The Relationship Between BIM and Electrical Prefabrication

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ABSTRACT

Recently, with the help of Building Information Modeling, prefabrication has become popular amongst electrical subcontractors. This report dives further into the relationship of the two counterparts and analyzes what allows the relationship to be successful. Currently, little information has been published regarding how Building Information Modeling and electrical prefabrication play off of each other. This report serves to provide information to electrical subcontractors that are either looking to start prefabricating or further their prefabrication methods. Analytical methods used consist of online research combined with interviews from three different people at three different electrical subcontracting firms. All interviewees hold different job titles and have an extensive background in electrical prefabrication. Through research and interviews it becomes evident that prefabrication completely relies on Building Information Modeling, and in most cases cannot be completed without some type of modeling. As Building Information Modeling continues to develop it increases potential for what can be done with electrical prefabrication. This project implies that any company looking into prefabrication needs to have an active BIM department.

Keywords: Building Information Modeling, prefabrication, subcontractor, electrical, firms

Introduction

Building Information Modeling (BIM) was first developed by Leonid Raiz and Gabor with the introduction of Archicad, the first BIM software to be made available on a personal computer. Since then, BIM software has become capable of representing both the physical and intrinsic properties of a building as an object-oriented model tied to a database. BIM allows for the user to interact with the building model in two-dimensional plan view as well as a three-dimensional model. BIM even has a 4^{th} dimension component of time that can be associated with the building model. BIM has been a progressive step away from the conventional 2-D plan view.

Prefabrication consist of manufacture sections of a building or piece of furniture to enable quick or easy assembly on site (*Merriam-Webster's Collegiate Dictionary*, 1999). Prefabrication on large scale projects has a huge potential to decrease cost and time and increase safety. However, when prefabrication is done incorrectly it has the potentially to cause costly damages. In order for prefabrication to be successful, different trades need to be able to collaborate beforehand on a shared model to maximize precision; this is where BIM comes in. BIM provides highly detailed architectural, structural, and MEP (Mechanical Electrical Plumbing) models that allow for specific trades to collaborate and conform their installations prior to the actual construction, thus eliminating clash and error.

BIM is quickly becoming a norm amongst various construction firms providing an opportunity for different trades to get involved in preconstruction and maximize efficiency in different areas.

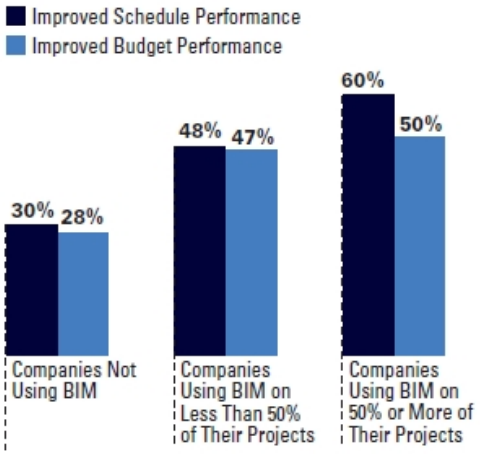

Figure 1, Yoders, Jeff. "SmartMarket Report Highlights How BIM Planning Enables Prefabrication and Modular Construction." *Engineering NewsRecord RSS*, Engineering News-Record, 19 Feb. 2020

Looking at the electrical trade in particular, there has been a direct correlation between the introduction of BIM and the resurgence of electrical prefabrication. I will be taking a closer look into the relationship between BIM and electrical prefabrication, and how it allows for the prefabrication of things such as outlet boxes, conduit bends, and temporary power units in an efficient and cost-effective manner. I will also be analyzing trends and identifying prefabrication techniques that can be more widespread in the future.

Electrical Prefabrication

Electrical prefabricated components can generally be put into three different categories. Here we will analyze how BIM has influenced each of these different building assemblies.

Components purchased by contractors who build assemblies

Certain components of electrical construction can be purchased ahead of time to be assembled on site. The most effective components that can be purchased ahead of time are conduit bends and larger precut cables / luminary whips:

Traditionally bending conduit is process that requires precise skill and many hours of labor. The process is highlighted below:

1. Drawing
2. Detail Out Conduit Bends
3. Calculate Measurement of Each Bend
4. Prepare Conduit for Bend
5. Bend Conduit

With BIM, there is an opportunity to eliminate these steps. Certain equipment such as the Greenlee Conduit Bending allows for the production of conduit bends to be done accurately and precisely. This type of prefabrication machine can be programmed using CSV BIM files to make exact bends and eliminate errors. Using BIM, prefabrication practices for conduit bends also produce less scrap and increase productivity.

BIM models can be used to identify exact lengths of precut cables and luminary whips which are a type of cable that converts a fixed-in-place device to a modular asset. Once the exact lengths have been determined these components can be produced to exact lengths in a production shop. These precut assemblies are ready to install with pre-fitted connectors, optional anti-short bushings, and customized tail and lead lengths. Prefabrication in this situation eliminates inefficient trimmings and extra cords produced by off-the-shelf electrical cables.

Box and bracket assemblies

Manufacturers produces a variety of prefabricated boxes and brackets for contractors to use on site. These products are made to be universal and fit into many mounting situations. These prefabricated box and bracket assemblies include Direct-to-Stud Brackets, Fixed and Adjustable Stud-to-Stud Brackets, Specialized Junction Boxes and Mud Rings, Mounting Templates, and overhead Conduit and Light Fixture Hanging Solutions. All of these products are provided to make the rough-in process more efficient than a "stick-built" wiring method.

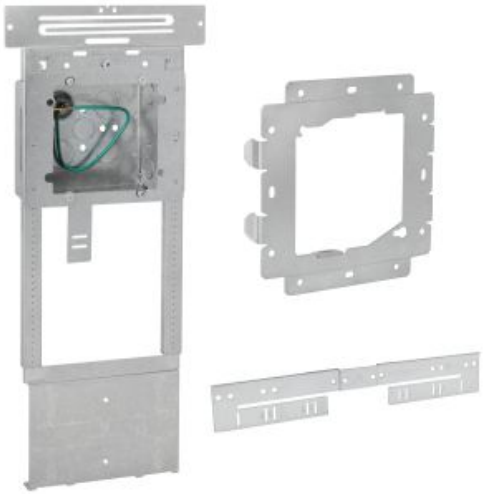

Figure 2, "Ultimate Support Bracket System." *Orbit Industries*, www.orbitelectric.com/prefab-products/usb.html.

Box and bracket methods are not meant to be unique to a specific job, therefore, this prefabrication method can be utilized without a building information model. However, using a model to find out exactly what type of prefabricated brackets and boxes are needed, and in which locations, might prove to be faster than a tradition takeoff method.

Complete assemblies

Completely prefabricated electrical assemblies are entirely prefabricated in a shop. These assemblies are ready to install once they arrive on site. No parts are needed; the assembly only needs to be installed.

Types of large prefabricated assemblies include skids, mobile substations, data centers, and substation power centers. The field team on the jobsite will determine which items they want to completely prefabricate, and the BIM manager will create and send a model to manufactures that can construct and transport the completed rooms.

Methodology

The research used in my report to support my conclusion utilized multiple methods such as three phone interviews and many online resources. All of these resources helped me to establish a strong background knowledge allowing me to make an educated assumption on the future of BIM and electrical prefabrication.

Interviews

Phone Interview with David Mulder, Associate Project Manager at Sprig Electric

On May 3rd, 2020, I spoke with Sprig Electric Associate Manager David Mulder. Mulder has been a part of the Sprig team for 3 years. He oversees all types of projects ranging from data centers to core and shell. Recently he has specialized in numerous tech projects including Apple and Google. Sprig Electric has been on the frontline of electrical prefabrication and Mulder, who works closely with the BIM team, has noticed positive trends with BIM and electrical prefabrication.

Mulder was quick to highlight the success of prefabricated conduit bends on the jobsite. In most circumstances all conduit bends that are larger than 1 ¼" diameter are prefabricated in a shop. Prefabricated conduits have allowed the bends to be more precise with less issues during installation. Mulder referred to a recent project where 12 identical bends were required. Using the BIM model these twelve bends were prefabricated and fit next to each other flawlessly.

Mulder also highlighted the success of prefabricated lighting systems. On jobsites with repetitive lighting fixtures this practice has been incredibly cost effective. He emphasized how BIM has allowed for preprogrammed lighting controls, and pre-colored bundled cable that allows for a single pull.

Precut wiring and whips have also proved to be a cost-effective practice on Mulder's jobsites. Entire Revit models can be sent to wiring manufactures that cut the cables in house prior to jobsite arrival. This saves valuable time on site.

Throughout the duration of the interview Mulder referred to no major issues with prefabrication in electrical preconstruction. Building information models have enabled electrical prefabrication

to run smoothly an accurately on site. The two main benefits that Mulder brought up were the time saved on site with prefabricated assemblies, and a less expensive labor mix that occurred in prefabrication shops. This labor ratio refers to a larger percentage of apprentice to foreman.

Phone Interview with Dustin Beabout, Electrical Drafter Helix Electric

On May 22nd, 2020, I spoke with Helix Electrical Drafter Dustin Beabout. Beabout has been a part of Helix Electric for 3 years. Beabout's duties are strictly related to electrical prefabrication. When the Helix Electric field teams determines items on the job that they want to be prefabricated they forward these items to Beabout. Once he determines whether or not it is possible to prefabricate these items, he drafts specific BIM details on Revit that can be sent to prefabrication manufactures.

In his three years at Helix Electric Beabout has noticed a few prefabrication items that provide greater efficiency and cost savings. These items include overhead conduit, strut backing for panel assemblies, spacers for underground duct banks, trapeze systems, and pull box knockouts. These prefabricated items required much less labor onsite and were simple to design and prefabricate in shops. In order for a manufacturer to prefabricate effectively a BIM model was required.

When asked about the benefits of electric prefabrication he highlighted cost savings, safety, and potential time savings. He did note that prefabrication requires BIM drafters like himself on payroll, however, the cost and time savings far outweigh the salaries of a BIM department. One negative he noted was the extensive planning and coordination that building information models and prefabrication require. Without proper planning and coordination, a model's prefabrication is an afterthought.

As BIM and prefabrication technologies advance, Beabout hopes to see entire rooms prefabricated and craned into place. He emphasized that this technology is a long way out and requires extensive planning and clash detection, but would save time onsite and could be performed with cheaper labor.

Phone Interview with Mason Hodges, BIM Manager at Rosendin Electric

On June 2nd, 2020, I spoke with Mason Hodges, Rosendin Electric BIM Manager. Hodges has worked with Rosendin for 9 years and has also had several years of experience as a field electrician. Hodges oversees his company's BIM group, and has been a part of countless electrical prefabrication items.

Like Sprig and Helix Electric, Rosendin has had great success with prefabricated conduit bends. Hodges explained that Rosendin uses Revit modification software such as Greenlee Bendworks software, which allows users to draw out the bends and mark out areas where the conduit needs to be bent. The actual bends are then construction using a special conduit bending machine on site. Hodges also highlight the success of the completed assemblies called skids. These skids are large prefabricated boxes that are delivered on site. The boxes can be filled with whatever

electrical solutions are needed for the project and plugged in. These skids can be customized to have specific holes cut out for conduit runs before being delivered.

When asked about the main benefits of electrical prefabrication, Hodges emphasized the increased safety and project timing. When raw materials are assembled on site there is a higher chance of field electricians being hurt. Hodges explained that when items are prefabricated, they are done in a controlled, clean warehouse with no other trades present. Items being prefabricated in offsite warehouse can be stored for controlled releases allowing for more storage onsite. When items are prefabricated, it becomes easier to work around other trades. Items can be prefabricated, delivered onsite in a flatbed, and Lego pieced together onsite.

One issue of prefabrication that Hodges highlighted was the potential for error. General contractors, subcontractors, and field electricians must be in sync for prefabrication to run smoothly. When BIM engineers create drawings, general contractors and superintendents need to take the time to double check the drawings are correct. Hodges highlighted an instance where 300 hangers were ordered too short due to incorrect drawings. Neither the field engineers nor superintendent took the time to look over the outdated drawings before they were pushed through resulting in a costly order of items that did not fit.

Data Analysis

After gathering information from a variety of sources it is time to dive deeper into the relationship between BIM and prefabrication.

One of the main takeaways from our analysis is that Building Information Modeling is an absolute necessity when it comes to electrical prefabrication. Electrical prefabrication is a very specific task that has little-to-no room for error. All three of the companies that were interviewed have had great success with someone in the BIM department that solely specializes in prefabrication. BIM engineers are the ones who create details that are then sent to the manufacturer where they are built. Without a BIM model, almost nothing can be prefabricated. It must also be noted that electrical prefabrication was very limited before the development of BIM, showing a direct correlation in the relationship.

The relationship between BIM and electric prefabrication has produced extensive benefits. Labor rates in a manufacturing warehouse are much cheaper than that of the field. Time onsite is heavily decreased as workers can easily piece together prefabrication parts. Electrical work becomes much safer onsite as electricians do not have to work around other trades as much, and the bulk of the construction is done in a controlled warehouse environment. The safety provided by this relationship is key as the construction world becomes more safety driven.

The interviewees made it clear that errors can happen in the process of electrical prefabrication, albeit rare. Electrical prefabrication requires utmost communication from the people in the field and the BIM office, and a system of checks must be established so that incorrect drawings never make it to the manufacturer.

As BIM systems develop further, the possibilities for prefabrication manufacturers are almost endless. Beabout discussed the possibility of entire floors being prefabricated ahead of time and craned in. Hodges highlighted electric skids which is a brand-new prefabrication technology. As BIM and manufacturing processes progress there is no telling what the future could hold for electrical prefabrication.

Conclusion

Companies that currently utilize the relationship between electrical prefabrication and BIM have had great success. This relationship has benefited in cost savings, time savings, and a safer working environment. The benefits received have far outweighed any problems.

Based on information gathered from online, Rosendin, Sprig, and Helix the relationship between BIM and electrical prefabrication provides much more room for construction progression as the possibilities are endless.

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