

Analyzing Industrialized Construction Methods in NECA Contractors

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Abstract

Construction is constantly changing and evolving. Companies are always looking to improve their skills, provide a better finished product, and satisfy their client all while working in a safe environment. Industrialized Construction is an increasing trend in all sectors of construction over the past couple of years, due to the success of creating a more efficient project. Projects that utilized Industrial Construction saved more time and therefore money, while also exceeding the quality of work expected. Industrialized Construction is a very broad term with a lot of subcategories of what goes into it. These methods of increasing efficiency on the jobsite have been successfully implemented by the biggest companies in the world leading to a large increase in profit margin and number of projects worked. And as these trends are becoming more popular contractors of all sectors and sizes are beginning to implement them. While there are thousands of successful implementations of industrialized construction, not many of these come from specialty contractors due to their smaller size and level of detail in the work. This survey will investigate National Electrical Contractors Association (NECA) contractors' level of knowledge and usage of Industrialized Construction, specifically Building Information Modeling, Prefabrication, and Automation.

Key Words: Industrialized Construction; Prefabrication; Building Information Modeling; Automation; Electrical Construction

Introduction

Industrialized Construction is the application of manufactured processes and production methods (e.g, Factory Physics - Operations Science) in Construction with the aim to improve productivity. The process commonly involves modularization, prefabrication, preassembly, and mass production. It requires more detailed and better-quality engineering, the ability to effectively manage supply chains,

and knowledge and application of production management including its underlying theory of Operations Science (Project Production Institute). Three of the most used and known methods are Building Information Modeling, Prefabrication, and Automation; companies who have implemented these methods into their construction projects have seen a lot of success. Over the past couple of years construction companies started to put an emphasis on creating more efficient projects, with an effort on keeping the quality of work and safety on the jobsite a big priority. A key ingredient to creating more efficient projects is companies using industrialized construction methods, but after seeing how successful these methods can be companies still choose to not implement them.

Industrialized construction has grown in popularity in all sectors of construction, but many are still spectacle of the benefits it can provide and doubt if it really is effective. Small companies often struggle and lose money when trying to implement these methods as they lack the money, manpower, and other resources that large companies have access to.

Below is Figure 1, an image coming from Amy Marks and Autodesk, showing how the use of enablers can expand Industrialized Construction throughout the industry. It also breaks down industrial construction into two primary sections, process enablers and technology enablers, allowing companies more access to the help they may need.

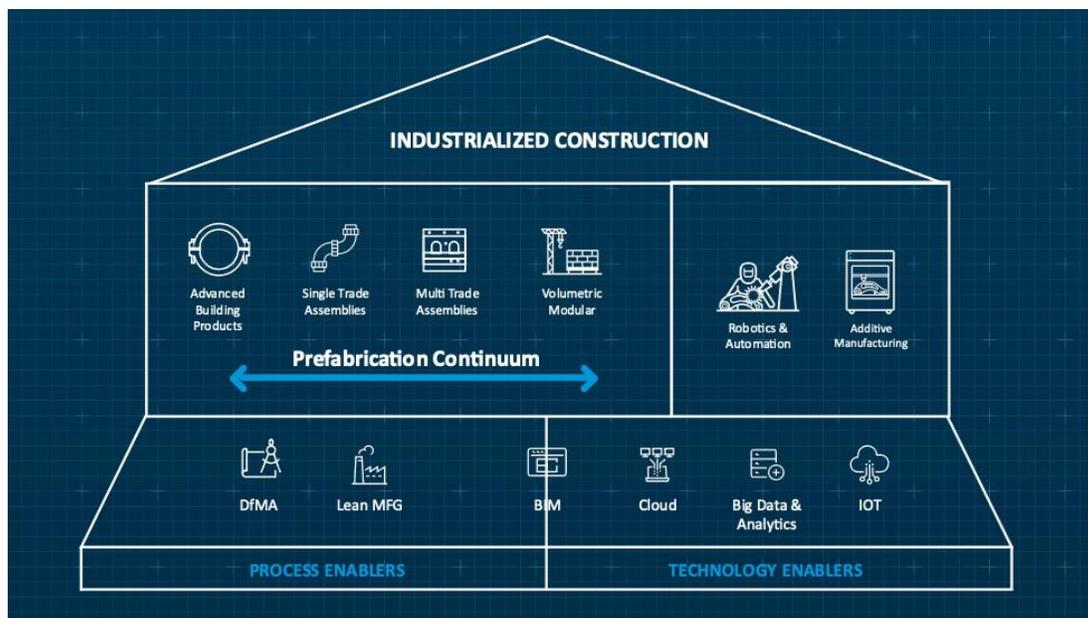


Figure 1. Image from Amy Marks and Autodesk

The goal of this research is to create hypothesis that will be compared to the results of this industry survey that analyzes the level of knowledge and current usage of Industrialized Construction methods in NECA contractors across the country. This survey also informs respondents of a potential future course offered by Paul Redden and Lonny Simonian on Industrialized Construction for specialty contractors at California Polytechnic University, San Luis Obispo. The survey gauges the potential willingness to attend the course to learn more about Industrialized Construction and the willingness to provide successful cases of implementation that can be used as teaching material.

Literature Review

Building Information Modeling

Building Information Modeling (BIM) is the process of creating and managing information for a built asset based on an intelligent model and enabled by a cloud platform. BIM integrates structured, multi-disciplinary data to produce a digital representation of an asset across its lifecycle, from planning and designing to construction and operations. BIM's software creates a database that allows users to interact between the plans and a three-dimensional model that maximizes the team's communication leading to increased efficiency and quality of work.

BIM has become very popular with Mechanical Electrical Plumbing (MEP) contractors because the 2D plans can be very complicated and full of mistakes or omissions that are often times overlooked, as it provides a very detailed MEP 3D model. This model allows for coordination between MEP contractors during preconstruction to visualize the work being done as well as identify any clashes, spacing problems, or other coordination items/issues before mobilizing to site. Additionally, BIM allows subcontractors to build shop drawing from the BIM Model, and due to the increased coordination that BIM provides the shop drawings are more accurate leading to a faster completion time. Using BIM not only helps the project limit the number of stoppages and extra costs, but it also improves the contractors understanding of the project which will maximize efficiency.

A study done by Dodge & Analytics Prefabrication & Modular Construction SmartMarket Report in 2020, asking contractors how using BIM increased the efficiency of the project. Figure 2, located below, shows that not only the use of BIM led to more success but increasing the level of BIM being used increased the performance of the schedule and budget.

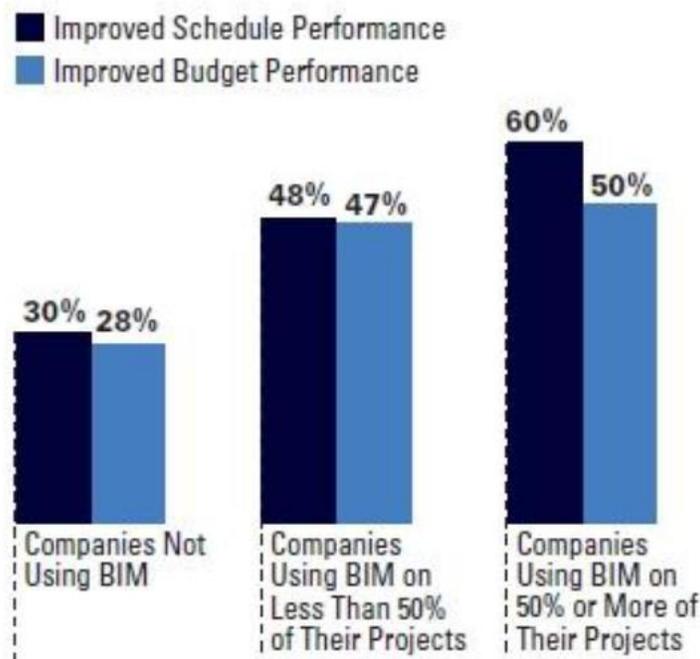


Figure 2, Yoders, Jeff. "SmartMarket Report Highlights How BIM Planning Enables Prefabrication and Modular Construction." *Engineering NewsRecord RSS*, Engineering News-Record.

BIM is known to be very successful through the construction industry, but never really touched on when it comes to the specialty contractors and the use of it between MEP subcontractors. A survey completed by Dr. Salman Azhar in 2009 analyzing NECA members use of BIM and results of the usage showed some very interesting things. Only 21% of the companies surveyed have used BIM prior to the survey, but out of the respondents that used BIM 70% of them reported significant time and cost savings and 64% reported that BIM helped the increase the quality of work done. Lastly, the primary reason companies did not use BIM was because they did not know about BIM (64%). This survey not only shows that BIM is useful in electrical construction, but it also shows that it not that difficult to implement and leads to immediate success. BIM is a tool that works successfully across the construction industry with companies of many different sizes and backgrounds.

Prefabrication

Prefabrication is defined as the manufacturing process that occurs in a centralized controlled facility to bring together raw material and standardized components into assemblies that are ready for site installation (Bogus et al. 2009). Some benefits of using prefabrication on the job site include increased productivity, increased safety, waste reduction, more protection against weather damage, and cost. It is not used commonly because it reduces the flexibility of owner due to the limited customization that prefabricated parts allows for and the possibility for major delays if parts need to be sent back to the factory. Those who do use it have found great success, ninety percent of contractors, specialty contractors and modular builders using prefabrication or modular construction who were surveyed by Dodge Data & Analytics said prefabrication and modular construction techniques improved productivity, achieved better quality product and increased schedule certainty when using prefabrication and modular construction methods, in comparison to traditional construction methods. (Yoders).

Traditional prefabrication is not as commonly used in electrical construction compared to other sectors in the industry due to the limitations it has in customization and the amount of detail needed to become a specialty contractor, which leads to contractors using prefabricated components which is still very effective. The use of prefabricated components, bought from suppliers or made in house, can lead to savings up to 70%, according to Randy Patek the vice president of PW Wiring Systems. (Griffin) This saving is not the only benefit in electrical prefabricated components, as safety on site is increased as well because most of the construction is being done in a warehouse environment and less time is spent on site.

According to Chad Reynolds, Senior Project Manager for Thomas & Betts, "Electrical prefabrication components usually fall into three general categories:

- . Components purchased by contractors who build assemblies, including devices and whips, in company prefab shops; the products usually are the same used in traditional construction, and the most popular are prefab brackets that can be used in a variety of assemblies
- . Box and bracket assemblies used by contractors who want to take advantage of prefabrication to reduce costs, but are not equipped to do a complete take-off on the job and build assemblies to the device and whip level

- . Complete assemblies, including devices and whips, purchased by contractors who want to benefit from total cost savings offered by prefabrication, but do not want to establish a prefab shop.” (Griffin)

NECA contractors can use prefabrication to start work for electrical rough-in work at an early stage of construction. Large companies that have the manpower, resources, and money to invest in and take advantage of industrialized construction can pre-fabricate electrical equipment to ensure job efficiency and lead to increased safety.

Automation

Automation is the application of any technology or machine doing tasks that would normally fall to a human in a faster and smarter way, leading to increased efficiency. In today’s world it is growing rapidly you can see this in grocery stores giving the option of self-check-out as well as the Amazon store that adds items into your cart as you put them in, making check out one click away. This is just one small example of automation in today’s world.

In construction, automation captures the processes, tools, and equipment that use automated workflows to build buildings and infrastructure. The use of automation enables productivity and performance benefits at the level of individual labor process and business. Currently large general contractor companies are beginning to utilize robot powered tools for layout. These robots utilize contract drawings, CAD drawings and BIM 3D models to “autonomously print a full-scale model onto the construction surface in a fraction of the time it takes a manual layout crew with a chalk line.” (Dusty Robotics) These robots can also depict hanger points and labels, wall penetrations, full ductwork runs, equipment labels, piping and fire sprinklers and electrical device locations. This device can eliminate errors caused by multiple, conflicting layouts that may have been missed on BIM. These layout robots can mitigate mistakes and have a positive effect on cost and schedule. Offsite construction methods have demonstrated that it is capable to reliably accelerate projects, cut schedules by 20-50% and construction costs by 20%. (Manyika).

Methodology

This project revolves around industry survey that was sent out to NECA companies all over the country in order to grasp the level of use and familiarity with Industrialized Construction and its methods. This survey was developed with the help of Paul Redden and Lonny Simonian who are leading an effort to create an industry course for companies looking to implement Industrialized Construction into their company. The survey was broken up into three separate parts: company background information; familiarity and use of Industrialized Construction methods in the last year; and interest in participating in course on Industrialized Construction hosted at Cal Poly, San Luis Obispo.

Background information was needed to understand the type of companies that participated in the survey. For example, a large company that has a lot of revenue and manpower is much more likely to implement industrialized construction than a family-owned company. These results also lead to trends on companies’ level of action based on location, size, and type of work they perform for a further breakdown on where companies are beginning to implement these methods and see success in them.

The objective of the second part of the survey was to analyze the level of familiarity and usage of industrialized construction methods based on the hypothesis that the author came up with based on outside research and prior knowledge. Questions were directly related to the level of usage across multiple aspects of construction and the amount of work done in house for the following Industrialized Construction methods: BIM, Prefabrication, and Automation.

The last part of the survey was to see if companies would be interested in participating in the course as an attendee or to volunteer prior case studies that would be the potential study material in the class. Contact information was requested from those who were open to giving case studies for the course and potentially participate in follow up interviews to gain knowledge on the reasoning behind an answer.

Research was done on topics in order to develop well thought out questions and answers, this research also played a key part in creating hypothesis for the survey.

Results

This survey was aimed to investigate the knowledge and usage in the last year of Industrialized Construction methods of NECA members throughout the country. The following hypothesis were developed based on outside research, preliminary survey data, and prior knowledge of the construction industry.

1. BIM will be utilized the most, followed by Prefabrication, and then Automation.
2. Companies using Industrialized Construction methods will experience a substantial positive change in time and money saved compared to projects that used other construction methods.
3. The most common area of electrical construction that uses industrialized construction methods is cabling, lighting assemblies, and device box assemblies.

Hypothesis 1

BIM will be utilized the most, followed by Prefabrication, and Automation will be utilized the least.

Prior research indicates that BIM is by far the most used in construction because it allows contractors to work closely with other trades before being on site, which ensures the product is of the best quality. It is so far in front because the majority of general contractor who create models for the plans use BIM, it is the industry standard. Prefabrication would be second because it is not as popular as BIM, especially in electrical construction who only use it for prefabricated components, but it is still used more than Automation.

Hypothesis 2

Companies using Industrialized Construction methods will experience a substantial positive change in time and money saved compared to projects that used other construction methods.

Companies that have used Industrialized Construction methods before will have success in using it, while the change will be a lot smaller for companies beginning to use it. This is because mastering the use of these methods take a lot of time and money, companies implementing will struggle in the short term before finding long term.

Additionally, companies that reported more profits will also have a higher percentage of positive change in time and money than smaller companies. A higher revenue stream usually indicates more manpower and resources available; these factors make it very easy for large companies to implement industrialized construction methods. The smaller companies tend to struggle during the implementation process because they lack those resources and the level of manpower that larger companies have available, so finding efficiency right away will be very difficult.

Hypothesis 3

The most common area of electrical construction that uses industrialized construction methods is cabling, lighting assemblies, and device box assemblies.

BIM is vital for the cabling of the building, it gives the electrician access into the walls to figure out spacing, which other subcontractors to work with, and other potential problems. And as Kevin stated two of the three most common electrical prefabricated components revolve around assemblies being prefabricated offsite, being assembled completely or partially the only thing that must be done on site with these is the installation.

Conclusion

Industrialized Construction is a tool used across the country to increase efficiency of construction projects while also improving the quality of completed work. While these methods are not for everyone, companies looking to create bigger and better things should begin the implementation process. This research resulted in hypothesis analyzing how Industrial Construction is being used by NECA Contractors. These methods are becoming normalized and leading to some of the best work done in construction, Industrialized Construction is only going to continue to make larger strides in the industry.

There are multiple opportunities for future projects that can come from this project, one is to analyze the results of the industry survey sent out to NECA members and compare them to the conclusions of this paper. Another is to conduct interviews with multiple respondents to learn their reasoning behind answers, details on the process of implementing these methods, and the level of success of Industrialized Construction in their projects.

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