LESSONS LEARNED IN BUILDING INFORMATION MODELING APPLICATIONS

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1. INTRODUCTION

In recent years, an increasing number of construction projects have adopted Building Information Modeling (BIM) as a primary collaboration mechanism. This in turn places pressure on universities to integrate BIM as a part of construction curriculum. There are various opinions on what should be taught in a BIM course. But it is generally agreed that successful executions of BIM projects often require good understanding of BIM processes and mixed use of several BIM software solutions. Understanding the overall process of BIM applications and the strength and limitations of existing BIM packages is an important aspect of BIM education. This paper presents the lessons learned on three student projects in developing building information models and in subsequent BIM applications including clash detection, 4D simulation, and cost estimation. These projects include a fire station, a university building, and a suspension bridge across the Mississippi river. The university building and the bridge are currently under construction.

2. MODEL DEVELOPMENT

Revit Architecture and Structure 2010 were used to model the fire station and university building; while Google Sketchup was used to model the Mississippi bridge (Figure 1). There are a number of challenges encountered in the modeling process. First, a part of the cladding of the university building consists of precast concrete panels. However, the Revit 2010 programs do not provide built-in families for precast concrete panels. To model precast concrete panels, a number of workarounds are typically used. They include: 1) using spandrel beams; 2) using architectural reveals; and 3) using curtain wall system but with the glass panels replaced with concrete material. These approaches do provide visual appearance of precast concrete panels; but the inherent building elements are not exact, leading to great difficulties when using these models for the purpose of clash detection, coordination, and cost estimation. There is a great need for a standard information model for precast concrete panels. Therefore models of precast concrete structures developed in other programs such as Tekla can be imported. This is actually an ongoing effort at Building Smart [1]. Second, a balance between level-of-detail and performance need to be considered when Google Sketchup is used to model large complex structures. At the end of model development for the Mississippi bridge, the model becomes too large to be efficiently manipulated. At the starting point, a level-of-detail at the fabrication level is envisioned. But, it soon became impractical. Google Sketchup represents many shapes, such as circles, as line segments. It is often very useful to group primitive shapes into components to improve performance. Although a model of Mississippi bridge was successfully developed in this project, the final model becomes very difficult to manipulate even on powerful graphical application oriented computers.

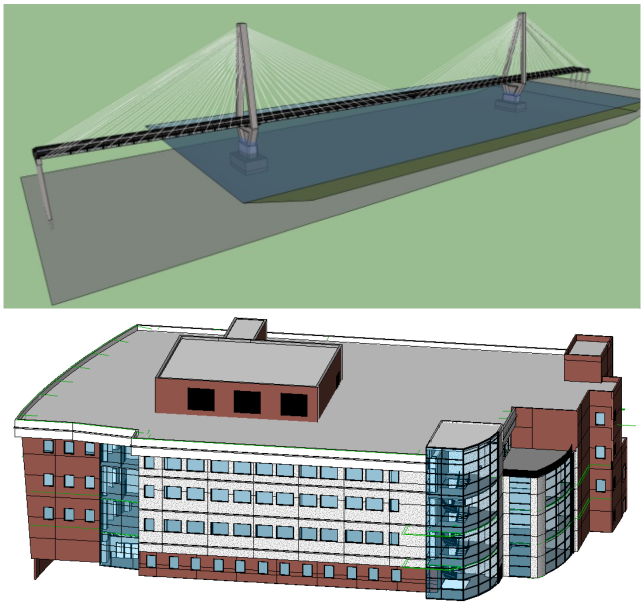

Figure 1. Snapshots of Developed Models

3. CLASH DETECTION AND 4D SIMULATION

The developed architectural and structural models for the university building were used to conduct clash detection. A 4D simulation was also conducted based on a project schedule provided by the project management. The important findings are that the problems with the models have significant impacts on the effectiveness of clash detection and 4D simulation. The models authored in BIM programs like Revit are often design oriented if extra care is not executed in the modeling stage. For example, the standard compound wall families in Revit provide an efficient means for architects to design wall systems. But, these compound walls don't reflect the correct construction sequences. When these walls are imported into clash detection and 4D simulation programs, such as Naviswork, they are one entity that cannot be separated. But, it is important to recognize that the components of a compound wall are constructed in different activities. Another example would be the slab. In an architectural model, a concrete slab is often modeled as one entity. But in construction, a large size concrete slab is often divided into a number of manageable pours. The difficulty of mapping the entities in architectural models to realistic construction activities is a central challenge to create sound clash detection and 4D simulation. This further raises the question of the difference between an Architectural BIM model and a construction BIM model. As of now, many general contractors have to redraw the BIM models they received to support the construction process. An understanding of this problem is an important aspect of BIM education.

4. MODEL-BASED ESTIMATING

Using of BIM models for estimation can be divided into two levels. The first level is to use BIM model for quantity takeoff; while the second level is to use BIM model to do integrated estimation. A prominent example of the second level is Vico Estimator, which binds methods and resources to extracted quantities. In this study, the fire station developed in Revit was used to do quantity takeoff. The fire station used concrete masonry units (CMU) as the cladding system. The core of the CMU was reinforced and grouted. As the students were developing the model, they ignored the modeling of reinforcement and grout at the core of CMUs. An architect would have done so, but with the supplement of boil plate details. In fact, there is no efficient means in Revit 2010 that can be used to Then, if the model is used for quantity takeoff, it is very easy to forget factoring in the grout and reinforcement. Again, this further demonstrated the importance of the structure and the content of model.

5. CONCLUSION

BIM is not a panacea for the fragmented building delivery processes. BIM applications are quickly evolving. This paper argues that learning problems in BIM processes should be an integrated part of BIM education. The problems encountered in three BIM course projects are reported above. They highlighted the significance of BIM execution planning. Without an agreed scope and process, there are a multitude of problems that can arise in BIM execution, which will possibly eventually defeat the purpose of BIM.

REFERENCES

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