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PROJECT WEBS AND NEW MODES OF ORGANISING IN THE CONSTRUCTION SECTOR: INSIGHTS FROM AN IN-DEPTH COMPARATIVE CASE STUDY

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ABSTRACT

There is a contemporary fascination with the way in which modern information and communication technologies (ICTs) may facilitate the emergence of innovative new forms of organising. In this paper we attempt to contribute to this debate by focusing on recent attempts to introduce Project Webs in the construction sector as a means of streamlining and improving the way projects are traditionally organised. We draw on in-depth, empirical evidence from interpretive studies of two high-profile construction projects, one based in Ireland and the other in the UK, to explore attempts to use such technologies to facilitate improved communication and collaboration between geographically-dislocated firms. Interestingly, the outcomes of the two projects contrasted radically with one another, with the technology enjoying significant success in one case while failing to make any significant impression at the other.

While we point to a range of technological and management issues that contributed to such polarised outcomes, we argue that one of the most significant problems with the successful use of such technology concerns institutionalised practices and relationships within the sector. In particular, we draw attention to the importance of the broader social, political and economic structures that are manifested in the traditional working practices that prevail within the industry. In conclusion, we argue that, rather than conceptualising the introduction of such changes as primarily a technical problem, attention needs to be paid to the manner in which the outcomes are shaped by the specific socio-political context within which such practices are situated.

BIOGRAPHICAL NOTE

Kate Kenny is a University Lecturer in Human Resources & Organisations at Cambridge's Judge Business School. Prior to her doctorate at this school, Dr Kenny was a consultant at the Irish Construction Information Technology Alliance. She has also been a professional services manager for BuildOnline UK (2000-2003), and a structural engineer in Ireland and Australia (1998-2000). She has won a number of awards, the latest being an Economic and Social Research Council Postdoctoral Fellowship (2006). Her research interests include critical management studies, issues of identity, power and emotion in contemporary workplaces and ethnographic research methodologies.

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INTRODUCTION

There is a contemporary fascination with the way in which recent developments in information and communication technology (ICT) may facilitate the emergence of innovative new forms of organising (see, for example, Kirkpatrick 1993, Lipnack & Stamps 1997, Boudreau et al 1998). Indeed, in recent times a plethora of evocative terms such as the "network organisation" (Miles & Snow 1992, Castells 2001), the "virtual corporation" (Davidow & Malone 1992), and even the "Moebius-strip organisation" (Sabel 1991), have been offered as a means of characterising such organisational transformations. ICT has been heralded as a key enabler of these more integrated, flexible, communication-intensive, network modes of organising (Lipnack & Stamps 1996), due to its supposed capacity to facilitate dramatic improvements in processes of collaboration and surveillance and management control. Despite the excitement about this ICT-enabled brave new organisational world, however, the empirical evidence to sustain such claims is decidedly mixed and a number of authors have questioned the conceptual assumptions upon which they are based (see, for example, Knights and Willmott, 1999).

Mirroring such broader trends and developments in management thought, there has, of late, been much excitement about, and investment in, the use of modern, Internet-based ICT in the construction industry[1] to experiment with more innovative, collaborative and productive ways of organising work practice (Egan 1998). In this sector, where traditional working practices are widely recognised as sources of unnecessary time and cost overruns (Latham 1994, Rojas and Songer 1999), there have been recent calls for the industry to improve and streamline the way in which work is carried out (Egan, 1998). Partly in response to this, the sector has seen the emergence of specialist providers offering software products specifically designed to facilitate more effective ways of managing and organising construction projects. A form of ICT widely used in construction is the 'Project Collaboration Website', or Project Web, which enables the sharing of project information between collaborating firms, via a centrally hosted Internet repository (Azhar, Ahmad & Ahmed 2000). On such systems, shared information is hosted electronically on a central server, with access being given to relevant members of the project team via username and password. Server space is typically rented for

[1] Interestingly, project-based industries such as construction and the film industry have been cited as potential models for the virtual organisation (Grant 1998, Introna et al 2000).

an annual fee from the software provider, who develops and maintains the web-based interface technology, which follows the Application Service Provider (ASP) model of software provision. A typical Project Web will have the following features:

- A customisable 'Project Homepage' with images of the project, latest updates and relevant web links (for example, to media articles on the project, or to material suppliers' websites).
- A central document manager where files can be organised and managed by project members.
- Built-in viewing software where users can view and add comments to documents, drawings and Computer Aided Design (CAD) files regardless of the software package used to create the file.
- An automatic messaging facility that notifies team members when new files have been added to the project site. Members can choose to receive these updates by text message, email or fax.
- Online forms that resemble the paper forms normally used in construction. Examples include 'Requests for Information', typically issued by the contractor to the architect if there is a query about an aspect of a design, and 'Submittals' which are issued when a document must be checked by another party on the project.
- A facility to maintain a complete audit trail of all activity on the Project Website; e.g. who has opened, saved, edited or added a given document and the date and time that the action in question was carried out.

The potential benefits of using Project Webs have been widely trumpeted within the sector. For instance, the use of the Internet to share project information has been seen as offering the potential to "transform many construction operations" (Egan 1998). Wesek, Cottrez & Landler (2000) claim, in a widely cited industry report, that very real and tangible benefits are being experienced by firms adopting online project collaboration tools, including improved project progress communication, increased accountability and shortened project lifecycle. The idea is that the use of a shared electronic document repository on construction projects will reduce administrative work by facilitating easier distribution and version control of all documentation, whilst also improving monitoring and management control processes due to the increased transparency of activities associated with the introduction of a comprehensive electronic audit trail. Others have claimed that the use of Project Webs will

result in “improved relationship with the client, and all partnering companies in their supply chain” due to “less project management time spent on administration and more time to focus on delivering quality work to the client.” Azhar, Ahmad & Ahmed (2000) argue that the use of e-commerce in construction, including Project Webs, will introduce badly needed efficiencies into the industry, and that “better relationships will develop due to the increase of information exchange and communication”.

Uptake of these technologies within construction has been relatively slow as reported by a recent review (Becerik, 2004). This report states that despite the many apparent benefits of these technologies and all the efforts that have been put into facilitating the communication among the participants in AEC projects, utilization of this technology hasn’t progressed beyond simple document storage, exchange and management. When the first extranet services were launched, many industry pundits forecasted that this market would grow dramatically to reach multi-billion-dollar size within a few years. Despite the admonitions of vendors, consultants, journalists and even fervent early adopters in design and construction firms, widespread customer adoption in the AEC industry has been far slower than initially projected .

However, albeit slowly, use of these technologies is spreading. A recent study indicates that 50% of those employed in the Swedish construction industry work in companies where such software had been used on at least one project (Bjork, 2001). A similar study shows that almost half of all construction projects of size greater than $21.3m US (€16.8m Euros) in Finland make use of this kind of software (Bäckblom, Ruohtula & Björk, 2003). In the United States, Azhar, Ahmad & Ahmed (2002) report that of the five hundred construction sector firms surveyed, 59% of respondent firms used project specific websites to share information with other members on their projects. The Engineering News Record (ENR) in the United States estimates that the number of A/E/C firms prepared to set up ‘‘virtual’’ project teams by using the WPMS concept is doubling every 6 months (Nitithamyong & Skibniewski, 2004). To gauge the amount spent on such systems, it is noted that software providers tend to charge approximately 0.1% of the total project value, per annum for the use of a project website (Bäckblom, Ruohtula & Björk, 2003). Thus, a medium sized project might expect to pay $25,000 US per annum for the use of a system.

Despite significant investment in such technologies in recent years, however, there is still very little tangible evidence of how effective they have been in supporting construction projects (Becerik, 2004). As with web-based collaboration processes in other industries

(Munkvold, 1999), there have been little in-depth empirical studies through which we might develop a mature understanding of the benefits of using such systems and validate the claims of their vendors (for one such study see Nikas, A. & Poulymenakou, A. (2005)'s study of the introduction of a web-based collaboration platform in a construction consortium in Greece).

Despite these exceptions, the majority of published evidence in existence tends to be in the form of quite superficial case studies of projects that have used construction Extranet technologies (Becerik 2004, George 1999). Such accounts tend to be suspiciously sanguine regarding the potential contribution of such systems and the ease with which they may be embedded within such contexts, which are typically marked by deeply institutionalised work practices and complex mosaics of social and organisational relations. Indeed, Broyd (1999) argues that the published evidence does not reflect the varied outcomes experienced by practitioners who have used such technologies. Nitithamyong & Skibniewski (2004) point out that in studies of web-based collaboration systems to date, technically related factors have often gained sole attention while nontechnical factors are considered separately, overlooked, or even ignored completely.

In this paper, then, we attempt to address this apparent empirical lacuna by providing an in-depth interpretive account of the attempted implementation and use of Project Webs on two different construction projects. Interestingly, in one case the technology was considered a great success, contributing to some key changes in working practices, while in the other it was only used in a very superficial manner. We attempt to explain such divergent outcomes by pointing to key differences in the broader institutional context that pertained in each case, and try to demonstrate how this context shaped, and was shaped by, key actions (i.e. human interventions) and events as the implementation process unfolded. In so doing, we point to the social and organisational difficulties associated with implementing Project Webs and we attempt to theorise about the circumstances under which such implementation attempts are more likely to be successful.

The paper is organised as follows. In the next section we briefly review key lessons that have been learned from general studies of ICT innovation in other sectors, and we attempt to elaborate an appropriate theoretical perspective for understanding the implementation and use of Project Webs. We then go on to provide some important contextual background on the way in which construction projects are traditionally organised. In the subsequent section we outline and justify our choice of research methods and research design, before moving on to an exposition of the implementation process at the two research sites chosen. We then

attempt to explain why the outcomes of the two cases were so divergent and, finally, go on to discuss some of the main conclusions and implications that might be drawn from our analysis.

UNDERSTANDING THE RELATIONSHIP BETWEEN ICT AND SOCIAL AND ORGANISATIONAL CHANGE

There are reasons to be more than a little cautious about the claims made about the radical transformative potential of Project Webs in the construction industry. In particular, it is instructive to consider some of the literature on groupware implementation and use. While the notion of ICTs as being embedded in complex organisational and social contexts has been introduced in some studies of web-based systems in construction, such as Becerik (2004) who mention that "most important problems are not technological but they are organizational and

Physiological" and Nitithamyong & Skibniewski (2004)'s comment that "factors such as sociological and people issues… greatly impact the system's performance", more detailed examinations of these processes has been carried out in the groupware literature. Therefore, we hope that this body of work would provide a useful means of highlighting some of the key difficulties that are often associated with ICT innovation of this nature. Indeed, in their study of the introduction of a web-based collaboration platform in a construction consortium in Greece, Nikas, A. & Poulymenakou, A. (2005) draw extensively on this body of literature to inform their understanding of the case.

Groupware is a term given to software that is designed to support groups of people working together, by supporting rich and varied forms of communication, collaboration and information sharing (see Baecker 1993, Ciborra 1996a). Project Webs, then, may be seen as a specific example of groupware technology. Despite early optimism about the transformative capacity of groupware, however, the empirical evidence supporting claims of radical organisational change is decidedly mixed: amongst the relatively small number of in-depth, situated studies of attempts to use ICT to facilitate innovative forms of organising, one can find evidence of great successes (see, for example, Malhotra et al 2001, Orlikowski 1996), failures (see, for example, Orlikowski 1993, Vandenbosch & Ginzberg 1996, Ciborra & Suetens 1996) and elements of both success and failure (see Kelly & Jones 2001). This great divergence in the reported outcomes of groupware implementation raises important

questions about how we should interpret such seemingly 'contradictory' results (Robey & Boudreau 1999), and how we should approach the study of groupware innovation in organisations. We will begin by addressing these questions, before going on to take a more careful look at groupware literature for insights into the social and organisational problems that can hamper groupware innovation.

Perspectives on IS and organisational transformation

Orlikowski and Iacono (2000), in attempting to summarise some of the lessons learned from studies of technology over the past 20 years, warn about dangers of drawing conclusions about the organisational implications of a particular technology by merely extrapolating from its identified technical features. In particular they argue that, as technology is 'interpretively flexible' (i.e. open to being interpreted and appropriated in divergent ways), it is important to carefully distinguish between "espoused technologies" and "technologies-in-use". By the former they mean idealised descriptions of how the technology is used, arguing that these are rarely a good indicator of the nuanced and multiple ways in which technology is actually appropriated and used in practice. Consequently, they contend that if we want to really understand the organisational implications of ICT, then we need to look carefully at how they become embedded in specific social and organisational contexts. In other words, our understanding of a specific technology must be based on in-depth empirical studies of its use in diverse contexts.

Of course the notion that technology is, at least partially, socially constructed (see Bijker 1987), or an 'equivoque' (Weick 1990), is not new. The key issue is how this construction process unfolds and how it is shaped. Walsham (1993) has drawn on the work of Pettigrew (1985, 1990) to argue that, in studying IS in organisations, we need to consider not only the technology itself (i.e. the content of the change), but also the social and organisational context in which it is embedded and the process by which it is introduced. Robey and Boudreau (1999) reinforce this point by arguing that studies of IS in organisations need to become more theoretically sophisticated by drawing on intellectual traditions in social thought that take issues of context and process seriously, and that avoid the twin traps of technological determinism and managerial voluntarism (see Markus & Robey 1988, Orlikowski 1992). In particular, they identify what they consider to be four fruitful theoretical directions (cultural, political, institutional and organisational learning theory), and

emphasise that all these could be located within the broader meta-theoretical framework of Structuration Theory (Giddens 1979, 1984).

Structuration theory is an attempt by the British sociologist Anthony Giddens to develop a sophisticated ontology of the social world by overcoming the traditional dualism between determinism and voluntarism that is a feature of much social theory. Giddens argues that social structure should be understood as the rules (i.e. knowledge) and resources that are constitutive of recurrent social practices (i.e. institutionalised ways of thinking and acting), which are reproduced over extended tracts of time and space. Critically, structure is reproduced, and changed, through the actions of 'knowledgeable' human agents, but this knowledge is a product of participation in such practices. Human action, then, both shapes (i.e. reconstitutes or changes), and is shaped by, social structure. Giddens contends that, analytically, it is possible to distinguish between three different kinds of social structure: structures of signification are associated with procedural rules for making sense of actions/ events and are expressed through interpretive schemes; structures of legitimation are associated with normative rules that govern the legitimacy of action and are expressed through norms and values; and structures of domination are associated with ways of sanctioning action and depend on the distribution of resources within a social system.

Agency, or a person's ability to act or make a difference, depends on access to resources. By resources, Giddens means the material equipment (allocative resources) and organisational capacities (authoritative resources) that provide agents who have access to them with a range of facilities to achieve particular outcomes. All social systems involve asymmetrical distributions of resources and, consequently, exhibit some degree of political inequality. The exercise of power, however, depends not just on the relative quantity and effectiveness of resources to which agents have access, but also on the skills that they have mastered (i.e. their knowledgeability) to make use of them. These skills include verbal skill and other forms of, what the sociologist Pierre Bordieu would term, 'cultural capital' (Tucker 1998). Inequality of power relations both influences, and is reflected in, inequalities in the procedural and normative rules (mutual knowledge) associated with a social system, as well as the kind of sanctions that superordinates may impose on subordinates (and vice versa). Changes in the availability or distribution of resources within a system may result in a complex realignment of the relations of autonomy and dependence.

Social and organisational barriers to groupware innovation

There is a body of work that has focused on groupware as a socially-embedded phenomenon and has been concerned to provide in-depth, situated studies of groupware "technology-in-use", which provides insight into the difficulties associated with facilitating groupware innovation in practice. Grudin (1989), for instance, draws attention to the fact that groupware use may often be associated with perceived costs as well as benefits, prominent amongst which is the increased work or effort that may be involved in using the system (Orlikowski, 1996, for instance, points to the increased administrative workload that was associated with the introduction of a groupware system in the Customer Services Department of a large software company). Moreover, Grudin (1989) also argues that the perceived costs and benefits associated with groupware use may be unevenly distributed amongst users and, consequently, that the design of such systems should be underpinned by the principle that most of the burden of using them be shouldered by those who have most to gain by their introduction. This point is in agreement with existing studies on web-based collaboration in construction (Becerik 2004). For example, Nikas, A. & Poulymenakou, A. (2005) observe in their study of the introduction of a web-based collaboration platform in a construction consortium in Greece, the construction site manager reported seeing little benefit from the use of the system besides a potential improvement in data transfer. The costs of using the system included great difficulties in transferring information to the right recipients and a reported feeling that the new web-based system was a tool for "spying" on his every day work.

Ciborra (1996b) develops this argument about the difficulties getting people to use groupware technologies, by pointing out that in many social contexts "substitute media" like telephone, fax and Filofax will already be deeply embedded. Consequently, people's familiarity with, and mastery of, such "substitute media" may often make them very reluctant to switch to the groupware medium. This was noted by Nikas, A. & Poulymenakou, A. (2005) in their study of the introduction of a web-based collaboration platform in a construction consortium in Greece, in which the various problems with interoperability, instability and performance of the technologies resulted in users developing mistrust in the new technology and thus preferring to use substitute media, in this case fax instead of e-mail.

Furthermore, as the advantages of using groupware often depend on everyone else using it too, some authors have pointed to the difficulties associated with, and importance of, mobilising a 'critical mass' of users (Markus 1987, Dennis et al 1998). The provision of adequate incentives to use such systems (through the use of appropriate rewards and

sanctions) has been seen, therefore, as a key issue in successfully managing groupware innovation (Orlikowski 1993a).

Another key insight that emerges from such studies is the often open-ended and emergent nature of groupware innovation. Orlikowski and Hofman (1997) argue that groupware innovation is manifested in an ongoing process comprised of anticipated, emergent, and opportunistic types of change. Consequently, they argue that, rather than trying to comprehensively plan the implementation process ex ante, a responsive management style that focuses on making ongoing adjustments to the technology, and organisation within which it is embedded, is more appropriate. On this issue, Becerik (2004) reports that poor planning, little flexibility in implementation processes contributed to many unsuccessful implementations of project webs in the construction sector. In fact, they note that a popular misconception is that: because a web-based tool requires no resident software to use, then it requires no implementation to make it successful. The phrase "Just log-on and go" was widely employed by vendors and contributed to this problem.

Groupware and Construction Project Webs: Additional Observations

In the few in-depth studies of construction groupware systems that have been carried out, a number of unique features of these contexts have been observed.

In their study of the introduction of a web-based collaboration platform in a construction consortium in Greece, Nikas, A. & Poulymenakou, A. (2005) note that when the project collaboration system was introduced, significant changes were implied not only to the structure and core processes of the organisation using it, but also the work conditions of the people involved. They point out that the introduction of a new IT application influences roles, tasks, co-ordination activities and hence these systems necessitate the formulation of new formal and informal work procedures that need to be embedded into existing 'compulsory' processes as well as in informal norms. In his 2004 report, Becerik agrees that significant changes to work processes, roles and responsibilities and the degree of visibility of the work of individuals are frequently overlooked by those in charge of implementing construction project web systems (Becerik, 2004).

Drawing on Alshawi et al. (2003), the authors note that unlike many IT tools, the successful introduction of web-based tools requires the same "degree of readiness" both within each organisation *and* across the whole network of collaborating organisations. This makes the

implementation process very complicated and more difficult than the introduction of a new system into a single organisation.

Finally, in their study of a problematic implementation of construction project web software in Greece, Nikas, A. & Poulymenakou, A. (2005) note that the actors' familiarity with the use of such technologies was very low (Ciborra, 2000) and that actors IT literacy level was diverse within the network, prior to implementation.

BACKGROUND: THE ORGANISATION OF CONSTRUCTION PROJECTS

In the construction sectors of the UK and Ireland, specific practices and modes of organising have emerged over time. These traditional features of the industry are observable in the governance structure of projects, the nature of inter-firm relationships and the ways in which firms collaborate to get work done.

The governance structure commonly used to manage construction projects is important to understand for this study. Once a project has been proposed, and planning permission secured, the construction 'client' (financier of the project) assembles a design team. This design team typically consists of a representative from an architectural firm, one from a structural engineering practice and a services engineering firm, all of whom will collaborate to produce a design plan for the final construction to be built. A quantity surveyor is appointed to continually monitor cost information and report on this to the client as the project progresses. The role of each party on a construction project is clearly defined; these distinctions are introduced at university stage and are continually enacted within the professions (Broyd 1999). While these divisions are criticised for leading to poor communications between distinct professions in construction (Hamer 1999), one useful result is that once a project commences, each firm is aware of its implicit responsibilities from the outset (Introna, Cushman & Moore, 2000). During this initial 'design' phase, the work of the group is coordinated by a project manager, or on smaller projects, by the architect. Once the completed design documents have been approved by the client, these form part of the 'tender package', which is distributed to interested contractors. Contractor firms then 'bid' for the construction phase, by submitting price estimates for the work, which are evaluated by the

client. The successful contracting firm is awarded the tender and it is this firm's responsibility to 'manage' the project from this stage on.

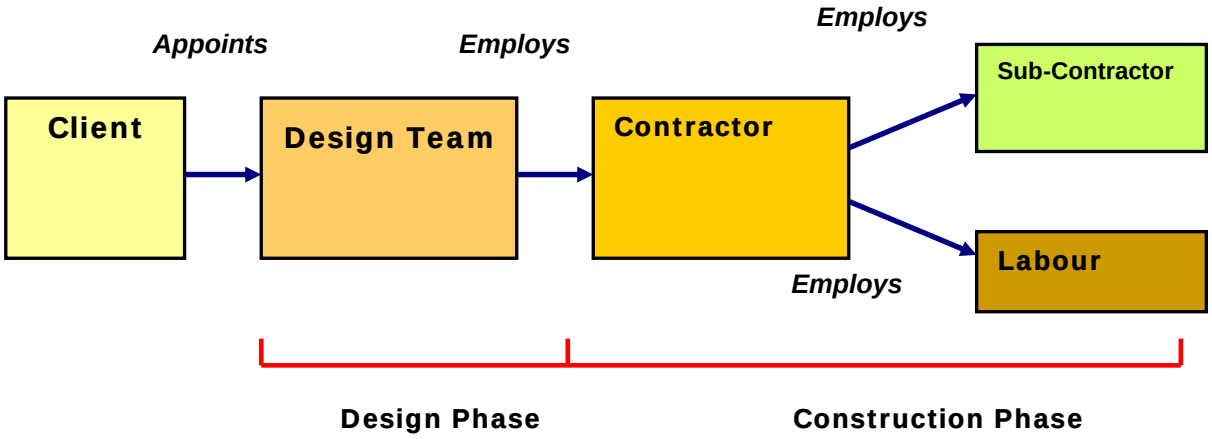

Figure 1. Overview of Hierarchy on Traditional Construction Contract

This governance structure involves clear decentralisation of control; responsibility for the progress of work is 'owned' by one of at least three different actors, depending on the stage of the project. Initially, the client is the central figure, but the project manager is responsible for the design phase, with the contractor managing the construction phase.

A second feature of traditional construction industry practices involves the lack of emphasis typically placed on the development of ongoing inter-firm relationships (Cushman, Franco & Rosenhead 1997, Danwood et al. 2002). Traditionally, projects are completed by short-term alliances, with a new team assembled for each new project. For example, a given contracting firm may never work with the same architect twice.

The final feature that concerns this research is the model of collaboration traditionally adopted for the carrying out of project work. Typically, when one party completes a document, copies are circulated to the rest of the project team. Each party must make corrections and comments on the documents, which are then returned to its author who makes the necessary changes to the original before redistributing. The postal service, email and the Internet all provide media by which output is passed from one collaborating partner to another. The process of design is conducted in this modular, point-to-point manner. Team meetings typically occur only once per fortnight.

The construction sector is undergoing significant changes. Competition from abroad and higher client expectations have put pressure on the industry to work towards the kinds of

performance improvements that appear to be transforming other industries; faster time to market, better quality and service and better control of risk and costs (Grant 1998). In particular, the features of the traditional construction process outlined above are widely criticised for impeding improvements within construction (Egan 1998, Sun and Aouad 2000). For example, the complex point-to-point method of design collaboration can lead to costly errors which are seen to increase with the scale and complexity of the project (Hamer 1999, Rojas and Songer 1999). The pressure to improve is mounting (Alshawi et al., 2003).

The result of this pressure to change has seen some firms adapting their practices, although this change is occurring very slowly and sporadically across the sector.

One notable change has been the emergence of the Design Build governance structure. Under such a model, the construction client appoints a main contractor at the very start. Full responsibility for cost, co-ordination and management, from initial design through to construction, is 'novated' to the contractor. This centralisation of control is intended to contribute to the kind of process improvements outlined above. An outline diagram of the structure of such a contract is given in Figure 2.

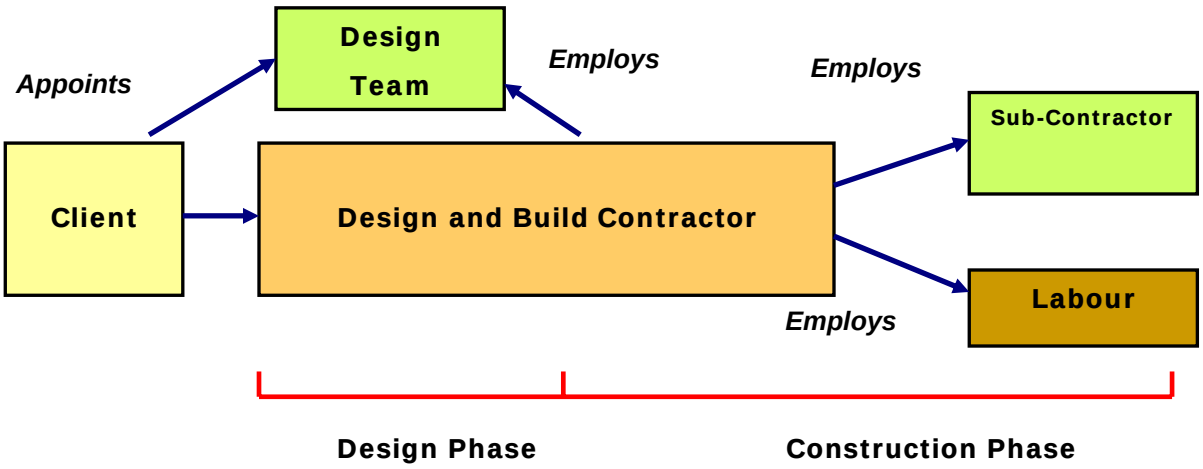

Figure 2. Overview of Hierarchy on Design and Build Contract

The adoption of a Design Build model has obvious implications for the governance structure of a project. The main contractor directly manages the entire project team, which represents a dramatic departure from traditional inter-firm relationships. The rise in popularity of new

governance structures such as the Design Build model has required main contractors to develop design expertise in order to manage design teams, along with project management skills. Architects have been required to adapt their skills to be able to design with the contractor, with the process of construction in mind, a significant departure for the profession. The spread of new models, such as Design Build thus led to some blurring of the boundaries between traditional roles.

A second change that has emerged in recent years has been a growing tendency for firms to foster long term partnerships in order to improve repeated inter-firm work processes over time (Sun et al., 2000).

Finally, industry changes have resulted in new modes of collaboration being necessary. Circumstances on a project, such as a 'fast-tracked' arrangement, or a Design Build model often mean that round-table, face to face design must occur between firms who would previously had a modular, non co-located working relationship.

Along side these changes are rapid technological advances in Information and Communication Technologies (Alshawi et al., 2003) such as web based collaboration systems and other innovations that promise to facilitate improvements to industry processes.

RESEARCH METHODS AND DESIGN

The first instances of construction Project Webs were noted in the United States in 1996. Research to date on this topic is limited and tends to focus on statistical survey results and other numeric methods.

As a new departure, the aim for this study was to understand the ways in which various social practices were sustained, resisted and changed with the introduction of web-based collaboration systems. Hence the focus was on observing interactions between people, reading and analysing the documents produced and more generally, observing social contexts as they develop and change over time. A number of authors have proposed that a study of a ICT implementation and the changes that occur over time is best suited to a longitudinal approach (Walsham 1993), perhaps combined with ethnographical data collection methods whose central concern is with detailed, in depth descriptions.

To facilitate this, a qualitative, interpretivist involving participant observation combined with semi structured interviewing was adopted for this research. The methodology employed was

broadly informed by principals for the evaluation of interpretivist research (Klein and Myers, 1999).

One of the authors acted as a participant observer in a firm that develops and supplies a web-based collaboration system ("Construct") to the construction industry. The period of participant observation lasted for approximately ten months. During this time, two particular instances of implementation of Construct were chosen for detailed study. Drawing on Orlikowski (1993) and Walsham (1993) it was hoped that this choice of two cases would facilitate useful iterative comparison between the sites, involving continuous juxtaposition of conflicting realities, that might assist in identifying useful patterns in the data (Orlikowski, 1993).

Site and Participant Selection

The Tullow Technology Park project was selected as an initial research site in April 2002. It was noted from observation and through the use of interviews that the poor quality of the Internet connection speeds at this site appeared to form a barrier to the use of the technology at Tullow. This led to the choice of Project Tyne for a second research site, as it was initially believed that Internet connection speeds were better at this site (although this turned out not to be the case). There were a number of similar features between the two cases whose presence made the comparison interesting. Obviously, both cases involved an implementation of the same technology. Both were construction projects and both implementations had begun and ended at the same time (roughly April 2001 to January 2002). In addition, the interviews were carried out when both projects had reached the stage of 'practical completion' (~ ninety five percent complete). This had the advantage that the experience was relatively fresh in the mind of participants at the time of carrying out the interviews. Differences between the cases were also identified. These included variations in the scale and scope of the projects and the structure of the contract in each case, and are discussed in a later section.

Data Sources and Analysis

In interpretivist research studies, "thick" descriptions are favoured, with an emphasis on painting a picture of the context surrounding the phenomenon being studied (Klein and Myers, 1999) and to this end as much relevant information as was possible was gathered. In

addition to meeting minutes, diary notes from the period of participant observation and semi-structured interviewing, usage logs for the two projects were also obtained from the software provider and participating firms' websites were consulted for published information on the projects. Relevant newspaper and newsletter articles were also gathered.

The participant observation phase of the research was chiefly concerned with the observation of the ongoing implementation practices at both sites. Participant observation as a research method originates from the disciplines of social and cultural anthropology where, by spending a significant amount of time in 'the field', and immersing themselves in the lives of the people they study, participant observers seek to develop a deeper understanding of the phenomenon being studied, as it is located in its social and cultural context. Ethnographies of management research are becoming more common (Collinson 1988; Van Maanen 1979; Watson 1994) with studies focussing on issues surrounding ICTs and management increasingly using this approach (Myers 1997; Orlikowski 1991 ; Schultze 2000).

The stated research focus on the meanings ascribed by individuals to various phenomena implied that it would be particularly useful to engage in semi-structured interviewing with key participants at each research site. A useful overview of semi-structured interviewing as a technique in interpretive approaches to management research is given in Easterby-Smith, Thorpe et al. (1991), while Walsham (1995) discusses its uses in interpretive information systems research. In selecting who to interview, construction projects consist of relatively clear and distinct roles and so it was clear from the outset who best to approach. The researcher's position within the software provider firm helped to gain access to more senior participants for interview. In all, fourteen interviews were conducted:

Roles	Software Account Managers	Architects	Project Managers	Contractors	Engineers	Quantity Surveyors	Client
Tullow Technology Park	2	1	1	1	2	1	1
Project Tyne	1	1	2	1	1	0	0

Table 1: Interview Participants

Most of these meetings took place at the offices of the individual, with two being carried out over the telephone. Interviews typically lasted between twenty and forty minutes. To assist in building credibility with the participants, one of the authors was able to draw on her own background in Civil Engineering and significant practical experience in working on implementations of the same software. In the interviews, which were tape recorded and fully transcribed, participants were asked simply to first describe their role in their own organisation, and then to "tell the story" of the implementation and subsequent use of the Construct system. The confidentiality of the participants' responses was also guaranteed during the initial correspondences and then again at each interview. An abbreviated report of the research was distributed to each participant after completion of the study.

As data was gathered, it was continuously revisited and key concepts or themes were identified. This process continued on throughout the period of research. Throughout the period, relevant literature addressing these apparently dominant themes was consulted. The themes and concepts that had been identified from the first case were used as an initial guide to the data collection at the second site, but it was found that there was no smooth correlation between the data gathered at both sites, a feature referred to by Klein & Myers (1999) as one of the challenges of interpretivist research.

Authors' reflections: Limitations of the research

The retrospective, once-off interviewing process has recognized limitations (Majchrzak et al, 2000) including that it is seen to encourage respondents to gloss over events, or that accounts may be biased by the same recently institutionalised practices and perceptions that participants are attempting to describe. It is hoped that the participant observation aspect of the research would help to overcome this limitation (Walsham, 1993). In addition, the fact that one of the authors had a strong background in this area proved useful both in gathering background information to understand the broader social, political and historical context of the case and also in understanding the language used in the construction industry, which can be quite specific.

Limitations remain in the research methods chosen however. Geertz (1973) problematises ethnographic approaches by his comments that 'in finished anthropological writings, this fact- that what we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to- is obscured because most of what we need to comprehend a particular event, ritual, customs, idea or whatever is insinuated as

background information before the thing itself is directly examined…. We are already explicating: and worse, explicating explications.' (Geertz, 1973). Van Maanen (1979) provides a detailed discussion of the potential pitfalls inherent in an ethnographic approach to qualitative research, again pointing out that the results of ethnographic study are thus mediated several times over: first, by the fieldworker's own standards of relevance as to what is and what is not worthy of observation; second, by the historically situated questions that are put to the people in the setting; third, by the self-reflection demanded of an informant; and fourth by the intentional and unintentional ways the produced data are misleading.

THE IMPLEMENTATION AND USE OF CONSTRUCT AT PROJECT TULLOW AND PROJECT TYNE

Project Tullow

This project was concerned with the construction of Tullow Technology Park, an office development in County Tipperary, Ireland. The project team, assembled by client Mike Haniffy, consisted of a quantity surveying firm, an architectural practice and a structural engineering firm whose offices were all located in Limerick, along with a Cork-based services engineering firm. It was noted that none of these firms had worked together previously, nor had they any definite plans to work together on future projects. The governance structure chosen was that of the traditional project model described in Section 3 and the overall value of the contract was $4.7m US (£3m IR).

In March 2001, soon after the team had been assembled, Mike Haniffy proposed that they implement the Construct groupware system. By this stage, the initial detailed design had been carried out by the architect, with limited input from the engineering firms and the quantity surveyor, and project documents were being exchanged via email, fax and snail mail in the traditional point-to-point fashion typical of the construction sector. Haniffy explained his decision to implement Construct as follows:

> "It [Construct] had been in the press a few times; I was aware of it, and there was no project in [this] region who had used it before. It was a good chance to get ourselves good promotion on it; to try and give it a shot and see if we could use it. It's eventually going to be a technology building, and we want to link the "technology park" with technology." (Mike Haniffy, Client)

Training was provided and Haniffy made it clear to all involved that, from this point onward, the Construct system was to be the medium by which all documents and messages would be exchanged between team members. In April 2001 the latest set of project documentation was added to the Construct site, login details were issued and the team began to use the system.

Mike Haniffy was very pleased with the system and enthused about being able to access the latest project information from his desktop computer.

> "…I think it made the whole job a lot more transparent from my point of view. You could see a lot more of what was going on; you could watch the information flowing to and fro without being involved in the actual process…" (Mike Haniffy, Client)

This enthusiasm, however, was not shared by other members of the project team who were much more sceptical about the benefits of adopting such a system. A key issue was that people found it difficult to appreciate the advantages of using a system like this by comparison with a conventional email system:

> "There is no advantage in using Construct if you can email drawings and minutes of meetings around between the design team members quicker." (Lorcan Carty, Services Engineer)

> "If I need a drawing from the architect I just ring him up and if he has the drawing he'll email it to me… normally there's no problems really in getting drawings from people." (Séamas Canning, Structural Engineer Technician)

Indeed email was seen to be better means of communication and document exchange as, without broadband Internet connections like those at Haniffy's office, the daily procedure of logging on to the web-based system to obtain the latest project documents was becoming a long and arduous process:

> "Before you even went to turn the thing on or start into it, you were almost annoyed with it because you knew this was going to take time and you were trying to allocate an hour to get something done and that really should be taking 15, 20 minutes. …You'd accept a little bit longer than email because of all the extra benefits but not to this level, that it was just… quite a struggle." (Ruth Staunton, Quantity Surveyor)

In addition to these system performance related difficulties, a further issue related to compatibility problems amongst the different software applications that were being used by project team members to produce documents. The architect used a different CAD (Computer

Aided Design) package to the one used by both project engineering firms. This meant that extra work was required to share drawings on Construct.

> "…If I was to do it right with Construct, I was meant to export them as DWG format and then go into AutoCAD and export them as a DWF and then put them onto the Construct system which… There was no way on earth I was going doing that." (Martin Garrett, Architect)

Similarly, the quantity surveyor's package for producing the regular cost reports that detail the current financial status of the ongoing project was not compatible with the others' systems. A tentative effort was made to overcome this incompatibility by experimenting with alternative file formats, but this was soon abandoned as the team resorted to circulating paper reports instead.

The frustration felt by members of the project team resulted in a general avoidance of the system and by the time the project was ready to begin construction, an element of 'token' usage had emerged among project team members.

> "… As regards to how often I used it, I think we were supposed to keep it updated the whole time but that didn't really happen… If there was a design team meeting coming up, the engineer here would ask me to upload all our own up-to-date drawings because there would probably be a request made by someone at the meeting to keep Construct up to date. " (SG, Structural Engineer)

At project meetings, members of the project team repeatedly complained of the problems they were experiencing with the collaboration system. The client, Mike Haniffy, duly reported these problems to the software provider, specifically requesting that the software be redesigned in parts to make it faster to use over slow Internet connections. This request was not entertained by the provider BuildNet, who simply recommended that the participating firms should update their Internet connection speeds. This did not occur.

By September 2001, the design phase had concluded, the main contractor had been chosen and the project was ready to begin on site. Within the terms of contract, it had been specified that the contracting firm must make necessary provision to ensure that they could accommodate the Construct system. Training was provided to the contractor's site foreman but in this case, the foreman had 'never used a computer before'. Again, the Internet connection speeds available on site were extremely slow.

Two weeks after construction commenced, it was decided by Mike Haniffy to discontinue active use of the system. By the time research for this study was carried out, the building was

practically complete. Despite the abandonment of the Construct system the project was completed on time and within budget.

Project Tyne

The second site chosen for research was another office facility development. In this case, however, the project was based in the UK (in Hartfield, an hour north of London) and its value was $104.9m US (£60m sterling), more than 20 times larger than the Tullow development. Harrington Development had been appointed to develop the facility and decided to adopt a Design Build management model (see Section 3). Consequently, when Kent Construction was appointed main contractor in January 2001, the contracts that had existed between Harrington and the project architect firm during the very initial 'concept' phase, were now passed to Kent. In the course of our research work, management at Kent indicated that although this was their first project with Harrington Development, they had ambitions to continue working with them on an ongoing basis.

The design and building of the project was to be fast-tracked and so work quickly began with an intense period of design and negotiation between architect and contractor. This involved members of both firms working together in the same office at the construction site for an initial period of six to eight weeks.

> "No detailed design had really taken place [before the main contractor had been appointed] so we were designing on the hoof with Kent. We had to have a very good working relationship and very good communications with them." (Paul Martin, Architect)

As the design developed, a full project team consisting of services and structural engineers was assembled. Under the Design Build model, Kent personnel adopted the roles of quantity surveyor, main contractor and project manager. Then, just as the project began on site in March 2001, Kent's design manager, Noel Armstrong, decided that a groupware system would be useful as a means of overcoming or avoiding a number of anticipated project management problems.

Main contracting firms have traditionally only had to concern themselves with managing subcontractors, but the emergence of the Design Build contract structure has meant that firms

like Kent must now also take on the management of design teams. This can be prove quite problematic:

> "Traditionally, design teams do not like working for contractors, they feel that contractors are too cost-centric. The result is that they (design teams) don't manage themselves very well in terms of communication and delivery to the main contractor. … With the design team, their client is not Kent; their next job will not come from Kent. So typically contractors have a much harder time managing the design team." (Nigel Franklin, Account Manager)

By using a centralised groupware system like Construct, with its reporting, 'request for information' and messaging facilities, Noel Armstrong hoped that Kent's role in co-ordinating the design team's work on the project would be made easier. While this was Armstrong's original motive for implementing the Construct system, broader applications the technology soon became apparent. For example, the opportunity of gaining cost savings in distribution of documents to subcontractors via the Construct system had not been foreseen in advance, but only occurred to Neil Armstrong once use of the system was underway:

> "…I think very quickly they (Kent) realised that '… crikey there is an opportunity here to not only link us with the design team but also to link directly with all the subcontractors'" (Nigel Franklin, Account Manager)

By making all documentation available to subcontractors in electronic format, it was hoped that administration costs and time involved in printing and distributing documents around the site would be greatly reduced. The projected administration costs on a project of this scale are significant, and are said to form 1% of the total project cost (which in this case would constitute a sum of nearly $1.5m US). Similarly, the complexity of organising the timely distribution of design team information increases dramatically with project size. Based on this rationale, Noel Armstrong proposed the use of the Construct system. Paul Martin, the architect, agreed that it was worth trying and his firm committed to working with Kent on its implementation. As Kent had not used such a system on any previous projects, senior management within the firm made it clear to Armstrong that they would not 'officially' approve its use on a project that was so strategically important. He could, however, 'unofficially' purchase the software, on the basis that he and his team would have to justify its cost at the end of the project.

Once training had been completed, both the architect and contracting firms began to use Construct as the only means by which construction drawings and documents would be issued

to site. From the outset, Construct's central role in the project was actively promoted by Noel Armstrong.

> "…Noel's aspiration was that we would all totally commit to this… That was the way it was going to be done. And everybody did commit to it. There was a little bit of under the table dealing with little bits of information but it was relatively modest." (Paul Martin, Architect)

Use of the system, however, was not without its problems. Just as in the case of Project Tullow, slow Internet connection speeds meant that the system performance experienced by Kent's staff located on site was very poor, which resulted in complaints.

> "…It is really time wasting to be honest.... We just don't have the speed here. If we did then that would be fantastic." (Lara Wilkes, Design Co-ordinator)

Nonetheless, Kent's site-based staff used the Construct system for all project communication from start to finish. In doing so, they found that they had to innovate and experiment with the way work was carried out in order to keep up with the speed of document exchange on this fast-track project, while still maintaining the integrity of the painfully slow Construct system. For example, where a piece of information was needed urgently, it often made more sense to email or fax it. However, the relevant document or message would always be recorded on Construct after this was done, in order to maintain the completeness of the electronic project record.

Despite labouring under these slow connections, Construct staff spoke about the reduction in administrative work that the Construct system provided to them. In particular, these advantages were linked to the scale of the project, as people described the difficulties that they would have experienced, *without* the Construct software.

> "… You *are* cutting out the distribution time to the contractors and the clients …. For someone in my position, I am not copying drawings to everyone; I will just copy one for our engineers, not eight." (Lara Wilkes, Design Co-ordinator)

While some members of the project team, including the architect firm and Kent's own staff, embraced the Construct system and used it actively from the outset, it was noted that other parties, such as the services engineer and some subcontractors were more reluctant. The services engineer, Peter Burton who worked for a firm called Antec, described how, prior to the implementation of the Construct system, email had become the norm for Antec staff to communicate with others on the project. It was mentioned that even this represented a

significant progression from previous projects, on which fax or post had been used. Within this firm, as within many engineering firms, incoming project emails and documents were generally printed off by junior staff and delivered to the engineering manager's desk in paper format. Particularly in a busy construction environment, time spent doing what a junior staff member could be doing, such as operating the Construct system, is be seen as time wasted. In addition, the Internet connection speeds in Antec were slow, and not all PCs had Internet connections.

> "The onus is on *you* to go in and get it (the information) out of the system. Previously, if someone sends you drawings they land on your desk. Now I have to download them and I don't have the resources in-house to do that; to download fifty drawings quickly…" (Peter Burton, Services Engineer)

When it was introduced into this context, the Construct system presented an unwelcome source of delay on a job that was already operating under significant time pressure:

> "…It was proposed as a system that would make things quicker but I could see it was the opposite; because of the time taken to get things out of the system. It meant more time in front of the computer rather than doing what you should be doing; designing." (Peter Burton, Services Engineer)

Furthermore, while many architects, including Paul Martin are typically responsible for *one* job at a time; within engineering firms like Antec, designers are often working on many projects at once. Standardised processes are difficult to change for just one project while the old way of working remains in place for all others.

Notwithstanding such difficulties, however, Kent continued to promote the system vigorously and continued to insist that it be used.

> "Kent spent time and effort and repeatedly stressed to the subcontractors that; this is how you are going to get information out of us. If you are not on the system, you are not going to get any information. So if you are expecting these drawings on Tuesday, don't bother ringing us on Wednesday to say you don't have them. The people in Kent were very hard-nosed initially. The response from some subcontractors was; we don't know how to get on the system, and Kent staff would say, get BuildNet in and get some training." (Nigel Franklin, Account Manager)

Whenever a subcontractor came to the site office claiming that their Internet connection was 'down for the day', Kent staff would relent and provide a paper version of whatever drawing was required to progress with the work. As the project progressed, the amount of leniency shown was reduced.

Requests were made regularly to the software provider for various enhancements to the functionality. These changes were generally implemented by the software provider a month or two after the initial request came in from Noel Armstrong. Due to the scale of Kent Construction, and their influence in the UK construction sector, BuildNet reported that they were keen to impress Kent, so that the firm might use Construct on other projects in their substantial portfolio.

> "…We have made some changes; to start with we didn't have the option to look at all the actions linked to a particular piece of information, so we requested this and now you can do this. So that was a good change. We needed that because the previous system we had for managing documents had a checking procedure like this." (Lara Wilkes, Design Co-ordinator)

Architect Paul Martin made some changes both to the information technology available in his office, and to his working practices in order to use the Construct system. These changes began with an Internet upgrade.

> "…We got upgraded very early on in the job to some mega zillion whatever line. Now I can use Construct like I would use a normal computer… its just click click click…" (Paul Martin, Architect)

Paul also described the problem he was having with file formats. As on the Tullow Technology Park project, the architect's firm was using a different CAD graphics package to the rest of the design team. Having experimented with different possible solutions, Paul decided to convert his files to the common PDF format, which had the advantage of reducing the file size of his drawings, which resulted in quicker upload times to the Construct system. PDF format also enabled Paul to determine in advance how the eventual printed document would appear, regardless of the printer or software used to print it. In the rare instance where individuals required the actual files, these would be converted and sent.

A further change concerned the way Paul's office used Construct. In many firms using systems like Construct, it is the junior members of staff who are required to access the system and retrieve the latest information for reporting to senior management. In contrast to this, Paul Martin had decided from the outset to be his firm's main user of the Construct system. Rather than request others to go into the system and retrieve the drawings he needed, he would log in, respond to his messages and retrieve the drawings himself. He would ask his technicians to email completed drawings and documents to him, he would then check these drawings and if satisfied, upload them himself to the system.

"…So what it *does* mean, although it sounds silly, is that every single drawing going onto Construct, I've seen, and I've checked and I have uploaded it. Now you could say that an administration assistant or someone else should be doing all of that, but as Project Architect, if I were doing prints, I would be supposed to check all the prints and sign every single drawing that goes out. But the fact that I have uploaded it; Construct has a record of every single drawing that it was *me* that uploaded it and exactly when I did it. If I were to get our technicians to upload drawings, how would I know what had gone up; did he put it up? Did he do what I wanted him to do? And I think that that is where companies have to modify their management strategies; of how they do a job." (Paul Martin, Architect)

Having made these changes, architect Paul Martin noted that the Construct system held some significant advantages in terms of his working day.

"…I think it just mirrors what you do normally, but it is easier to do! The whole palaver of doing a whole load of prints, collating them, filling out an issue sheet, putting a felt pen through who its going to, getting it into the envelopes, getting it in the post, making sure someone has got the address, worrying about whether the post comes on time…" (Paul Martin, Architect)

The architect had an in-house problem with which the system helped greatly.

"…The project is being designed and drawn in two different (Browning) offices. So although I run it from here and I have a small team doing the external works, all the buildings were drawn in our Bristol offices. So… when I was trained on Construct I was then able to have a Net meeting on the computer, with a conference telephone call, and I was able to spend an hour and a half on the phone to them and brief them on Construct and that was it; it saved me a four hour car journey and half a day in Bristol." (Paul Martin, Architect)

Further unexpected uses and unforeseen opportunities emerged from the use of the Construct system. For example, the Paul Martin decided to rely on his Construct message system as his main storage area for project communications. He was no longer called upon each month by his firm's IT administrators to clear out his email inbox; a job he previously found both time consuming and annoying.

"…On a Friday afternoon, when everybody is panicking trying to run 300 prints through the printer and it is running out of paper, I am sitting there uploading a drawing and checking a drawing! At one point I individually revised 70 drawings in just over an hour. I upload the drawing and I'm gone. There's no panic waiting for the postman. And I have got almost the tidiest desk of anybody." (Paul Martin, Architect)

During the course of his interview, he mentioned that had compiled a report on the advantages and potential hurdles of this kind of software, which reflected these positive experiences,

> "…So from my point of view, it has made my life possible. I would not want to do another serious job without a system like this." (Paul Martin, Architect)

Despite the reluctance shown by Peter Burton and others on the project, and despite the slow Internet connection experienced by Kent on the site, by the time Lara Wilkes, design co-ordinator joined the project; the system had become almost totally embedded in the workings of the site offices.

> "… I had just come from another job, and the other job I have been on, everything was paper distributed. Then I came to Hartfield and it just was the norm, it was what they were using…. If you didn't use it, you just wouldn't have access to everything you need!" (Lara Wilkes, Design Co-ordinator)

MAKING SENSE OF THE DIVERGENT OUTCOMES

Here we attempt to explain why the Construct system enjoyed such contrasting fortunes at Tullow and Tyne. We begin by considering the difficulties experienced in implementing the system at Tullow and then go on to compare and contrast this with the more successful implementation at Tyne. Overall, we argue that the broader institutional context within which the technology was embedded at Tyne was much more amenable to IS innovation of this nature than that which prevailed in the case of Project Tullow, and this had a significant influence on the outcomes of the respective implementation attempts.

As we have seen many of the key participants in Project Tullow described their attempts to use Construct as excessively time-consuming and disruptive by comparison with the more familiar traditional approaches to exchanging project documentation that were based around the use of substitute technologies such as telephone, email (for project drawings), fax and snail mail (for paper-based cost reports). They could see no advantage in abandoning what they considered to be very effective practices, with which they were very comfortable and which were deeply institutionalised throughout the sector, to incorporate a relatively complex groupware system that was, in their experience, little used elsewhere within the industry.

Indeed, consistent with Grudin's (1989) observation about groupware technologies, the available evidence from the case would suggest that the benefits of using such a system were perceived to be unequally distributed throughout the project team. In this case, the client representative, Mike Haniffy, appeared to be the main (or, indeed, the only) beneficiary in so far as he claimed that the system made the project work processes more "transparent" from his point of view. All considered, then, the reluctance of most participants to adjust effective and deeply institutionalised work practices on one small project, for no tangible benefits (indeed, the adoption of Construct threatened to be very costly in terms of time spent training and using the system and the investment required to upgrade Internet connections) apart from compliance with a request from a client representative (which must have appeared quite whimsical – "… a good chance to get ourselves good promotion on it; to try and give it a shot and see if we could use it. It's eventually going to be a technology building, and we want to link the 'technology park' with technology." – Mike Haniffy), would appear to be eminently understandable.

Interestingly, similar concerns about the use of Construct to those reported in Tullow were expressed by some of the parties involved in Project Tyne. Those based at Kent's site office complained of very poor system performance due to the restricted bandwidth of the available Internet connection, while use of the system by sub-contractors and the services engineering firm was not welcomed due to scepticism regarding the benefits, performance issues, set-up costs (including costs associated with installing adequate Internet connections and the provision of training for staff) and, particularly in the case of the services engineering firm Antec, the disruption to deeply institutionalised work practices. Indeed, the Antec experience provides a very illuminating example of the difficulties associated with this kind of technological innovation in such a mature industry sector. Antec had only recently embraced email, having traditionally relied on fax and snail mail for document exchange, and using a computer was still not seen as a legitimate part of the activity of design engineering ("…[using Construct] meant more time in front of the computer rather than doing what you should be doing; designing" -Peter Burton). Work practices were organised in a strict hierarchical fashion with junior staff charged with collating all relevant paper documents in paper form and delivering them to the relevant senior engineer's desk. Moreover, changing such institutionalised routines to support different work practices on one project was problematic, given that most of the wide portfolio of projects Antec were involved with were organised in very traditional ways. Yet, contrary to what happened in Tullow, change they

did, and in attempting to explain this one can point to distinctive differences in the broader institutional context that pertained in each case. In particular, it is useful to consider important structural differences at both the industry-level and the project-level that were especially influential in shaping the way people made sense of and appropriated the technology.

For one thing, the structures of signification and legitimation that prevailed in the case of Project Tyne diverged from those in Tullow in the sense that in the former case there was much more awareness of Project Webs and more openness to experimenting with new ways of organising construction work. Most of those interviewed on Tyne, for instance, reported a strong awareness of broader trends to introduce such technologies within the sector and some had even used them on previous projects. By contrast, there was much less awareness of such systems and their potential contribution to construction work in the Irish context, where more traditional organising practices were still very much the norm. This may have had much to do with the typical scale of Irish projects by comparison with the UK construction sector. Indeed, the significant different in scale between Tyne and Tullow appeared to have made it much easier to legitimate the Construct system in the former case, due to the increased complexity of project administrative and the decreased significance of the of the costs associated with adopting the technology in the context of the overall project budget. Furthermore, as the project was organised in a very unconventional fashion (it was meant to be a fast-track development and was organised around a Design Build model, thus embodying an alternative interpretive scheme), there was more openness to experimenting with more unconventional work practices. The fast-track nature of the project meant that much more emphasis was placed on meaningful collaborative engagement, from a very early stage, between parties such as the contractor, architects and engineers. It seemed that this 'partnership model' of working had helped create a strong sense of collective endeavour that was more sympathetic to the use of a collaborative technology like Construct. Some of the key project actors viewed the system as useful means of facilitating meaningful collaboration and, as evidenced by the architects' use of the technology to reduce the need to travel to their Bristol office, the introduction of Construct prompted further experimentation with innovative modes of organising work.

While these structural differences between Tyne and Tullow appeared to contribute to the attempted introduction of the groupware technology being interpreted in a much more sympathetic manner in the former case, it is also important to consider the role of

institutionalised structures of domination in shaping implementation outcomes. In particular, it was apparent that Noel Armstrong, as Kent's design manager, was a much more influential actor in the overall network of project relations on Project Tyne than Mike Haniffy at Tullow. First, the Design Build contract structure conferred significantly more legal and operational authority on Kent as the organisation mandated to manage the project. Noel Armstrong, then, could draw on extensive authoritative resources to promote the adoption and use of the technology, while no such clearly defined and agreed authoritative agent existed in the case of the more conventional Tullow project. Consequently, his directive to all parties involved to use Construct was taken very seriously. In addition, the Design Build model confers responsibility for document checking and distribution on the main contractor, effectively placing them at the 'chokepoint' of document and information flow on the project. Armstrong, then, benefited from being in a key strategic position that allowed him to effective dictate the medium by which documents were circulated.

Kent's eminent position as a major player within the broader UK construction sector would also appear to have been very significant in shaping the outcomes of the implementation effort. As a very large and powerful corporate actor within the sector, it was important for other players to cultivate good relationships with Kent on an ongoing basis and this played a vital role in influencing people like Antec to make the effort and investment required to adopt the groupware system. The fact that Kent were able to tell sub-contractors to ensure that they received training in, and used, Construct at their own expense also illustrates the extent of the asymmetry of the power relationships that pertained on the project. Moreover, Kent's influence extended outside of those parties who were directly involved in Project Tyne, in that BuildNet's preparedness to make changes to the Construct software at Kent's request was an important contributor to the success of the initiative. Notably, they did not respond to similar change requests on Project Tullow.

We have argued, then, that the broader structural context that pertained in Project Tyne was more supportive for groupware innovation that at Tullow. This is not to say, however, that the outcomes of the implementation processes were determined by the structural issues described above. Notwithstanding the fact that he could draw on much more effective authoritative and allocative resources than Mike Haniffy, Noel Armstrong demonstrated great political skill in the manner in which he managed the process at Tyne. In many respects, the groupware implementation process conformed with Orlikowski and Hofman's (1997) improvisational approach. The original decision to implement Construct was an

opportunistic one taken soon after the project had begun. Despite not receiving the official blessing of his superiors at Kent, Armstrong skilfully drew on the authoritative and allocative resources at his disposal to introduce the software. He was also able to leverage the close working relationship that he had developed with the architectural firm during the design phase to mobilise the support of other key agents. Emergent benefits of using the system, such as the streamlining of the project document distribution process and the reduction of travel costs due to Construct's support for virtual meetings, became apparent as the project progressed and participants opportunistically altered their working practices to take advantage of them. Armstrong was also able to skilfully manage his relationship with BuildNet to ensure that they made important ongoing adjustments to the software to better support the requirements of the project.

CONCLUSIONS AND IMPLICATIONS

In this paper we have provided rare in-depth empirical data on the implementation and use of Project Webs in the construction sector. In so doing, we have attempted to critically examine the picture of the 'espoused technology' depicted in much of the popular literature, by carefully studying the 'technology-in-use' on two construction projects. The contrasting outcomes of the technology innovation attempt in each case provides a useful basis for theorising, in a grounded way, about the difficulties associated with implementing such systems, the circumstances in which they are likely to become successfully embedded within such organisational contexts, and their potential contribution to the management and organisation of construction projects.

With regard to the challenges associated with implementing such technology on construction projects, the case studies presented here have highlighted the danger of these systems disrupting deeply institutionalised working practices. Document exchange, for instance, has traditionally been conducted in a 'point-to-point' manner between project participants using effective and familiar substitute media such as email, fax and snail mail. In the absence of high-bandwidth Internet access, the use of technologies like Construct may greatly increase the time and effort associated with such work, thus disrupting established work routines. Moreover, the Tullow case raises questions about the espoused benefits of such software in the context of smaller scale projects that are organised in a traditional manner. In particular,

many of the proposed advantages of Project Webs may be undermined by the modular organisation of much construction work where efforts are made to tightly specify component work tasks in such a manner as to reduce the need for high levels of co-ordination and collaboration amongst constituent firms in a project network, and by the absence of a single central co-ordinating actor who is charged with maintaining a complete up-to-date set of project documentation on an ongoing basis. Interestingly, despite the failure to use the Construct software, Project Tullow proved to be a very successful venture and was completed on time and within budget.

Project Tyne, on the other hand, provides interesting insights into the circumstances under which the implementation of such technology is likely to be more successful. Here we saw how the project manager was able, through the skilful use of the allocative and authoritative resources at his disposal, to successfully open us a space to accommodate the Project Web within the deeply institutionalised practices of the construction world. Although the implementation process was managed very skilfully by the manager in question, he capitalised on a much more hospitable institutional context than that which pertained in Tullow. Of particular importance, in this respect, was the scale of the project and the manner in which it was structured (particularly the fast-track approach and the Design Build governance structure), the high level of awareness of Project Webs within the broader UK construction industry, and the eminent strategic position of Kent within this sector. Not only did these factors make it much easier for Noel Armstrong to legitimise the use of Construct, but they also meant that he had meaningful and effective sanctions at his disposal to ensure that all involved with the project made the (not inconsequential) effort and investment required to successfully adopt the system.

The implementation process at Tyne closely resembled an improvisational model of change, as emergent benefits/ problems and opportunities to change work practices around the technology only became apparent as the process unfolded. Importantly, BuildNet were prepared to make alterations to the Construct software on an ongoing basis as issues and opportunities were identified in practice. As well as anticipated benefits of using the system such as the creation of one unified and accessible project document repository and comprehensive audit trails, important emergent benefits included a significant reduction in the time and effort associated with document distribution (central repository removed need for point-to-point distribution) and successful experimentation with the use of other Internet-based technologies to facilitate remote work and reduce travel requirements.

Overall, then, in this paper we have attempted to develop a more nuanced and critical understanding of the opportunities and difficulties associated with the use of Project Webs for organising construction projects. In particular, we have sounded a cautionary note by challenging the contention that such technology should be widely adopted within the construction sector. We have argued that the degree of institutionalisation of traditional work practices, the immaturity of IT infrastructure and skills, and the extent of the embeddedness of existing substitute media (such as telephone, fax, email and snail mail) may present a significant barrier to IS innovation in such a mature and, from an IT adoption point of view, relatively unsophisticated industry sector. Despite the claims of the software vendors, such systems may currently only have very limited applicability in the context of traditional small-scale, modular projects that lack a strong centralised authority structure.

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