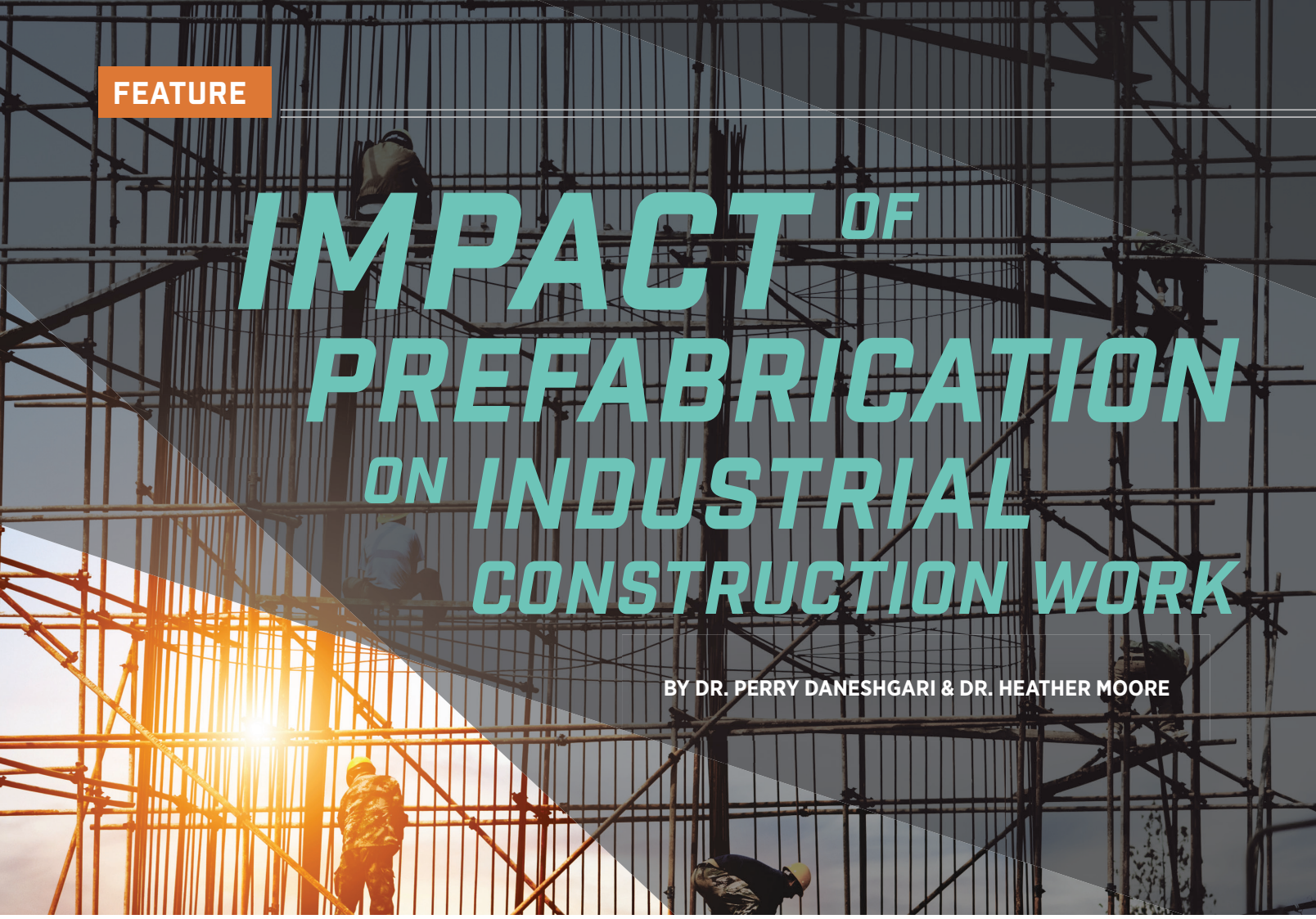
FEATURE

IMPACT OF PREFABRICATION ON INDUSTRIAL CONSTRUCTION WORK



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When it comes to prefabrication (prefab) for electrical construction work, there are three types of attitude and answers that can be heard from the electricians:

1. We can only prefab for standard items, and a maximum of 3-5 percent of the job can be prefabbed.

2. Prefab is only for commercial and residential work and won't work for industrial.

3. Prefab takes our work away.

The reality is much different than that. Companies that have adopted the prefabrication philosophy have had to change their culture from the traditional skilled trade model to the Industrialized Construction model. The question is no longer, "what can we prefab?" but rather "what is it that we can't prefab?"

Prefabrication is no longer a standalone approach to construction decided only by the "shop foreman" or "our prefab catalog." It is no longer being identified by just the electricians and field people; it is a way of doing business. It follows the Industrialized Construction model by the application of Segregation and Externalizing Work®. When the challenge is looked at in this light, it is much easier to see the application in all types of work, especially industrial construction. Segregation of work starts by identifying what has to be done to complete the work on the job. The best method for this is Work Breakdown Structure (see *Insights* article "How to Manage Your Job Using Work Breakdown Structure," September/October 2014). Once the work is made visible, it is possible to see hundreds of opportunities for externalizing it through prefabrication or use of other resources such as material and equipment suppliers. In addition, once the work is visible, it can be studied, modeled, and utilized to enhance the current building information models (BIM) with a dimension beyond just the physical building or built environment. Electrical contractors can maximize their productivity in the physical environment by planning and modeling what can be done where, by whom, and when.

This article focuses on the application of prefabrication for industrial work, by first answering the motivation for prefabbing, then explaining how to go about it on industrial projects, and finally how to go beyond prefab on one project to a full prefab process to support industrial and any other type of construction.

1. WHY SHOULD A CONTRACTOR CONSIDER PREFABRICATION

For any type of construction, the question has to be answered "Why should we prefab?" Typical answers include: Saving hours, saving labor cost, lowering the estimate to win the job, or because the material is cheaper. Prefab can have impact on all of these; however, none of them are the primary motivators. Prefab is about reducing risk, and industrial work often involves more risk than other types of work. For example, industrial work typically has higher technical requirements, more stringent safety regulations and protocols, tighter time constraints, and more complicated working conditions. **Figure 1** shows benefits of using prefab. None of these have to do with hours, the estimate, etc.

Consider the following reasons to prefab:

- Eliminates the negative impacts of weather and other trades if you:
  - Plan
  - Measure it
  - Make it visible
  - Fix issues
  - Learn
- Provides an avenue for quicker learning
- Stabilizes man-loading on projects
  - Labor can go from prefab (planning phase) to the jobsite
  - Provides a buffer for the "peaks and valleys of work" that impact the labor pool
- Creates ownership in the job early on
- Reduces mistakes and rework
- Allows for correct billing

2. THE PRACTITIONERS' APPROACH TO INDUSTRIAL PREFABRICATION

All types of construction can benefit from doing prefabrication because of a primary objective of reducing risks in the field. The first step is evaluating the type of work to determine the prefabrication application that will reduce risk the most. **Figure 2** shows a table of types of construction that can be evaluated for prefabrication. The detailed types of work for the industrial categories are also shown. For instance, the risk of weather and outdoor elements will be more present in a substation than in a manufacturing facility. On the other hand, interference from operating facilities could cause conflicts in an industrial maintenance application. So, the first step to seeing what can be segregated and externalized is evaluating these risks based on the type of work.

The opportunities to prefab for any type of work begin in the planning phase. Work breakdown structure (WBS) is a good approach to start with. The work can be segregated by where is the best place to do it (e.g. onsite, at an onsite pre-assembly controlled area, at an offsite prefabrication shop), who is the best person to do it (e.g. a helper, an apprentice, a journeyman, a foreman, or vendor resources), and when is the best time to do it (e.g. early job, mid job, late job). From here, the opportunities to externalize the work from the jobsite become plentiful. The final install or assembly is technically the only work that justifiably has to be done onsite. **Figure 3** shows an example of a WBS created for a power substation project. In addition to planning for the prefab up front, opportunities that occur throughout the job should be captured and planned for externalizing. As the project goes from one phase to the next, the WBS can be revisited for opportunities to reduce the changing risks.

Once the opportunities are identified, the next question is "how should we externalize the work?" There are no magical answers to this question. The foreman can either draw what he wants to have done or specify it from prior experience or catalogs. The types of things that can be done can be categorized into three buckets, and examples for industrial work application are shown in **Figure 4**. Pictures of a few of these are also shown in **Figure 5 and 6**.

Many tools are also available for aiding the process. For instance:

- Software and tools to help with drawing and coordination for physical installation, such as CAD and BIM, or layout/surveying equipment.

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Figure 1

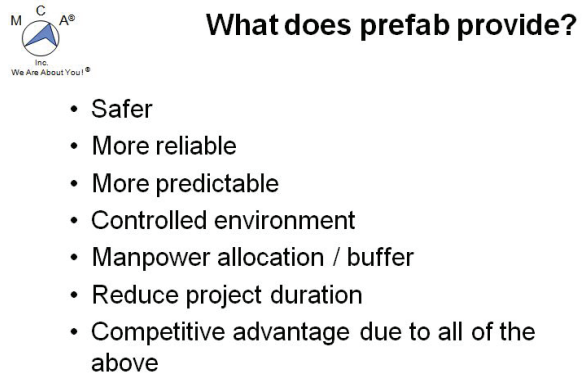

Figure 2

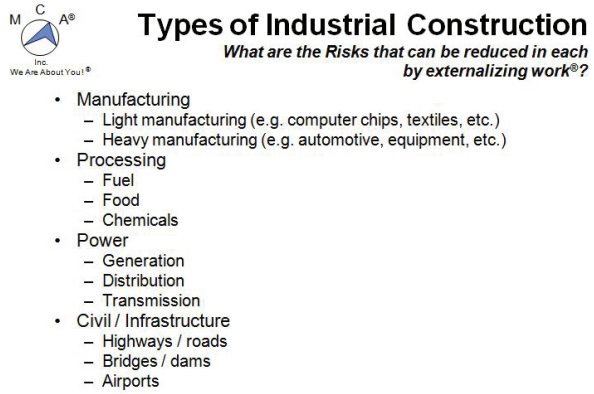

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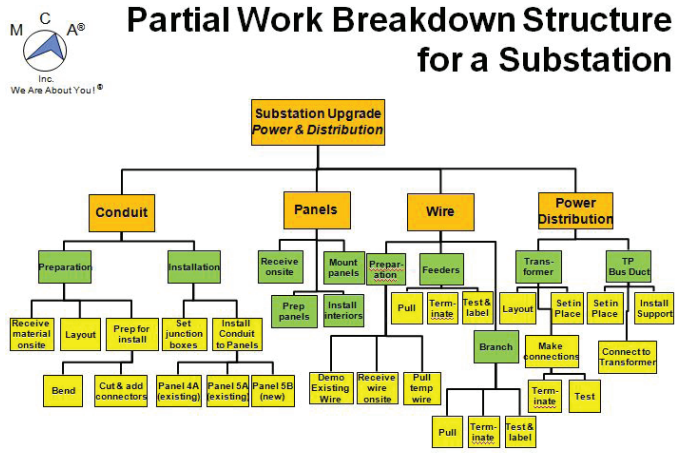
Figure 3



- Tools for improving the prefabrication work, such as benders, cutters, and jigs
- Material handling carts and packaging
- Special printers and programs for labeling, tagging, etc.

However, the source of ideas and how they get built still need to stay with the guy in the field. Plus, the "keep it simple" principle should also be in place to avoid complexity in the prefab shop. Remember, the goal is to simplify and reduce unnecessary movement and work. Externalizing the work to an equal or more complex environment or process doesn't bring any benefit.

3. PREFAB PROCESS DESIGN

Once the opportunities become more and more visible and prevalent, from the standpoint of the installers, the next challenge to an electrical contractor is ensuring he has a process for keeping up with the demand.

What are the potential obstacles for prefab?

- Incorrect or incomplete specs and drawings
- Field labor is unfamiliar with the process
- Education – how to use it, how to think about it
- Availability of material

How can we avoid the potential risks of prefab?

- Make sure every electrician on the job understands how to use prefab
- MEP coordination, through drawings, shared CAD
- Understand BIM requirements
- Various trades review each other's plans for the building
- Hold a coordination meeting up front with the trades
- Involve vendors early for what material will be needed at the shop and at the project site
- Handoff and kickoff meetings – discussions of prefab up front, bring vendors into the meetings (especially on fast-track projects)
- Conduct a post-project conference review with vendors, and if applicable other trades

The design of a prefabrication process has to take into account at least the following critical criteria for its success and optimization:

- The material flow (including from the vendor, within the prefab assembly, and to the jobsite)
- The information flow for prefab identification and specification
- Assembly of standard parts
- Assembly of standard, but job-specific parts
- Assembly of job-specific parts

The offsite prefabrication has to be job independent and contributes to reduction of labor cost in material handling and labor wastage on the jobsite. Material flow needs to be mapped between the vendor to the shop, within the shop

Figure 4

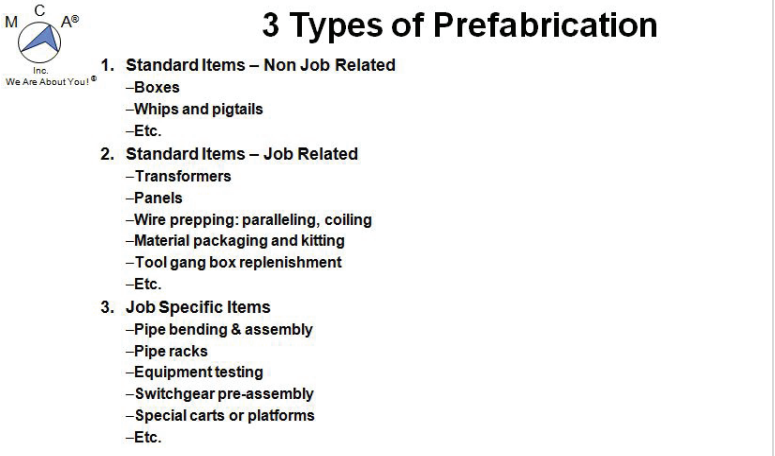


Figure 5

Prefabricated Transformer

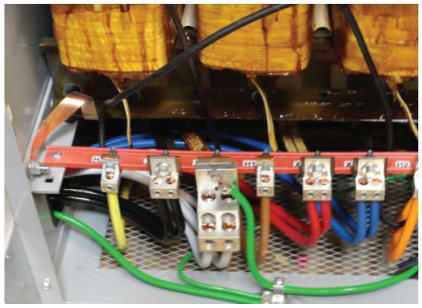


Figure 6

Prefabricated Conduit System

itself (see an example of this in **Figure 4**), to the jobsite, and within the jobsite. Without planning for this, all the hard work on coming up with prefab can be lost with one late shipment or one piece of the assembly going on backward. To resolve this, the second requirement of "information flow" needs to incorporate plenty of testing. Testing can be done with ideas and design, with prototype parts, with the assembly process itself, and with the packaging/delivery specifications. The breakdowns of this information are the majority of the root cause for the above-listed pitfalls. Coordination between the "onsite foreman" and the "shop foreman" is critical and must be done through a process that is visible to the entire project team.

4. MEASURING THE IMPACT OF PREFABRICATION

A critical part of the prefabrication process is how the operation is measured and tracked. Determining the impact of prefabrication in any application is not a one-dimensional measure. Here are some guidelines for measurement:

- Cost code development and content (who creates these and what purpose they are optimized to satisfy)
- Measure the work with a methodology that doesn't rely on just hours or dollars
- Measure the contribution of externalized work® to the overall job completion
- Prefabrication shop production requires different measurements than the jobsite productivity measurement
- Feedback for estimation on assemblies, but only once the prefabrication process is well established, which could take several months or years

5. CONCLUSION

Prefabrication by adaptation of Externalizing Work® is here to stay. No matter what type of work is performed, making it safer and lowering the risk will reduce the cost of production and improve productivity leading to profitability and better competitiveness.

Increased adoption of prefabrication is fueling the industrialization of construction™ as a critical new trend. Leading commercial, industrial, and residential prefabrication practitioner's opinions can be summarized as follows:

1. Prefabrication is not a magic tool; it's a known environment to execute a plan consistently and predictably.
2. It was noted that it is harder to take a prefabrication shop out of an operation that relies on it than to build one.
3. "We have four to 14 men in the prefab shop and our 18-month job is going to be done in eight months. We have records showing the dollar value of material waste reduced. The goal is to reduce risk by bringing it into the shop."
4. "The question is 'Where do we lose the hours?' not just where do we gain."
5. "Measurement has provided confidence. We don't need all the detail – just the cost code level. Keep the areas observable so it is easy to witness the completion."
6. "Our planning process has opened the door for field managers to talk to each other and share experiences."

Dr. Perry Daneshgari is the President/CEO of MCA Inc. MCA Inc. is a research and implementation company that focuses on implementing process and product development, waste reduction and productivity improvement of labor, project management, estimation, accounting and customer care. He has also published four books and an ASTM Standard for Job Productivity Measurement.

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