

# EFFECTIVELY MANAGING THE CONSTRUCTION NETWORK: THE ENABLING ROLE OF IT

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## Abstract

*The aim of this paper is to give new insights to researchers that are working on CIC. It stresses that if we only pursue full construction information integration and automation we will miss a great opportunity to radically improve the construction process. The paper claims that the effective management of the interdependence of the construction process will require that construction companies reengineer their business processes and networks in order to form IT-enabled networked firms and that pointing towards CIC we should consider three different levels: industry; inter-organisational; and within companies.*

## 1. - INTRODUCTION

Many of the problems of the construction industry are claimed to derive from its structure. However, leading-edge companies of manufacturing and service industries are reengineering their business processes and adopting new and more flexible organisational structures, similar to current construction structure. The prime enabler of this transformation is Information Technology (IT) which seeks to support the networks existent within business processes. This paper argues that the scope for IT in Computer Integrated Construction (CIC) should be more than just to seek information integration and automation. It stresses that construction companies should reengineer their business processes and develop IT-enabled networked firms in order to effectively manage the network of complex inter-relationships between the various parties. Based on the work of the authors, this paper concludes by arguing that pointing towards CIC, the redesign of construction processes should be considered in three different levels: whole industry construction processes; inter-organisational; and within processes of individual companies.

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## **2. - GENERIC CONSTRUCTION INDUSTRY PROBLEMS**

The construction industry structure is characterized by its fragmentation and traditional organisation. The existent structure is the market response to the peculiarities of the construction product but it is also acknowledged by many as the cause for the construction problems.

The construction industry has evolved a structure that provides extreme flexibility but that can cope (although inefficiently) with its peculiarities. The construction industry structure is composed mainly of a multitude of small highly specialized firms, that are generally subcontracted to a few large general contractors or consultants (Bennet and Ferry, 1990). Some authors stress that this fragmentation constitutes a barrier to the investment in innovation and that it is unlikely that companies will invest in improving their inter-organisational relationships (Hillebrant and Cannon, 1990; Atkin and Potheary, 1994, CSSC, 1989).

The roles, responsibilities and relationships amongst the people existing in a traditional organisation of a construction project are determined by the procurement method (Latham, 1994). The team that is involved has rarely worked together before, and the different goals for different parties often leads to conflict between the parties instead of the much needed collaboration. The result is usually time, cost and waste overrun, with a very unsatisfied client (CSSC, 1989; Latham, 1994; Atkin and Potheary, 1994).

Much of the characteristics of the construction process have developed a sense of uniqueness within the industry. However, many construction companies have been looking to other industries' companies in order to borrow ideas that may help to overcome its problems. Nevertheless, construction companies and the construction research community have always been slow to adopt improvement methods from industries (Betts and Lansley, 1993).

## **3. - LOOKING OUTSIDE: MANAGEMENT PULL vs TECHNOLOGY PUSH**

Companies in service and manufacturing industries have been until recently adopting two different improvement philosophical approaches: management pull and/or the technological push.

### **3.1. - Management Pull**

The management pull consists of applying concepts like Just-In-Time (JIT), Total Quality Management (TQM), Continuous Process Improvement (CPI), Lean Production (LP), or Business Process Re-engineering (BPR) to the organisation and production process. The common link between all is the perspective that the

primary unit of a company is the process. A process perspective allows production organisation to be seen as a flow of material and information, where the goods are either being processed, moved, inspected or waiting. This flow can be evaluated in terms of time, cost, quality and value (Davenport, 1993; Hammer et al, 1993; Lubben, 1988; Hakes, 1991). These approaches focus on improving the performance of operational objectives of the administrative and production processes, and differ in the scope and approach of the change. Focusing on the processes by which the product is produced, instead of focusing just on the product itself, anticipates problems and prevents them before they occur. Apart from BPR, the methods utilize IT only as a support to the changes. The application of these methods to construction firms has been scarce and usually restricted to major firms (Betts et al, 1995a; Koskela, 1992). There has been some academic discussion about how the new production philosophies can be applied by construction companies (Young et al, 1995; Koskela, 1992).

### **3.2. - Technology Push**

Technology push is the name given to the application of information technologies such as Electronic Data Interchange (EDI), Computer Integrated Manufacturing (CIM) or Office Automation (OA), etc. The principle is that by having electronic links the overall productivity of the companies will raise, and they will produce better products. Although in the service and manufacturing industries, companies have been quick to respond to these technologies, as demonstrated by the increasing levels of investment in IT (Keen, 1991) the bottom-line results have been disappointing (Thurow, 1991). The same has been happening to construction companies although the pace of IT adoption has been slow (KPMG and CICA, 1993). Apart from the discrete functional benefits, Information Technology is believed to have reinforced organisational barriers and perhaps also increased the cost of the resulting waste and inefficiency (CSSC, 1989).

### **3.3. - Merging The Two Approaches: Business Process Reengineering**

Following studies that concluded an absence of a relationship between IT expenditure and productivity, recent literature has advocated that the economic return from IT investment is insignificant when IT is used to merely automate existing manual activities. Benefits occur when there is a change of the company's processes enabled by the technologies (Hammer, 1990; Davenport, 1990; Davenport, 1993; Hammer et al, 1993; Keen, 1991; Tomasko, 1992; Scott Morton, 1991). This concept is the core of Business Process Re-engineering and has been the management and technology fad of the moment (The Economist, 1994), due its successful application in some exemplary cases and its blend of technological and management issues. Although the components of BPR are unoriginal, borrowed from disparate disciplines like TQM, JIT, System Thinking, Strategic Planning of IT, etc., the combination of factors within the concept has originated a novel approach to the solution of business problems (Earl, 1994; Grint

1994; Davenport, 1993). There is evidence that some construction companies, e.g. Wimpey, John Laing, Skanska, Bechtel, etc are starting to apply this concept in order to attempt to improve performance and productivity (Betts et al, 1995a).

### **3.4. - The Networked Firm: The New Structure Paradigm**

As a consequence of the redesign of their business processes, companies have had to adopt new structures, and new paradigms have emerged. Based on the response of the forefront companies, the new ideas and concepts advocated by the leading management thinkers are the development of the networked firm, where the company disintegrates functions, keeps a fundamental core and subcontracts to specialists (outsources) the various activities required to produce the final product. The unit of management is the project. The great challenge for companies is to know how to effectively manage the interdependence and relationships of this network, and the internal business processes (Peters, 1993, Scott Morton, 1991, Keen, 1991, McHugh, et al 1995, Gouiarld, et al, 1995, Hammer et al, 1993). The exemplary structure is the one of professional service firms. The enabler of this transformation is Information Technology, and it is supported by new Human Resources Management concepts.

## **4. - THE PARADOX**

Construction researchers and practitioners have long seen manufacturing and service companies as the paradigm to follow as far as productivity is concerned. Moreover, they have always tried to adopt manufacturing/service improvement concepts although in a slower pace and regarding the structural differences. But while we are trying to create structures and ways of working similar to them, they are moving and acknowledging the advantage of a structure like ours.

For the construction industry this seems to be a paradox. What have been attributed by many as the causes of construction productivity problems when compared with other industries (CSSC, 1989, Atkin and Potheary, 1994), its structure with high fragmentation (many specialists) and traditional organisation (project and temporary multi-organisation) seem to be the new paradigm to follow by these industries that are already more productive, with constantly higher productivity demands.

This suggests that the major problem with construction companies is not so much the industry structure but the way companies manage their interdependence within the informal network of the construction industry. Indeed, if manufacturing/service are now adopting a structure that has many similarities with construction structure, we should be looking at how they are overcoming many of the problems that this type of structure poses. And manufacturing/service companies should be learning something from the vast construction expertise.

#### **4.1. - The Construction Process as a Network**

The construction process is essentially a network of complex inter-relationships between the various parties involved (Tavistock, 1966), such as the client, the consultants, the general contractor, the various specialist subcontractors (on the design and construction phases), and within each party. Different studies have concluded that it is a fundamental factor for the success of construction companies, specially general contractors, and consequently of project success, that the relationships with specialist subcontractors be carefully addressed (Latham, 1994; Bennet, 1993; Bennet and Ferry, 1990; Lawrence and Dryer, 1983; NCE/NB BAA, 1995).

Construction companies have found disparate ways of managing this interdependence. In Japan long-term relationship between the general contractor and the subcontractors appear to lead to their success. In USA, Lawrence and Dyer (1983) have found that the success of house building firms has come from their capacity for creating quasi-firms by subcontracting. In the UK, the Latham report recommends team-work between the clients, consultants, main contractors, and specialist contractors.

Another dimension to the formation of these networks is if it should be a client pull (market demand) or companies push (market supply). Many advocate that great improvements in construction will happen when clients start to be more sophisticated and demand a better co-ordination for the projects. The Latham report suggests that the public sector should give the example. Private clients like British Airports Authority (BAA), Marks & Spencers and McDonalds have taken the lead to demonstrate that there is clear scope to improve the inter-relationships between the various parties (Betts et al 1995a; Latham, 1994; NCE/NB BAA, 1995). BAA is exemplary in its approach to build the network. They started by mapping the processes associated with the network of their construction activity, and have removed blockers in order to facilitate smooth process operation. After defining how they should work, they have made arrangements that will provide guaranteed workload for a limited number of contractors, designers and suppliers. The profits will come if they increase their productivity and if they help to redesign their processes in order to achieve dramatic operational results.

#### **4.2. - The Networked Firm**

What does a networked firm really mean? In fact, to see firms as a network comes from the necessity of overcoming the reductionist approach of optimizing operations within functional departments, product lines, or geographical organisations. There is the need to see the whole business processes and how each sub-unit within the business process is or should be dynamically linked with various other sub-units within the firm as well as other units in other firms or organisations (Rockart and Short, 1991; Peters, 1993). For example, a site engineer may be

dependent on his firm's administration services for the placement of an order; from a subcontractor that is on site to build a part of the product; from an architect that is in his own organisation; from the quantity surveyor representing the client, etc.

In this perspective, the meaning of a networked firm is not only the inter-relationship between the firm and the external organisations that it is dependent on, but also the inter-relationships within the firm, between the different subunits that are dependent on each other and have direct links and where there is sharing of work, responsibility, expertise, and decision-making. A network is a dynamic multi-disciplinary and multi-unit capability, where the authority is derived from the formal or informal procedures existent in the network and not from the traditional vertical chain of command.

Construction companies, specially general contractors, fit quite well in this definition of a networked firm due their geographical dispersion (branches, sites, etc), functional fragmentation, and product variety (housing, buildings, civil engineering, facilities management, etc). Indeed, project-oriented firms tend to exploit networks of relationships between their participants, rather than trees as in simple one-dimensional hierarchies or even matrix organisations (Morgan, 1986). However, a networked firm doesn't mean that all employees are networked, since most of the daily work activities are routines that do not require network activity. Another important issue is that a networked firm doesn't mean that there is only one network: a networked firm usually has a complex web of networks working within the firm.

## **5. - BUILDING THE NETWORKED FIRM: THE ROLE OF IT**

In the academic community Computer Integrated Construction (CIC) is addressing many of the problems of the deployment of IT in construction. However, it does not always seem clear if the right approach is being made (Betts et al, 1995b). Integration and automation should not be an end in itself but only a means. Indeed, CIC efforts should be aiming at forming IT-enabled networked structures. Full integration and automation is seen by Venkatraman (1991) as only an evolutionary level as far as business transformation enabled by IT is concerned (Figure 1). In fact, Venkatraman argues that to fully exploit IT potentialities, companies should move to the revolutionary levels: business process/network redesign and business scope redefinition. This will enable the formation of the IT networked firms.

In manufacturing and service industries, much of the deployment of IT in companies that are reengineering their business processes/networks are to form IT-enabled networked firms (or virtual organisations, holonic firms, etc) and thus improve operational performance objectives. As mentioned above, their new organisational structure has many similarities with construction companies like contractors.

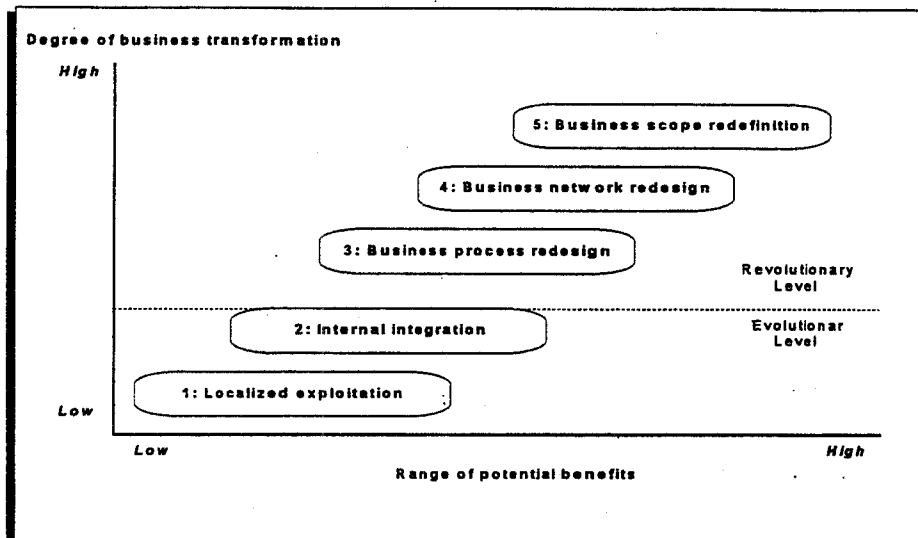


Figure 1 - Venkatraman's (1991) Levels of IT-Induced Business Reconfiguration

However, it doesn't seem evident from the literature that contractors are exploiting the potentialities of IT to form IT-enabled network firms. Actually, there isn't evidence that despite the network structure existent in most construction projects and companies this is being acknowledged as such and managed as such. Lundergard (1994), conducting case-studies of eleven major European contractors found that the use of IT has been to improve performance of internal operations, with very few situations where IT was being used to form internal or external networks.

Hence, the formation of an IT-enabled networked contractor will require the redesign of both internal business process but also the redesign of the business network, since general contractors are prone to subcontracting, and links with suppliers and clients are usually very rich. The richness of the network where they usually are involved (with external parties or even within the firm) calls for a broader perspective, where the redesign of the business processes should not only be led by short-term operational performance objectives but also by developing an effective IT-enabled network that manages effectively the interdependence of the various units and sub-organisations involved.

## 6. - FROM COMPANY TO INDUSTRY LEVEL

This paper has made a case for our purposeful application of IT in construction to extend beyond the goals of automation and integration to the revolutionary redesign of business process to enable IT to make a significant impact. A brief description is given above of how such redesign of processes can be achieved. Given the fundamentally different operating levels of construction, we now need to consider what BPR means at the different levels of the construction industry.

Most of the literature, techniques and case studies of process redesign in all sectors has been focused on companies. There appears great scope for further applications of process redesign to the overall construction industry network.

Moreover, many of the benefits of process redesign are realised at interfaces between companies. Given the way that construction companies are increasingly looking to extend the virtual or networked organisation within a fragmented construction industry, process redesign across corporate boundaries appears increasingly significant. Within construction there are a number of ways this can happen. One might be through major contractors developing closer relationships with their many and preferred sub-contractors and suppliers. The way that the major automotive assemblers have pursued this route with their suppliers has been well documented (Womack et al, 1990). Major contractors may also pursue such a strategy through corporate acquisition. As evidence of such an approach, a medium sized UK contractor has recently acquired a design and build specialist company partially to enable linkages between computer systems .

A further driver of inter-organisational process transformation enabled by IT arises from the increasing customer orientation of construction. Major clients, like BAA referred to earlier, are well placed to impose process changes on inter-organisation relationships through preferred supplier schemes and to use IT as a major mechanism to achieve this. BAA in their attempts to impose process changes on how the construction industry works with them have seen integrated computer modelling systems as a key mechanism.

Beyond corporate and inter-organisational IT-enabled process change comes the whole industry initiatives. This has been evident in recent UK initiatives when national IT strategies with technological vision based on process redesign (HMSO, 1995) and new whole industry research strategies with process and IT at their heart have both recently been published.

The authors have been principally involved with these activities (Betts et al., 1995a) and what seems clear from this review is that these three levels of corporate, inter-organisation and national IT-enabled process change can obviously benefit from being integrated.

## **7. - CONCLUSIONS**

This paper set out to present a new role for IT as an enabler for business process change within construction companies. Having seen how, why and where this is possible this should cause us to fundamentally reconsider our current research initiatives. Our preoccupation with technological issues is well documented. The need for a combination of technological and process-based concerns is demonstrated by the arguments made here. There is a need for researchers to fundamentally re-orientate the aims of their studies to recognise revolutionary



targets that most construction companies have for their IT applications. A failure to recognise this change in the company/industry will mean that we will continue to derive increasingly sophisticated answers to questions that no-body is asking.

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