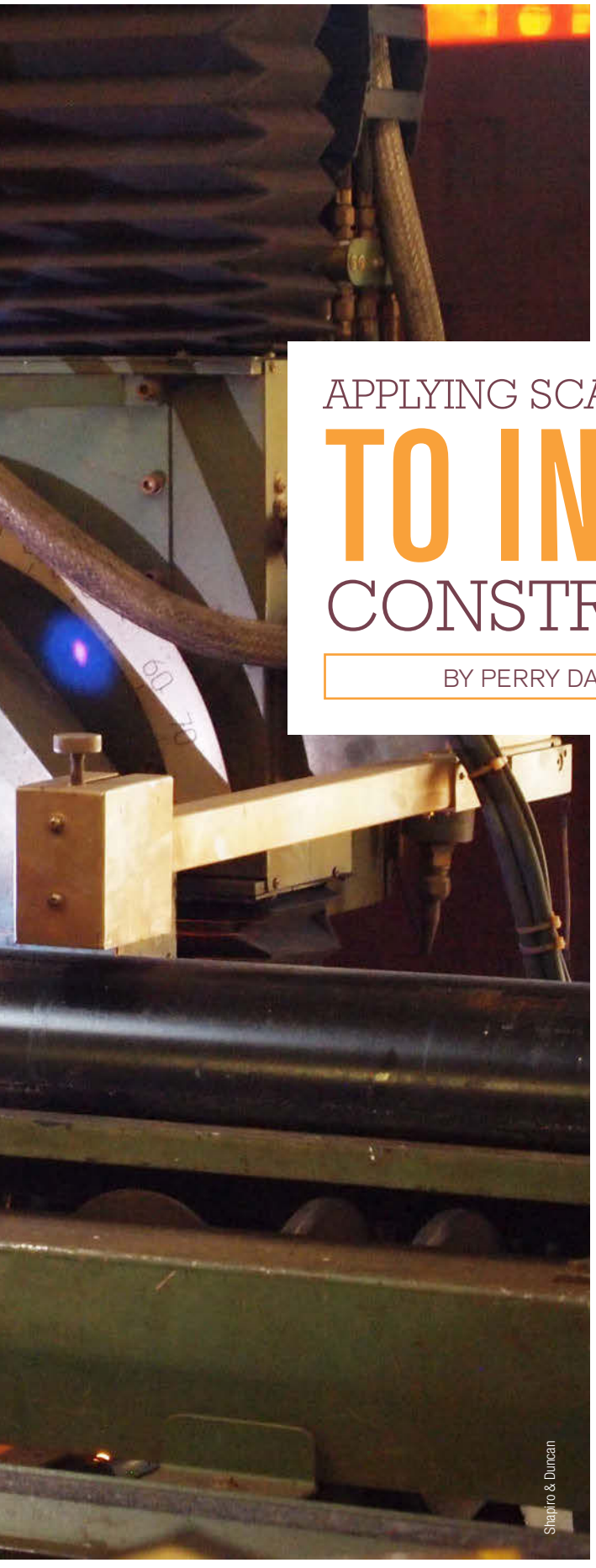

APPLYING SCALABLE PREFABRICATION

TO INDUSTRIAL CONSTRUCTION WORK

BY PERRY DANESHGARI AND HEATHER MOORE

The industrialization of construction is upon us. It is no longer a choice to participate in productivity-enhancing activities to improve the time, cost and quality of construction project delivery. Prefabrication is only the stepping stone in the application of industrialization through agile construction, the precursor of lean in construction.

When it comes to prefabrication, three attitudes prevail from contractors with a traditional mindset:

1. The team can only prefabricate for standard "cookie-cutter" items, and a maximum of 3 percent to 5 percent of the job can be prefabricated.
2. Prefabrication is only for commercial and residential projects and won't work on industrial jobs.
3. Prefabrication takes the work away, and it's easier to just do it onsite.

But the reality is much different. Companies that have adopted a prefabrication philosophy have had to change their culture from the traditional model of relying on the skilled trades to do all the work to an industrialized construction model. In this new

environment, the question is no longer, "what can we prefabricate?" It's "what can't we prefabricate?"

Prefabrication is best described as externalizing work. It is not just about fabricating ductwork or using pre-built trusses anymore. Those are still valuable components and will continue to be used; however, the opportunity to do upwards of 50 percent to 70 percent prefabrication on any type of project, especially industrial applications, comes by first identifying the work through a Work Breakdown Structure (WBS), and then focusing on reducing the risk on the project

> "Jobs can 'start' sooner with prefabrication assemblies and packages being prepped before the work even begins onsite.

ADVANTAGES OF PREFABRICATION

The main reason to prefab is to reduce risk. Construction is a very risky business because of the unknowns and uncertainties that exist on every jobsite. The majority of work scheduled for any given day does not get completed as scheduled. Following are the top reasons why:

- absenteeism;
- trade interference;
- requests to move to another task by the general contractor or customer;
- issues with materials or tools;
- not knowing the crew's capabilities; and
- jobsite conditions (e.g., congestion or lack of access).

Each of these obstacles can be mitigated by removing as much of the "work" as possible from the exposure to these elements. That is the secret behind the success of prefabrication. The work itself does not even have to change; it just needs to occur in a controlled environment where the company can visibly manage and train the workforce, prevent conflicts with other trades, and maintain control over materials and tool utilization. Many contractors start prefabricating to "save hours" or "reduce the estimates to win more work," but neither of these are direct results of prefabrication.

Following are more realistic motivations behind prefabrication.

- **Reduce safety risk.** Work done in a prefabrication shop will ensure the entire environment is set up and monitored for safety compliance, especially for cuts, falls, sprains and strains. By working on the ground, with supervision, and using tools that are properly maintained, daily safety incidents are dramatically reduced. Furthermore, by working in a facility intentionally designed for physical work (as opposed to a jobsite where laborers have to constantly work around obstacles), long-term back, knee and shoulder injuries can be reduced. Daily fatigue caused by conditions such as extreme heat and cold is reduced as well.
- **Increase reliability of the installation.** When each element of work has to be planned, designed and built with quality in mind, and with the time and space to do it effectively, the quality of the installed final product will improve. In a traditional jobsite where parts and pieces are built on sawhorses and bent, cut or threaded by hand and on the ground, the quality cannot be as high as when the activities are performed in a well-designed setting. In addition to reliability of the installation, the reliability of resources for doing the installation is better. Knowing that materials deliveries come to the prefabrication shop every Tuesday and Thursday—and the truck driver knows exactly what to put where in the shop—is much easier than the typical 5 percent to 10 percent of laborers' time that is currently spent receiving and inspecting materials at the dock, potentially hundreds of yards away from where they will end up.
- **Increase predictability of the outcome.** In addition to reliability of the work, the final outcome of the installation can be modeled, prototyped, tested and inspected much closer in a prefabrication shop than when it is built onsite.
- **Reduce uncertainties in the daily work environment.** Day-to-day and minute-to-minute interruptions on the jobsite—from materials in the way to getting called on to help someone out that is two floors up—goes away in a prefabrication environment. The shop environment should be completely visible, but be isolated from conditions such as weather and other construction activity.
- **Provide a manpower buffer and training ground.** Why send novice workers out to

deal with all of the above-mentioned field circumstances? They may have been through the apprenticeship, but they haven't been trained how to think about their work via WBS, or how to lay out the work environment for the most effective use of their time and skill. The prefabrication shop is a perfect opportunity to ingrain these valuable lessons. Furthermore, the worst pain of a contractor is trying to keep a steady workforce. The prefabrication shop can flatten the overall labor loading in the company; jobs can "start" sooner with prefabrication assemblies and packages being prepped before the work even begins onsite. Once the job starts ramping down, managers can send workers back to the shop before the next one starts up, but keep them busy with anything and everything possible that can be externalized.

- **Reduce overall project durations.** "It takes what it takes" is the usual answer from the workforce when asked how long it will take to complete a given task. However, the more tasks that can be done simultaneously, the shorter the duration of the project. In other words, once the work is defined through a WBS, the majority of it can be done independently of time and space, in the prefabrication shop. Instead of waiting onsite for the ceiling to be framed before the lights can be hung, the electrician can be doing all the prep work for those lights offsite well ahead of the framing, and the framing and lights mounting can then happen onsite in parallel, instead of one after the other.

INDUSTRIAL CONSTRUCTION PREFABRICATION APPROACH

Once the motivations for externalizing work are understood, prefabrication can be applied on any type of project, including industrial construction, which often demands a more stringent level of quality and technical complexities than in other types of work. This is all the more reason to remove as much risk as possible by externalizing the job from risky conditions.

The risks can be identified through a WBS, which breaks down the overall project by phases, areas, systems and tasks. The WBS is created by the foreman or field labor leader who is responsible for the work outcome; it stands alone from the estimate and gets generated based on the foreman's vision for each of the work steps necessary to get the project completely done.

Once the WBS has been developed, opportunities for identifying risk can be examined. Risky areas of the project are a good place to look for opportunities to externalize work. Risks vary depending on the type of work. Risk in an industrial manufacturing project may be working in an occupied space and more rigid specifications for jobsite cleanliness, whereas an industrial power plant may have a higher risk in a specific type of equipment to install or a particularly challenging power cut-over.

Using the WBS on an industrial project, the project team should segregate the work based on the best location (e.g., onsite, at an onsite pre-assembly controlled area or at an offsite prefabrication shop), who is the best person to do it (e.g., a helper, apprentice, journeyman, foreman or vendor), and when is the best time to do it (e.g., early in the job, mid-project or late in the job). The opportunities to externalize the work from the jobsite become visible when the question of "what doesn't have to be done offsite?" is asked of the WBS.

To avoid "refab" (re-doing the prefabricated work or taking it apart once it gets onsite, only to be re-assembled and installed), the field absolutely must be involved in the WBS—evaluating what to externalize and developing the

3 TYPES OF PREFABRICATION

1. Standard Items: Non-Job-Related
   - Boxes
   - Pipes with pre-built connections
   - Prepped piping (with threads, connections, bends, etc.)
2. Standards Items: Job-Related
   - Pre-assembled equipment and controls
   - Panels and variable air volume units
   - Wire prepping (paralleling, coiling)
   - Material packaging and kitting
   - Tool gang box replenishment
3. Job-Specific Items
   - Pipe bending and assembly
   - Racks for distribution of MEP equipment
   - Equipment testing
   - Special carts or platforms

plan for interfacing between the offsite work and onsite work. This requires a high level of planning and information transfer between the field and the shop.

Three types of prefabrication are specific to industrial work: non-job-specific, job-specific and project-specific (see page 43). How the prefabrication occurs will depend on the type of work, type of prefabrication and job-specific risks to be mitigated.

PROCESS LAYOUT FOR PREFABRICATION

A process of prefabrication is needed to scale any type of prefabrication work, but can be tailored for industrial projects. How this process is applied will depend on the type of prefabrication being used on a project.

Following are the initial steps to starting a company-wide prefabrication process.

- Develop a company-wide strategy for externalizing work to sustain market presence or gain competitive advantage, but not just to "save hours."
- Use the WBS process on every project for planning, evaluating risk and identifying opportunities for externalizing work.
- Establish a simple prefabrication shop, or enhance the existing shop.
- Establish a measurement system for tracking the progress and production of the prefabrication, as well as an appropriate measurement of prefab's contribution to the overall job progress and productivity.

In conclusion, the advantages of prefabrication benefit industrial work due to its high risk and, in some cases, high complexity. Prefabrication can be applied by involving the project team in planning the project using the WBS approach, and identifying what cannot be prefabricated.

Increased adoption of prefabrication is fueling the industrialization of construction as a critical new trend. If a company wants to expand and reap additional benefits, a process of procurement is needed to ensure the most high-quality and profitable results.

Dr. Perry Daneshgari is president/CEO and Dr. Heather Moore is vice president of operations for MCA Inc., Grand Blanc, Mich. For more information, email perry@mca.net *or* hmoore@mca.net.