ABSTRACT

BIM (Building Information Modeling), cloud computing, and social media are disruptive technologies which are altering the basic foundations of the AECOO sector (Architecture, Engineering, Construction, Owners, and Operations). Unproductive ad hoc processes traditionally associated with the design, construction and management of the built environment are being replaced by robust life-cycle management and efficient project delivery methods. While notoriously unproductive and somewhat technology adverse, the AECOO sector is undergoing a culture shift in response to the demands of increasingly altered global competitive and environment landscapes, and the empowerment of transparency and collaboration enabled by social media technologies.

Keywords: BIM, cloud computing, integrated project delivery, disruptive technology, collaboration, social media, strategy, life-cycle facility management, IPD, JOC, job order contracting, efficient construction project delivery.

1. INTRODUCTION

Accurate, efficient, timely, and transparent cost estimating and project management is critical to the success of any renovation, repair, sustainability, or new construction project. While historically the construction sector has suffered a decline in productivity it can be argued that multiple factors are converging to alter this trend. In order for this to occur, however, a major cultural shift must occur. A fundamental change in how day-to-day business is conducted during all phases of the life-cycle of a built structure. This paper focuses specifically on the current and potential impacts of construction delivery methods, cloud computing/social media, and Building Information Modeling (BIM).

2. CONVERGENCE - PROCESS, CLOUD COMPUTING/SOCIAL MEDIA, & BIM

2.1 PROCESS – Construction Delivery Methods

There is a great deal of prior work addressing the shortfalls of the Architecture, Engineering, Construction, Operations, and Owner sector (AECOO). The adversarial aspects of the traditional design-bid-build (DBB) and the lack of robust business process supported by digital technology have been especially well documented.

The construction delivery method plays a significant role in setting the tone of any renovation, repair, sustainability, or new construction project and its eventual success or failure. The latter being simply defined as the Owner/Client/Building User getting what they initial had anticipated on-time and on-budget and the associated “constructors” successfully delivery the project with a reasonable profit margin. The importance of collaboration among all stakeholders as a prerequisite to “success” is equally well documented. Collaborative construction delivery methods are not new, though are only recently
beginning to enjoy accelerated usage. Most notable example of robust collaborative and efficient construction delivery methods include integrated project delivery (IPD) for new construction, and job order contracting (JOC) for renovation, repair, sustainability, and minor new construction. Both methods have existing for decades and promise greater efficiencies, however, both are somewhat contrary to traditional DBB. For comparison purposes let’s take a look at the characteristics and/or components of JOC program in comparison to traditional methods. Job Order Contracting includes:

1. Qualifications Based or Best Value Selection
2. Some form of pricing transparency- Typically a Unit Price Book (UPB) containing preset unit prices for construction tasks. [Note: Most JOC programs leverage a standardized third party cost book such as RS Means Cost Data.]
3. Early and ongoing information-sharing among project stakeholders
4. Performance-based structure - Some form of financial incentive to drive performance
5. Appropriate distribution of risk
6. A long term relationship (3-5 years) between Owner and Contractor/AE
7. Standard specifications established in a master contract with a summary of work, also including any specific or client-driven conditions.
8. Facility owner issues a request for qualifications (RFQ), evaluating firms using best-value, performance-based criteria, or an invitation to bid awarding to the lowest responsive and responsible bidder.
9. A guarantee of minimum amount of work for the contractor. This is usually a small amount for consideration – a requirement in most states for contracts.
10. Issuance of contractor’s work orders based on owner’s requirements.
11. Costs for individual work orders are calculated by multiplying the preset unit prices by the quantities multiplied by the contractor’s coefficient.
12. Open communication between facilities team and the contracting/AE team, including a kick-off partnering session between everyone utilizing the contract.

Advantages typically associated with JOC - Job Order Contracting Program include;

1. Fast and timely delivery of projects.
2. Low overhead cost of construction procurement and delivery.
4. Virtual elimination of legal disputes.
5. Reduction of change orders.
6. Transparency - standard pricing and specification utilizing a published unit price book (UPB)

The following graphics demonstrates how the above varies from traditional construction delivery methods (Figure 1), and a typical JOC Process (Figure 2).
Figure 1: Traditional vs. Integrated Project Delivery (4Clicks Solutions, LLC 2012)

Figure 2: Job Order Contracting – JOC Process
(4Clicks Solutions, LLC 2012)
2.1 TECHNOLOGY/SOCIAL MEDIA

The historical of cloud computing upon social and business behaviors are demonstrated by instances ranging from the recent politics in Egypt, to Amazon.com, Google, and FACEBOOK. The rapid shift from Web 2.0 to Web 3.0 may catch many by surprise; however, the evolution of the Internet/WWW to virtually “free” and unlimited intelligent and automatic computing resources will transform the fundamental way business is done in the AECOO sector.

An AECOO technology timeline is shown in Figure 3. Most construction cost estimating and project delivery continues to rely primarily upon hardcopy documents and electronic spreadsheets such as Microsoft Excel™, with relatively small percentage using dedicated commercial off the shelf (COTS) or custom software programs and relational database technology. While both spreadsheets and “traditional” software architectures have merit and are well suited for certain types of users they are not optimal for multi-user and/or larger projects. Non-trivial issues such as security, audit trails, data hierarchy, and flexibility limited the cost effective deployment and use of truly collaborative tools.

Let’s take a deeper looks at a specific cloud computing and associated innovations by way of an example. Spreadsheets have been in use for a considerable length of time within the AECOO sector. With the advent of microcomputers, spreadsheets became electronic and more user friendly than early paper spreadsheets. Electronic spreadsheets were an improvement over the first paper versions, in part, because of the ease of making entries, revising entries, performing calculations, sorting, etc. As a result, the time for the user was reduced for using the spreadsheet. Because calculations were performed by a computer, rather than by hand, electronic spreadsheets also reduced errors, which were attributed to input errors rather than calculation errors. As a result, electronic spreadsheets became a powerful tool for cost estimating, organizing data, and managing various AECOO tasks. As noted, spreadsheets remain the
number one tool used by cost estimators and construction project managers. However, spreadsheet
technology has not kept pace with the need to collaborate and share information. As spreadsheets
became more complex it was equally more difficult and costly to manage changes within cells and
formulas. Furthermore the concept of information hierarchy, the ability to automatically roll-up data
across multiple spreadsheets from multiple locations at will was simply not available. Multiple users
simultaneously working on copies of the same spreadsheet result in changes that are at best difficult to
track. Users must manually keep track of, and merge, the changes themselves. Web-based spreadsheets
currently available (e.g., GOOGLE ® Docs Spreadsheet, MICROSOFT EXCEL ®) offer limited multi-
user capability, however, current web-based spreadsheets have, for the most part, simply replaced the
hard drive or network storage available to a traditional electronic spreadsheet with internet based storage.
Connecting a spreadsheet to non-spreadsheet data and enforcing a multi-level hierarchy with multiple
access privileges is not currently available in these products.

Thus, larger, multi-level hierarchical organizations traditionally adopt one of two methods for their
organizational data needs. They either develop or use traditional database tools. Traditional database
tools have the advantage of being very fast for the collection and reporting of information at all levels of
the hierarchy; however, they have a disadvantage of lacking in flexibility. Users at different levels cannot
customize and link outside data to the relevant portion of their data. It is also very time consuming to
make any changes to the system and development, such that maintenance costs may be high.
Organizations that use off-the-shelf solutions may have lower development costs, but then lack the same
flexibility just mentioned and also have the added difficulty in making any changes. Other organizations
opt for spreadsheets that are similar to the conventional spreadsheet systems described above. The
advantage of conventional spreadsheets over conventional database tools is that spreadsheets may be
more flexible than database tools in both the type of data and links to other data. However, conventional
spreadsheets may introduce the other problems described above. For example, the quasi-manual process
of collating spreadsheets throughout the hierarchy may create an issue of data latency, meaning the
required data at any given point in the process is out-of-date and/or inaccurate. Data latency is a factor of
how many collations are needed and how long it takes to do each one. Using conventional spreadsheets
can be very slow, if not impossible, to quickly gather relevant and timely information. By the time the
data is collated at any given level, there is a good chance the data is already out-of-date. Thus we have a
trade-off between the current systems. One is fast but not flexible and the other is flexible but not fast.

An embodiment cloud computing with a novel approach of managing a “spreadtree hierarchy” has
been developed and is currently being made available. This method comprises storing spreadsheet or
spreadsheet like formats in a network environment accessible to a plurality of users, and storing at least
one data object in the network responsive to an edit of the at least one spreadsheet-like structure, the at
least one data object having a unique ID and data associated with the edit. An associate spreadtree system
comprises an application server configured to operate within a network, and further configured to
communicate with a plurality of users and manage a spreadtree hierarchy. The spreadtree hierarchy
comprises a plurality of linked spreadsheets having reference files stored within the network, and a
plurality of data objects associated with the plurality of linked spreadsheets. Each data object of the
plurality includes a change to at least one cell in at least one linked spreadsheet of the plurality. A
method for operating a spreadtree hierarchy system is also included. The method comprises updating a
network-based reference file for a spreadsheet responsive to a user’s edit to the network-based reference
file, and automatically updating another user’s local version of another spreadsheet linked to the
spreadsheet responsive to the user’s edit to the network-based reference file.

The following screen shots demonstrate a typical example of how a cloud computing application,
leverage a spreadtree approach can be used to enable secure, scalable collaboration.
Multi-User Aware/ Multi-Office Launch Portal

Multi-User Aware/ Multi-Office Estimate
3. CONCLUSIONS AND FUTURE WORK

Building information management, in its simplest definition, is the life-cycle management of the built environment supported by digital technology. Due to the multiple knowledge-domains, competencies, and associated business processes required to achieve BIM, cost-effective methods of collaboration and information sharing are needed. Also needed is a culture shift. A move from a silo-based mentality and mistrust, to open discussions with shared goals and rewards. Cloud computing allows users throughout the life cycle to share and collaborate on all aspects of the Design/Build process without regard to their physical location.

The disruptive technologies of cloud computing, BIM, and innovations such as spreadtree hierarchy systems, combined with efficient and collaborative project delivery methods stand to catalyst AECOO industry change. Market drivers such as an altered global economic landscape and the need to address environmental/sustainability issues will also help to push the AECOO sector to the tipping point.

An overall BIM framework is evolving and will like continuously change. Nonetheless it is expected that cloud computing, BIM, AECOO culture, and efficient project delivery methods will all evolve together
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REFERENCES