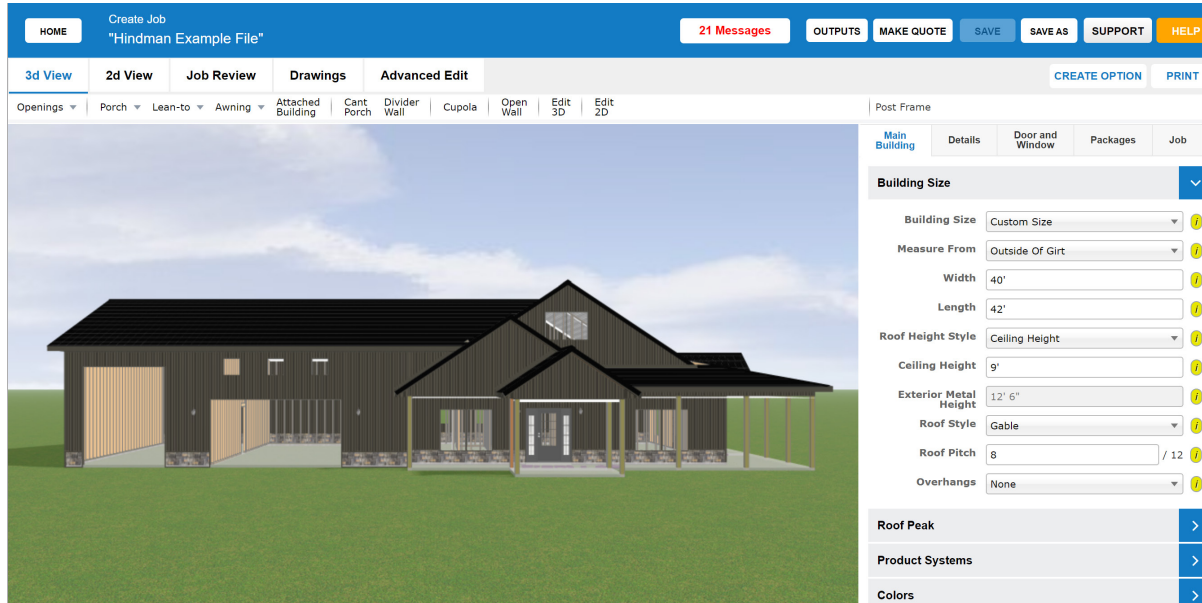# BUILDING INFORMATION MODELING (BIM): CAN IT HELP US BUILD BETTER POST-FRAME BUILDINGS?

As a professor in the Department of Sustainable Biomaterials at Virginia Tech, I help prepare students for working in the construction industry using wood, wood composites and other materials such as bamboo and hemp. Most of my students become designers, manufacturing engineers or construction managers involved in residential construction, or the manufacture of construction supplies, such as wood trusses, wood composites, flooring, or other materials. About six years ago, students came to me concerned that they needed a new skill set to be able to apply for jobs and internships in construction. They talked about a program called REVIT, which I had heard of, but had no prior experience with.

One of my graduate students insisted that we needed to invest time and resources in addressing this problem and understanding what students needed. As I learned more about REVIT, and building information modeling, or BIM, I realized how useful and helpful this tool could be for my student's learning and for the construction industry in general.

Since that time, I have been teaching a class called "BIM in Wood-Based Construction." This is a sophomore level class where I introduce the methods and materials for various types of wood construction, and how to create detailed models using REVIT software. Over this time, I have also noticed a larger trend of BIM use in building construction, and I also noticed several BIM software companies exhibiting at the Frame Building Expo trade show. I suggested this topic for a technical article to help the post-frame community understand what BIM is, and how this tool can be used to improve post-frame construction.

By Daniel P. Hindman Ph.D., P.E.

Throughout this article, I will try to answer the question in the title of this paper. As a user and educator of BIM software, I believe that there are definite advantages to using BIM. However, there can be a learning curve and costs associated with software and computing needs. BIM has the ability to help us visualize our final buildings in a very organized and systematic way. Using BIM, more accurate and detailed models of buildings – and the information they contain – are available to

us. The possibilities of what we do with this information are powerful. We have the ability to improve our ordering and material needs, predict and avoid potential interferences and construction problems, render beautiful views to visualize the completed building before construction begins, pull detailed information for energy modeling, life cycle analysis, and predict future building maintenance needs. I will try to illustrate each of these uses in this article.

As a disclaimer, I want to mention that this article will talk about various software packages for BIM. These should not be construed as endorsements of specific programs. These programs are listed as examples, and are not a comprehensive list of available software.

BIM Defined

According to the Whole Building Design Guide, BIM is defined as a "digital representation of physical and functional characteristics of a facility" (https://www.wbdg.org/bim). Here the 'digital representation' is not just the visual graphics, but also the information contained about the object. This information can be as detailed as needed to accomplish the model goals. Most models contain information on dimensions and general material properties (density, R-value, permeability, thermal mass, roughness). More detailed model elements list component shapes and materials, cost, material strengths, carbon storage, and links to manufacturer's websites.

Building Information Modeling – Isn't That Just CAD?

Many engineers and designers have learned CAD – computer aided drafting, or even hand drawing early in our education. Drafting and CAD has become the standard methods of information transfer in construction for many years. But in its simplest form, CAD is still an advanced drawing software. Of course, drawing software has evolved to include standard forms and 2- and 3-dimensional items. For instance, creating a wall requires a 2-dimensional drawing of a rectangular shape. For 3-dimensional parts, this shape would need to be extruded by adding a third dimension.

What makes BIM different is the added information. When I draw a wall in BIM, I am assigning a set of properties to that wall. Functionally, I draw a line – located at an edge or center of the wall, as I define it – but then that line sprouts into a wall section (Figure 1a). Options are given to bound the wall vertically, and the profile of the wall is stored as a collection of components. Properties of those components include physical dimensions, but also thermal and moisture properties, cost, and sourcing information (Figure 1b). Even after creation of the wall, the components of the wall can be modified and changed (Figure 1c). All of this information stays with the wall I have drawn, and can be accessed by the software when needed. While I began by drawing a simple line, that line represents a thorough material description of this wall.
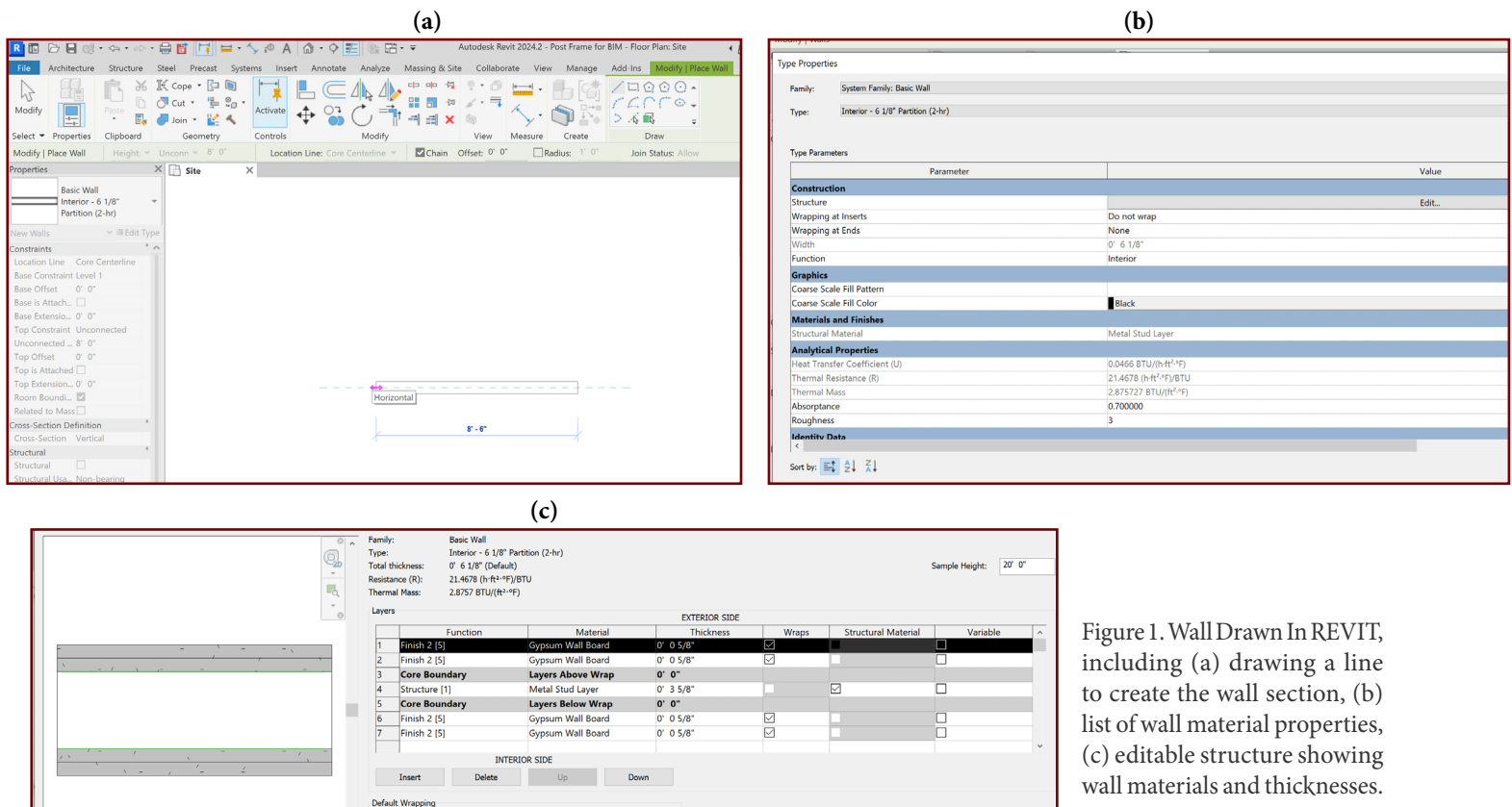
(a)

(b)

(c)

Figure 1. Wall Drawn In REVIT, including (a) drawing a line to create the wall section, (b) list of wall material properties, (c) editable structure showing wall materials and thicknesses.

RESEARCH & TECHNOLOGY

Advantages of BIM

As designers create the building representation in BIM, all of the information for the various materials and elements is cataloged and contained within the file. This higher level of detail contained has led to greater accuracy and certainty in the ordering of building products. Benefits of using BIM include:

a. **Reduced Time in Creating Designs** – By transferring information as well as the drawing elements, architects and designers can communicate their ideas more accurately to suppliers, engineers and other collaborators.

b. **Increased Collaboration** – BIM software has many opportunities for different groups and trades to collaborate. Drawings can be sent electronically for review and comment, with all comments logged and tracked. Also, REVIT and other programs contain options for inserting MEP (mechanical-electrical-plumbing) systems into the building which use the designer's drawings but limits the ability of MEP designers to modify non-MEP parts of the design. Another advantage of increased collaboration are tools related to detecting and eliminating interferences, or locations where different building systems overlap or clash. Detecting and eliminating clashes is often given as one of the biggest cost-saving features of BIM.

c. **Scheduling / Project Staging (4D BIM)** – Many BIM tools have features known as phasing, which can define different time periods in a project. For instance, using phasing, the same project file can host the original drawings of the building, demolition plans, and new construction. Having all of these project phases available allows designers to create drawings and sheets for different construction phases of the project without losing any fidelity or measurements.

d. **Developing Accurate Cost Estimates (5D BIM)** – Because BIM is able to track and determine the size / number of components of a building, estimators can produce an accurate value of building materials. Pairing BIM tools with current cost software programs can now help designers formulate quicker building cost estimates and accurately order the correct amounts of materials.

e. **Visual Tools Available to Understand Final Construction** - One of the challenges of the building industry is to accurately interpret customers' needs and vision to create the building they want. Our written and oral language is often inadequate to completely capture these thoughts, and use or lack of knowledge of jargon specific to the industry can create confusion. Being able to display what the building will look like – including multiple options and views – is helpful.

An interesting feature that I impress upon my students in REVIT is the 'Walkthrough' tool. This tool allows you to create a virtual movie where you walk through the finished structure. Independent controls are given for the location of the viewer and the camera view, allowing views that sweep through rooms or highlight important features. The Walkthrough tool allows the designer to be a movie director, creating a moving view of what it looks like to travel through the building.

f. **Connecting Information to Other Tools (6D BIM)** – Through the information tracking abilities of BIM, there are another host of possibilities to use the data from the building design. One use of the data is calculating the life cycle analysis of the building (https://carbonleadershipforum.org/introduction-to-lca/) . Life cycle analysis is an estimate of the environmental footprint of the building materials and systems that is used in green building certification systems. Another use of the information extracted from BIM is to create a 'digital twin' of the building (https://www.buildingsmart.org/take-bim-processes-to-the-next-level-with-digital-twins/). This is really a virtual model of the building that can be used for planning building maintenance, understanding building performance, or used to understand effects upon the building systems over time.

Disadvantages of BIM

There is a host of possibilities for the use of BIM software. However, it should be noted that there are challenges to the use and implementation of the advantages listed above. First, many of the advantages describe an ideal scenario, where all members of the building team are using the same software and methods. This may require suppliers and subcontractors to be familiar with multiple programs or systems. Second, there are costs – both the cost of purchasing software as well as the cost and time of training – to using these tools. More complex programs will require more advanced training. The limitations of time and cost can be significant, especially for smaller firms.

Is BIM Software Useful for Everyone?

The purpose of BIM is to help in the design, documentation and construction process of buildings. For more specialized or complex buildings, the use of BIM can represent significant cost savings. For simpler or more standardized buildings, the use of BIM may be most helpful for the initial design, but not necessary for every design. Design service providers, who are subcontracted to create BIM designs for standard models, may be cost-efficient options as well.

BIM Software Customized for Post-Frame Buildings

BIM software has been expanding in the last few years, and most NFBA members who peruse the Exhibition Hall at the Frame Building Expo will note a growing number of companies in this area. Traditionally, BIM has been dominated by Autocad REVIT. This is the most common BIM software in the construction area. However, REVIT is more of a generalized BIM package that must accommodate a large number of different types of construction. As a professor, most of my BIM experience has been with REVIT as well.

However, REVIT has some interesting ideas about wood construction that continue to confound. For example, REVIT is unable to do is to create an accurate wall section with stud cavities, which would be considered overlapping materials by the program. REVIT also has no specialization for post-frame systems and nomenclature. Another challenge of working in REVIT is there is no natural stopping point – you could keep adding details and features to a project forever. An important question to ask with BIM is 'How Much Detail Do You Need To Accurately Communicate Building Plans?'.

Other BIM programs specifically for post-frame buildings exist and two programs, Smartbuild and Construction Maestro, are discussed below. I reached out to representatives from these companies to gain some insight into the how they create post-frame structures. Both companies offer trial version of software. These products are tailored to post-frame design and focus on features and building types typical of post-frame. Many of the color palettes are connected with different manufacturers. Figures 2 and 3 are screenshots of the modeling environment and the outputs page from SmartBuild. Figures 4 and 5 are screenshots of the modeling environment and outputs page from Construction Maestro.
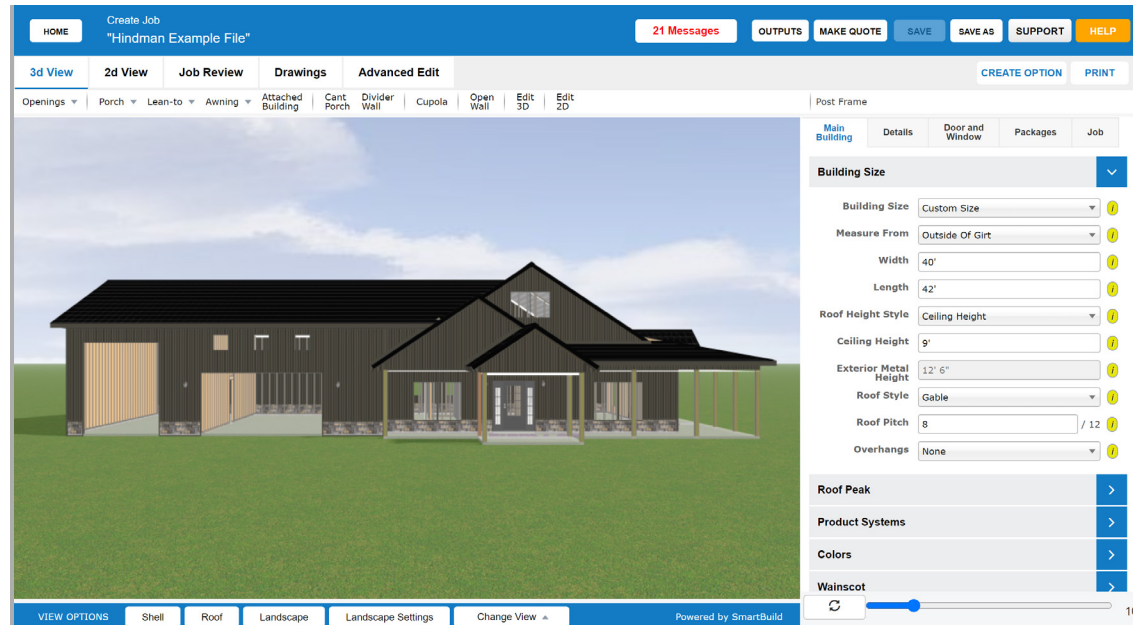

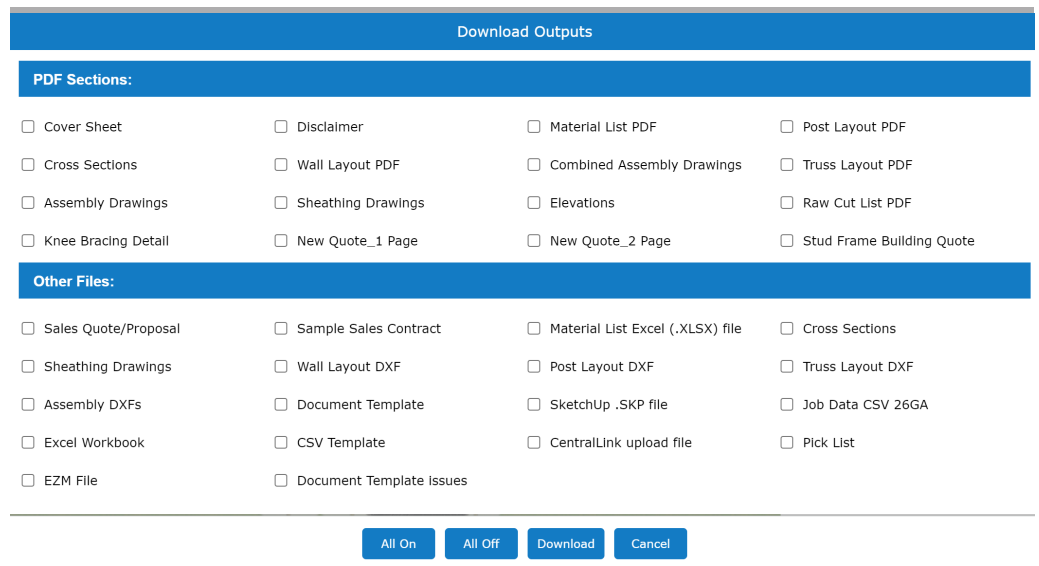**Figure 2**. Example of Modeling Environment for SmartBuild

Figure 3. Example of Outputs for SmartBuild

In general, I found both of these programs to be easy to use and was able to create the models shown in Figures 2 and 4 with relative ease. These programs both relied on numerical inputs, drop-down menus or slider bars rather than the drawing palletes shown in REVIT. Modifications of the buildings were easy to conduct and the focus on post-frame buildings (and use of correct terminology!) allowed for accurate communication. Both programs were tied to supplier products and color palletes, allowing accurate visuals to be created. Figures 3 and 5 also show the output screens for the two programs, just to demonstrate the range of building plans and graphics that can be generated.

RESEARCH & TECHNOLOGY

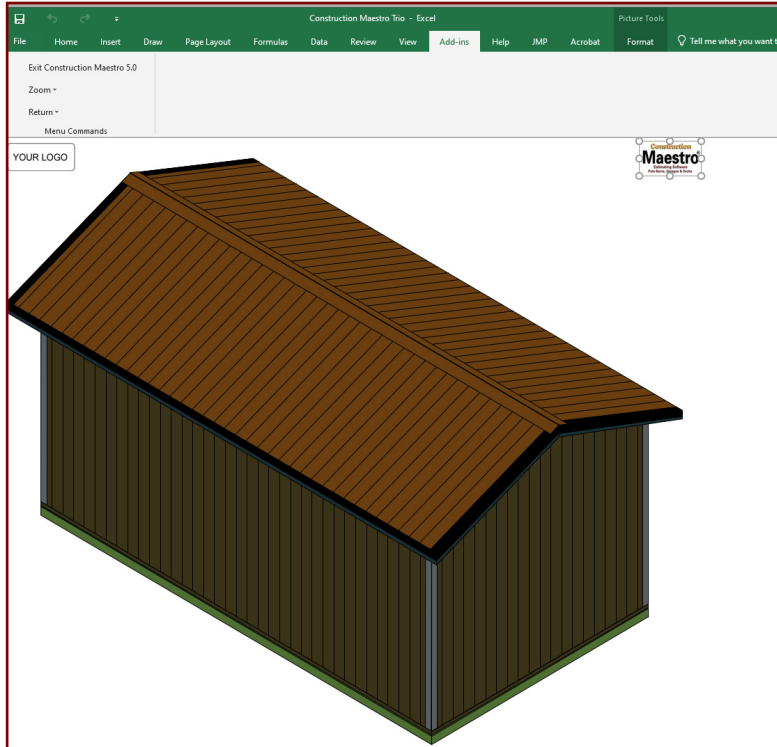
Figure 4. Example of Modeling Environment for Construction Maestro

Figure 5. Example of Outputs for Construction Maestro

Conclusions and Advice for Purchasing BIM Software

To summarize, BIM software design can help improve the design and construction of post-frame buildings. However, there are advantages and disadvantages. BIM software tends to be more helpful when buildings become more specialized and unique, but can still provide advantages in presenting graphics to customers, and accurately representing colors and finishes of materials. Yet, there are costs associated with using and training of the software to get the most efficient use.

If you are considering using BIM software, I would like to offer the following suggestions:

1. **Identify Your BIM Needs First** – Spend some time thinking about how BIM can help improve your design and construction delivery strategy. What does your company do well? What could you improve? You may have particular needs or gaps to address.

2. **Speak With a Technical Representative** – Your technical representative can help you meet your needs and understands what the capacity of their BIM software is.

3. **Try a Trial Version** – Both of the programs discussed above had free trial versions that allow you to use them. Also, the technical representatives may offer training.

4. **Focus On Value** – BIM is really about improving construction, and bringing more value to your business. Be sure you understand how BIM software can do this.

Acknowledgements

This article was subjected to a peer review process conducted by the NFBA Editorial Committee, which consists of at least 10 members from engineering and academic organizations throughout the United States who are each knowledgeable about Post-Frame construction.