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JOBSITE TO GARAGE: *Changing the Mindset of Prefab & Modular Construction*



As the construction industry continues to head toward industrialization, modular construction (or multi-trade prefabrication) is on the rise. How will your company keep up?

Given the current workforce challenges that require different skills and methods, especially as skilled tradesmen retire, this is the perfect time to amplify your company's prefabrication efforts no matter how much you are (or are not) doing today.

This article will present a new mindset about prefabrication, including how to move work from the jobsite to a simple production-oriented setting without significantly investing in a prefabrication shop. It will also introduce training and processes that are needed to support this new mindset and prepare you for what tomorrow's workforce will require in terms of new roles, skills, and backgrounds.

PREFABRICATION: A NEW MINDSET

When most contractors consider prefabrication, they think of building assemblies or subassemblies before they need to be installed on the jobsite. This is a good start to help save time and money.

However, to proactively go from traditional prefabrication to modularized construction, the organization's mindset from the top down must change, including the business model, the make-up of the workforce, and how they are trained.

Rather than asking what *can* be prefabricated, the project team must ask what *can't* be prefabricated, and then look at every opportunity to move work away from the final point of installation. Easier said than done, this requires discipline and focused planning across the entire company.

Since aggressive offshore competition has already made this transition to build faster, better, and cheaper, time is of the essence for this shift to happen in the U.S. In addition, the workforce shortage will require a new way of working similar to the industrialization of

the agriculture and manufacturing industries. Furthermore, industry veterans are retiring faster than they are being replaced, creating a knowledge and experience gap.

MODULAR (OFF-SITE) CONSTRUCTION AS A DISRUPTIVE BUSINESS MODEL

The evolution of prefabrication from traditional to modular construction through Externalizing Work® was introduced in “Industrialization: Is Construction Next?” from the January/February 2020 issue of *CFMA Building Profits*.

As shown in Exhibit 1 below, megacenters are the final step in the industrialization of the construction industry. To move from doing only *some* prefabrication to more than half of the work being performed off-site, the view must shift away from building faster and toward a means of reducing risk.

Construction jobsites are high-risk environments due to such uncontrolled factors as weather, coordination of installation, material delivery and movement, absenteeism and the multi-trade nature of the project sites, authority’s requirements, etc. The separation of work and packaging from the point of installation will reduce the impact of many of these variables on the outcome, and therefore, on project profitability.

Reducing the impact of unknown variables on the project’s outcome is the purpose of prefabrication. Based on more than 30 years of research, observations, and implementation work with hundreds of contractors by MCA, Inc., traditional field labor encounters the following obstacles and handles them, and their decisions are only reported 11% of the time:¹

- Absenteeism
- Trade interference
- Request to move to another task by GC or customer
- Material or tool issues
- Not knowing the crew’s capabilities
- Jobsite conditions (e.g., lack of access, congested, etc.)²

Modular construction can mitigate these obstacles by removing as much of the work as possible from exposure to these elements.

The work itself does not change; it just occurs in a controlled environment where it can be visibly managed, physical conflicts with other trades can be avoided, material and tool utilization can be controlled, and the workforce can be trained.

EXHIBIT 1: Evolution of Prefabrication

Type	Description	Examples	% of Work Done Off-Site	Level of Supply Chain Integration
Prefabrication	Building subassemblies away from the installation location	<ul style="list-style-type: none"> • Ductwork • Bathroom plumbing carriers • Fully assembled fixtures 	3-5%	None
Modular Construction	Combining subassemblies into cross-trade integrated final assemblies	<ul style="list-style-type: none"> • Hospital headwalls • Ceiling MEP racking systems 	7-10%	Low (across trades)
Externalizing Work®	Any work not needing to be done onsite is done away from the jobsite	<ul style="list-style-type: none"> • Only final assemblies delivered (no parts are manipulated onsite) • No movement of individual tools or materials done onsite 	30-50%	Moderate (involving vendors)
Megacenter (full application of Industrialization of Construction®)	All trades work in production setting off-site to build and integrate assemblies: the “jobsite” is only final erection and connections	<ul style="list-style-type: none"> • Broad Group Building in China (three stories per day built off-site) • Marriott Hotels (built in Poland, assembled in U.S.) 	70%+	Full Construction Logistics-Centric Model™

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The benefits of modular construction include:

- **Reducing safety risks** with well-designed ergonomic work environments in a controlled prefabrication facility;
- **Increasing the reliability of the installation** with a higher focus on the technical quality and craftsmanship when translated and produced in a controlled environment;
- **Increasing the predictability of the outcome** with a process to design, test, and verify the installation means and methods before everything “shows up” onsite to be put together;
- **Providing a training ground for various skills**, especially for new workforce entrants (i.e., every new apprentice should start in prefabrication), and training on the company mindset about prefabrication before a new worker hits the jobsite;
- **Reducing the project duration** due to the ability to build pieces of the jobsite in parallel off-site vs. waiting and relying on other trades to work in sequence onsite; and
- **Reducing the labor cost** by reducing the composite rate with the ability to better mix the crews in an off-site setting and by using lesser-skilled labor more effectively with direct supervision and training.

The first step to realizing these benefits is by going from “jobsite” to “garage” to control the environment and minimize risk, which starts with training the workforce on the work breakdown structure (WBS).

The next step is to build a process that supports maximizing prefabrication through modular construction, which requires different workforce skills and backgrounds, as well as a process of prefabrication. Full Externalizing Work® and the modular construction business model occurs when the means of measurement change from jobsite-oriented measures to risk-based measures.

THE FUTURE WORKFORCE

To understand the workforce of the future, let’s look at transitioning from the past and preparing for the future.

Transitioning from the Past

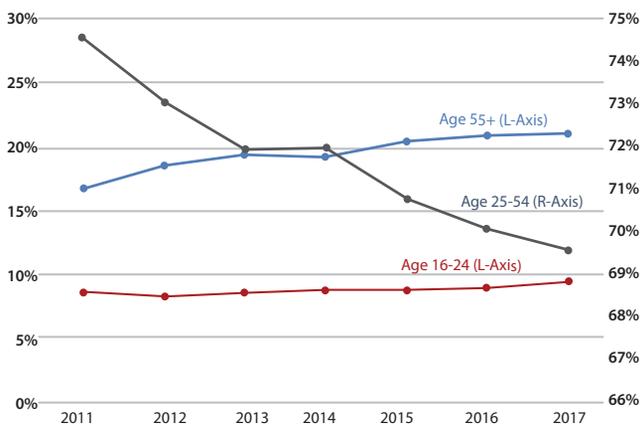
Exhibits 2 and 3 below display the key demographics of the current construction workforce. As seen in these exhibits, there are only a few years left to collect and translate the tacit knowledge of hundreds of years of construction building and work experience of the skilled trades.

Although the future construction environment and how to build may change, the knowledge of how to build is centuries old, and the best way to retain the knowledge is through a WBS. Current foremen and experienced field managers are best utilized by creating a WBS or overseeing the process with a less experienced workforce.

Project Manager

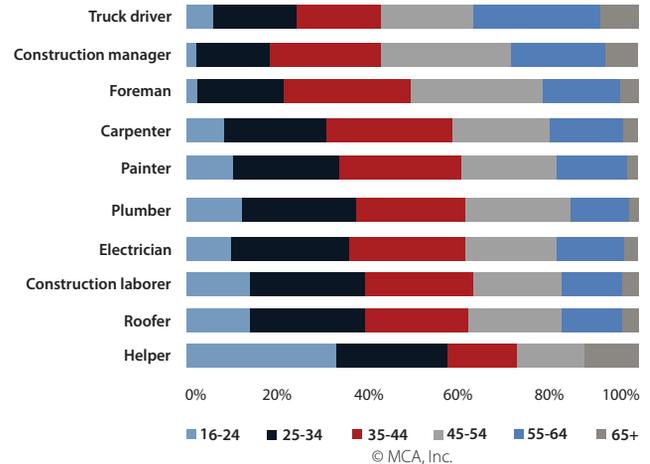
A key role that will transition with industrialization is the project manager (PM). More than a title or position, project management is a science.

EXHIBIT 2: Distribution of Construction Employment by Age 2011-2017



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EXHIBIT 3: Age Distribution Among Occupations in Construction, 2017



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PMs are typically:

- 1) Field leaders who are elevated to PMs with zero training, or
- 2) Construction management/civil engineering graduates who have little to no field experience.

The transition to this role might be difficult, but as the work speeds up and becomes more complex, PMs must keep pace, manage the data, understand the science of project management, and become engaged in the process (see “The Impact of Job Planning on Profit” in the November/December 2005 issue of *CFMA Building Profits*).

Prefabrication Manager

As prefabrication shops are created and expanded, the position of the prefabrication manager becomes more necessary. Similar to PMs, prefabrication managers are usually transitioned from a field role and consist of the best field leaders with sound mechanical ability. The top performers can see both the work and the need for resource management with an eye for innovation. Unfortunately, prefabrication shops cannot scale much beyond 5% prefabrication with this model.

Accounting

The last and most critical step is the transition of the accounting role. Although prefabrication does not seem to be very connected to accounting, it cannot expand without a transition of financial measurement and management. Prefabrication requires a transition of the following financial processes:

- Revenue recognition to account for progress in prefabrication
- Cost codes and labor codes to track prefabrication
- Knowing and following Davis-Bacon laws
- Capitalization vs. expenditure
- Tax considerations, such as the Research and Development (R&D) tax credit and equipment depreciation
- Risk and liability for prefabrication performed in a centralized facility, such as in multi-trade prefabrication or modular construction

All of these transition items can be completely beneficial to the contractor’s bottom line, but only if financial managers understand how they change in a prefabricated environment.

Preparing for the Future

Understanding the construction workforce means looking back at the industrialization of other industries. New roles, skills, and backgrounds are needed to help them expand the use of their craftsmanship – not replace the skilled trades.

Multi-trade prefabrication is the first sign of the future for the skilled trades. The knowledge of mechanics, electricians, carpenters, ironworkers, pipefitters, and others can be best used by planning and integrating their work before anything is built. The physical labor of material movement, logistics, and tool management does not require a skilled tradesperson. Projects can be built faster, better, cheaper, and safer in these conditions.

As the construction industry becomes industrialized, the following skills will be needed:

- Production management
- Industrial engineering
- Logistics and transportation
- Data management and analysis

Similar roles were incorporated in other industrialized settings like manufacturing and agriculture. Today’s automotive skilled trades are no longer operators. Farming can produce more without farmers planting each seed and cutting each stalk.

The future of construction and increased prefabrication requires seeking, hiring, and training new roles from nontraditional sources and other industrialized settings.

TRAINING & PROCESSES NEEDED

The future workforce that comes with industrialization requires a blend of transitioning the workforce of today and building that of tomorrow. The change in mindset comes from education; “unlearning” the current way of construction will be the biggest hurdle for the current workforce.

Jamie Sullivan, President and CEO of Staff Electric, says it best: “We can’t build today like we did five years ago, and we can’t build five years from now like we do today.” Bridging this gap requires exposure to how it could be done by studying and translating principles from other industrialized industries and seeing working models.



To move from doing only some prefabrication to more than half of the work being performed off-site, **THE VIEW MUST SHIFT AWAY FROM BUILDING FASTER AND TOWARD A MEANS OF REDUCING RISK.**

The easiest and fastest way to start is to reduce the risk to ramp through the evolution stages (outlined in Exhibit 1) and to have project teams realize that the prefabrication shop is just another jobsite.

Education and training are both required for the workforce of the future. Education is required to understand the modular construction business model.

Once this new way of thinking is clear, specific training and layout of the prefabrication environment will be required in order to scale and sustain it.

Three specific topics and processes to focus on include a WBS, the process of prefabrication, and measures and financial implications of prefabrication.

Work Breakdown Structure

To manage any work, it must first be identified. Historically, the definition of work in construction has been limited to installation and onsite preparation in support of stick build. Such other ancillary work as shown below in Exhibit 4 has not been considered work; therefore, the labor interacts with them only as needed.

Exhibit 5 shows what a WBS should look like. It can be created top-down by putting the project name on top and breaking down its phases, systems, etc., into finer detail; it can also be created bottom-up by having the skilled trades identify individual work activities first and then group them together to build a hierarchical structure. The focus is on the work only, not on time, hours, or cost codes.

The main purpose of a WBS is to transfer/document how the project teams, particularly the skilled trades, see the work. The WBS will reflect how they would build the job, unbeknownst to anyone until it is physically in a place where changes and opportunities for prefabrication are no longer possible. Therefore, the format, “accuracy” to the design or estimate, or any other judgments should be reserved until the project team has a chance to think and work together.

Maximizing prefabrication comes from externalizing work and reducing risk, not just fabricating. Once the work is documented, then *who* does *what*, *when*, and *where* can be planned by individual trades or across trades. Exhibit 6 at left shows an example of a WBS for the electrical scope of a substation.

EXHIBIT 4: Non-Installation Work

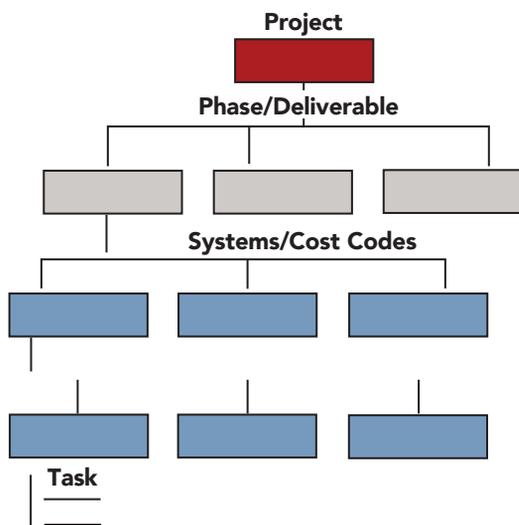
Planning	Pre-Install/Prep	Material Movement	Clean Up
Obtaining permits	Coordination with vendors	Permits	Testing
Mobilization	Coordination with other trades	Returns	Labeling
Demobilization	Coordination with GC	Cleaning up	Troubleshooting
Getting tools	Coordination with change orders	Moving material	Programming as-builts
Ordering material	Owners	Receiving material	Tagging
Manpower planning	Coordination with manufacturers		
Layout	Scheduling install		
Safety plans	Studying cut sheets		
Preparing workspace	Training explaining		
Drawing review			
RFIs			

EXTERNALIZING WORK WILL FILL THE GARAGE

Once the types of work and risks are clear, the WBS is used to identify the work and evaluate the risk in more detail to determine *what* to prefabricate.

From here, the opportunities to externalize the work from the jobsite become plentiful. The final installation or assembly is the only work that must be done onsite. Exhibit 7 shows the

EXHIBIT 5: WBS Example



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process that the workforce can use, based on the WBS, by asking one simple question: “What does not have to be done onsite?” Material handling and identifying risk areas, particularly safety issues, are good starting points for removing the risk from the jobsite.

Exhibit 8 shows the skills required for work once it is made visible. More than half of the skilled trade work has an opportunity to be done by someone other than a skilled tradesperson, which can help expand the industry’s workforce.

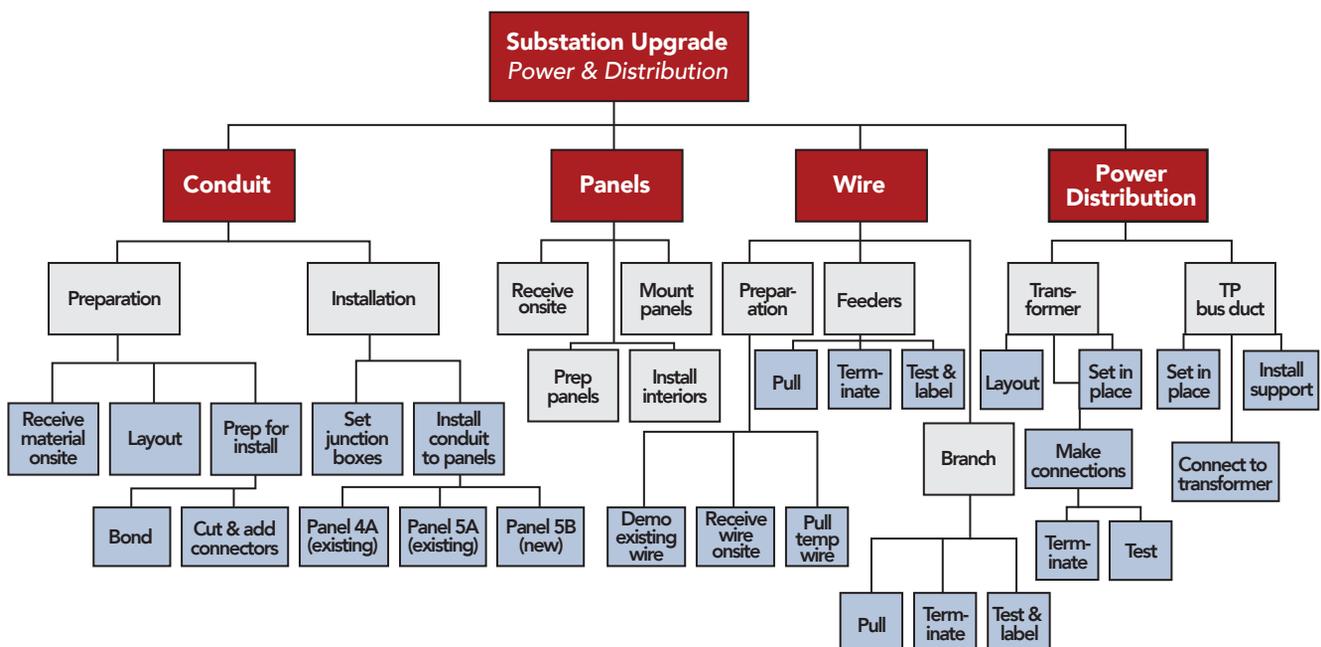
The Process of Prefabrication

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 is to be done or identify it based on prior experience. There are three types of opportunities for prefabrication:

- 1) Common amongst all jobs
- 2) Type of work-specific (common within a type of work)
- 3) Build-to-order (project-specific and one-off items)

This categorization helps to standardize and train people to identify the opportunities for prefabrication, make the selection, and place the order, which makes all additional downstream prefabrication processes more consistent and manageable.

EXHIBIT 6: Partial WBS for a Substation



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The common items – and even some of the type of work-specific items – can be produced and/or bought directly from distributors or vendors.

The high-level process of prefabrication that has proven effective over many years is shown in Exhibit 9 on the next page. This process can be tailored for any of the three types of prefabrication and ensures that what gets conceived by the project team translates into useful installation onsite.

Measures & Financial Implications of Prefabrication

Measuring prefabrication is easy, but measuring its impact is not, especially with current/traditional means of measurement. Many companies try to make a direct comparison of doing the work in the field vs. the shop to see which is faster, but the differences in the shop and field are not comparable.

Rather, the difference is between efficiency and effectiveness – efficiency is doing things fast, while effectiveness is being productive. In other words, assemblies may be built faster in the field, but the non-assembly time can eat up all of that advantage with one trip to the material storage area. Herein lies the difficulty, since measuring the impact requires a comparative measure of the entire job's productivity, not just production or production rates.

Keeping it simple is best to start, and Exhibit 10 a few pages ahead shows how the measurement methods can escalate from simple to complex as the prefabrication volume increases.

Companies must determine if prefabrication will be treated as a cost center or profit center. Some companies try to add incentives or quotas for project teams to utilize a certain amount of prefabrication.

If the measurement itself is punitive (i.e., the job is charged for a certain amount of prefabrication whether it is used or not), then a company may end up reversing the culture of prefabrication, which could lead to poor system productivity since the usage of prefabrication is sub-optimized, whether it be for one job or one PM's preference at a time.

CONCLUSION

The industry is quickly changing in many ways including the nature of the work, demographics of the workforce, and evolution of technology. Construction is following the same industrialization path that other skilled-trade-reliant industries have followed.

For contractors to get and stay ahead, the work must be externalized, starting with prefabrication and moving the work from the jobsite to a lower-risk place to build. It can then evolve toward the modular construction business model, where more than half of the work can be done off-site.

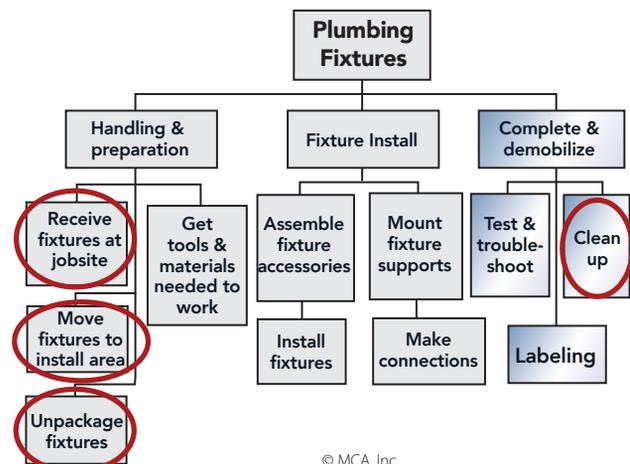
This article has given a preview of what companies need to do to prepare for a workforce that supports such a model, along with a few key processes and training required. The CFO's role in these processes is critical, particularly on selecting and implementing a means of measuring prefabrication and its impact on the overall business.

EXHIBIT 7: Compilation of WBS Results



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EXHIBIT 8: Opportunities for Externalizing Work



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and procedures, measure and track the progress and results, handle procurement and logistics connections, and address challenges to prefabrication and modular construction. ■

Endnotes

1. Moore, Dr. Heather. "Exploring Information Generation and Propagation from the Point of Installation on Construction Jobsites: An SNA/ABM Hybrid Approach." Dissertation, Michigan State University. 2013.
2. Daneshgari, Dr. Perry & Moore, Dr. Heather. "Prefabrication Handbook for the Construction Industry." MCA, Inc. 2019.

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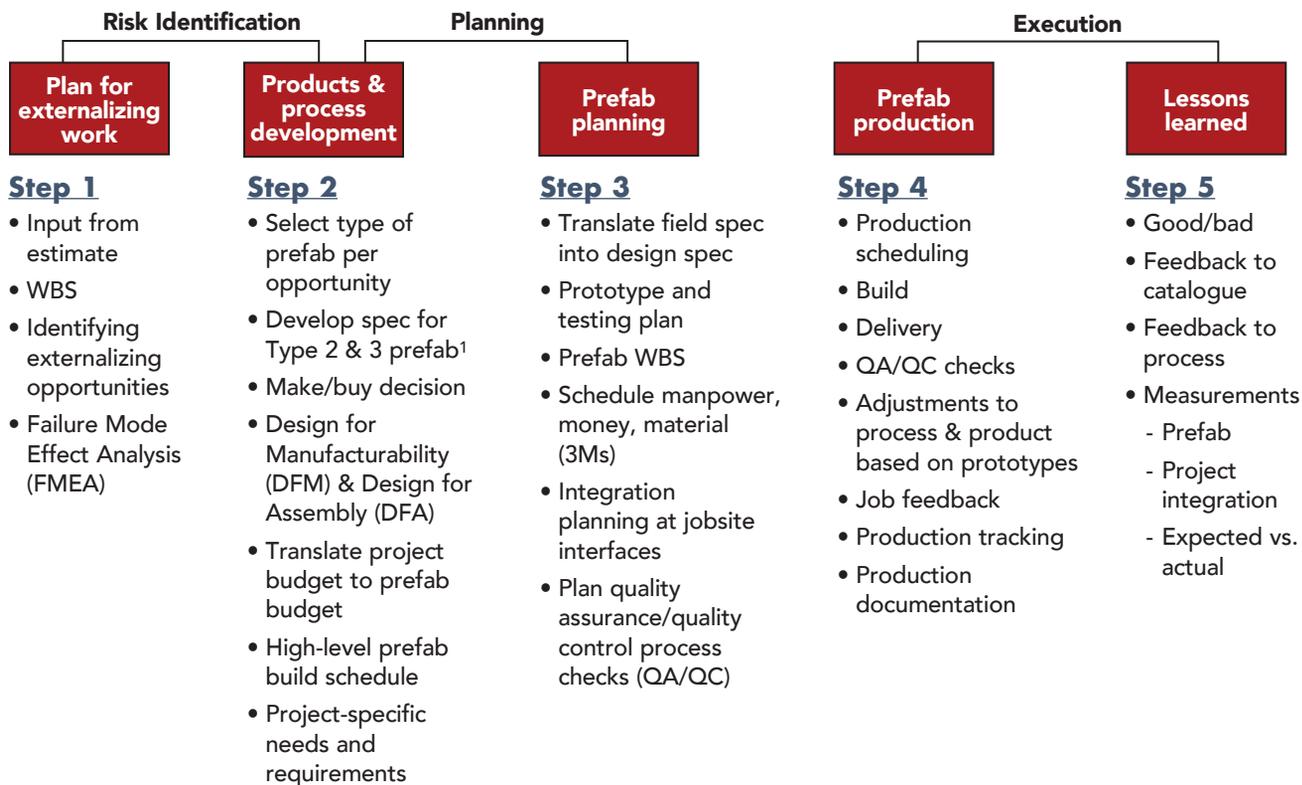
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EXHIBIT 9: The Process of Prefabrication



¹Prefab Types:

- Type 1 = standard items (non-job related)
- Type 2 = standard job relations
- Type 3 = non-standard items (job specific)

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EXHIBIT 10: Spectrum of Methods to Measure Prefabrication

Method	Measurement	Advantages	Disadvantages
Simple	Overall job and/or company composite rate	<ul style="list-style-type: none"> • Data is already available in accounting • Consider the most important cost-related advantage of prefabrication 	<ul style="list-style-type: none"> • Prefabrication's impact on the composite rate (vs. other factors managed onsite) is assumed rather than viewed separately
Intermediate	Track all prefabrication activities in one dedicated prefabrication cost code	<ul style="list-style-type: none"> • Easy to set up in databases • One "bucket" to use for planning and tracking 	<ul style="list-style-type: none"> • No segregated production or production rate information
Advanced	Develop prefabrication-specific labor codes that coincide with field install labor codes	<ul style="list-style-type: none"> • Progress tracking that coincides between field and prefabrication • Analyzing productivity with available data 	<ul style="list-style-type: none"> • Difficult to segregate activity tracking in prefabrication according to field labor codes • Leads to poor data
Comprehensive	Measure prefabrication and job productivity separately with their own cost codes that roll up to an overall job measurement	<ul style="list-style-type: none"> • High-quality data • Tracking is meaningful for prefabrication, the field, and the overall job collectively 	<ul style="list-style-type: none"> • More complex to establish means of measurement

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