DESIGN-BIM-BUILD-OPERATE – HOW OWNER REQUIREMENTS ARE INFLUENCING CONSTRUCTION FIRM STAFFING AND ACADEMIC EMPHASIS

James G. Sullivan, Charles R. Perry Assistant Professor, sullj@ufl.edu
Rinker School of Building Construction, University of Florida, Gainesville, FL, USA

ABSTRACT
This paper proposes that an evolving delivery method, Design-BIM (Building Information Modeling)-Build-Operate (DBBO) for which construction and design firms contractually take responsibility for a complete coordinated virtual model of a building at the end of construction, is creating new career paths for young construction professionals. This paper presents a case study highlighting the influence owner requirements have on construction management firms working to deliver a building, both in the real world and a virtual one, at the University of Florida. The paper proposes that these owner requirements are requiring onsite staffing and corporate staffing for the construction management firm that is unique to this delivery method. Likewise it is requiring unique BIM modeling skill sets for individuals within a company and changing corporate organizational structures to account for these new individuals. Owner driven requirements and adapting construction firm structures are placing an emphasis on the core BIM skill sets emerging graduates should possess upon graduation. The question remains on how the design/build academic world responds to these real world owner driven and contractually required staffing needs.

Keywords: BIM, owner requirements, virtual design coordinator, Design-BIM-Build-Operate delivery method

1. INTRODUCTION
Construction projects in the United States have traditionally been driven by meeting and exceeding owner projects requirements – for both the design firm and construction entities the goal for all involved in the project is to complete it to the satisfaction of the owner’s group. Traditional delivery methods have focused on design-bid-build for which there has been a distinct demarcation between design services (Architect/Engineer) and means and methods (Construction Management Firm/General Contractor). This distinction has also influenced the academic and professional requirements for those in the design and building industries. Building Information Modeling (BIM) is placing the requirements for delivering a complete virtual design model in both the architects and the construction management firms hands (Azhar et al, 2008). This change in delivery method also brings about issues of risk and reward by those involved when it comes to delivery innovations (Rigby et al., 2012). Large scale construction firms are increasingly showing favor to the potential performance benefits that BIM projects provide (Suermann and Issa, 2009). Additionally the industry as a whole has been raising the expectations for the entry level BIM knowledge (Chasey and Pavelko, 2010).

The academic world has been taking stock of its curriculum offerings and have been establishing individual courses and an integrated approach across curriculum in response to this demand albeit at a slower pace relative to the changes in the industry (Sabagoni, 2009). Innovations within courses allow for students to see real world...
benefits and facilitate their understanding of transitions taking place in the construction world with regard to BIM and its impact on construction firm activities such as scheduling (Hyatt, 2011). Beyond this integration is the need to better understand the relevance BIM will play with students immediate and long-term goals. The unknown facing firms and undergraduates is the level BIM will play within the walls of the BIM savvy construction firm. A March 2012 survey released by Associated General Contractors (AGC) indicates that allow the use of BIM varies by market segment, 53 percent of hospital and higher-education contractors expect to work on BIM projects in 2012 (AGC 2012).

This paper focuses on how the University of Florida’s Office of Facilities, Construction, and Planning’s (UF Facilities) Building Information Modeling (BIM) requirements have influenced both the delivery methods and staffing requirements for the General Contractors bidding and performing major projects. In addition the internal organizational structure of these construction firms as well as indirectly changed the way BIM is being viewed in the local construction industry. A version of Design-BIM-Build-Operate is being developed by the UF Facilities that places contractual emphasis on all parties in the design and construction program to deliver a fully functional building and virtual model.

2. DESIGN-BIM-BUILD-OPERATE AT THE UNIVERSITY OF FLORIDA – AN EVOLUTION

2.1 Facilities, Construction, and Planning

The University of Florida (UF) Facilities, Construction, and Planning Division oversees major renovation and new construction projects typically greater than two-million dollars on the main UF campus and throughout the state. The Facilities Planning and Construction Division (Facilities Office) is responsible to the Vice President of Business Affairs and Economic Development for the planning and construction of all physical facilities of the University of Florida and the management of its space and physical resources. The role of this department is to serve as the owner group representative in guiding and procuring the design and construction of project. The Facilities Office is responsible for establishing the UF Construction Standards which include design and construction specifications and requirements. The Facilities Office also plays a crucial role in the turnover of a project to operational department at UF – The Physical Plant Division (PPD). PPD’s responsibility is the operating and maintenance of the buildings once they are turned over to the owner’s group which funded the project. The UF Construction Building Standards are updated and influenced by feedback from PPD with regard to performance and maintenance. Likewise the traditional asbuilt drawings are crucial in operating and maintaining buildings. Over the past eight years the value of the BIM model to this user group has become highly valued and the importance of having a correct and fully loaded model has proved to be a vital deliverable at the time of project turnover.

2.2 University of Florida BIM Timeline

The Facilities Office has been incorporating BIM on various levels of complexity since early 2004. Table 1 reflects key milestones for the inclusion of BIM for major projects at UF. The adoption of BIM tools has been a ‘grass roots’ development and partnership between the Facilities Office, designers, construction managers, and PPD over the past eight years.

Within traditional design-bid-build relationships the initial value of BIM tools was discovered by the Construction Management (CM) team in modeling subcontractor coordination and clash detection (the identification within a model to show two elements within the same physical space). In this early time frame and within the constraints of the contract this required CM firms to hire externally or develop the capabilities internally to produce these models. This development phase was crucial in that CM firms chose to go beyond the contracted scope of work
required by the owner as well as take on a technology risk. The evolution continued with CM teams converting traditional 2D AutoCAD drawings to “asbuilt” Revit Models to track and coordinate work in place. Once a congruence was established between jobsite coordination and owner end benefit the initial design teams started to develop the models at various levels of detail prior to construction. A key deliverable was the Mechanical-Electrical-Plumbing (MEP) portions of the final design. BIM tools allowed for better fit among elements as well as means to track equipment and performance data. Beyond the traditional architecture/design team, engineering companies as well as the trades that were impacted with simultaneously contracting for BIM services or developing the services internally to communicate with the entities involved in delivering the final design.

The next evolution was the development of site and civil coordination in BIM models for underground utilities and project connections to UF systems. This is one of the first pieces that tied the design and construction phases of project to real value added campus operations performance functions. From here projects began to become more extensively coordinated with the Physical Plant Division and systems operations.

### 2.3 Current and Future BIM Goals at UF

The success of the BIM progress at UF has been anchored in the value added perceived benefits by both the owners group and the CM team. The final asbuilt model that may turned over to operations is considered the goal for the Facilities Group. The ability to better coordinate and avoid delays due to traditional drawing conflicts and details is considered the benefit by the CM group. The Facilities Office at UF strategy to maximize the return-on-investment (ROI) is to target the following types of projects:

- **Research Facilities**
  - Complex design, MEP intensive, structural and interiors intensive (clash detection)
- **High Profile**
  - Large budget projects (greater than $15)
  - Expedited delivery projects
- **Simple Design**

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone</th>
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<tr>
<td>2004</td>
<td>Facilities Office internal use of BIM for pre-planning and fundraising efforts</td>
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<tr>
<td>2007</td>
<td>First use of BIM on UF major projects. Initiated by project team – not a UF requirement.</td>
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<tr>
<td>2008</td>
<td>Selective use of BIM initiated by Facilities Office. Not part of qualification for work but minor language included in construction contracts and documents.</td>
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<tr>
<td>2009</td>
<td>Formally introduced into Consultant and CM qualification process. Several ongoing projects select to use BIM tools to facilitate clash detection and subcontractor coordination.</td>
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<tr>
<td>2010</td>
<td>Formally introduce BIM language in model contracts. BIM becoming primary design tool to document projects.</td>
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<tr>
<td>2011</td>
<td>Goal to further collaborate with other UF departments to support campus wide BIM implementation strategy.</td>
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</tbody>
</table>
Bring smaller firms up the learning curve
Support goal of long term strategy on camps

The successful process of change within the construction industry and within a small market such as Gainesville, Florida, is remarkable. This change has required two major factors: 1) strong leadership from the Facilities Office and 2) perceived and actual benefit from the CM firms that continue to lead in supporting the owner’s goal of a completed and accurate model to be turned over at the completion of the project. This second factor has not come as a now cost or even low cost change to the CM firms but the return-on-investment and reduction of risk has also been recognized.

3. EVOLUTION OF THE CM BIM ROLE AT UF

3.1 Early Success and Benefits
Successful innovations in construction are often linked to perceived benefits. The stated perceived benefits from the combined evolution between the owners group and the initial CM teams (as noted by the Facilities Group) include:

- Early identification and elimination of interferences between discipline models
- Effective coordination between design and construction disciplines
- Deeper understanding of design concept through visualization
- Higher Order of Collaboration Among Project Participants & Stakeholders
- Quality improvement and reduction in delayed coordination and decision making
- Reduced RFIs, Field Rework and Associated Time and Cost

3.2 Construction Management Building Modeling
As CM firms saw the benefit of the building modeling to avoid clash issues and have a better understanding of the design concepts the initial development of in house capabilities to manage and work with these models started to develop.

The contractual relationship between the design firm and CM teams is critical is the development phase. The Facilities Group at UF did not initially put require that the design teams develop their concepts in AutoCAD Revit (or similar tools). Therefore for CM teams to achieve the coordinated outcomes they desired from modeling they had to do so at their own risk and with limited resources. Initial modeling on UF jobs were done by third party contracted designers but the according to the UF Facilities Group CM teams quickly developed their own in-house and onsite capabilities to manipulate the models. It is important to note that these models often lacked the information data associated with components in that the primary functions were often to show special constraints (such as clash detection).

3.3 Construction Management Fall 2012 BIM Requirements
The current Facilities Office BIM Selection Criteria for both the Architecture/Engineering Firm and the Construction Management (CM) Firm essentially require the companies to address both their experience and proposed staff for the job being bid. Additionally they request the firms to discuss whether the design firm self-performed their models or if the models were coordinated with an outside firm. The
CM firm is asked to discuss their experience (proposed staff) and any lessons learned from previous projects. This staffing component on the CM side specifically addresses how BIM is altering the knowledge base and requirements that CM companies are requiring from new hires out of academic programs. Contractual requirements further define roles and responsibilities among the parties responsible for designing and completing the BIM model. The “BIM Execution Plan” is a project contract addendum that identifies project participants and responsibilities.

The key component for the CM firm is defining the role of the BIM coordinator. From an organizational chart perspective companies are having to determine if this position is one person onsite or by a person or department offsite and when in the process is the activity contractually required and how is it to be managed. Additionally the skill levels needed to fulfill the contractual requirements must be addressed. Examples of contractual requirements for a construction BIM coordinator fall among various previously defined traditional roles such as designer, project manager, and superintendent.

The design and construction process is one for which information transforms from the abstract to the finite. Figure 1 reflects the type of information that would be coordinated by the CM Firm – the outline reflects the role of the CM BIM department and when (if at all) a jobsite coordinator is required (i.e., the construction phase).

3.4 Corporate Staffing Requirements and Skill Sets

Prior to the inclusion of BIM on UF projects traditional CM Firm main office responsibilities included fundamental departments such as Preconstruction, Estimating, Purchasing, Scheduling, Cost Engineering, Safety, and Business Development or Marketing.

3.4.1 Preconstruction Services

BIM has evolved into a “preconstruction service” within many companies. In others it falls within the estimating department. The evolution and adaptation of these firms to acquire and reflect their expertise is demanding a different skill set for new graduates.

Preconstruction services may cover a vast array of deliverables for a CM Firm. Services may function to service existing clients with negotiated work or assisting business development to acquire new clients. Should the BIM department fall within this structure it may also serve to help the estimating department with material takeoffs and the scheduling department with jobsite logistics and coordination.

3.4.2 Construction Phase Jobsite Activities

Likewise when projects begin the construction phase companies will assign a “Modeling Engineer” to the job – typically the one that is presented during the qualification phase of contract review. This new job, similar to that of the safety officer in the 1980’s, falls with the operational jobsite chart. The modeling engineer may be both helping the Project Manager fulfill contractual requirements regarding submittal information and meeting minutes as well supporting the Project Superintendent with jobsite layout and field coordination.
Figure 1. Contracted CM BIM requirements

Construction phase activities critical for the completion of the final model need to be coordinated in real time. What traditionally had been kept in submittal logs and operation manuals are becoming part of the final BIM model. Similarly the process of shop drawing coordination and material inspection is becoming included the model. What once took place on light shelves in subcontractor offices is now happening during the exchange of model data. The means and methods of the placement of materials is being coordinated in the model prior to installation whereas this information was traditionally captured post-installation. Jobsite activities include tasks such as the following – parenthesis indicate traditional responsibility:

- Ensure subcontractor participation and performance (Superintendent)
- Create and reconcile coordination schedule with construction schedule (Superintendent)
- Obtain and convey materials necessary to coordinate MEP (Superintendent)
- Obtain BIM submittal content (Project Manager)
- Facilitate use of trade models/shop drawings with A/E model (Superintendent)
- Coordinate final asbuilt data with A/E model (Superintendent)

### 3.4.3 Modeling Engineer Career Path

Discussions with CM Firms such as Skanska have lead to the understanding that three foreseeable career paths exist for BIM specialists within a CM firm. The first being that similar to that of a jobsite superintendent for which the complexity of the job would dictate which modeler was assigned and to what degree their experience and know how would allow them to move up to bigger and more complex projects. The second being an in-house Preconstruction Service Department manager working to develop protocols, understanding future technology needs and working to greater efficiencies in the over project delivery systems. And lastly a person that moves through the department similar to those that rotate through estimating or scheduling now from the project management side or as an assistant superintendent from the field side of the corporate organizational chart. Figure 2 reflects the possible options for a modeling engineer today.

Companies like Skanska see BIM as a tool that all members of the construction team should be comfortable operating and using to extract the data needed to perform work. Internal training is provided to ensure this occurs. Although the basic understanding of the modeling needs to be achieved so meaningful conversations may occur internally the need for specialized departments and job associated employees remains in the future. The future may exist where virtual models replace plans tables and technology savvy superintendents and projects managers operate seemingly in a virtual world but for the immediate future having specialized individuals remains a need to be filled.

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1 Figure 2. Potential career path for modeling engineer
4. CONCLUSIONS AND FUTURE WORK

This case study reflects the self-reported benefits of BIM on a campus setting. These benefits are mirrored in recent surveys that indicate a greater than fifty-percent uptake on BIM projects in a campus or healthcare settings. The range of institutional projects at the University of Florida reflects those of other large universities in the southeast. The contractual requirements by forward thinking owner groups are creating new opportunities for recent college graduates both on jobsites and in construction management central offices. As educators working within the confines of accreditations programs it becomes imperative that technology be integrated throughout the coursework. The argument that the basics need to be taught with pencil and paper before a modeling tool is introduced does a disservice to the students we are providing for and to industry that is continually adapting and moving forward. The focus of course offerings may need to track this particular trend as it relates to all core facets of construction education outcomes.

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REFERENCES


