INNOVATIVE USE OF CONSTRUCTION PROJECT EXTRANETS TO FACILITATE PROJECT COLLABORATION AND MANAGEMENT

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ABSTRACT

In today’s world people can work independently for a shared purpose across space, time, and organizational boundaries with the help of Information Technology (IT). Working with a wide diversity of knowledge and skills from all over the world brings a broad range of viewpoints and expertise to the construction projects. With the assistance of “Construction Project Extranets” (CPEs), construction project teams become more flexible, adaptive and competitive by improving their performance and get more efficient. In addition, the project time cycle can be reduced, as the information flow became faster and continuous communication is established with accurate data. This technology is an innovative approach to collaboration and project management and it is being used by the industry more commonly an increasing speed in the past few years.

However, despite all the benefits and opportunities that CPEs provide, the adoption rates are still not very sufficient. To understand CPE implementation and operation issues, three construction projects, which utilized CPE technology as a sole source for management, were studied. The paper provides an updated overview of current implementation practices, factors associated with successful adoption, the opportunities these tools promise to the project stakeholders, latest innovative approaches/uses and last but not least; the improvement areas.

Keywords: Communication, Collaboration, Extranets, Information Technology and Virtual Teams

INTRODUCTION

The AEC industry has very distinctive characteristics such as fragmented organizations, the uniqueness of each project, relatively short period of production, outdoor and unstructured working conditions, and labor-intensive activities. Successful completion of construction projects requires communication and collaboration of numerous multidisciplinary and sometimes geographically separated team members. With the latest developments in Information Technology (IT) and increased competition in the industry, AEC organizations have faced with many new challenges including the need to: change current work practices; become more client orientated; more competitive as well as productive.

Continuous and accurate formal/informal communication among project participants is the key to resolve conflicts, keep the project on time, on budget, speed up solutions, and to share knowledge for coordinating these efforts. Better information sharing between disciplines and the automation tools can ensure large improvements in the efficiency, productivity and quality of the AEC industry. (Howell, 1996) However, the AEC industry is making insufficient use of transferring project data and information electronically. (Love, 1996) On the other hand, the rapid advances of
Construction Project Extranet (CPE) technology offer new opportunities to improve existing construction project communication and enhance the collaboration. By CPEs, project communication and team collaboration can occur in a controlled, timely and less costly manner than would traditionally be the case; the information leakage is kept to an absolute minimum; and all members of the project team are in possession of the most up-to-date and accurate project information. (Weippert, 2002)

CONSTRUCTION PROJECT EXTRANETS

In this paper, the term “Construction Project Extranet” is used to define any number of web-based and web-enabled technologies, which offer communication platforms, project management functionalities and hosted collaboration spaces for capital AEC projects. This technology allows members of a project team to access it directly through their Internet browsers, with limited if any downloaded plug-ins. In these configurations, information generated by project team members is automatically saved for permission-based access by other project team members. Although business models vary among CPE providers, these services are typically leased for either a periodic and/or per-user fee. CPE technology is being used for facilitating team communication, managing and storing documents, controlling workflows and automating construction processes. These tools enable project participants to send, record, store, share, receive, monitor, and manage correspondence, Request for Information (RFI), drawings, specifications and other documents involved in the design and construction processes.

METHODOLOGY & DATA COLLECTION

The aim of the research is to explore the implementation and usage of CPEs in real life context, evaluate the benefits (if any), and identify improvement areas as well as innovative solutions developed by the vendors or project teams for faster adoption. This research has been supported by General Services Administration’s (GSA) Public Buildings Service (PBS), which is the world’s largest landlord of the civilian federal government, (General Services Agency, 2004) and by Harvard University. To accomplish research goals, three GSA construction projects have been studied. GSA helped to identify three construction projects to get in-depth analysis of implementation and usage of CPE technologies, provided access to the project information and also helped to contact the projects’ participants. The case studies in this research focus on details and descriptions to examine the conditions, why and how the decisions were made, and what the obstacles and their consequences were.

Structured phone interviews, which each lasted approximately one hour, were conducted with the projects’ team members. The information requested was straightforward and didn’t involve sensitive material, so potential bias was low. Prior to the interviews, requests were sent to the Project Managers and the administrators of the CPEs to find the most suitable group as respondents. The author was careful to interview at least one team member from major participant stakeholders with various roles. Construction Managers (CM), General Contractors (GC), Project Managers (PM), Architect/Engineers (AE), and the owners were among the interviewees. The interviews deepened the author’s understanding of the step-by-step logic of a situation as it occurred, the interviewee’s experience with the tools, the lessons learned in the project and the users’ opinions for improvements areas.
CASE STUDIES

Three case studies were studied for the purpose of this study. Professionals who are at the cutting edge in the use of IT were interviewed and the findings were summarized. Each case study focuses on new construction with traditional project delivery method (design-bid-build) but they all have different scopes. All of the projects were managed by CM agencies acting as GSA’s representatives. Each case study is ten to twelve pages long and structured with the following sections: (1) Introduction: Design Features, Project Team Structuring, (2) Construction Project Extranets: Design Phase, Construction Phase, Selection of the Tool, Implementation and Usage of the Tool, Benefits, Improvement Areas, and (3) Conclusion. A brief summary of each case study is provided below with its title. For confidentiality reasons, the names of the interviewees and the CPE products implemented weren’t included in this research paper.

The case studies cover implementation and operation of CPE tools both in the design and construction phases. For each case study, several project participants were interviewed in order to learn about the project, specific issues and also to get different opinions about the benefits and bottlenecks of the tools. A common challenge for the project teams was working with a number of team members from different disciplines that are geographically distributed. The CPE solutions utilized in the construction phases of Miami Federal Courthouse Project and World War II Memorial Project were both web-enabled whereas the rest of the CPEs were web-based. A brief outline of the case studies’ statistics about the size, cost and design & construction periods is provided below. (Table 1) The following subsections provide a brief overview of each case study and the CPEs implemented.

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Location</th>
<th>Design &amp; Construction Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Miami</td>
<td>08/’98 ~ 12/’02</td>
</tr>
<tr>
<td>02</td>
<td>Suitland</td>
<td>06/’98 ~ 11/’02</td>
</tr>
<tr>
<td>03</td>
<td>Washington, DC</td>
<td>08/’01 ~ 04/’04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Location</th>
<th>Size (sq. ft.)</th>
<th>Construction Cost ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Miami</td>
<td>208,271</td>
<td>129</td>
</tr>
<tr>
<td>02</td>
<td>Suitland</td>
<td>322,345</td>
<td>72</td>
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<tr>
<td>03</td>
<td>Washington, DC</td>
<td>577,784</td>
<td>125</td>
</tr>
</tbody>
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Table 1: The project size, period and the cost

This paper is submitted to be presented at the AEC2005, 3rd International Conference on Innovation in Architecture, Engineering and Management, 15-17 June 2005, Rotterdam
Case 01: Miami Federal Courthouse Project
ARQ and HOK collaborated on design, provided architecture, interior design and landscape services for the Miami Federal Courthouse Project, which is a 14 floor post-tensioned concrete structure comprising approximately 577,000 gross square feet including 110 secure interior parking decks. The space includes 14 District Courtrooms and 2 shelled courtroom areas. Upon completion, the new courthouse will host the U.S District Court and Clerk of Court, Court Administration, U.S. Marshals Service, U.S. Attorneys office, U.S. Probation office, Federal Public Defender and supporting space for these functions. GSA manages the project from their Atlanta office, where EllisDon provides CM services in Florida and Dick Corporation from Pittsburgh participates to the project as GC firm. (Figure 1) The project team implemented a CPE solution in the design phase however there has never been a complete buy-in therefore, the team abandoned the tool soon after implementation. As implementation of a CPE solution was a requirement of GSA in EllisDon’s contract, EllisDon has introduced its corporate wide CPE solution to the project. With the leadership of EllisDon, the team had successfully implemented and accepted the tool in order to facilitate communication and document exchange as well as project management.

Figure 1: Miami Federal Courthouse rendering and team members’ locations

Case 02: NOAA Satellite Operation Facility Project
National Oceanic and Atmospheric Administration (NOAA) Satellite Operations Facility is a new special purpose computer facility with an area of 208,271 square feet and total cost of US $62 million. GSA’s Public Buildings Services (PBS) department is responsible for overall project management of the new center, which will combine an innovative design with state-of-the-art technology. As a result of a design competition, Morphosis and Einhorn Yafee & Prescott (EYP) joint venture has been selected for the design services. The construction contract was awarded to PJ Dick Incorporated, which is based outside Pittsburgh. As a result of the competitive bid, 3D/International was chosen as construction phase CM. NOAA project team decided to use CPE technology at the planning phase to increase team productivity and decrease the inefficiencies of traditional team communication and collaboration. This project has been an excellent fit for online collaboration for the joint venture architecture firms as the design architect, Morphosis, is based in California and the architect of record & engineering firm, EYP located in Washington, DC. (Figure 2) The team decided to shift to another product for the construction phase simply because they believed planning/design phase-CPE wasn’t sufficient enough to support construction.

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activities. With the strong support of PM and the GSA’s requirement in the contract, the team utilized another CPE for the construction phase and observed great productivity gains and better project outcomes. NOAA project team was not only willing to use it but also understood the necessity of CPEs.

Figure 2: NOAA Satellite Operation Facility rendering and team members’ locations

Case 03: World War II Memorial Project
National World War II Memorial is the first National Memorial to be dedicated to all who served in the American Armed Forces during the World War II. The design submitted by Friedrich St. Florian, based in Providence, was selected as one of six semi-finalists in an open national competition. Leo A Daly, an international architecture firm located in Washington DC, assembled the winning team with St. Florian as the design architect. (Figure 3) GSA provided overall project management responsibilities from design & construction excellence to project completion and acting on behalf of the American Battle Monuments Commission (ABMC) for this US $72 million project. GSA awarded the construction contract to the joint venture of Tompkins Builders and Grunley-Walsh Construction. Gilbane Company of Pittsburgh was selected through best value selection as CM agency in the pre-design phase. As PM of the design phase realized CPE technology as a quicker way to communicate and better way to collaborate, the team started to use a CPE solution starting from this stage. Given the number of the participants and the size of the project, CPE tool was used mostly by the A/E firm to coordinate with its nine consultants all around the country from Boston to California for this highly visible and important project. The product gave the firm the flexibility to schedule their work on their other projects since they knew that the technology was stable, they could easily distribute the number of documents (AutoCAD files, specifications, project team list, meeting minutes, daily reports, etc), and also coordinate the design effort easily across geographic distances. With the start of the construction phase, the team decided to change the CPE product as new parties were joining the team and design phase CPE was not satisfactory enough to support construction processes. However, the usage of the tool stayed very limited and the team has not utilized most of the modules mostly due to lack of management support and motivation.

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CPE RELATED ISSUES

CPE technology holds a great promise, however it needs improvements and its implementation has to be handled very carefully. This technology is surely bound to replace “old economy ways”, but only if the tools can adequately fulfill the specific needs of building designers, constructors, owners, managers, and suppliers. (Callaghan, 2002) The future is inevitable, but slow at the same time. The following two sections cover issues related to the implementation and usage of CPE tools in these three construction projects. Success factors, benefits, innovations, and improvement areas have been identified based on the formal and informal interviews with the project stakeholders are listed in the following subsections.

Success Factors:

(1) **Champion:** In order to have a successful implementation and complete team buy-in, management support and presence of a champion is the most important factor. It has been observed from the case studies that the biggest challenges of implementation: people’s mindsets, and the way the work has traditionally done, have been overcome by strong support of a champion, usually the project manager. Project Managers have to work closely with the teams, attend regularly to the team meetings and be the point of contact when needed. Project teams have to pay extra attention to find out solutions to problems similar to the traditional project management problem solution methods. Success starts from the top to down. Therefore, having a pro-extranet project manager, who is very technology savvy, understands the necessity to use this technology, and what the tool is offering for this project is extremely important.

(2) **Responsiveness of the Technology Provider:** At the early stages of the implementation, quick response of the technology provider to the implementation/technology related problems is crucial. Specially, Miami Federal Courthouse Project team benefited from quick comeback and fast solutions of CPE vendor. The vendor answered the questions and solved technical problems in an early matter. The vendor also developed additional functionalities as the team demanded such as the deficiencies module. System engineers of the CPE providers have been updating their system continuously according to the feedbacks and suggestions they got from the Miami Federal Courthouse Project team members. Having customer support for extended hours and quick
turnaround time for the directed questions has been very important in all of the cases to avoid frustrations and easy adoption of the CPE solution.

**Benefits**

1. **Virtual Collaboration**: One of the biggest advantages of CPE tools is enabling working remotely. Project participants can work from hotel or home and still be connected to the team. Project teams or sub-teams in the case studies were pretty much distributed and were still able to communicate and collaborate efficiently. The tool helped the teams to save time and money on travel as well as overnight shipments. Team members mentioned that the number of the site visits has been tremendously decreased. For example, CPE was used mostly by the A/E firm in World War II Memorial Project to coordinate with its nine consultants all around the country from Boston to California. The product gave the firm the flexibility to schedule their work on their other projects since they knew that the technology was stable, they could easily distribute the documents (AutoCAD files, specifications, project team list, meeting minutes, daily reports, etc), and also they were able to coordinate the design effort easily across geographic distances. The A/E firm as well as all the consultants found the tool excellent for improving project communications and enhancing the team productivity.

2. **Audit Trail**: The interviewees mentioned that enabling project members with access to the same unchangeable record provided a complete audit trail of project communications. Unexpected surprises and claims were avoided by having a reliable record of who said what and when. This reduced the concerns and enhanced the trust between the project team members. The information was never lost and always available. There has been no doubt that it is modified or deleted, which strengthened the trust in the project teams.

3. **Information Availability**: Project teams started to use CPEs to get rid of the inefficiencies of traditional (paper based) collaboration and project management. The design, which is very decision intensive with no limit in study and redesign, changes very fast in the conceptual design phase. Therefore project teams wanted to avoid problems related to having the most updated version and being able to reach it. The tools provided a very good way to upload and accurately keep track of the documents as every document was stored at the same place and was available to everybody immediately. This reduced the concerns such as somebody loosing meeting minutes. The information did never get lost; participants could always see what is uploaded when. The tools kept track of all of the documentation and communication, submittals, RFIs, directives from the owner at one place, which made accessibility easier and more convenient.

4. **Speed and Automation**: The teams mentioned that CPEs helped them to reduce the cycle times of RFIs and Change Orders, which in return helped them to fasten the overall project schedule. Most interviewees indicated that having access to information electronically and having electronic history of the project is the biggest innovation. For example, RFIs may have multiple attachments, which can be sketches, drawings. Each one of the RFI is numerically listed in the system so that somebody can click on and get all the attachments simultaneously. When a question arrives, if a participant wants to look at the floor plan he/she can go and look at the document section and can see the floor plan simultaneously. When a question arrives, if a participant wants to look at the floor plan he/she can go and look at the document section and can see the floor plan simultaneously. Another example given by one of the NOAA Satellite Operation Facility Project team member is ease of sharing/transferring documents. For example to review the shop drawings, they just looked at scanned drawings, printed them, (if needed), added red marks in Adobe Acrobat with questions and posted it to CPE. This reduced tremendous amount of time needed for the reviews, as they didn’t need to wait for overnight delivery of the drawings.
Innovation
(1) Coordination with tenants: Miami Federal Courthouse Project used the CPE to coordinate with their 14 tenants. There has been at least one representative from each tenant agency that has access to the database with provided user names and passwords in order to log-in and check any document issued to them. Each tenant had access to their portion of the budget whereas GSA can monitor the overall budget and contingency. This function has provided a good way of keeping all of the tenants informed about the budget and the contingency without showing them the whole project information. Also tenants were very satisfied with this application as this was the first time that most of the tenants witnessed how their budget has been managed. They were also able to monitor their “change order status” immediately.

(2) Capturing emails and faxes: One of the CPE providers developed a system that captures all documents sent via fax and email by unconnected subcontractors and consultants. A “project email address” provided to the team members. When the user added this email address to his/her email, the correspondence was added to the database automatically with its attachments. Similar to the project email address, 1-800 fax number, provided by the CPE vendor, served the same purpose. The faxes were converted to Adobe Acrobat documents automatically and saved to the project database.

(3) Talking databases: Interconnected databases have been developed for one of the projects as a result of CM-GC relationship as both companies wanted to maintain their own databases. This system enabled the parties to access each other’s databases up to certain permission levels. For example whenever CM sent a letter to GC, it was populated in both databases. As a result double inputting was prevented and a complete project record in both databases was achieved. This innovation works perfect when companies don’t prefer to have one common database because there is always some private information neither of the companies would like to share.

(4) Contract Requirement: Another innovative act that fastened the adoption of the tool was GSA’s requirement in all of their contracts that CPE technology is going to be the way to facilitate communication, collaboration and project management. According to this requirement, the owner would provide the system and the participants would use it. The cost of the tool was included A/E firm’s fee in the design phase and in CM firm’s fee for the construction phase. GSA prescribed which tool exactly would be used and also priced it based on GSA pricing without any mark ups. GSA also made it very clear that they were purchasing these tools for GSA use therefore GSA would be the administrator of the sites, handle all the information and at the project completion GSA would own all project data.

Improvement Areas
(1) Ease of Use: Some of the interviewees indicated that they had hard time using the CPE tool implemented because they found the tool user-unfriendly and difficult to learn. Unfortunately, some of the solutions didn’t have the power and the sophistication to accomplish day-to-day communication.

(2) Bandwidth and unconnected parties: In general the speed of connection is pretty well and the processing time is usually acceptable. However, connecting to the system gets very difficult during heavy usage. For example, during weekends someone can upload documents very easily and fairly quickly whereas during heavy usage time when there are multiple people uploading documents or accessing the CPE, it can get slower. There have been some cases; the contractor couldn’t attach sketches or documents because the system has been slow. Besides bandwidth problem, downstream parties such as subcontractors and sub-consultants are still not electronically connected. The whole industry’s mindset is still on paper, which becomes the main
challenge. Solution to this problem might be finding a way to capture paper documents or mandating electronic submissions and electronic document management.

(3) **Flexibility**: Construction projects are usually unique, complex, custom-built responses to specific clients’ interests. AEC organization is based on “temporary networks” of architects, engineers and contractors forming and reforming into corporative groups for each project. Therefore, CPEs should be flexible enough to align with different structures of project teams, project types and delivery methods. For example, in all of the case studies GSA hired a CM to act as the owner’s representative, supervise/inspect the GC and oversee several consultants. In this team structure, almost all communication and document flow had to go through the CM. However, most of the available tools were built according to a traditional delivery system that the A/E and GC communicate directly. Moreover, the tools were very rigid and didn’t allow the team to modify the modules to accommodate their needs. In the end, either the teams found a custom-built solution, which was unpractical, difficult to use, and the cause of many delays and frustrations, or they stop using the modules.

(4) **Project Life Cycle Support**: Construction projects are subject to the influence of highly variable and sometimes unpredictable factors. During specific phases, coordination and collaboration may be required in different levels. Participating organizations and the tasks they perform may vary during the project phases while the shared information should be kept stable throughout the life cycle of the project. Managing construction projects is an interdisciplinary art requiring professional skills to achieve the maximum performance. Therefore, CPEs should be developed to satisfy needs and desires of the project participants. It has been observed from all of the case studies that there were no tools that would fulfill all stages of the construction projects. Today there are some CPEs that focus efficiently on workflow and process automation during the construction phase, and there are other CPEs tools that are very good at enabling team communication and document management. Not having one product that fulfills all stages of the construction projects forced teams to shift to another product, which resulted in knowledge, time and money lost due to data re-entry, learning curves, and productivity loss. These tools should support the project team during all phases of projects with variable and flexible modules.

(5) **Mindsets**: It seems like not all of the implementation problems were not due to technical problems but due to more organizational and cultural issues. Most of the users think that the tool is effective but only as effective as the people that are using it. Sometimes having a piece of paper on somebody’s desk constantly reminds him/her that he/she needs to take care of it. This may make people act in a more slow-manner. Also the fact that they have to go to several folders to access for reviewing might make people more reluctant. The most important factor for these tools to be more successful is to change the mindsets and overcoming the organizational barriers.

**CONCLUSION**

The future is inevitable and bright. CPE technology gives project teams an opportunity to form a collaboration platform for continuous and accurate communication, immediate access to the project information, and provides a central communication and project management interface with all information stored in a virtual project space. The goal is to have better communication, more comprehensible documentation and optimal control regardless of the location through fast and accurate information flow, secure document availability, and continuous reporting. CPE technology makes all the information available to everyone at the same time, increases accessibility and improves the communication lines between the parties. Most agree that these
tools are useful for project management and helpful for project success. Interviewees participating to this research stated that they are now more likely to recommend using CPEs in the future based on their experience in their project. However, the team members also agree that CPEs are in their baby steps. They have to be re-developed in such a way that the interface is not complex but intuitive. The tools also need to have different set-ups and functions to fulfill the needs of different project types, teams & delivery methods. Customizability and flexibility is among one of the important issues of development of CPEs.

ACKNOWLEDGEMENTS

The author wishes to thank PMs as well as team members of Miami Federal Courthouse, NOAA Satellite Facility, and National World War II Memorial projects. The author also would like to thank to all of the interviewees, without whom these case studies would not have been possible. The author gratefully acknowledges US General Services Administration and head of Project Knowledge Center, Stephen Hagan, and implementation assistant, Mark Ilich, for their enormous assistance.

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