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## The Use of Building Information Modeling in Generating Hard Bid Estimates

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The Use of Building Information Modeling in  
Generating Hard Bid Estimates

Peter Jensen

A thesis submitted to the faculty of  
Brigham Young University  
in partial fulfillment of the requirements for the degree of  
Master of Science

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## ABSTRACT

### The Use of Building Information Modeling in Generating Hard Bid Estimates

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Building Information Modeling has provided many benefits to the architectural, engineering, construction and facilities management communities. Many studies have been done to validate the asserted benefits, including benefits to the field of estimating. The studies on estimating are currently limited to the realm of conceptual estimates, and have only treated detailed estimates in the abstract. The purpose of this study was to determine how BIM was being used by companies in a hard bid, or detailed estimate scenario. The research team used the Deseret Towers housing project at Brigham Young University as the basis for the research. A building information model (BIM) was provided to all bidders on the project, and at the conclusion of the bidding process a survey was used to determine how the contractors used the model in their bidding processes. The findings determined that a few of the contractors did use the model for quantity takeoff, and one actually used the quantities as the basis for the submitted bid. Additionally, the survey attempted to determine the prevailing attitudes of the estimators toward BIM as a tool in estimating, and their opinions of the future of BIM in estimating.

Keywords: estimating, BIM, Building Information Modeling, commercial, hard bid, detailed estimate.

## ACKNOWLEDGMENTS

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## 1 INTRODUCTION

In the past decade, technology in the construction industry has been developed that can help managers streamline and automate various stages of the construction process. One of the most remarkable of these technologies is Building Information Modeling (BIM) software (Azhar, Hein and Sketo, 2008). BIM software is a compilation of many layers of information that are embedded in a three-dimensional representation of a building structure. With all of the information in a single location it is possible to analyze and extract the data from BIM in a way that offers an increased comprehension of the building, and construction processes (Levy, 2006). This allows better management of the resources involved in a construction project, and allows for significant savings of time and money.

BIM has shown benefit in many areas of the pre-construction and production phases of construction projects. Due to the graphical nature of BIM it has been utilized as a marketing tool to help owners visualize the completed project. It has been extremely useful in coordinating systems such as the structural, mechanical, electrical and plumbing components of the building. It has saved companies millions of dollars and weeks of rework that would have been required without BIM (Azhar, Hein and Sketo, 2008). BIM has been useful in managing cash flows as well as scheduling and coordinating the timing of construction events (Eastman et al., 2008). Given the amount of information that is compiled in a building information model there are countless benefits available to the knowledgeable user (Samphaongoen, 2009).



With such a wide range of possibilities this research has narrowed its focus to concentrate on the advantages available to the field of estimating. Inaccurate estimates have been identified as a significant factor leading to the high rate of failures among construction companies (Shen and Issa, 2010). It has been suggested that BIM could be the means of increasing the accuracy of estimates allowing for more precise bid numbers. Efficiency could be improved and the frequency of human error could be reduced (Alder, 2006). This would allow companies to operate more profitably, and decrease the number of construction business failures.

The construction industry in general is cautious to accept the new technology. In preliminary discussions between the research team and local contractors it has become apparent that few have used the product, and fewer still have incorporated it into their estimating procedures. If BIM is implemented for estimating, the benefits could be significant for increasing speed and accuracy, but it would also require a change in business practices, and additional education and training. Thus, it is important to establish a metric to help contractors know the potential savings and efficiencies that are available with this new technology.

BIM has been emerging as a new technology for several years and has proven to be a benefit to many aspects of the pre-construction processes, including preliminary estimates. During the review of literature stage of this study the researcher was unable to find any documentation or studies that addressed the use of BIM in a hard bid or Design/Bid/Build product delivery method. All of the studies that were found of BIM in estimating indicated that BIM has been effectively used in preliminary estimates, and Design/Build methods, but expressed concern over BIM's ability to be accurate, or reliable enough for a hard bid scenario (Shen and Issa, 2010). Additional discussions with local contractors has led the researcher to believe that few, if any, are using BIM to develop detailed estimates. To aid in the development

and proliferation of this technology additional studies need to be conducted that will show the direct benefits that BIM can provide to contractors in their regular business practices.

### **1.1 Problem Statement**

BIM promises increased efficiencies in the field of estimating. The problem is that some contractors are using BIM for conceptual estimates, but few if any are using it to generate the detailed estimates necessary for generating bids.

### **1.2 Purpose of Study**

This study will use surveys of contractors to determine attitudes about BIM software, and to determine how it is being used to develop detailed estimates in construction projects. The data collection has focused on Salt Lake and Utah counties. This data will uncover the barriers to implementation, and help develop plans for training contractors for more widespread use of BIM for detailed estimating.

### **1.3 Research Questions**

- How frequently is BIM being used in estimating applications?
- How are contractors using BIM?
- Why is BIM not being used more?
- How familiar are estimators with BIM?
- What BIM training have estimators received?
- What is the perceived future of BIM in estimating?
- What plans do companies have for implementing BIM in the future?

## **1.4 Delimitations of the Study**

This study focused solely on the Deseret Towers housing project at Brigham Young University. This was necessary as there were no other instances known to the researcher where a building information model was provided to contractors along with the two-dimensional plan set for the purpose of preparing a hard bid estimate. The eight contractors bidding on the project were the only contractors included in the survey. All eight contractors have their company headquarters in the state of Utah. Even though many of them do work in other states from time to time, it should not be considered that contractors from other states were included in the study. These contractors were all general contractors. No subcontractors or suppliers were contacted for any portion of the study.

This research narrowed its scope to how contractors are using BIM for estimating where an owner in a hard bid scenario supplies a model. There are many studies that focus on using BIM for estimating in a conceptual estimate and Design/Bid scenarios. In the interest of broadening the field of knowledge about estimating from building information models this study was designed to concentrate on the hard bid scenario.

Additionally, this study explores the reasons for the slow adoption of BIM as a tool for estimating, and the contractor's perceptions and opinions on the future of BIM.

## **1.5 Definitions**

BIM: "A computable representation of the physical and functional characteristics of a facility and its related project/life-cycle information using open industry standards to inform business decision making for realizing better value." (Eastman, 2009)

## **2 LITERATURE REVIEW**

This chapter reviews the existing literature related to the topics treated in this study. The topics to be discussed are: The acknowledged benefits of BIM to the Architectural, Engineering and Construction (AEC) community, and the weaknesses of BIM as applied to estimating.

### **2.1 Benefits of Building Information Modeling**

There are a myriad of benefits available to owners, designers, builders and facility managers through the implementation of BIM. A few of the major benefits have been outlined and explained below.

#### **2.1.1 What is Building Information Modeling?**

A BIM is a three-dimensional representation of a structure comprised of individual components defined by a series of parameters. The parameters can give an object dimension, location, texture and other physical characteristics. Functional characteristics may also be attached, such as information about the manufacturer, and operating and maintenance procedures (Azhar, Hein and Sketo, 2008). These characteristics of a BIM allow it to have many advantages over the more common two-dimensional computer aided design (CAD) drawings (Dzambazova, Demchak, and Krygiel, 2007). It also provides many advantages to designers during the project development stage (Smith, 2009). Many of these benefits are expounded under the headings below.

### **2.1.2 Conceptual Design Feasibility**

The initial stage of a project is referred to as the conceptual design stage. At this stage the owner and designer collaborate to determine the possible parameters of a building given a specific timeframe and budget. Increasing the certainty of the project parameters increases the chances of success in the building phase. Some projects are carried through the design phase but cannot be built when the builders discover that the design exceeds the available resources. BIM can produce a much more reliable estimate of the overall cost and time involved in the proposed project, even at this early stage of the design process (Eastman et al., 2008).

It is possible to evaluate proposed design layouts by performing simulations, and analyzing performance of a designed structure or component over time. This ability, available throughout the initial design stage results in better overall design, and better building performance (Azhar, Hein and Sketo, 2008).

### **2.1.3 Improved Sustainability and Energy Performance**

Building a schematic model early in the design process makes it possible to evaluate more accurately whether the building is meeting project requirements, including energy efficiency and sustainability. With this model in place, the necessary calculations can be done early on allowing for more revisions and greater flexibility in the overall process. Ultimately, the resulting building will be of greater quality than one designed using other methods (Eastman et al., 2008). One researcher summarized the benefit of BIM to building energy performance in the following manner:

...By being able to virtually construct the building before physical construction begins on site, BIM adds a level of accuracy to both building quantities and quality that supersedes historic processes of design and documentation. Building materials and environmental variables can be demonstrated in real time rather than manually estimated. (Krygiel and Nies, 2008)

#### **2.1.4 Better Design Through Collaboration**

One of the keys to efficient project management is coordination of building specialists during the design and building phases. BIM allows for specialists in these multiple disciplines to work on the same model at the same time. While it is also possible to work simultaneously with two-dimensional drawings, collaboration with BIM simplifies the process and allows for better control and management of multiple users making changes simultaneously. The simultaneous collaboration shortens the overall design time, and decreases the likelihood and number of errors and omissions (Smith, 2009). This collaboration also allows designers to identify design problems much earlier in the design process, and continually improves the overall design throughout the design stage. Making these changes in the design stage rather than waiting until construction has begun and then attempting to address the issues through design engineering can save both time and money (Watson, Watson and Krogulecki, 2009; Cannistraro, 2010).

#### **2.1.5 Extract Estimates During the Design Phase**

BIM allows for an estimator to pull a fairly accurate bill of materials and square footages of spaces at any point in the design process for use in estimating. In the early design phases, most estimates are developed using unit costs as applied to square footages. As more details are added to the design, increasingly accurate and comprehensive estimates can be generated. BIM allows quantities to be obtained with much greater ease than by using a pencil and scale, and this makes it possible to continuously maintain a grasp on how design changes are impacting the

overall budget for the project (Hartung, 2007). This ability not only aids the designers in designing within budget, but also helps the owner to understand what options or upgrades the budget will allow to be included in the project. At the end of design, this tool can also be used to assess the project to increase accuracy of future estimates or bids. “It is possible to make better informed design decisions regarding costs using BIM rather than a paper-based system.” (Eastman et al., 2008)

### **2.1.6 Synchronize Design and Construction Planning**

A building information model can be linked to a scheduling program that provides the fourth dimension, time, to the model. The construction process can then be observed at any moment in time, or level of completion. The construction site as a whole may be observed at that point to determine potential problems such as material staging, crew and equipment needs, safety concerns, etc. This is a benefit in BIM that is not available from two-dimensional construction documents. An additional benefit may be obtained by including temporary construction objects in the model such as major equipment, cranes, shoring and barriers. These items may also be linked to the appropriate scheduling activities and can be figured into the overall construction plan (Eastman et al., 2008).

### **2.1.7 Reduction of Errors and Omissions**

In a traditional computer aided design (CAD) system there are many different files that are used to document the parameters of building construction. Some files document the floorplans, others show the building elevations, still more show building sections, and yet others provide building details. Each of these types of sheets usually incorporate many pages. To implement a design change each page needs to be updated individually. This gives an extremely

high probability that something may be missed on one or more of the pages creating confusion and potential change orders when the plan is implemented. BIM takes a different approach by combining all the information and relating it to a single file, thus guaranteeing a consistent model (Dzambazova, Demchak, and Krygiel, 2007).

Additionally, because the systems for all disciplines can be included in the BIM, third party software can be used to analyze and identify system collisions both systematically and visually. This allows the majority of incongruities in the construction plan to be dealt with before construction starts, resulting in better collaboration among systems, and significantly reduced costs. The cost savings are due to the elimination of the need to re-work and re-engineer systems and spaces in an attempt to accommodate conflicting systems. The entire construction process runs more smoothly by detecting and addressing conflicts beforehand (Eastman et al., 2008).

### **2.1.8 Quickly Implement Design Changes**

Incorporating changes to a design in a paper-based system is extremely time consuming and error prone. In a BIM model many of the systems are interrelated and will automatically adjust to certain changes based on pre-established parametric rules. Additionally, due to the visual nature of the three-dimensional model, inconsistencies can be detected and adjusted. When a change is made to the model all other views are also automatically updated. Therefore there is less need for coordination among different designers drawing different systems. This results in much quicker and cleaner turn-around (Eastman et al., 2008).



### **2.1.9 Coordinate Design, Construction and Procurement**

A building information model provides accurate quantities for all elements that have been modeled. These quantities can be used in conjunction with their specifications and properties to procure the materials from supply houses and subcontractors. This has been successfully done, primarily for steel and precast concrete components (Sacks et al., 2005). Software is being developed to allow other disciplines to benefit from this attribute. Using BIM in the procurement process allows for just-in-time procurement with less waste and greater accuracy (Eastman et al., 2008).

Additionally, the model's digital file can be used to instruct computerized machines how to produce building components. Traditional CAD files need to be altered before they are sent to the fabricator. Models from BIM, however, can be sent directly to fabrication machines without having to produce shop drawings (Dzambazova, Demchak, and Krygiel, 2007).

### **2.1.10 Lean Construction**

In lean construction, production systems are manipulated in a way that maximizes the value produced, while minimizing the waste of materials, time and effort (Koskela and Howell, 2002).

...BIM maximizes the efficiencies by providing accurate model information and the material resources needed for the different stages of construction. It provides the basis for better planning and scheduling. This helps ensure that labor, equipment, and material are ready at the job site when they are needed. (Samphaongoen, 2009)

## **2.2 Estimating with Building Information Modeling**

Estimating is the practice of predicting the total cost of a construction project. The estimator helps the owner of the project to set the budgets and plan for necessary cash flows

(Choi, 2004). There are essentially three different kinds of estimates, each of which is useful at a different stage of the building process. These estimate types are the conceptual estimate, the systems estimate and the detailed estimate. The conceptual estimate is used at the programming and schematic stage and is considered to have a 10 to 20 percent margin of error. The systems estimate is used at the design stage and is considered to have a 5 to 10 percent margin of error, and the detailed estimate is used at the plans and specifications stage and is considered to have a 2 to 4 percent margin of error (Holm et al., 2005).

The preliminary phase of cost estimation is the quantification phase. This can take up to 50 to 80 percent of a cost estimator's time on a project (Sabol, 2008). There are various means of collecting and quantifying data, but generally the estimator systematically moves through the plans, either with paper and pencil, or through a digitized version of the plans with computer software, to tally up system totals. These totals are then converted to estimate costs by processing them through a spreadsheet, or some other program that applies unique formulas to each quantity in order to arrive at an estimated cost. This system of collecting data is prone to human error through miscounting or missing details on the plans, resulting in a tendency to promote inconsistencies that creep into the tallies (Rundell, 2006).

### **2.2.1 Estimating in a Design/Bid Scenario**

A Design/Bid project delivery method is one where an owner contracts a single party, usually a general contractor and or architect/designer, to provide both the design and construction of the project. This method works best with a group that is highly collaborative and team-based (Potter, 1994). BIM is ideal for the Design/Build method as it requires all participants to work together in virtually building the project even before construction begins (Eastman et al., 2008).

### **2.2.2 Estimating in an Integrated Project Delivery Method**

In an Integrated Project Delivery (IPD) method the owner contracts with all concerned parties in a way that all parties are engaged to work collaboratively to complete the project. This method integrates people, systems, business structures and practices to collaboratively harness the talents and insights of all participants. In IPD, BIM plays a central roll by providing a work surface where the collaboration of ideas can take place. All of the benefits of BIM mentioned above are available to the designers and builders throughout the construction and design processes (Hartung, 2007).

### **2.2.3 Estimating in Design/Bid/Build Scenario**

The Design/Bid/Build project delivery method is the one that has been most used over the past century. In this scenario an owner contracts with a designer who provides all designs, engineering and plans necessary to build the building. These plans are then sent out to contractors to allow them to compete for the job. The contractor with the lowest bid usually is awarded the job (Ibbs et al., 2003).

During the review of literature for this study the researcher was unable to find any papers dealing with the use of BIM in estimating in a design/bid/build project.

### **2.2.4 Weaknesses of Estimating with Building Information Modeling**

While BIM does offer significant benefits to estimating, there are also limitations that must not be ignored particularly when dealing with detailed construction estimates (O'Brien et al. 2002; Shen, Issa and Gu, 2007). Quantity takeoffs from BIM generate accurate tallies of materials needed for a project, however they do not automatically quantify the procedural aspects

of construction. There are costs associated with construction methods and procedures that may be unique to each company or local area. These must be taken into consideration when generating a detailed estimate. Examples of these types of costs are labor and equipment costs (Shen and Issa, 2010).

A distinguishing characteristic between material quantities and procedural quantities is the variability in their cost. Material quantities are determined by the design, and their quantity is fixed as long as the design remains constant. An example of this would be the quantity of linear feet of a particular wall type in a project. As long as the plan does not change, the total linear feet of this wall type will remain the same. Procedural quantities depend on the construction means, methods and unique conditions of each project. An example of this would be digging a trench by hand or with a backhoe depending on which resource is available to the contractor. The procedural quantities could vary significantly from one contractor to another depending on the knowledge, experience and resources available to each individual contractor. Procedural quantities are often based on a more detailed breakdown of the associated material quantities while relying on productivity factors, such as locations, geometric characteristics, and/or construction methods (Sanders and Thomas 1991; Thomas et al. 1990; Shen and Issa 2010).

Another challenge in developing estimates from BIM is the level of detail in each model. BIM can only calculate quantities for objects that are included in the model. For example, if the estimator wants BIM to provide a quantity for rebar, the rebar must be included in the model. Many of the smaller elements that need to be included in the construction process are not included in the model and so cannot be tallied in the same way as the major building elements. For this reason, businesses using BIM as the basis for estimating need to establish methods and

standards for object development that would allow for the optimal level of detail in the model for estimating (Rundell, 2006).

Another item that should be standardized is who controls the data input to the model, and therefore who is accountable for any inaccuracies in it. Whether it is the owner, the designer, or the contractor, the person in control of the model takes upon himself a great deal of risk, as they would be liable for any errors or omissions. Consequently, complicated indemnities, limited warranties and disclaimers of liability by the designers accompany most models (Azhar, Hein and Sketo, 2008).

### **3 METHODOLOGY AND PROCEDURES**

This study looked at commercial contractors in Utah and sought to determine whether or not they were using BIM to aid in collecting data required to prepare cost estimates for bidding purposes in a hard bid scenario. It also attempted to learn the factors influencing their current level of use and their intended future use of BIM in estimating.

#### **3.1 Qualitative Studies**

This study is qualitative in its approach. Merriam (1998) describes quantitative research as a means of interpreting data in a personal way in order to arrive at an explanation for the outcome. She suggests that by using the instrument of qualitative research six assumptions can be made: (1) Qualitative research focuses on the process and not solely the outcome or product, (2) This type of research is more focused on lived experiences and the meaning of those experiences, (3) The researcher is the primary instrument for data collection and analysis, (4) Qualitative research usually involves fieldwork, (5) It is descriptive in that it describes events, attitudes, and outcomes, and (6) It requires some deductive reasoning by the interpreter of the data.

As the data that gathered was only attainable by individual interviews with the general contractors it was necessary to use a qualitative research methodology.

### **3.2 Study**

It has been determined that contractors are using BIM for estimating in certain scenarios. Studies have been done which show that BIM can be useful in Design/Build projects where the contractor has control and ownership of the model (Hartung, 2007). However, there are no existing studies known to the researcher that explore the use of BIM in a hard bid or Design/Bid/Build delivery method. Design/Bid/Build projects require reliance on bidding documents that have been provided by others rather than documents for which the contractor had input at the design stage. This level of estimating in particular requires a greater degree of trust in the model and the software providing the quantity takeoff. It was expected that because of the precision required at this level of detail, a hard bid scenario would provide an adequate test of the weaknesses and progression of BIM as an estimating tool.

The first Design/Bid/Build project known to the researcher where traditional plans and specs were given to the bidders along with a building information model was a new housing project on the Brigham Young University campus. There were various disclaimers that were sent out along with the model to limit the liability of the Planning Department with regards to the use of the model even though the model was considered by Brigham Young University to be complete and accurate. This was deemed to be necessary as the technology is relatively new and is untested in this application.

### **3.3 Subjects**

The subjects for this study are the eight commercial contractors that bid on the Deseret Towers housing project at Brigham Young University. The housing project consisted of four buildings to be completed in phases, each in an L-shape and having four floors and a basement in

each one. It was anticipated that due to the size and complexity of the project, it would be sufficient to provide a realistic scenario for testing the viability of BIM in a hard bid project.

### **3.4 Procedure**

All bidders were provided a building information model of the project to use in the preparation of their cost estimate. It was undetermined whether any of the bidders had previously used BIM for preparing hard bids. The Brigham Young University Planning Department provided the names of the contracting companies to the researcher for inclusion as subjects in the research. The bidders were each contacted by phone, and upon initial contact were given the opportunity to participate, or exclude themselves from the study. All eight of them agreed to participate.

The purpose and scope of the research was described, along with the assurance that their anonymity with regard to the data would be maintained. The survey contained 23 questions, with nine sub-questions and took an average of 15 minutes for each respondent to complete. The majority of the questions were open-ended, providing the subjects the opportunity to provide as much or as little information as they were comfortable giving. Quantifying questions were avoided, with the belief that more valuable data would be gathered by allowing the subjects to respond in a way that reflected their perceptions and knowledge of the subject.

Responses were collected and grouped with similar responses to try to determine significant trends in the data. As this was a qualitative study, the researcher used his knowledge and experience to interpret the data provided and to coalesce it into a cohesive data set.



### **3.5 Validity of Survey Instrument**

It is traditional in academic writings to make a statement regarding the validity of the survey instrument, where a survey is the primary means of data-collection. This is done in order to instill confidence in the reader that the findings of the survey provide an adequate sample of the population as a whole. As a 100 percent response rate was achieved, and the position of every member of the population was determined it was decided that no such statement was needed. The survey results do reflect the position of the population as a whole.

## 4 FINDINGS

The data collected through the survey is included in these findings. For clarity, the responses have been grouped into common response categories. Special notice has been taken of responses that were unexpected or remarkable.

The complete survey has been included in Appendix A, and the associated, unedited responses are found in Appendix B. A brief summary of the findings is given below.

### 4.1 Survey Questions

*How often have you received a model as part of the bidding documents prior to this project?*

According to the data a building information model is rarely available to general contractors for estimating purposes. Four respondents stated that they had never received a model as part of the bidding documents. Two received a model with the documents less than 10 percent of the time. The last two, however, claimed to receive a model with the bidding documents 50 to 60 percent of the time.

One of these last two respondents indicated that he was including renderings, which are two-dimensional elevation drawings, as part of his model count. It is clear that his understanding of the word model was different than that intended by the survey. The wide disparity between these two respondents and the rest of the respondents makes it seem possible that both of these respondents may have had the same misunderstanding of the term “model”.

Three of the respondents who said they had never received a model with the bidding documents, replied that they did not consider a model to be a part of the bidding documents under any circumstance, particularly given the disclaimers attached to the model by the designers.

*Approximately how many total jobs have you bid during that same time period?*

The six respondents that answered the question did so by stating how many jobs they bid in a year. Four of the respondents reported bidding between 40 and 60 jobs a year, two of them claimed to bid more than 175 and two did not answer the question.

*What estimating software did you use to help prepare the estimate for the Deseret Towers project?*

Most of the respondents reported using multiple programs to develop and process their estimates. Of the eight respondents, seven used Excel, four used OnScreen Takeoff, three used Timberline, two used Revit, one used the SmartBidNet online software, one used Roctec which is a proprietary estimating software package, one used Interactive Cost Estimating by MC2, and one used PlanSwift.

*How complete was the model you received?*

Three respondents did not use the model and were not sure of its completeness. The other five responses ranged from “pretty complete” to “really complete.” One of the respondents that did not use the model stated that the reason he did not use it was that he did not trust the quantities provided by the model. The respondent who stated the model was really complete posed the question “How do you define complete?” He then provided his own definition by stating that the model had all the information that would be available on a traditional two-dimensional plan set.

*Did your company use the model to help prepare the estimate for the Deseret Towers project? If so, how?*

Three respondents stated that they did not use the model at all. Of the remaining five, three used it to get an overview of the project to, “fill in the gaps and to understand the scope of the project.” The three-dimensional aspect of the model helped them to understand the project better, and more rapidly than would have been possible from the two-dimensional plans alone. The final two respondents both used the model to generate quantities during the bidding process. One of respondents used the quantities generated from the model to check against the quantities generated through his usual estimating methods. The other respondent used quantities generated from the model as the basis for the estimate.

*Did you perform quantity takeoffs from the model, why or why not? If yes, how was it done?*

Only two of the eight respondents performed quantity takeoffs from the model. Both used Autodesk’s Revit as the means to perform the takeoff.

*If you did receive quantities from the model, how accurate do you feel they were?*

One of the two that did perform a quantity takeoff from the model also used the quantities to compare against the data he had collected from his usual method. He found that the totals gathered through the model were “fairly similar to the other quantities.” From this statement we can perceive that while the two sets of data were not identical, they did not vary to the point that the two sets of data would have seemed completely disparate when compared side by side.

The respondent that used her data as the basis of her estimate said that while she was fairly confident in the accuracy of the data generated she was “not sure if the Revit software is more accurate than OnScreen Takeoff, or other estimating software, or practices.”

*Did your subs receive the model? Did your subs use the model to help prepare the estimate for the Deseret Towers project? If so, how?*

Only three of the respondents stated that the model was made available to their subcontractors and none were sure if or how it may have been used. One respondent indicated that their steel fabrication shop might have used the model to generate quantities, and prepare their bid. He was unaware as to if or how this was actually done. From the data given it would appear that subcontractors and suppliers are not using BIM at all, with the possible exception of steel fabricators.

It is important to note that the subcontractors were not interviewed directly, nor were the respondents given the opportunity to check with their subcontractors to determine to what extent they may have used the model.

*Did your suppliers receive the model? Did your suppliers use the model to help prepare the estimate for the Deseret Towers project? If so, how?*

The three respondents who made the model available to their subcontractors also made it available to their suppliers, but were again unsure if or how it may have been used. The explanation given above with regards to the indirectness of the knowledge of the respondents about their subcontractors also applies in this instance.

*If you were awarded the job how would you have planned to use the model?*

Most of the respondents would have used the model for multiple purposes. Of the eight respondents five stated they would have used it for clash detection. Two would use the model for scheduling, two would use it for project overview, one would use it for project management, one would use it to generate shop drawings, and one would use it to generate some quantity takeoffs.

*What do you feel are reasons that companies do not use BIM in estimating more frequently?*

Each respondent listed multiple reasons for not using BIM more frequently for estimating. Four respondents cited the lack of familiarity with models and model estimating software. Three respondents stated that they were uncomfortable with the reliability of quantities generated from models. Another three cited the cost and time required for training in a new system to be prohibitive. Two respondents stated concern about the liability associated with the quantities generated from models, since the architect's and designer's disclaimers lead one to doubt the accuracy of the model. Another two respondents stated that many general contractors do not self perform quantity takeoffs but rely on their subcontractors to generate their own quantities. Two more respondents said that older contractors do not want to learn a new system. Finally, one respondent stated that the industry is not being pushed into using models for estimating by subcontractors or suppliers.

*Have you ever received training on estimating from a model? If not, do you plan to receive training on estimating from a model in the future?*

Three of eight respondents had received hands-on training on estimating from a model. Two additional respondents stated that they had been "self-taught" through online tutorials. When those who had not received hands-on training were asked if they would receive training in the future their responses were less than enthusiastic. The most positive response was "Yes, I assume so." However, none went as far as to flatly refuse, though one came close when he said "No, though someone could convince me." The general attitude seemed to be summed up in this response: "Possibly, depending on interest from other estimators," or, to rephrase, "I will if I have to."

*How frequently do you work with models?*

Four of the respondents work with models on a regular basis, meaning that some of them work with models at least once a week, and some as often as every day. The remaining four reported working with models only rarely. Two stated that they have never worked with a model, and the other two reported working with models “hardly at all.”

*Have you ever done a takeoff from a model before?*

Four of the respondents had done takeoffs from a model previously. The remaining four respondents had not.

*How much information useful to estimating do you feel is contained in a model?*

The respondents replied on a scale from one to five, with one being “very little”, and five being “a lot.” The average of all respondents was 3.625 showing a slight preference toward there being a lot of useful information. The lowest score was a 2.5, however, the individual added the comment that “we are barely touching the surface of its capability,” indicating that even he felt that there is a tremendous amount of potential information in a model.

*Have you ever attended any BIM seminars? If so, what did you gain by going to that seminar?*

Three of the respondents replied that they had attended a BIM seminar. One of them felt that the presenter was far too optimistic about the future of BIM, another was intrigued to see how other contractors were using BIM, and the third had the opportunity to practice clash detection, scheduling and estimating using BIM.

*What do you feel is the future of BIM in estimating?*

Five of the respondents stated that BIM will be used in estimating in the future to some degree, though one of those qualified his statement to only include Design/Build and CM/GC projects where the General Contractor is involved in the preconstruction phase. Two of the

remaining respondents stated that they don't know what the future of BIM is in estimating, and the final respondent said that he thought BIM was weak on the estimating side of things, though it is great in other applications.

*How do you plan to incorporate BIM into your estimating practices in the future?*

Three of the respondents indicated that their plans for the future included hiring people who already know how to use the software and then have them train the rest of the office. The rest of the respondents stated that they currently have no plans to incorporate BIM into their estimating practices.

*How many people make up the estimating department you are involved with?*

Four of the respondents work in estimating groups made up of five or less individuals. Two of the respondents departments are made up of between 10 and 20 people and the remaining two work in departments of between 20 and 30. The average department size was 11.625.

*Is the total cost of this project typical of the projects you usually estimate?*

Four of the respondents regularly work with projects similar in cost and scope to the Deseret Towers project. This project was larger than usual for the remaining four respondents.

*How many jobs have you bid in the last year?*

One respondent reported bidding less than 20 jobs a year, four reported between 40 and 60 jobs a year, and two bid more than 175. The final respondent qualified his statement by only reporting the ten projects his company bid in the last year that were similar in cost to the size of this project. The average number of projects bid per year was 83.375.

*How would you describe your typical project?*

The general contractors were typically involved in more than one type of project. Rather than stating their typical project the respondents stated the types of projects that they generally



construct. Six of the respondents stated that they build commercial projects, four build hospitals, four build school projects, two build municipal buildings, and one works on industrial projects.

*What aspects of construction do your company self-perform?*

The respondents were allowed to give more than one answer in order to get a more complete idea of the work that is generally self-performed by the companies. Seven of the respondent's companies self-perform the concrete work, six self-perform rough carpentry, two are involved with the steel erection, one works with the earthwork and utilities, and one does doors and hardware.

*My company uses BIM in the following applications:*

The table below shows the uses of BIM common to the construction process and how frequently the respondent's companies are incorporating them. All eight companies responded to this question, and each was allowed to indicate all uses that they incorporated.

**Table 4-1: Uses of BIM**

<b>Uses of BIM</b>	<b>Count</b>	<b>Percent</b>
Marketing	8	100%
Collision Detection	7	87.5%
Estimating	2	25%
Scheduling	4	50%
Budgeting	2	25%

## 5 CONCLUSION

While BIM is not being used very frequently at present for detailed estimates, the data indicated that contractors are incorporating it into their procedures. It was evident that each contractor is proceeding at a pace with which they are comfortable. Nearly all of the contractors were aware of BIM and were carefully following its progress with the intention of including it to a greater degree as it becomes proven and its weaknesses are overcome. The majority of contractors to one degree or another have adopted BIM as indicated by the industry's use of BIM for collision detection and marketing.

There are aspects of BIM that are easily incorporated into established business practices, and others that appear to be more difficult to implement. Estimating with BIM may be one of those aspects that is more difficult for contractors to incorporate. It requires a greater understanding of how BIM generates its quantities and how those totals can be manipulated to create accurate costs. There is investment of time, money and research required to reach the level of comfort with BIM estimating necessary to put business managers at ease. It is a significant factor to the success and profitability of a construction company (Shen and Issa, 2010). Many business owners don't want to disrupt a delicate system that is working well enough. The solution to overcoming these fears is training and experience. As BIM becomes more widely used for estimating it will eventually become unavoidable. Companies will need to adopt it in order to stay competitive.

From this study it appears that one of the primary barriers to the adoption of BIM is fear of the unknown. There is little understanding of the real benefits available through BIM, and what steps must be implemented to incorporate these benefits into standard business practices. There is uncertainty about costs of implementation as well as the potential financial benefits. There are uncertainties about the liability issues involved with performing takeoffs from a model that has disclaimers from the designer, essentially voiding the validity of quantities generated from it. Few are exactly sure how accurate the BIM estimate is when compared to already established estimating methods.

Despite these issues, BIM is certain to have a future in construction and a future in estimating. Nearly all of the contractors in this study felt that it is inevitable that BIM will be used for estimating in the future and that it will eventually be able to deliver all of the promised benefits. However, there is work that certainly needs to be done to get the construction industry to that point.

Contractors should develop a plan of integration that would provide the necessary equipment and training on a graduated schedule. The plan should incorporate stages at which BIM estimates are compared against estimates produced by the company's established methods to verify accuracy and to be able to make any necessary adjustments. It should be accomplished at the rate at which the funding can be safely secured. It is an investment that is worth making, but as with any investment, it must be wisely implemented.

## **5.1 Further Study**

In the interest of increasing the understanding of the benefits of BIM, a study should be undertaken to verify the accuracy of detailed estimates prepared using BIM, and thereby

identifying potential traps that should be avoided. It would also be useful to do a study on the implications of the liability to the designer, the owner and the contractor, who would best carry that risk, and how it could best be dealt with. Further work in establishing a standard protocol the use of BIM could be promoted. Finally, an additional study could be conducted that would clarify how BIM is being used by subcontractors and suppliers in their bidding practices.

## **5.2 Recommendations**

It is the researcher's opinion that contractors should begin implementing portions of BIM into their estimating practices immediately. As was acknowledged by the majority of the participants in this study, BIM will likely become the standard for estimating practices in the future. There is a learning curve with BIM, and implementation takes time and money. Now is the best time to learn how to integrate the new systems into business practices, so that when the software and other procedures are standardized there will be no delay to the realizable benefits of estimating with BIM. The company that does this will have an advantage in the marketplace over a company that delays implementation.

A further recommendation is for all parties involved in building design and construction to set aside time to review the liability issues with BIM and decide upon a way to fairly distribute the risk among all parties. The potential benefits to all parties warrant some give and take from each entity. As BIM is a wholly collaborative effort any party unwilling to accept any liability may find themselves as a stumbling block to the eventual acceptance and integration of BIM to the construction industry. It would be best for parties that habitually absolve themselves from all liability to change their approach to contracting so that they can remain players in shaping the future of the construction industry.

BIM is a movement that is gaining momentum, and with the vast array of benefits available to everyone involved in construction, from owners to facility managers, BIM will continue to spread and become central to the way construction is done in the future.

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## APPENDIX A. Survey

### Phone Introduction:

Hello, my name is Peter Jensen. I am a Masters student at BYU and am conducting a study for my Thesis that is trying to determine the current use of BIM models in estimating. This interview will include 23 questions and should take no longer than 15 minutes to complete. The study is in no way connected with the Planning Department at BYU, and all data that is gathered will be presented in an anonymous format to any other party. Are you willing to participate in this study?

1. How often have you received a model as part of the bidding documents prior to this project?
  - a. Approximately how many total jobs have you bid during that same time period?
2. What estimating software did you use to help prepare the estimate for the Deseret Towers project?
3. How complete was the model you received?
4. Did your company use the model to help prepare the estimate for the Deseret Towers project? (yes/no)
  - a. If so, how?
5. Did you perform quantity takeoffs from the model, why or why not?
  - a. If yes, how was it done?
6. If you did receive quantities from the model, how accurate do you feel they were?
7. Did your subs receive the model? (yes/no)
  - a. Did your subs use the model to help prepare the estimate for the Deseret Towers project? (yes/no)
  - b. If so, how?

8. Did your suppliers receive the model? (yes/no)
  - a. Did your suppliers use the model to help prepare the estimate for the Deseret Towers project? (yes/no)
  - b. If so, how?
9. If you were awarded the job how would you have planned to use the model?
10. What do you feel are reasons that companies do not use BIM in estimating more frequently?
11. Have you ever received training on estimating from a model?
  - a. If not, do you plan to receive training on estimating from a model in the future?
12. How frequently do you work with models?
13. Have you ever done a takeoff from a model before?
14. How much information useful to estimating do you feel is contained in a model?

Very Little    1    2    3    4    5    A lot

15. Have you attended any BIM seminars?
  - a. If so, what did you gain by going to that seminar?
16. What do you feel is the future of BIM in estimating?
17. How do you plan to incorporate BIM into your estimating practices in the future?
18. How many people make up the estimating department you are involved with?
19. Is the total cost of this project typical of the projects you usually estimate?
20. How many jobs have you bid in the last year?

21. How would you describe your typical project?
- a. Commercial
  - b. Residential
  - c. Industrial
  - d. Hospitals
  - e. Schools
  - f. Other \_\_\_\_\_
22. What aspects of construction does your company self-perform?
23. My company uses BIM in the following applications: (check all that apply)
- Marketing
  - Collision detection
  - Estimating
  - Scheduling
  - Budgeting
  - Other \_\_\_\_\_

**APPENDIX B. Survey Results**

<b>Results</b>
<b>Total Records in survey: 8</b>
Percentage of total sample: 100%

Question #1:		
How often have you received a model as part of the bidding documents prior to this project?		
Answer	Count	Percentage
Answer	8	100.00%
No Answer	0	0.00%
Answers		
1	"Part of the bidding documents"—never. Considering BYU and Nexus’s disclaimers that we had to sign, I would not say that the DT model was “part of the bidding documents”.	
2	10% of the time	
3	Several. 50-60% currently. Becoming more available all the time.	
4	Never	
5	Never	
6	I can't think of any	
7	Maybe 5% of the time.	
8	50% of the time (Renderings, etc.) This was the first time on a hard bid	

<b>Question #1a:</b>		
<b>Approximately how many total jobs have you bid during that same time period?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	7	87.50%
No Answer	1	12.50%
<b>Answers</b>		
1	We had other guys in our office that were involved on DT on bid day that bid other jobs during the bid time but my time was almost all on DT.	
2	About 250	
3	No Answer	
4	40/year	
5	50	
6	Which time period? We probably bid at least 50 projects per year	
7	179	
8	60 hard bids.	
<b>Question #2:</b>		
<b>What estimating software did you use to help prepare the estimate for the Deseret Towers project?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	Timberline, Onscreen & Excel	
2	Timberline	
3	Excel, Revit	

4	Timberline, OST, Smart bid.net, Excel		
5	Excel, Roctec (proprietary)		
6	On-Screen Takeoff, Excel, MC2 ICE		
7	Plan Swift Takeoff (like OST), Excel, Revit		
8	OST, Excel		
<b>Question #3:</b>			
<b>How complete was the model you received?</b>			
	<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
	Answer	8	100.00%
	No Answer	0	0.00%
<b>Answers</b>			
1	No idea...didn't even open the file prior to winning the job. What is the point when neither the GC or any of the subs can be tied contractually to it?		
2	Pretty complete		
3	90% complete		
4	Did not use it. Nobody in the office that knows how to use the model. Received some training from BYU but do not trust quantities provided.		
5	Unsure		
6	Model wasn't used, not sure on completeness.		
7	Only the architectural was modeled, but it seemed complete		
8	Really complete. Though how do you define complete? All the information that you would have on a 2-D plan set.		

<b>Question #4:</b>		
<b>Did your company use the model to help prepare the estimate for the Deseret Towers project? (yes/no)</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	NO	
2	I didn't - I'm Old School, but Mark did	
3	Yes	
4	Yes	
5	Not very much	
6	No	
7	A little bit	
8	No	
<b>Question #4a:</b>		
<b>If so, how?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	5	62.50%
No Answer	3	37.50%
<b>Answers</b>		
1	No Answer	
2	Familiarized himself with the the project through the model. Double-checked quantities with Revit	

3	Quantity takeoff		
4	Just to get an overview of the project.		
5	General overview		
6	No Answer		
7	Fill in the gaps. Scope of project. No takeoffs.		
8	No Answer		
<b>Question #5:</b>			
<b>Did you perform quantity takeoffs from the model, why or why not?</b>			
	<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
	Answer	8	100.00%
	No Answer	0	0.00%
<b>Answers</b>			
1	NO! Again, given the disclaimers, I can't rely upon this model in any way.		
2	Yes		
3	Yes		
4	No		
5	No		
6	Model not used		
7	No		
8	No		



<b>Question #5a:</b>		
<b>If yes, how was it done?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	2	25.00%
No Answer	6	75.00%
<b>Answers</b>		
1	No Answer	
2	With Revit to double-check quantities	
3	With Revit	
4	No Answer	
5	No Answer	
6	No Answer	
7	No Answer	
8	No Answer	
<b>Question #6:</b>		
<b>If you did receive quantities from the model, how accurate do you feel they were?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	2	25.00%
No Answer	6	75.00%
<b>Answers</b>		
1	No Answer	
2	Fairly similar to estimated quantities	
3	Fairly accurate. Not sure if it is more accurate than OST or other estimating software or practices.	

4	No Answer
5	No Answer
6	No Answer
7	No Answer
8	No Answer
<b>Question #7:</b>	
<b>Did your subs receive the model? (yes/no)</b>	
<b>Answer</b>	<b>Count</b> <b>Percentage</b>
Answer	8      100.00%
No Answer	0      0.00%
<b>Answers</b>	
1	No. The list of subs that bid this job, and would be sophisticated enough to utilize this information, is in the single digits.
2	Yes
3	Yes
4	No
5	Not sure
6	No
7	Yes
8	No

<b>Question #7a:</b>		
<b>Did your subs use the model to help prepare the estimate for the Deseret Towers project? (yes/no)</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	4	50.00%
No Answer	4	50.00%
<b>Answers</b>		
1	No Answer	
2	Steel suppliers may have	
3	Not sure	
4	No Answer	
5	Don't know	
6	No Answer	
7	No Idea	
8	No Answer	
<b>Question #7b:</b>		
<b>If so, how?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	1	12.50%
No Answer	7	87.50%
<b>Answers</b>		
1	No Answer	
2	Don't know	
3	No Answer	

4	No Answer
5	No Answer
6	No Answer
7	No Answer
8	No Answer
<b>Question #8:</b>	
<b>Did your suppliers receive the model? (yes/no)</b>	
	<b>Answer</b>
	<b>Count</b>
	<b>Percentage</b>
	Answer
	8
	100.00%
	No Answer
	0
	0.00%
<b>Answers</b>	
1	Not from me if they did.
2	Yes
3	Yes
4	No, nobody is asking for it yet. We do Design-Bid jobs – two BIM guys work with subs to create models. Model provided to same estimating department, but still not using model. Waiting for a job with more time to estimate both ways and then compare to find inconsistencies.
5	Yes
6	No
7	Yes
8	NO. It is not a contract document. It just confuses people. If model is incorrect there is a liability issue, as to who accepts responsibility for the error.

<b>Question #8a:</b>		
<b>Did your suppliers use the model to help prepare the estimate for the Deseret Towers project? (yes/no)</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	4	50.00%
No Answer	4	50.00%
<b>Answers</b>		
1	No Answer	
2	Don't know	
3	No Idea	
4	No Answer	
5	Don't know	
6	No Answer	
7	No Idea	
8	No Answer	
<b>Question #8b:</b>		
<b>If so, how?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	0	0.00%
No Answer	8	100.00%
<b>Answers</b>		
1	No Answer	
2	No Answer	
3	No Answer	

4	No Answer
5	No Answer
6	No Answer
7	No Answer
8	No Answer
<b>Question #9:</b>	
<b>If you were awarded the job how would you have planned to use the model?</b>	
	<b>Answer</b>
	<b>Count</b>
	<b>Percentage</b>
	Answer
	8
	100.00%
	No Answer
	0
	0.00%
<b>Answers</b>	
1	Now that we have the job, we are using the model. Mostly to building a 3D schedule for sub / project management purposes.
2	For Reference as it is a visual representation of the completed project.
3	Clash detection, shop drawings.
4	Would have used the model for clash detection.
5	Yes, overview.
6	Coordination of subcontractor systems, some quantity takeoffs
7	4d schedule, mechanical/electrical Coordination, clash detection.
8	Clash Detection

<b>Question #10:</b>		
<b>What do you feel are reasons that companies do not use BIM in estimating more frequently?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	Unreliable qty's....by the time I verify and feel good about it I may as well have just used On Screen. How do you use it in a hard-bid scenario when the architect won't stand behind any of the information?	
2	Not comfortable with the software, the model or generated quantities.	
3	Ignorance. They don't understand the capabilities. They think it is expensive. We detected over 11,000 clashes on a recent project. Reduced the size of change orders by 90%. If we had one million dollars worth of change orders on this project, it would have been 10 million without clash detection.	
4	One is cost (hiring personnel), training – trust factor in estimating – leery of automatically generated quantities – with OST estimator can control whether estimate is skinny or fat. Estimating is a process where the estimator can learn the project at the same time as doing the takeoff. Model still needs to be learned. We are not pushed by subs or suppliers to have a model to takeoff from.	
5	New to people. Shy away from new things. Don't know what it is about. Rely on subs rather than self-performing takeoffs.	
6	Subcontractors do a bulk of the quantity takeoff, older estimators are not interested in learning a new system	
7	Time constraints don't allow for the opportunity to get into it. Design build, CM/GC would allow more use of BIM in estimating.	
8	Liability issues. Greater familiarity with 2-d environment. If you can visualize the 2-d environment there is no need for the model. The model is good for getting an overall feel for the project.	

<b>Question #11:</b>		
<b>Have you ever received training on estimating from a model?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	Just presentations on it. Not hands on training.	
2	Mark has, not me.	
3	Yes, Autodesk online training.	
4	QTO training with Kevin Miller. Great get your feet wet experience. Would need many more training sessions to feel comfortable. May get one QTO guru to train everyone else.	
5	No	
6	No, self-taught	
7	Yes, 2 - 8 hour seminars.	
8	No	
<b>Question #11a:</b>		
<b>If not, do you plan to receive training on estimating from a model in the future?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	5	62.50%
No Answer	3	37.50%
<b>Answers</b>		
1	I assume so.	
2	Mark will, not me.	
3	No Answer	



4	No Answer
5	NO, someone could convince me.
6	Possibly, depending on interest from other estimators
7	No Answer
8	Possibly. Would be interested
<b>Question #12:</b>	
<b>How frequently do you work with models?</b>	
	<b>Answer</b>
	<b>Count</b>
	<b>Percentage</b>
	Answer
	8
	100.00%
	No Answer
	0
	0.00%
<b>Answers</b>	
1	For estimating purposes, never. For pre-construction proposals about 30% of the time.
2	Not very often
3	3 to4 times a year. Company has a dedicated BIM person.
4	Never
5	Hardly at all
6	Daily
7	Frequently – design build jobs
8	Weekly. Fairly comfortable with navigating and understanding the model. Not a guru

<b>Question #13:</b>		
<b>Have you ever done a takeoff from a model before?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	Yes	
2	No	
3	Yes, 1 out of 10 jobs bid in the last year.	
4	No	
5	No	
6	Yes	
7	Use to get general quantities. Just for budgeting not for bids.	
8	No	
<b>Question #14:</b>		
<b>How much information useful to estimating do you feel is contained in a model? 1 1 (very little) - 5 (a lot)</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	That I would be comfortable relying on "very little". Information available "a lot"	
2	4.5 - 3d view - no guess work	
3	2.5 Currently. We are barely touching the surface of its capability.	

4	5 - depends on how the model is developed. QTO could replace OST if the model is done right.		
5	3		
6	4		
7	5		
8	5 - 2d is also 5		
<b>Question #15:</b>			
<b>Have you attended any BIM seminars?</b>			
	<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
	Answer	8	100.00%
	No Answer	0	0.00%
<b>Answers</b>			
1	YES		
2	No		
3	No, but others in the company have.		
4	No		
5	No		
6	Yes		
7	Yes		
8	No		

<b>Question #15a:</b>		
<b>If so, what did you gain by going to that seminar?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	3	37.50%
No Answer	5	62.50%
<b>Answers</b>		
1	That there is great potential but most "salesman" are far too optimistic about how fast this will be incorporated into estimating....	
2	No Answer	
3	No Answer	
4	No Answer	
5	No Answer	
6	Seeing how other generals are using BIM for their work	
7	First one I attended was an introduction to BIM. Second was practical, and a portion was estimating (20%). Mostly coordination and 4d scheduling.	
8	No Answer	
<b>Question #16:</b>		
<b>What do you feel is the future of BIM in estimating?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%

<b>Answers</b>		
1	On a design/building or CM/GC job where the General is involved through preconstruction, I can see it being utilized in the future—but probably not as fast as the “salesman” like to say. On a hard bid job, such as DT, I’m skeptical that it will ever be used.... Architects don’t want that responsibility.	
2	Most clients want to see a model.	
3	Computer will spit out quantities. Estimator not necessary for obtaining quantities.	
4	It is where it is going. No getting around it.	
5	Don’t know much about it.	
6	Automated quantity takeoffs, you still need an estimator to analyze for costs though.	
7	At some point we will just use the model.	
8	I think it is going to lag behind 2-d estimating. Primary uses with MEP coordination. Clashes don’t create a big difference in estimating. BIM is weak on the estimating side. Great for other applications.	
<b>Question #17:</b>		
<b>How do you plan to incorporate BIM into your estimating practices in the future?</b>		
	<b>Answer</b>	<b>Count</b>
	<b>Percentage</b>	
	Answer	7
	No Answer	1
		87.50%
		12.50%
<b>Answers</b>		
1	We’ll see where it goes from here....wait and see...	
2	Hire people like Mark to do it	
3	Not sure. We are in the wait and see mode. Waiting for program to progress further. Need to determine the accuracy of the quantities generated from the model using Revit.	
4	BIM guru to be trained and then train the rest of the office.	

5	Not immediately
6	See above
7	We are using it more and more. We have hired a revit guy and are doing more in house
8	No plans at this time. Other than project overview.

**Question #18:**

**How many people make up the estimating department you are involved with?**

Answer	Count	Percentage
Answer	8	100.00%
No Answer	0	0.00%

**Answers**

1	Lindon office: 4 SLC office: 15
2	4 total
3	30 people
4	8 people in immediate group. There is another group with 3 estimators
5	3 work on different aspects
6	Approximately 20
7	5
8	1

**Question #19:**

**Is the total cost of this project typical of the projects you usually estimate?**

Answer	Count	Percentage
Answer	8	100.00%
No Answer	0	0.00%

Answers		
1	Larger	
2	Yes, as an average	
3	Yes	
4	Yes	
5	Bigger than usual. 5 - 15 million area typical.	
6	Yes	
7	This is on the larger side. Jobs this size 20/180	
8	No this is larger	
<b>Question #20:</b>		
<b>How many jobs have you bid in the last year?</b>		
Answer	Count	Percentage
Answer	8	100.00%
No Answer	0	0.00%
Answers		
1	Probably around 18	
2	Around 250	
3	9-10 in the \$40 million range.	
4	Around 40 - a lot of remodel	
5	50	
6	Unsure, Salt Lake Office has bid approximately 60	
7	179	
8	60	

<b>Question #21:</b>		
<b>How would you describe your typical project?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	Commercial	
2	Schools, Hospitals, Rec-centers, jails, commercial	
3	50-60% commercial, 5-10% hospitals, the rest schools, industrial	
4	Mostly hospital or healthcare. The other group does schools and municipal buildings	
5	Schools	
6	Commercial	
7	Commercial, Hospitals, Schools	
8	Commercial	
<b>Question #22:</b>		
<b>What aspects of construction does your company self-perform?</b>		
<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
Answer	8	100.00%
No Answer	0	0.00%
<b>Answers</b>		
1	Concrete, Some rough Carpentry	
2	Earthwork, Utilities, Concrete, steel erection, carpentry	
3	Concrete and rough carpentry	
4	Concrete	



5	Concrete, carpentry, some steel		
6	Concrete, some carpentry.		
7	Concrete, Carpentry		
8	None – sometimes doors and hardware. Small stuff		
<b>Question #23:</b>			
<b>My company uses BIM in the following applications: (check all that apply)</b>			
	<b>Answer</b>	<b>Count</b>	<b>Percentage</b>
	Marketing	8	100.00%
	Collision Detection	7	87.50%
	Estimating	2	25.00%
	Scheduling	4	50.00%
	Budgeting	2	25.00%
	Other	0	0.00%
<b>Other Comments:</b>			
1	We have 3D concrete Estimating Software but we use it only for concrete		
2	It is coming		
4	Just a matter of time. We know we need to head in that direction.		
8	Sometimes owners don't want to pay for modeling expenses.		