LINKING PROCESS MAPPING AND TECHNOLOGY: A CASE STUDY OF TEAMWORK 2001

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There has been considerable interest in process modelling since the publication of the Egan Report as construction organisations seek to focus on core competencies and also to improve inter-organisational interfaces. Other studies have mapped available technologies and in particular the alignment of ICT's through the supply chain. This paper investigates the relationship that exists between the design/construction processes and the information technologies used to support them through a case study. It is suggested that the ability to position technology usage in the design/construction processes will enable more rigorous control to be exercised resulting in greater efficiency. The framework that has been used to position the technologies is the Process Protocol developed by Salford and Loughborough Universities. The case used in this paper is TeamWork, an educational initiative established to develop new working models for building procurement using the latest IT to simulate construction activities in a virtual environment. This mapping was shown to be useful in identifying gaps and overlaps in IT provision and also in specifying required IT support at different project phases. The use of the Process Protocol was found to form an appropriate frame of reference for this study.

Keywords: communication, information reuse, information technology, management information systems, process mapping, process protocol.

INTRODUCTION

Process and technology are two separate fields of study that are gravitating towards each other. This paper focuses on the processes and technology used in the early stages of the overall construction project process, to develop an understanding of the relationships that exist between the two. The benefits of understanding of this relationship are then discussed. These benefits would equally apply to the later stages in the construction project.

The reason for mapping the use of technology in the process is that technology can easily be identified as being used or not used, which makes positioning where you are in the process straightforward. Understanding the link between process and technology also helps the wider field of design management by identifying efficient technology enabled communication channels that can deal with the flow of information supplied by different design disciplines involved in engineering projects. The reverse is also true where non-technology enabled processes can be identified as areas of potential software development that can then be designed from the outset to integrate with the outputs from, or as the inputs to, other applications.

By having better technology-enabled communication we can develop a more structured understanding of the design information requirements of different

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disciplines making it easier to co-ordinate design activities that can occur concurrently. Linking technologies together could in the long run start influencing the process by managing design iterations through integrated software, and streamlining the creation and management of information required by different parties in the design and construction process.

BACKGROUND TO CASE STUDY

TeamWork is an educational initiative established to develop new working models for building procurement, their use of processes and technology over the LiveWeek has been used in the case study to explore the relationship that exists between the two. TeamWork uses the latest Information Technology to simulate all construction and operational activities in a virtual environment, allowing them "to build before they build, to occupy before they have built." (TeamWork, 2001). For TeamWork successful building procurement depends entirely on the communication between diverse design, construction and operational professionals. Information Technology has been used to date only to aid existing communication processes, but TeamWork aims to establish that Information Technology enables new processes and communication (TeamWork, 2001a).

The Process Protocol (Kagioglou, *et al.* (1998)) has been used as the framework within which the relation between process and technology has been explored. The Process Protocol is not the only process map that has been developed for the construction industry. Frameworks for the construction process have been mapped on numerous occasions and trying to get the one that works in all situations might be the philosopher's stone. But it was new developments in Business Process Re-engineering (BPR) and Information Technology combined with a different approach, based on an project team members viewpoint that have been considered in the Process Protocol which holds the potential for much wider market acceptance and use and why it was chosen as the process framework.

The background, concepts and the process itself are covered in Kagioglou, *et al.* (1999) and Kagioglou, *et al.* (1998). How IT can be an enabler of implementing the Process Protocol is described by Aouad, *et al.* (1999) and Aouad, *et al.* (1998).

TEAMWORK2001 LIVEWEEK PROCESSES

TeamWork2001 brought together a wide-ranging group of design and construction professionals to explore the potential of collaborative working. TeamWork2001's aim was to unlock the strengths of innovative IT through a short-term simulated building project and develop working processes that are swifter, more productive and truly cost-effective. (TeamWork, 2001b).

Alperton Community School, the clients for the TeamWork demonstration project, are located in north-west London, UK, currently occupies two sites - one the upper school, two the lower school. Working with TeamWork, they explored the potential of a sustainable new-build school on one of their two existing sites.

Meetings with the client determined their aspirations for an ideal school, from the perspective of both educators and students. This information, in combination with agreed schedules of accommodation, was presented to the project team on the Monday, the start of the LiveWeek. (TeamWork, 2001). It was agreed that the design and modelling exercise represented a theoretical, aspirational process rather than the generation of a design for comparison purposes.

To ensure the planned objectives and deliverables were reached by the end of the LiveWeek a considerable amount of time and effort was put into determining the design activities and process that the week would follow through and the IT that could be used to support these activities. This resulted in a process map that was agreed to by the TeamWork directors, which was based on the Process Protocol map, with certain elements, stripped out for simplicity (see Figure 1 for high-level map, more detailed maps were available for each activity).

Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
Undertake Feasibility Study for Each Option	Perpare Concept Design	Perpare Outline Concept Design	Perpare Full Concept Design	Perpare Detailed Design	Finalise Produce Model
Legacy Archive					

Figure 1: Elements of the Process Protocol covered during the LiveWeek

TEAMWORK2001 TECHNOLOGY USAGE

Over the LiveWeek in June 2001 as the team progressed though the different stages of the project their use of technology was captured and logged. This then allowed a representation of technology used over the LiveWeek (see Figure 2) to be produced.

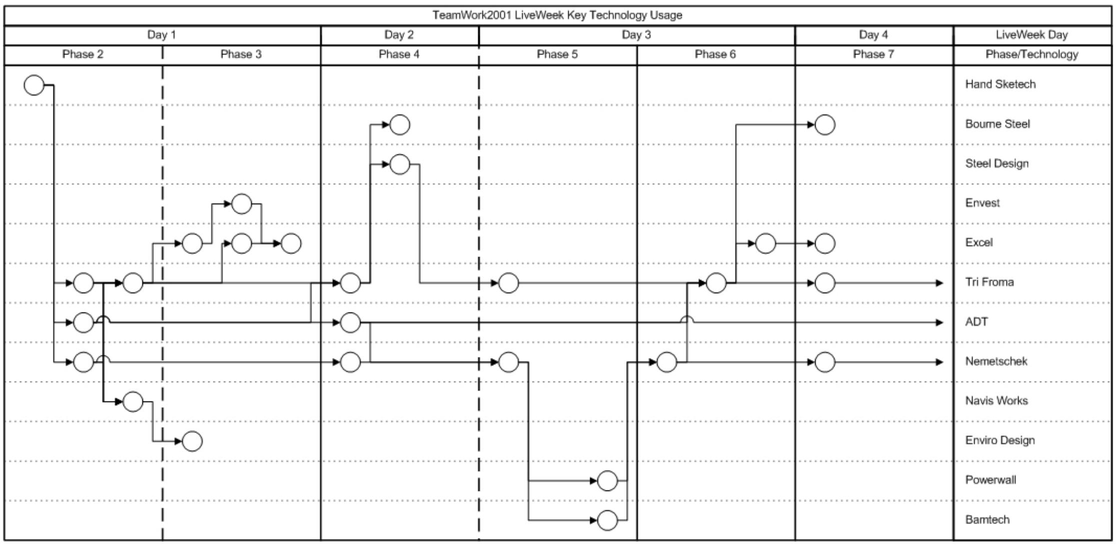

Figure 2: TeamWork2001 (Key) Technology Map

Note: that in the TeamWork technology map all the CAD modelling was done in 3D.

One of the first technology exchanges to occur was with the BRE Envest application that was used to help the client make an informed decision about the environmental impact of the different block massing models presented as possible solutions to their needs. What is of interest is that the TeamWork members had developed code that converted the output from one of the CAD Modelling platforms to be the input to the Envest application with minor manual modifications required. The final result gave a comparative analysis for the three proposed site layout solutions to the clients brief but due to the simplification of data on import, the result may not have been as precise as if the data had been input by hand. Even with the manual user intervention, it was a very rapid way of getting the dimensional and orientation information into Envest without having to measure from paper drawings.

A more familiar and tested interaction between different technologies was between the modelling and structural design software technologies, where un-sized members were passed to the design software so that a number of options could be explored and tested before the chosen sized members were passed back to the modelling technology adding an extra level of detail.

By being able to link applications together ensured that everyone was supplied with the information they require to carry out their element of work. Bringing it all together in a single model helped ensure an optimised and coordinated solution was delivered to the client, which had been clash detected to avoid unnecessary problems on site.

Information reuse was probably one of the main reasons that allowed the breadth and depth of work covered during the week to be achieved. It should also be noted that nearly all the information was exchanged electronically (evidenced by there only being one A4 ink jet printer available at the event).

One problem that was encountered and which is a real area for future software development was the work done costing the building model. During the week attempts were made to integrate cost modellers spreadsheets with information directly taken from the CAD modelling systems. Although the team did not achieve as much as was planned, it has enabled the interface between the model and its cost attributes to be explored. This demonstrated that a considerable amount of additional development is required to put protocols in place to assist with the effective management of the data sets.

Other areas of technology integration that occurred later in the process was with a number of supply chains reusing the design information resulting in three small pieces of material being supplied at the end of the event:

- Hy-Ten (Hy-Ten (2002)) reinforcement suppliers produced a small piece of rolled mat reinforcement that was designed and manufactured based on the outputs of the BAMTEC (BAMTEC (2002)) slab reinforcement design software.
- Powerwall (Powerwall (2002)) produced a small piece of cladding with an opening for a steel member that was designed and detailed using the output of the 3D model as the input to their design and manufacturing software.
- Bourne Steel (Bourne Steel (2002)) produced a pin joint member, the details of which were given to them direct from the 3D model.

Designers and Steel Fabricators exchanging steel frame models is not new. The TeamWork event was the opportunity to further explore new information sources that can be shared and how these information sources can be used. The information identified for testing was that contained in the steel fabricators' manufacturing scheduling software. What was tested was the ability to place fabrication details directly on to their system and to later change the detail of the order based on it not yet being manufactured. Although the demonstration only undertook to change one item, it is a vital step towards extending such functionality to all members of a steel structure. Such steps allow us an understanding of the process of changing an order remotely and how such a system would work in practice. Tests that are more extensive will be needed before a full model can be used.

INTERPRETATION OF PROCESS ISSUES

The Process Protocol is a framework for the life cycle of construction projects that has addressed many of the issues set out in the Latham (1994) and Egan (1998) reports.

For the Process Protocol to be adopted it is important that the different processes are mapped, understood and incorporated into quality procedures and contractual agreements. The literature consulted saw little evidence of this being addressed. Nonetheless, the technologies, which it highlights, have no barriers to being accepted and incorporated by the construction industry. IT and IS therefore appear to be the stepping-stones for the adoptions of the Process Protocol.

The Process Protocol is an enabler for BPR. Figure 3 illustrates the possible adoption life cycle of the Process Protocol and the importance of IT/IS, QA and Knowledge Management (KM) based on the proposed entry point into the system.

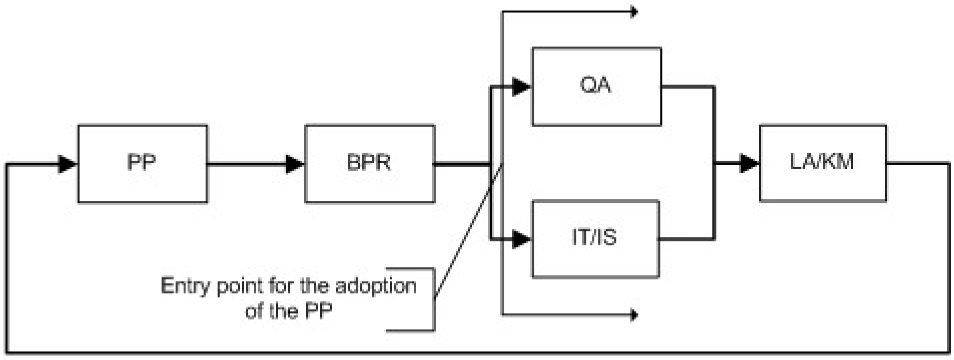

Figure 3: The Process Protocol market adoption life cycle

In the TeamWork case, there is a good correlation between design phases/activities and the Process Protocol high-level activities, as these were the starting point (see Figure 1), in the planning of the design activities for the LiveWeek.

One of the uses of the process maps were to communicate to the users who they need to interact with and what effect their decisions have on the overall project. This understanding would then allow them to identify unnecessary design iterations and bottlenecks and establish how to remove them. The real problem encountered during the LiveWeek with process map was the inability of team members to position themselves in the process. This therefore meant that it was quite difficult to manage the process.

Even though experienced team members have an ability to intuitively know what activities follow on from each other and the different people they need to interact with at different stages of the project they still find it difficult to determine where they are in the process. The idea of managing the process is brought out in the Process Protocol but until people can easily and accurately position themselves in the process, this idea will be very difficult to achieve. Being able to manage the process is of vital importance in managing design changes and understanding the implication of these changes on the overall project.

INTERPRETATION OF TECHNOLOGY ISSUES

The reliance upon and use of technology illustrated in Figure 2 demonstrates the links that can possibly be made between process and technology. Whilst certain technology used can be linked to a specific point in the process, it is important to note that this only applies to a limited number of technologies as most are used through many or all phases of the project. Only the technologies used at specific points in the process like Powerwall and BAMTEC can be used as process markers. These could be referred to as plug in technology, whilst the remainder can be referred to as core technology respectively.

By differentiating between core and plug in technology we can start to use the plug in technology as a process marker. Also we can start to establish a precise schedule of information requirements for these design activities that will help reduce the number of assumptions needing to be made.

What was achieved in the short space of time in the LiveWeek demonstrates what can potentially be achieved through the development and use of interfaces between different software applications even though significant progress still needs to be made before we can have a fully integrated model. But by bringing experts together at these technology interfaces allows them to start to understand the other parties' information technology requirements and find solutions. The working relationship that existed between a number of the different team members facilitated this.

Using the Process Protocol as a framework within which technology usage can be positioned, will allow a more structured approach to be taken with regards to the work that is being done and that needs to be done, by highlighting gaps in technology, and links that if created would improve the process. This would also reduce the potential for technology vendors producing application, which they then need to find a purpose for, which was one of the points that was raised during the LiveWeek. This technology process map will also allow users to communicate with vendors their design process information needs.

CONCLUSION

There a number of ways in which using the relationship between technology and process can help the overall design management process that have been identified in the case study.

During the LiveWeek it was difficult to get people to explicitly position themselves on the process maps, however one thing they could easily tell you was what computer package they were using and what they were doing with it. Subsequent analysis/interpretation shows more closely the different design activities in relation to the process. However, such difficulty needs to be removed so that more efficient management of the design process can occur through policing of the processes by process /design managers and project team members themselves. If we can position all the different technologies in the design process map then non-process aware project participants stand more chance of positioning themselves in the process.

Design technology can be considered as the tools used by project team members in the design process. Certain tools will be used at different stages of the design process. This is similar to the ability to monitor construction progress on site through the different items of machinery that are on site like the presence of piling rigs, erection of the tower crane, demobilisation of the piling rig and mobilisation of ground works all representing different stages of the construction project.

As well as helping us position ourselves in the process through associating certain technological applications with certain phases of the project, the technology map that is produced will help us understand the different technology interfaces that currently exist and new ones which if created would improve the process by seamlessly integrating key technology interfaces. The process and technology map will also discourage technology vendors producing technological applications, which they then need to find a purpose for by clearly highlighting technological gaps and the process that need to be fulfilled by a new application.

This understanding can reduce the number of design iterations. By supplying the correct information at the correct time this will reduce the amount of rework, improve the quality and reduce the overall cost of the project.

The TeamWork interoperability team tried to develop an interface between the 3D CAD technology (core technology) and environmental assessment application (Envest (plug in tech)). This idea of outputs on one package being the input to the next application leads to greater efficiency in the process where any changes can simply be reran.

Reducing the amount of rework should allow engineers to spend more time on doing the work at hand right the first time knowing that they will only have to do the work once. This should ensure that fewer errors creep in.

As part of the ongoing research, the development of the map and addition of further detail with regards to the value of the processes being completed will allow better business cases to be put forward for the development of new applications or interfaces between applications based on the value chain that can be created.

In the future technology becoming more integrated could lead to the situation where certain design activities become controls on the overall design process rather than design activities in their own right due to the speed in which they can be undertaken.

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