

Building Information Models as Contract Documents: Common Practice for the U. S. Construction Industry – A Preliminary Report

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Abstract:

Building Information Models (or “BIM”) are being utilized to facilitate better collaboration and coordination on construction projects throughout the building industry. The question this research seeks to answer is, “To what extent is BIM being relied upon as contract documents by the U.S. construction industry?” In the United States, two different contract addenda (E202 Building Information Modeling Protocol Exhibit and Consensus Document 301 BIM addendum) have been introduced to allow the contracting parties to decide whether or not BIM is to become part of the contract. Further, the parties may then decide the order of precedence of the design information which may include both BIM and two-dimensional drawings created independent of BIM. The reasons in favour and against BIM being treated as contract documents should reveal some of the shortcomings and challenges related to BIM which, in part, prevent such models from completely replacing traditional two-dimensional drawings. For this research, architects, contractors and owner representatives were surveyed to discover their methods for dealing with the issue of BIM as contract documentation.

Although BIM has been utilized as a design and planning tool for a number of years, many in the construction industry are more comfortable with the use of traditional two-dimensional environments to define the construction contract. Even on projects that utilize BIM, it appears that BIM has not supplanted the traditional two-dimensional drawings when it comes to defining the scope of work through the contract documents. The goal of this study is, therefore, to determine to what extent BIM contract language is supplementing traditional contract language as used in the U.S. construction industry.

Keywords:

BIM, Building Information Models, Construction Documents, Order of Precedence

1 Introduction/Background

Building Information Modeling is a data-rich, object-oriented, intelligent digital representation of a facility. Two-dimensional drawings, such as lines, arcs and circles, are graphical entities only. In contrast, BIM define objects in terms of building elements and systems like spaces, walls, beams and columns (Azhar et. al., 2008 citing AGC, 2005 and CRC Construction Innovation, 2007). Building information models are much more than just three-dimensional representations of two-dimensional drawings. They also enable users to add cost, schedule, sustainability and other useful information to

the model. Despite all of the potential and possibilities, the legal and business structures for incorporating building information modeling lag far behind the technical advances (Ashcraft 2008). Since its introduction, BIM has been seen as the cornerstone of a promising technology that could revolutionize the construction industry by enabling construction professionals to engage in virtual design and construction. This would allow participants to achieve an unprecedented level of collaboration, and in return, have significant impacts on cost efficiency and effectiveness. One of the biggest obstacles to implementing BIM has been the fact that most, if not all, of the standard form contracts employed by construction professionals completely ignored, or inadequately addressed, how BIM is to be a part of the process (Lowe and Muncey, 2009).

In construction contracts, words alone do not define the agreement. Many documents, including graphical representations, come together to form the contract. These documents are naturally referred to as contract documents and are used to define the scope of work. Traditionally, contract documents include (a) the contract, (b) general conditions, (c) plans, (d) specifications, and (e) any other written conditions upon which the parties agree. The plans included in this traditional definition of contract documents are typically two-dimensional drawings (Hurtado and O'Connor, 2008). BIM potentially could upset the traditional definition of contract documents and replace some or all of the two-dimensional drawings, specifications and other written conditions with BIM based information and data.

Defining the contract documents is much more than a trivial part of the construction process. It is the basis from which the parties will work, coordinate and collaborate throughout the building process. According to the Spearin Doctrine¹, if a contractor follows the plans and specifications provided by or on behalf of the owner, and if those plans or specifications turn out to be defective, the contractor cannot be held liable for any losses related to those defects. Despite the age of the Spearin case, this doctrine remains the law in the United States and, as such, “contract documents” are of critical importance to the entire construction process. To stand in place of traditional two-dimensional contract documents, BIM must contain a tremendous amount of information and be relied upon by the parties as the primary source of information. Depending upon how BIM is utilized on a project, each model may not include enough design information to be referred to as a “contract document.”

Theoretically, each construction project utilizing BIM would have a fully integrated model from which all design and construction information could be obtained. If this were the case, BIM could be used to replace many contract documents and stand by itself as the single source of information for the design, construction and operation of a facility (Post, 2009a). While conceptually possible, several key points have prevented BIM from being fully adopted in this manner. First and foremost, the concept of a single model for a building project is not currently a reality. Often on projects that utilize BIM, several federated models are created for individual components of the facility. Secondly, the federated models are often themselves not the product of shared efforts and information. Instead, each is created independently from the two-dimensional drawings received from the designers (Post, 2009a; Post, 2009b).

From the designer’s perspective, the use of BIM often presents increased risk and effort for very little reward. Use of BIM requires a higher level of accuracy and integration from the designers;

¹ *U.S. v. Spearin*, 54 Ct. Cl. 187, 248 U.S. 132, 136-37, 39 S. Ct. 59, 63 L. Ed. 166, 42 Cont. Cas. Fed. (CCH).

however, it does not always entitle them to more compensation. The nature of BIM's three-dimensional environment requires designers to coordinate the drawings much more purposefully and to take on some of the coordination efforts that traditionally have been the responsibility of the contractor (Post, 2009a). Ironically, from a designer's perspective, it is oftentimes deemed better to incorporate as little detail as necessary into the model, so as to not take on additional responsibility and expose themselves to additional risk. With traditional two-dimensional contract documents, designers are able to show certain systems and components schematically (i.e. MEP & structural steel) while leaving the detailed design up to the fabricators and specialty contractors. By introducing the three-dimensional environment, lines and symbols no longer suffice and specific objects have to be added to the model.

On the other hand, contractors typically desire the model to contain as much information as possible to enable them to coordinate the work, get accurate quantity takeoffs, and to perform class detection. Clearly, the full adoption of BIM continues to be hampered by positives and negatives that tend to offset (Post, 2009a; Post, 2009b). Currently, while members of a project team intend to use BIM for collaborative purposes, they also operate independently of one another. The team's collaborative efforts are based primarily on digital models, while the contract documents legally governing the contractors' work continue, for the most part, to be two-dimensional plans and specifications (Larson, 2008).

In 2008, two groups independently proposed contract language to incorporate BIM into the construction process. Both groups referred to their recommendation as a BIM addendum. The first to come out with its recommendation was a conglomerate of trade organizations that collaborated to develop and promote a new set of construction contracts called ConsensusDOCS. This group referred to its proposal as ConsensusDOC 301 - BIM Addendum (CD301). Later that year the American Institute of Architects came out with its BIM addendum which is called AIA-E202 "Building Information Modeling Protocol Exhibit" (E202). Both of these, while significantly different, were created to provide a contractual framework for the use of BIM on a specific project. Neither of these addenda was intended to replace the standard prime contracts; but rather created as contract riders to deal specifically with the issues surrounding BIM in the building process. The intent of these BIM addenda is to "create a document that would enable parties to easily and effectively introduce 21st century technology, namely virtual design and construction or building information modeling, into construction projects utilizing standard form documents" (Lowe and Muncey, 2009).

The BIM Addendum is an *addendum*, and is not intended to be used as a substitute for other standard form agreements between owners, design professionals, and contractors. Rather, an identical copy of the BIM Addendum is required to be appended to the contract between the owner and design professional and to the contract between the owner and the contractor. The effect of his arrangement is that the contractual relationships among the three principal parties (owner, design professional and contractor) are largely preserved, and any significant shift in contractual responsibility among these parties is avoided. At the same time, by implementing the BIM Addendum, all three of the principal parties agree to perform certain BIM-related tasks and assume certain BIM-related responsibilities, all of which must be addressed in order for a BIM project to be successful (Lowe and Muncey, 2009).

While there is a great deal of similarity between the approaches each of the BIM addenda takes, there is also a fundamental difference. While CD301 advocates the implementation of a BIM Execution Plan, E202 introduces the concept of Level of Development. The BIM Execution Plan of CD301 requires that all “Project Participants” meet within 30 days of contract signing and “use their best efforts to agree upon the terms of or modifications to the BIM Execution Plan” (ConsensusDOCS, 208). As a part of this process a checklist is used to guide the parties in the plan development. The checklist begins by identifying what models are to be developed, who will be responsible for developing the model and for what purpose each is to be used. The checklist is not intended to be exhaustive but rather a framework from which to develop the plan.

The E202 Level of Development (LOD) requires the parties to assign a LOD from between one to five for each model used in the process. For each LOD there is a description detailing exactly what that particular LOD will include and for what purpose the model can be used. For example, a LOD100 (first level) model element only provides overall building massing information such as area, height, volume, location and building orientation. A LOD500 (fifth and highest level) model is made up of constructed assemblies which are accurate to the extent that they can be relied upon for purposes of construction, maintaining, altering or adding to the project (Haynes, 2009).

The very nature of BIM introduces additional risks that must be allocated among the Project Participants. The BIM Addendum attempts to allocate these risks in the most fair and efficient manner possible. At the same time, the BIM Addendum attempts to deal with these additional BIM-related risks in such a manner as to not upset the typical allocation of risk on a project utilizing two-dimensional drawings and specifications. One of the risks unique to a BIM project is the risk that project participants may rely on the contribution of another project participant as accurate when in fact that contribution is not accurate. CD301 handles this risk by making each party responsible for any contribution that it makes to a model or that arises from that party’s access to that model. E202 addresses this potential problem with indemnification language whereby each party agrees to indemnify the other against claims resulting from modifications or unauthorized use of a model. The approach adopted by each BIM Addendum is simple and straightforward—each party is responsible for any contribution made by it or by any party for whom it is responsible (Lowe and Muncey, 2009).

The emergence of the CD301 and E202 in 2008 can be seen as a major step forward in addressing some of the contractual risks which have previously impeded the implementation of BIM. While these documents have differences, experience and further development of BIM will undoubtedly result in even further modifications to their respective formats and contents. At this stage it is too early to assess which form will become the more preferred as continued development and use of BIM will undoubtedly raise new issues and suggest new solutions. The purpose of this research is to explore some of the issues that have emerged as BIM addenda have been incorporated into construction contracts to get a preliminary understanding of how the project participants chose to address the problem as it applies to the commercial construction industry in the United States.

2 Methodology

This research was conducted to explore how the construction industry in the United States is incorporating the issue of BIM into their contract documents. The research was conducted by sending a survey to designers and contractors requesting their opinions, based on their own personal experience, on how BIM is being incorporated into their contract documents. The survey was an online survey facilitated through Zoomerang. Nineteen complete responses were obtained. One reason for the limited number of responses is simply a reflection that few in the building industry are truly engaged in the use of BIM. Three of the nineteen responses were from designers while the remaining sixteen were from contractors. This is not a statically significant population size but it did allow inferences to be ascertained which were later confirmed via interviews with respected industry professionals who were known to be heavily involved with BIM.

3 Results/Analysis

The first question was simply designed to classify the respondents by profession. As stated above, complete responses were obtained from three designers and sixteen contractors. These two respondent groups were split them into two different tracks in order to track their responses to the questions separately. The first question to the architects' group related to how they initiated their design on projects which utilized BIM. Most responded that they began their design with two-dimensional drawings (See Figure 1).

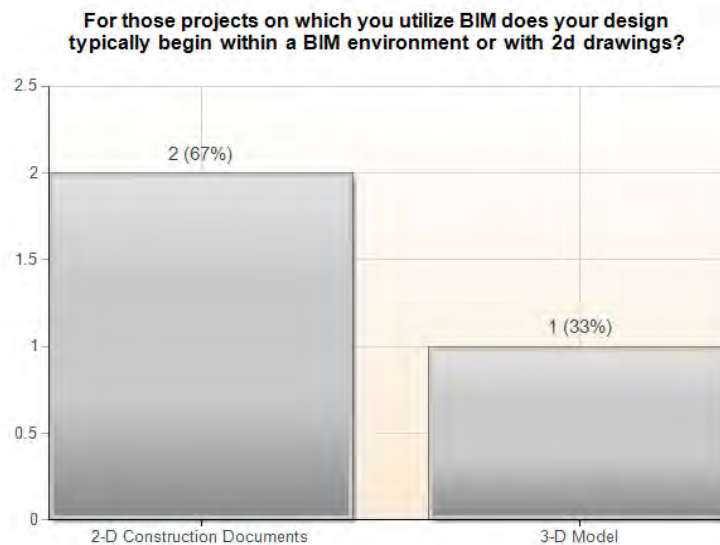


Figure 1.

The next question, asked to both designers and contractors, was which party they saw as responsible for creating the model. This question allowed the respondent to select all that apply but generally the designers (see Figure 2) and the contractors (see Figure 3) agreed that it was primarily the architect's responsibility to create the model, but other parties shared some modeling responsibilities. It appears that the responses to this question reflect the reality that multiple models are produced on a project but participants believe that it is the architect's primary responsibility to create a BIM model.

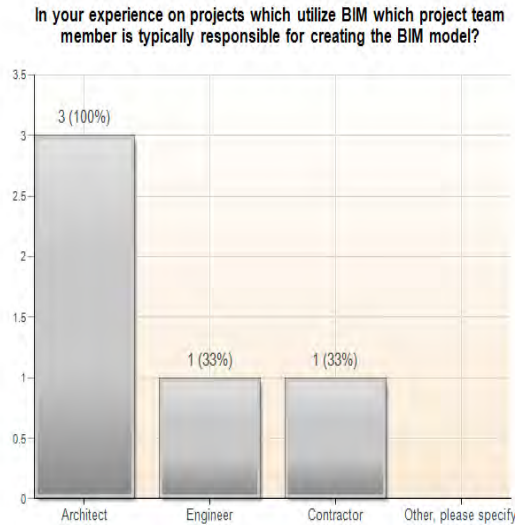


Figure 2.

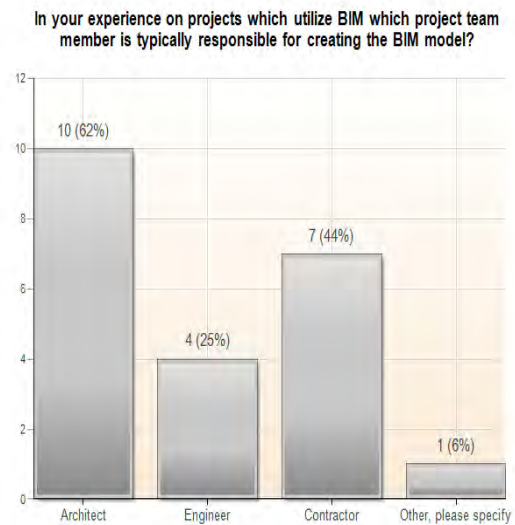


Figure 3.

The next question asked both the designers and contractors to comment on what they see as the primary role of BIM on a construction project. This question allowed the respondent to select all that apply but generally the designers (see Figure 4) and the contractors (see Figure 5) felt that the primary role of the model was to use it for coordination drawings followed by marketing.

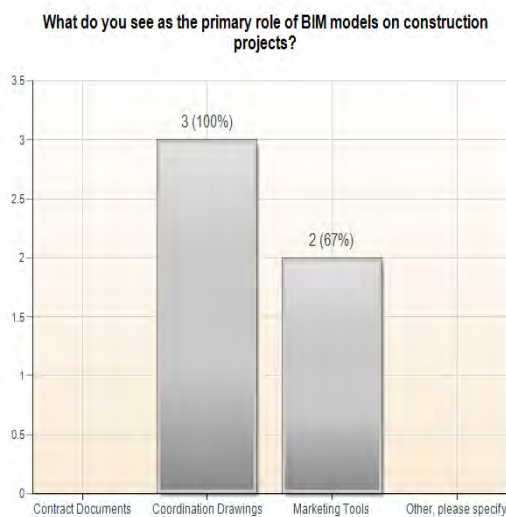


Figure 4.

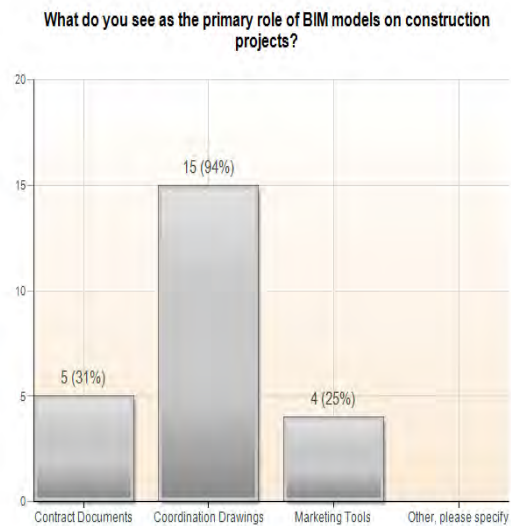


Figure 5.

The next question asked to both the designers and contractors was in their experience whether they had ever used the model as a contract document. This question allowed the respondent to select only one response and generally the designers (see Figure 6) and the contractors (see Figure 7) agreed that the model is typically not defined as contract documents.

On projects in which you were part of a project team and which utilized BIM models, how often does the contract define the BIM model as a contract document and allow all parties to the contract to rely on it as such.

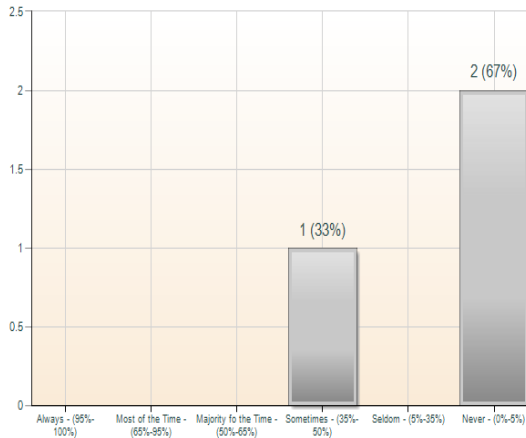


Figure 6.

On projects in which you were part of a project team and which utilized BIM models, how often does the contract define the BIM model as a contract document and allow all parties to the contract to rely on it as such.

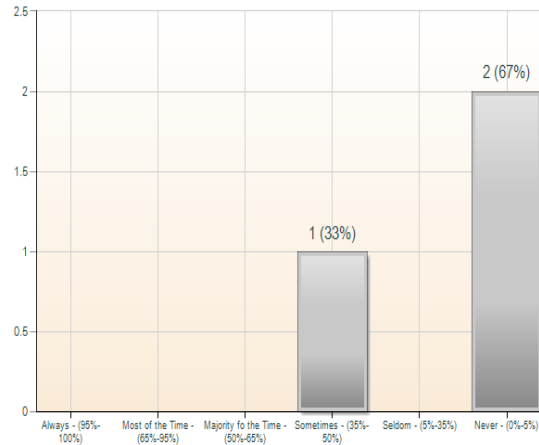


Figure 7.

The next question was asked to both the designers and contractors as a follow up to the previous question to clarify some of the inevitable confusion related to 2-D documents which were derived from the BIM. This question allowed the respondents to distinguish between 2-D documents derived from BIM and those created independent of BIM. Respondents were allowed to select all that apply and generally the designers (see Figure 8) and the contractors (see Figure 9) agreed that two-dimensional drawings created independent of BIM are most often defined as the contract documents.

For projects in which design information is created and communicated through a combination of BIM models, 2D drawings derived from BIM models, and 2D drawings created independent of a BIM models, which design information is primarily defined as the "Contract Documents."

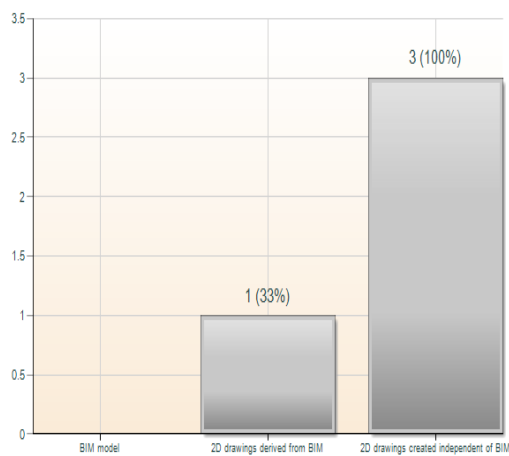


Figure 8.

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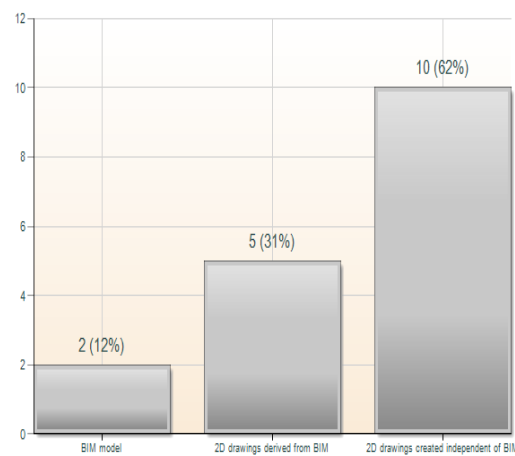


Figure 9.

The last question was to determine order of precedence on projects which defined models derived from BIM and two-dimensional drawings as contract documents. It asked that in the event of an ambiguity which instrument governs. This question allowed the respondent to select single response and generally the designers (see Figure 10) and the contractors (see Figure 11) agreed that if projects used both 2-D drawings and BIM as contract documents, the two-dimensional drawings would govern.

If you have been on projects which utilize a combination of BIM models and 2D drawings to define the "contract documents", typically how has the contract resolved an ambiguity (Order of Precedence).

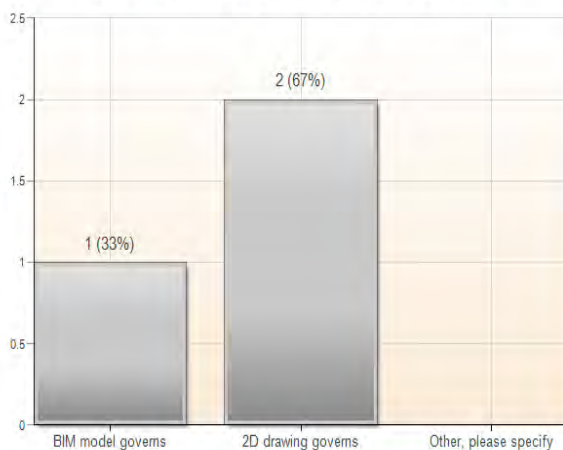


Figure 10.

If you have been on projects which utilize a combination of BIM models and 2D drawings to define the "contract documents", typically how has the contract resolved an ambiguity (Order of Precedence).

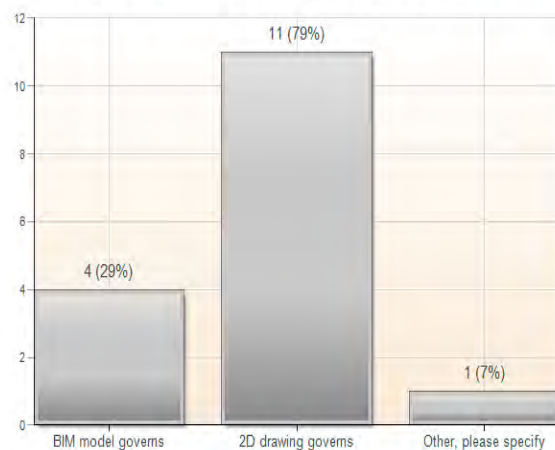


Figure 11.

Due to the limited number of responses and the potential for misunderstanding in a blind survey, personal interviews were conducted with five industry professionals who had significant experience and expertise with BIM. Four of the five worked for contractors and held positions related to their BIM expertise, and the remaining individual worked for the General Services Administration and had significant knowledge of, and experience with, BIM. The comments received from these five individuals were generally in line with the responses received from the survey participants. The following is a summary of the interview responses from the five industry professionals.

Two-dimensional drawings are still used as the primary contract documents.

For different reasons this group of industry professionals agreed that two-dimensional drawings remain as the primary source of contract documents. Even if the two-dimensional drawings were derived from models created with BIM, the 2-D drawings were favoured as the primary contract document. The general consensus was that on every project team there were still members who were not completely comfortable with the BIM environment and for that reason they continued to use the two-dimensional drawings as the primary source of information.

If both two-dimensional drawings and models developed with BIM are defined as the contract documents the two-dimensional drawings will govern.

Universally our respondents told us that if BIM models and two-dimensional drawings are defined as contract documents, the two-dimensional drawings will govern. This is simply

reinforcement that the traditional contract documents remain the favoured mechanism for determining a party's role and their responsibilities.

In the United States the primary use of BIM has been for clash detection and coordination.

Some are exploring different uses for BIM, such as estimating, scheduling, facility management, and as a contract document. However, it is widely held that the most common uses and benefits of BIM have been for clash detection and coordination purposes.

4 Conclusion

As with the advent of most new processes or technologies, it normally takes a period of time before a new process or technology is fully embraced. While BIM has been around for a number of years, it has only gained a much more widespread following over the past few years. Some of the reasons have to do with the cost of implementation; some have to do with learning curves and technical skills; and some are simply a reflection of the construction industry's reluctance to change. Each of these should go away over time as industry members become more knowledgeable of the benefits that can be achieved through the use of BIM and more comfortable with the use of the underlying technology.

However, other factors which contribute to this reluctance to take advantage of BIM include the shifting roles and increased risks and liability for some of the project participants. These inherent, underlying factors may not be as easy to overcome. The next step towards incremental change would seem to be that models derived from the BIM process and two-dimensional drawings created independent of BIM would both be defined as contract documents, and share an equal footing. It may take a number of years before the U.S. building industry adopts this position as significant contract changes are normally not forward looking but are a reflection of a legal system based on precedence. Eventually the need for efficiency and the desire to avoid duplication should dictate that the contract documentation be delivered via a single medium (BIM); and the traditional two dimensional contract documents will become obsolete.

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