Creating a Plan for Building Information Modeling

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Abstract-- **Building Information Modeling (BIM) is a relatively new technology emerging in the construction industry as it offers many advantages offers over typical construction drawings. However, new technology brings new problems and often uncertainty to an affected industry. Currently, the construction industry is experiencing much uncertainty as to how the BIM process works. There are very few industry standards, guidelines, or case laws assisting to govern the BIM process. Many industry professionals have stayed away from BIM to this point, because they are afraid of ending up in a costly dispute. This project looks at the importance of utilizing a BIM Execution Plan (BEP) in the contracts between the owner - architect and the owner - contractor. The paper will assist in managing the BIM process and define expected deliverables the BIM must model.**

Companies have already begun to incorporate a BEP into contracts. Nevertheless, each of these BEPs typically varies, because there are conflicting views on how the BIM process is to be conducted. The American Institute of Architects (AIA) published Document E202 in order to address this problem. It is recommended to use this document as a basis to develop a BEP that meets the project's needs.

I. INTRODUCTION

Poor interoperability and data management costs the construction industry, approximately $15.8 billion a year, or around 3-4% of the total industry, according to the National Institute of Standards and Technology. These costs arise from design changes and construction changes that must be made due to poor design or confusion in construction drawings. Many engineers, design, and construction professionals believe Building Information Modeling (BIM) to be the solution to this problem. The National BIM Standard (NBIMS) defines BIM as "a digital representation of physical and functional characteristics of a facility." [1] However, many people interpret BIM to be a 3-D model of a building. Though this is often one of the outcomes it could not be farther from the truth. According to the NBIMS Executive Committee Leader and former Chief Architect of the Department of Defense, Dana K. Smith, R.A., "*A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update, or modify information in the BIM to support and reflect the roles of the stakeholder."* (NBIMS, 2007) This can be done to assist in all stages of the facility lifecycle. The facility lifecycle is the process a building undergoes from conception to completion, in which facility management occurs. The facility life cycle is shown in Figure 1.

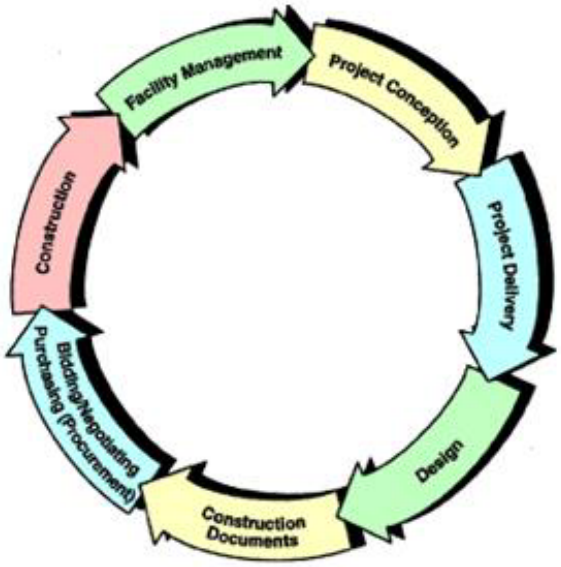

Figure-1: Facility Life-Cycle

Since the introduction of BIM, one of the greatest dilemmas has been defining what the BIM needs to model. Often the owner of a new building will call for BIM to be included in their Request for Proposal (RFP). However, they often neglect to specify what exactly is to be modeled and to what Level of Detail (LOD). According to Michael Tardif, Assoc. American Institute of Architects, *"this creates an environment that could, at best, lead to misunderstandings and, at worse, lead to contractual disputes."*

II. BACKGROUND

BIM is not software and software is not BIM. As defined earlier, BIM is a process involving communication and collaboration. [2] However, to perform this process software is required. In 1986 Graphisoft, a Hungarian software company introduced their first "Virtual Building Solution" known as ArchiCAD. Shortly after, other software companies, such as Autodesk and Bentley Systems created their own versions of the software. Each software company tried coining the BIM concept in different names until Jerry Laiserin helped to standardize the term as "Building Information Modeling." He knew every stakeholder in a project must understand what BIM is and is not. Having different terminology created even more confusion amongst Architect, Engineer, and Construction (AEC) professionals. [3]

Today it is possible to utilize BIM on countless projects and for an unlimited amount of uses on each said project.

This paper focuses on its applicability to the construction process between the owner and all other parties as shown in Figure 2. Building owners are not typically construction professionals and do not understand typical construction drawings. BIM allows for the creation of a 3-D model that can show: what the building will look like, the phases of the construction process, an estimate of the cost, the schedule of the project, etc. As stated earlier, the possibilities are limitless on what the BIM can model. [4]

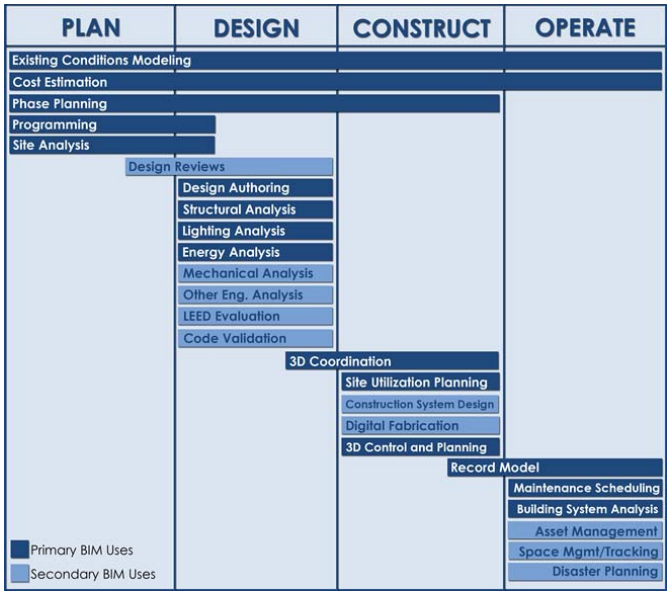

Figure – 2: BIM Users

BIM USE	Frequency	Rank	Benefit	Rank
	%	1 to 25	-2 to +2	1 to 25
3D Coordination	60%	1	1.60	1
Design Reviews	54%	2	1.37	2
Design Authoring	42%	3	1.03	7
Construction System Design	37%	4	1.09	6
Existing Conditions Modeling	35%	5	1.16	3
3D Control and Planning	34%	6	1.10	5
Programming	31%	7	0.97	9
Phase Planning (4D Modeling)	30%	8	1.15	4
Record Modeling	28%	9	0.89	14
Site Utilization Planning	28%	10	0.99	8
Site Analysis	28%	11	0.85	17
Structural Analysis	27%	12	0.92	13
Energy Analysis	25%	13	0.92	11
Cost Estimation	25%	14	0.92	12
Sustainability LEED Evaluation	23%	15	0.93	10
Building System Analysis	22%	16	0.86	16
Space Management / Tracking	21%	17	0.78	18
Mechanical Analysis	21%	18	0.67	21
Code Validation	19%	19	0.77	19
Lighting Analysis	17%	20	0.73	20
Other Eng. Analysis	15%	21	0.59	22
Digital Fabrication	14%	22	0.89	15
Asset Management	10%	23	0.47	23
Building Maint. Scheduling	5%	24	0.42	24
Disaster Planning	4%	25	0.26	25

Figure – 3: Frequency of Usage for BIM Capabilities

Figure 3 shows the frequency BIM uses were utilized in different projects. [5] It is interesting to see that site analysis is being used on over twenty-five percent of the projects studied. Disaster planning is a capability not readily used, but could be a useful tool for a subway station or ball park to create multiple evacuation plans in the event of a catastrophe.

BIM is a powerful tool that combines the drawings into three, four, and five dimensional CAD, including the material, schedule, cost, etc., but the high cost and lack of training opportunities are still some of the problems that need to be resolved.

III. PROBLEM DEFINITION

The differences in BIM and typical construction drawings are tremendous. However, there are very few industry standards and even less case law to govern the BIM process. Therefore, as an owner asking for BIM in a RFP, how can you make sure you get the model you need? As a designer responding to a RFP, how do you make sure you are setting your design fees correctly? As a contractor performing an estimate, how do you know if you can use the model for quantity take-offs, and if you can what quantities? [6]

IV. PROJECT OBJECTIVES

The main objective of this project is to demonstrate the importance of creating a well-defined BIM Execution Plan (BEP) as it will measurably decrease problems and disputes in the BIM process. The BEP should be in both the owner – architect and owner – contractor contracts. It must define what is being modeled, who is modeling it, when it is being modeled, and how it is being modeled. [7]

V. BIM IN THE REAL WORLD

With all of the change that BIM brings to the construction industry, many people are still very confused on what BIM does. Therefore owners who want to incorporate BIM into their projects must first decide how they are planning on acquiring all project members. Are they going to use a typical Design - Build process or Integrated Project Delivery? There are numerous other ways project members can be attained. [8] Therefore this must be addressed so that the owner will be able to assign roles in the BIM process to all members. If a project is using Integrated Project Delivery (IPD) all team members will be available to collaborate from the beginning of the design phase. If a project uses Design-Bid-Build, the construction team will not be involved until after the bidding process. Therefore; an owner must choose the best procurement technique that allows the achievement of their goals. (CSI handbook) In BIM, IPD tends to work best, as it goes hand in hand in the procurement method the BIM process is designed for. [9]

VI. BIM SWOT ANALYSIS

Strengths	**Weaknesses**
• Better coordination among design, engineering, and construction disciplines • Automatic 3D generation of building geometry • Easily understood visual depictions of building and components • Ability to generate 4D models (includes time) and 5D models (includes time and cost) • Decreased risk of change orders after construction begins • Data-rich model of building elements allows for use long after construction	• Lack of understanding in BIM process amongst majority of industry professionals ***(BEP helps to alleviate this)*** • Works best with IPD than with traditional design-bid-build • Many software packages that do not communicate with one another • Need computers handy in the field to view all models elements • Cost estimates do not take all factors into account • If a Change Order occurs there will be much greater debate as to who is at fault • Lack of education and training opportunities
Opportunities	**Threats**
• Addition of new markets in the construction industry • Greater leaps in design improvements from increased collaboration amongst suppliers and contractors • Addition of LEED credit tracking within the model	• Shift of risk from contractors to architects could cause resistance and confusion in the industry • Slow adoption by the construction industry, because of lack in technological knowledge in many construction industry professionals • Many different software packages that do not work together making companies hold out on purchasing until a clear software winner emerges or packages interact seamlessly

VII. ANALYSIS

BIM is currently only being performed by a very small amount of companies in the local area. These companies are using BIM for a wide range of services. Sometimes very small models to show an owner a portion of the building in order explain a change order. Some companies are using BIM for clash detection ensuring no spatial conflicts arise in the design of building mechanical systems. Some local projects are already using BIM software to design the entire project. According to responses from interviewees, BIM offers many advantages over the traditional design process and typical construction drawings. Every interviewee mentioned how it improved coordination amongst the stakeholders in the project. Another advantage included how BIM forces the designer to think in 3-D which makes the design "work better." [10] Additionally, BIM allows contractors and designers to educate an uneducated owner on the building's properties, because the model is so easily understood compared to typical blueprints.

VIII. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, BIM is currently being used locally in a variety of applications. However, it is only being utilized by a relatively small percentage of companies. These companies have yet to find a BEP incorporated into one of their projects. It is important to note that very little case law exists regarding BIM. In time, disagreements will occur and the outcome of their court cases will mold the way the BIM process is managed.

The role of BIM manager should be given to the project architect as they bear the burden of being ultimately responsible for the design of the building. Since architects are typically the first party an owner will enter into an agreement with, using the architect would be applicable to all forms of project delivery such as they typical design-bid-build or IPD.

REFERENCES

[1] Tardiff, Machael. "Defining the Scope of BIM." *The News of America's Community of Architects* 16, 2009.

[2] Hardin, Brad. *BIM and Construction Management: Proven Tools, Methods, and Workflows*. Indianapolis, IN: Wiley Pub., 2009.

[3] American Institute of Architects. *AIA Document E202*. American Institute of Architects, 2008.

[4] Bedrick, Jim, AIA. *Organizing the Development of a Building Information Model*. AECbytes, 2009.

[5] LeFevre, Michael. "No BIM for You: The Case for Not Doing BIM." *National Institute of Building Sciences,* Spring 2011.

[6] McBride, Jay, Robert Steffen, and Doug Kinard. "BIM as a Risk Management Tool." *National Institute of Building Sciences,* Spring 2011.

[7] Suermann, Patrick C., Maj, USAF, P.E., and Raja R.A. Issa, Ph.D., J.D., P.E. "Evaluating Industry Perceptions of Building Information Modeling (BIM) Impact of Construction." *Journal of Information Technology in Construction* 14, 2009.

[8] Rosenberg, Thomas L. "Building Information Modeling." *Roetzel & Anddress - A Legal Professional Association*, 2009.

[9] Ost, Nadine M. "BIM Lawsuit Offers Cautionary Tale." *Architecture Design for Architects*. Engineering News Record, 19 May 2011. <http://archrecord.construction.com/news/2011/05/110519-BIM-Lawsuit-1.asp>.

[10] Perreault, William D., Joseph P. Cannon, and E. Jerome McCarthy. *Basic Marketing: A Marketing Strategy Planning Approach*. Boston: McGraw-Hill/Irwin, 2008.