'adversarial culture', it could alternatively be argued that the discourse of SCM has been appropriated to justify existing trends and practices. Since the 1970s the UK construction industry has seen a dramatic reduction in directly employed labour in favour of extensive subcontracting. Construction is increasingly characterized by the 'hollowed-out' firm that retains only a small core of white-collar staff (ILO, 2001). The increasing need to extend control over the 'supply chain' is therefore predicated on a long-term structural shift in the way that construction is procured. The discourse of SCM can perhaps be interpreted as both reflecting and reinforcing the changing reality of the construction sector.

Best practice initiatives

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. 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.

The model of supply chain management advocated by the Construction Best Practice Programme (2003) 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. The advocated approach is in many respects inseparable from partnering. Companies are exhorted to appoint a champion. There is little emphasis on the way in which supply chain management is shaped by the broader context.

In addition to the academic outputs previously cited (Nicolini *et al.*, 2000, 2001), the 'Building Down Barriers' model of SCM has been disseminated widely to industry (Holti *et al.*, 2000; Cain, 2003). The approach has been embraced by the MoD and actively encouraged by HM Treasury. Key elements include the appointment of a 'prime contractor' and a pre-assembled supply chain. The espoused aim is to deliver optimal value to the client in terms of through-life performance, while maintaining the profit margins of all concerned. '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. As commented previously, the approach is described in isolation from the broader SCM literature.

In the aerospace sector, the Society of British Aerospace Companies' 'Supply Chain Relationships in Action' (SCRIA) initiative promotes a code of practice to achieve a cooperative 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. In contrast to similar construction initiatives, SCRIA is played out against a backdrop of 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

Table 2 Political economies of trust

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
Predominantly global markets	Predominantly local markets

to low-trust economies such as construction is less clear.

Practitioner interpretations of supply chain management

Research method

Twenty of the 65 semi-structured interviews were conducted with identified supply chain specialists on the specific theme of SCM. Equal representation was achieved from each sector. Interviews lasted between 40 and 80 minutes, with an average duration of an hour. The aim was to explore the meaning of SCM as understood by practitioners from the two sectors. Each interview opened with respondents being asked very general questions regarding the definitions of SCM, and their perceptions of its role within their sector. Follow-up questions were asked to deepen, develop further, or clarify the answers. The interviews were transcribed verbatim to allow for subsequent analysis and the coding of emergent themes (cf. King, 1998). The data collection occurred in parallel with the ongoing literature review, allowing the transcript data to be analysed thematically first, and then examined further in light of the literature. The interrogation of the data was supported by the use of qualitative analysis software specifically designed to remove rigid distinctions between data and interpretation (cf. Richards, 1999). The research team also reviewed various sets of in-house documentation relating to SCM policies from both sectors. The identified themes were corroborated within the context of a workshop involving 11 industrial participants drawn from both aerospace and construction. The findings were subsequently further validated through a series of dissemination seminars involving industry audiences.

Contextual influences

Interviewees from the aerospace sector readily supported the contention that the origins of collaborative SCM lie in the imperatives of global competition. Within BAE Systems, several interviewees referred to the way in which the share crisis of the early 1990s provided the platform for a revised way of working:

The push was based on the need to improve performance, the need to improve performance was based on the fact that we nearly went bankrupt ...our share price dropped below one pound, we were ripe for take-over...but we determined that if we were going to survive we had to do things radically different.

The need for collaborative working was repeatedly linked to a shared sense of mutual dependency in the

face of threats to the sector's continued existence. Trends of global consolidation also provided a recurring preamble to the need for SCM:

If you go back about twenty years there were probably about a dozen aircraft companies all capable of producing an entire aircraft; now there's just one. It's the same in France and Germany.

On a similar basis, the need for long-term relationships was frequently justified with reference to 'mutual destinies':

Our suppliers are pretty locked into our success. So our success as an organisation has a major impact of their success... we are pretty much in each others pockets I guess. If a supplier is not performing to the highest level then we are not able to market and sell our project into a very competitive market. So therefore, it is really down to mutual destinies...

The notion of mutual dependency found equal support among specialist suppliers:

We have two major customers who we consider to be the bedrock of the business. They will supply us with work for years because of our skills.

Such views reflect directly the consolidated structure of the sector and the tendency for supply chains to succeed or fail collectively. The supplier obviously feels confident that their two major customers will continue to use their services because of their unique expertise. The barriers to entry make it unlikely that new competitors will emerge. Interviewees were also quick to point out that the project development cycle in aerospace is invariably much longer than in construction. Firms are frequently locked into supply chain relationships for prolonged periods as a result of extended project durations. Such relationships were seen to be a matter of necessity rather than choice:

...the development cycle is radically different. We started the Euro Fighter twenty years ago. We currently have programmes just starting that probably will not come to fruition for another ten years. The development programme of defence and military platforms takes a lot longer. Aircraft take a fair amount of time, so do boats and ships. Land vehicles less so; but it is not the same cycle, I would imagine, that you have in the construction industry. In aerospace it must be long-term relationships; it's just a fact.

Within aerospace, trends of international competition combine with high development costs to provide the context within which SCM is implemented. Whilst caution is necessary from inferring too much from a limited set of interviews, the views expressed do support the need for a process analysis perspective on SCM. Of particular importance in the aerospace

context is the accumulative impact of mergers and acquisitions through which firms seek to position themselves in the market-place.

Within the construction sector, interviewees tended to echo the literature in conceptualizing context as a barrier to SCM implementation. Several cited the project-based nature of the industry and the dominance of risk-avoidance strategies:

If it's a project by project basis, if you get the risk balance wrong, and the project goes badly wrong, then you're stuck. So there isn't the same incentive for SCM unless the customer wants to come and try to promote a different way of working that involves more sharing of risk.

The construction sector does not seem to share aerospace's continued sense of crisis and therefore feels little imperative to change its long-established way of working. While many interviewees cited client pressure, the need to change was considered less than compelling. Indeed, several interviewees saw change to be dependent upon clients providing the necessary environment on individual projects:

A given client might provide the right commercial environment for the project team or it might not, and if they don't you are on a hiding to nothing.

There is also evidence within the interview transcripts that the 'stop-go' cycles of the past remain deeply rooted in the construction industry's collective memory:

I would say we are very reliant on the economic state of the country, the markets go through peaks and troughs. OK it has been relatively stable in recent times but it does not mean it is always going to be that way; so if there is a down turn in the market and then you have put a supply chain together it does tend to require a reasonably regular throughput of work to keep the supply chain together.

It is notable that no construction interviewees cited globalization to be a significant issue for the UK construction industry. Whereas aerospace sector managers talked readily of global influences, construction sector interviewees tended to talk of localized contexts.

Cultural barriers

Analysis of the transcripts reveals that construction interviewees are much more likely to refer to 'industry culture' than their counterparts in aerospace, who tended to justify SCM with references to the commercial realities of the global market-place. However, none of the interviewees linked culture to the structural changes that have shaped the construction sector over

the last three decades. The tendency was rather to conceptualize 'culture' as an independent variable. In this respect, aerospace interviewees seemed to be more self-aware of the trends that have shaped the current industry. The consolidated nature of the aerospace sector means that actors within it are much more likely to share a sense of 'common history'. The fragmentation of the construction sector, with its countless diverse and specialist niches makes the sense of shared history much less prevalent, with the notable exception of the collective memory of previous stop-go cycles.

Several construction interviewees cited the industry's 'in-built' cultural resistance to change:

The construction industry is so dinosauristic in its ways, it will never change. If there wasn't a catalyst there to change it, it would still be doing the same things as it was years ago in the same way. They would still go for the cheapest price, have adversarial contracts, and get lots of money for the lawyers.

Typical among construction supply chain specialists was the claim that 'new ways of working' require 'new thought patterns':

These behaviours are often accompanied by a particular mind-set, which itself contributes to the maintenance of certain behaviours and ways of working. To adopt alternative methods, new thought patterns must be introduced.

Construction interviewees repeatedly referred to 'adversarial attitudes' (or the 'adversarial culture') that had to be overcome. However, there was little explicit acknowledgement of any interplay between industry culture and structural change. It was also notable that the desired 'cultural change' only seems to apply to relationships between firms; none of the construction interviewees extended the argument to patterns of employment, or to the continued widespread reliance on false self-employment. Nevertheless, there was an acceptance that such issues are an important part of the construction context when they were raised during the participative workshop. Several suggested that the shift towards self-employment had been deliberately encouraged as a means of emasculating trade union power.

Despite the construction interviewees' lack of emphasis on mutual dependency, good relationships were commonly cited as the key to successful SCM. Trust was considered vital for achieving continuity of workload. Notwithstanding many exhortations regarding the mutual benefits of trust and long-term partnerships, many construction interviewees conceded that the espoused ethos of collaboration is frequently in conflict with the commercial imperatives of doing business within the construction sector:

Up to date we've worked in a particular way, and mainly because for us to win work there is the pressure always to get the cost down as much as you can, and that has to be passed on, because no-one can afford to fund anything. That's typically been the culture of what we're trying to do.

Others hinted at the need for construction sector managers to become more widely skilled in motivating teams:

Only the really good project managers...are able to adapt to different situations and types of people, in order to keep teams motivated. There are a lot of table bashers.

However, several interviewees expressed the view that the construction industry culture is changing:

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 making it work together. It makes life more enjoyable.

The abiding view was that the construction industry's culture continues to hold back the implementation of SCM. While there was a broad consensus that the culture is changing for the better, the rate of change was seen to be slow. It was repeatedly suggested that further progress is necessary if SCM is to become a reality in the construction sector.

Supply chain practices

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 Supply Excellence Programme (SEP) would appear to be widely applied by BAE Systems to both internal and external supply chains. While the SEP provided the dominant view of SCM, aerospace interviewees were also focused on the issue of core competencies. In the words of one aerospace interviewee:

Those parts of the supply chain that are vital to our core business – we would need to be sure that we developed strong, lasting relationships with them.

Several other aerospace interviewees cited the need for continual re-alignment in accordance with changes in the market-place. There was a keen awareness of the differing roles played by suppliers and the way that this impacts on the relationship:

There are parts of the supply chain where we merely place a purchase order because we want a piece of

off-the-shelf kit. For other parts of the supply chain we would wish to develop some sort of relationship...

Construction interviewees were heavily influenced by the 'Building Down Barriers' project that was repeatedly referenced. 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 recognize the need for a more integrated approach' were commonplace – even among alleged SCM experts. Aerospace interviewees tended to describe SCM on the corporate level as being central to the way in which the business operates. In contrast, construction interviewees tended to describe SCM as an approach that could be used on specific projects.

Twin modes of behaviour

Several of the construction firms interviewed had to reconcile the fact that whilst on some projects they would be required to demonstrate SCM, on others they would operate in the traditional mode of contract management. The issue provoked considerable debate within the workshop. Many referred to colleagues within the same company that continued to insist on competitive tendering for subcontractors. Construction interviewees directly involved in prime contracting saw SCM as an essential means of ensuring their competitive position in the market-place. However, several believe that the process of SCM represents 'absolutely nothing new, that people haven't done before in some shape or form... it's not rocket science'. Others were openly sceptical of what they saw to be the latest fad, preferring to emphasize the need to 'talk the talk' in accordance with the current improvement agenda. There was widespread concern that the Ministry of Defence (MoD) has yet to finalize the contractual basis of prime contracting. There is therefore a suggestion that even those who were originally enthusiastic about prime contracting are becoming disillusioned.

Several participants emphasized that many construction companies continue to be organized into quasi-independent regional business units. While this was seen to have advantages in terms of flexibility, it was judged to seriously impede information-sharing and the implementation of SCM on a corporate basis. Some major national contractors reportedly do not possess any centralized database of subcontractors. More traditional firms within construction tend to see SCM 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. Many interviewees seemed to accept the need

to work differently in different contexts. As such, they would seem to strive to behave collaboratively where required, while continuing to operate more opportunistically in other contexts. Some of those seeking to develop a track record in prime contracting ultimately hope that the widespread use of such procurement routes will encourage a more collaborative approach across the industry at large. However, those within contracting organizations emphasized repeatedly that they could not be expected to change their mode of operation unless such initiatives deliver continuity of work.

Concluding remarks

This paper has provided a fresh perspective on how SCM is interpreted and enacted in the construction and aerospace sectors. The adopted approach differs from previous studies in the way that context has been conceptualized as an active part of the analysis. As such, it provides the basis for an ongoing research agenda that addresses the way that the meaning of SCM is mediated by the structural properties of social systems and their evolution over time.

On the basis of the interviews and participative workshops, there is much to suggest that practitioners in the two sectors make sense of SCM in different ways. Aerospace interviewees consistently link the need for SCM to the imperatives of global competition. Furthermore, they frequently allude to the need for firms to strategically position themselves in the marketplace in pursuit of competitive advantage. In the case of the aerospace sector, it is therefore relatively easy to construct a sense-making narrative that relates SCM to the dynamics of sectoral change. Indeed, the narrative is readily identifiable in the views of industry practitioners.

In contrast, the derivation of a single sense-making narrative for the construction sector is more problematic. SCM is less well-established in construction with a notable diversity of views. Progress towards the implementation of any normative framework of SCM within construction would appear very limited. Many respondents tend to describe the frameworks they would like to introduce rather than systems that are already in place. Construction practitioners invariably see SCM as a means of improving operational performance, rather than a fundamental shift in the way that they do business. There is little evidence of any strategic perspective amongst those interviewed. However, there was considerable discussion of the barriers to implementation and the need for cultural change.

What was noticeably lacking among the construction interviewees was the shared sense of destiny that characterized those from the aerospace sector. Although they repeatedly cite SCM as a means of alleviating industry fragmentation, construction interviewees did not tend to refer to the dynamics of intertemporal change without direct prompting from the research team. For construction practitioners, the mantra of culture change seems to transcend all other issues. In common with much of the literature, the tendency is to view culture as an independent variable. The narrative of culture change is seemingly mobilized by construction practitioners to persuade others (and perhaps themselves) that they are striving to overcome the industry's adversarial culture by the adoption of enlightened management practices. In this respect, the narrative in support of SCM is inseparable from that of lean thinking, partnering, collaborative working and several other manifestations of 'enlightened' practice. However, in the case of the construction sector it seems that all such narratives are almost entirely disconnected from any grounded understanding of sectoral change.

Notwithstanding the above, any meta-narrative concerning the interaction between discourse, managerial action and structural change in the construction sector must be treated with considerable caution. The fragmented structure of the sector, coupled with a plethora of niche markets, means that practitioners' views are much more locally embedded than tends to be the case in aerospace. Pettigrew (1997) distinguishes between inner and outer context, and emphasizes the importance of understanding both. The consolidated nature of the aerospace sector means that SCM can be linked more readily to the outer context. However, in construction there is likely to be much greater variance in the inner contexts within which practitioners operate, thereby rendering any generalizations about the ascribed meanings of SCM much more tentative.

It must further be recognized that practitioners have considerable scope to shape the context within which they operate. In recent years many construction firms have attempted to integrate themselves into stable supply chains to take advantage of serial contract arrangements, including prime contracting. In many respects, the firms best placed to capitalize on the prime contracting market are those that have been successful in securing PFI work. Carrillo (1998) refers to the emergence of a 'super-league' of contracting groups formed through quasi-mergers to compete for PFI projects. In contrast to the SME sector, the PFI market is characterized by significant barriers to entry (Ezulike *et al.*, 1997). Indeed, there is already a degree of overlap between the firms that are competing within the embryonic prime contracting market and those that compete for PFI work. While the construction sector as

a whole has seen little consolidation, this is not true for the PFI and prime contracting markets.

The emergence of prime contracting and the increasing use of framework agreements in the construction sector potentially provides a more supportive climate for SCM than has prevailed traditionally. Providing that a regular workflow can be achieved, prime contractors may well be able to form collaborative relationships with key suppliers that approximate towards established practice within aerospace. If clients are able to deliver the required continuity of work, they will undoubtedly benefit in the short-term through a more integrated service. However, it must also be recognized that there is a point at which supply chain consolidation may become anti-competitive if new entrants are not encouraged. In either case, the influence of collaborative SCM practices on the construction industry at large is likely to remain small in comparison to highly consolidated sectors such as aerospace.

Acknowledgement

An earlier version of this paper was presented at the CIB W-92 conference in Trinidad & Tobago in 2002. The research was funded by the UK Engineering and Physical Sciences Research Council (EPSRC) under the 'Learning Across Business Sectors' initiative.

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