



BY DR. PERRY DANESHGARI & DR. HEATHER MOORE

# 2022 INDUSTRIALIZATION UPDATE: *Evidence & Projections*



The most notable continuing trends toward Industrialization of Construction® include new horizons for prefabrication, logistics, and data-driven approaches to job, project, and business management. Although construction has only been on this pathway for less than three decades (which took other industries a century or more), it's moving toward the goal of reducing the cost of shelter and infrastructure.

This article provides an update on where the industry stands with industrialization — including metrics, supporting standards, and specific examples and evidence — and covers the novel approach of Integrated Material Logistics Solutions (IMLS®), which is beginning to gain traction among a few suppliers and will be required to get to the true construction megacenter approach (as introduced in “Industrialization: Is Construction Next?” from the January/February 2020 issue<sup>1</sup>). To see where your company stands, take the Industrialization Litmus Test at [forms.gle/9P9dMkXY63Xp7bh1A](https://forms.gle/9P9dMkXY63Xp7bh1A).

## INDUSTRIALIZATION: WHERE THE INDUSTRY STANDS

As first presented at the National Electrical Contractors Association (NECA) Convention in 2010 by Dr. Perry Daneshgari, there are five steps that all skilled-trades-based industries go through to expand and evolve toward industrialization:

- 1) Managing Labor
- 2) Managing Work
- 3) Lean Operations
- 4) Modeling and Simulation
- 5) Feedback From the Source

In 2020 research on the topic,<sup>2</sup> the indications of industrialization were captured in three key metrics: labor cost per dollar sold, consumer expenditure as a percent of income, and workforce transition (expanding to secondary and tertiary roles from the primary skilled trades).<sup>3</sup>



In 2022, these metrics indicate that Industrialization of Construction® is continuing, but based on studies of similar indicators in other industries that followed the same path, there is still much to overcome in order to catch up with other industrialized sectors.

### Labor Cost Per Dollar Sold

Exhibit 1 depicts an update on labor cost per dollar sold through 2020, reflecting how much an industry sector can produce with its reliance on labor. Once an industry goes through steps 3 and 4 of industrialization, it requires less tacit knowledge from the skilled trades to produce the same output.

Exhibit 1 also shows that in electrical construction (and construction overall), there was movement in the right direction in 2020. However, when compared to agriculture and manufacturing (where the labor cost per dollar sold is less than \$0.15), construction is still behind. Getting caught up starts with the Industrialization Litmus Test ([forms.gle/9P9dMkXY63Xp7bh1A](https://forms.gle/9P9dMkXY63Xp7bh1A)), where an organization can determine how much of its decision-making is left to the jobsite environment and labor force.

### What's Next?

The industry must continue to look ahead at the work and business practices required for steps 3-5, while ensuring that *managing work* and *managing labor* is a staple on construction sites and within contracting businesses. In addition to the data-based evidence previously mentioned, the following are four examples of forward movement.

### The Traditional Model of Contracting Is No Longer Effective

The traditional operational model of construction contracting is a simple one-job-at-a-time approach (Exhibit 2).<sup>4</sup> Little to no data is required to operate in this business model; all that is needed is access to skilled tradespeople and payment.

In the most traditional state, estimates are done on legal pads; office employees and PMs typically come from the field (except for the accounting department), and the owner/President/CEO determines in the last month of the year if the company has made money. After working with thousands of contractors for three decades, MCA, Inc. has seen fewer companies starting from or surviving with this model.<sup>5</sup>

Survivors have moved into a transition model, where the transition doesn't happen by itself; "due to attrition or conscious decision of the owners, [they] are in the process of changing from traditional to professional."<sup>6</sup>

The operational model is independent of size. Many larger and legacy trade contractors still operate traditionally, relying on strong field superintendents and rigid accounting controls to strengthen the lack of connectivity to the work environment and sources of variation in project outcomes.

### Prefabrication-Centric Organizations Continue to Grow

The industry continues to hover at 3-5% prefabrication, and the best cases seen at the project level are 15% of the project being prefabbed and the company prefabbing 8% of its work. Industrialization will demand more than 30% of the work being done away from the jobsite,<sup>7</sup> and contractors as well as other businesses are migrating toward that outcome.

A trade contractor without some form of prefabrication is almost unheard of these days; many are on their second

## Get Up-to-Speed on Industrialization

Check out these articles from *CFMA Building Profits* for a recap of industrialization, what it could mean for construction, and the impact for your company.

"Industrialization: Is Construction Next?" from the January/February 2020 issue at [www.cfmaponline.net/cfmabp/20200102/MobilePagedArticle.action?articleId=1645219](http://www.cfmaponline.net/cfmabp/20200102/MobilePagedArticle.action?articleId=1645219).

"Jobsite to Garage: Changing the Mindset of Prefab & Modular Construction" from the March/April 2020 issue at [www.cfmaponline.net/cfmabp/20200304/MobilePagedArticle.action?articleId=1656724](http://www.cfmaponline.net/cfmabp/20200304/MobilePagedArticle.action?articleId=1656724).

"The Operational Model for Modular Construction" from the May/June 2020 issue at [www.cfmaponline.net/cfmabp/20200506/MobilePagedArticle.action?articleId=1656009](http://www.cfmaponline.net/cfmabp/20200506/MobilePagedArticle.action?articleId=1656009).

"Supply Chain Disruption: Are You in the Construction or Logistics Business?" from the July/August 2021 issue at [www.cfmaponline.net/cfmabp/07082021/MobilePagedArticle.action?articleId=1708730](http://www.cfmaponline.net/cfmabp/07082021/MobilePagedArticle.action?articleId=1708730).

"How Industrialized Are You?" from the November/December 2021 issue at [www.cfmaponline.net/cfmabp/11122021/MobilePagedArticle.action?articleId=1743447](http://www.cfmaponline.net/cfmabp/11122021/MobilePagedArticle.action?articleId=1743447).

or third shop expansion. Many contractors are also moving toward modular construction, combining subassemblies into cross-trade integrated final assemblies (see Exhibit 3).

Allfab Group (*allfabelectric.com*) is one example of a contractor aiming toward Externalizing Work®, combining electrical and plumbing operations with a prefabrication-centric business strategy. In other words, rather than figuring out *what to prefab one job at a time*, Allfab is Prefab Thinking™, which is an approach to prefabrication where the *entirety of a project is thought and planned as prefabricated*.

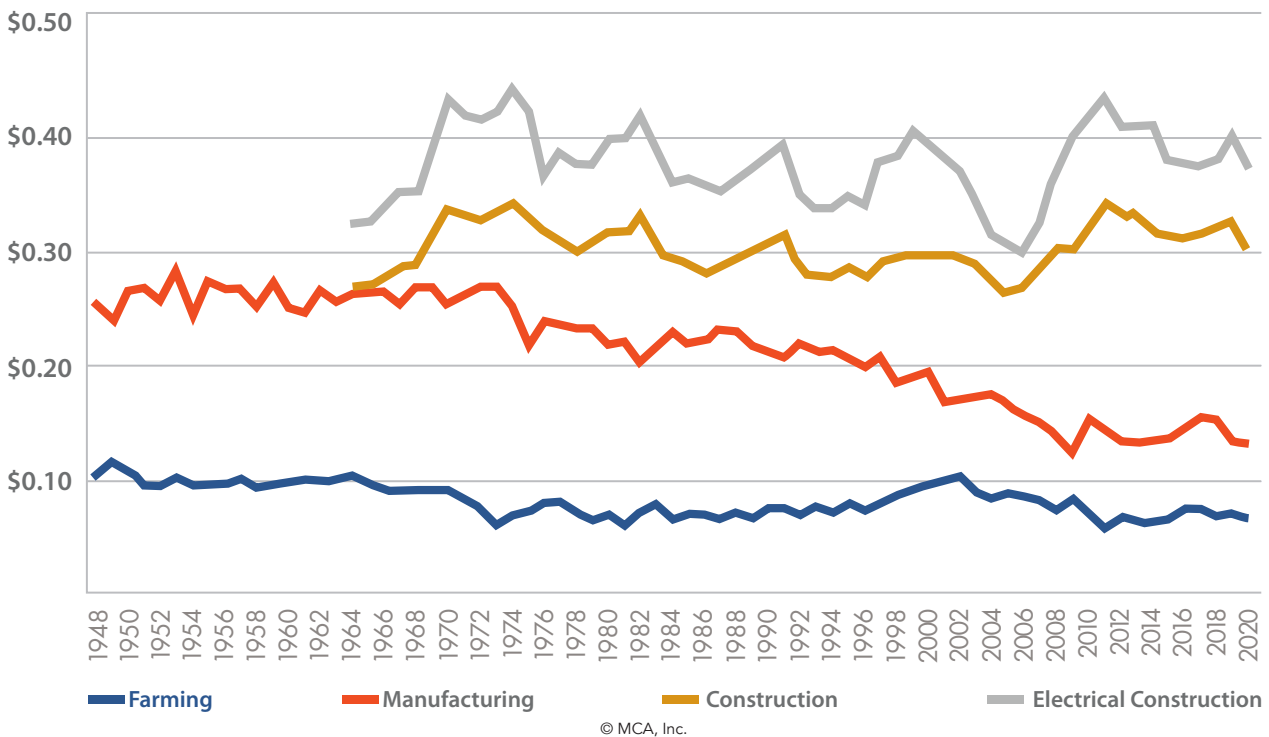
Prefab Thinking™ starts as if every part, piece, and hour begins in the prefabrication shop and is delivered to exactly where it's needed for final install; this line of thinking can

help bridge from modular construction to Externalizing Work®. These expansions from traditional construction will change the landscape, with facilities and logistics that support Externalizing Work® to the extent that no parts are manipulated on the jobsite.

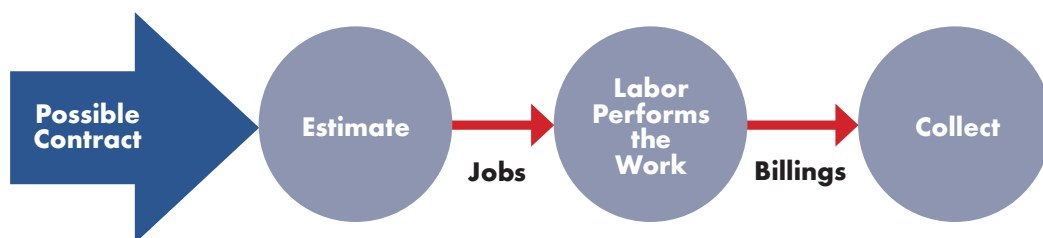
**The First-Ever Industry Standard on Prefabrication**

The industry's first standard on prefabrication, as part of the National Electrical Installation Standards, is in the final stages of American National Standards Institute (ANSI) approval. It is heavily focused on the infrastructure and processes required to assure quality to consumers and end users of buildings and infrastructure built off-site. The standard will bring a common reference point to construction procurement, craft training, and prefabrication metrics.<sup>8</sup>

**Exhibit 1: Labor Cost Contribution Per Revenue Dollar**



**Exhibit 2: Traditional Operational Model**



© Daneshgari, Dr. Perry. "Agile Construction® for the Electrical Contractor." MCA, Inc. 2020.



Based on 2020 research outlining the advanced model for industrialization,<sup>9</sup> the prefabrication standard is just the beginning of developing needed standards and regulations to move construction along the industrialization trajectory. Agriculture and manufacturing went the same route; higher production led to higher demand of quality in the product, which led to supply chain and social regulations that are required to consume more of the product.

### Continuous Learning & Pushing the Envelope

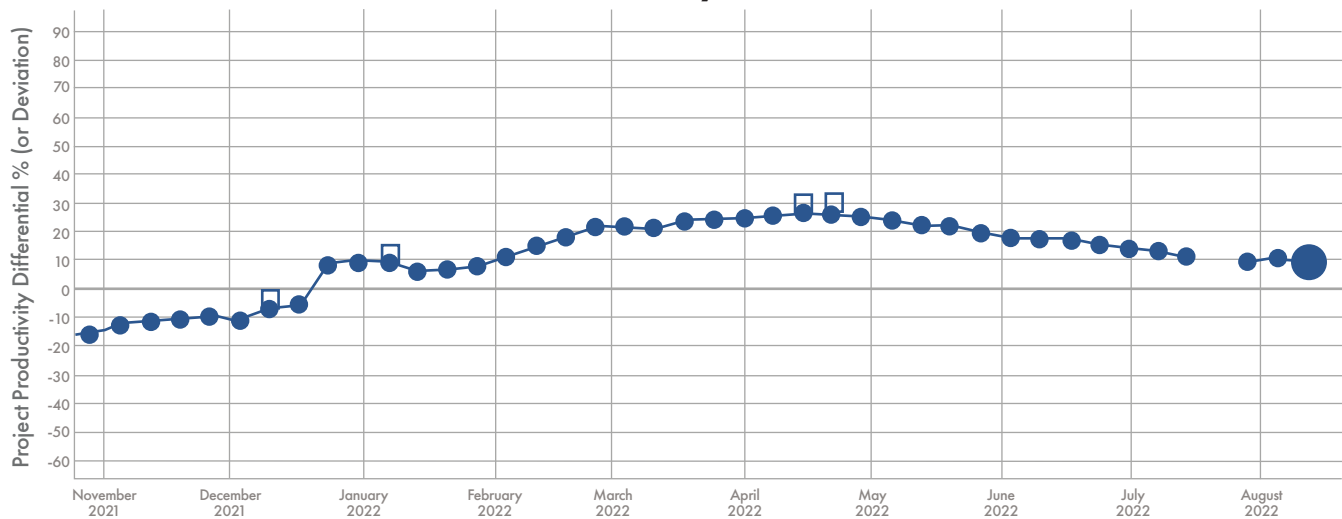
Despite the industry's progress, the involvement of construction's highly skilled and knowledgeable craftspeople is needed to get to industrialization. An example of this transition is when a project team starts with *nothing can be prefabricated on this project* and moves to *prefabrication on significant portions of the work* and recognizes the results in productivity, safety, and predictability.

**Exhibit 3: Evolution of Prefabrication**

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

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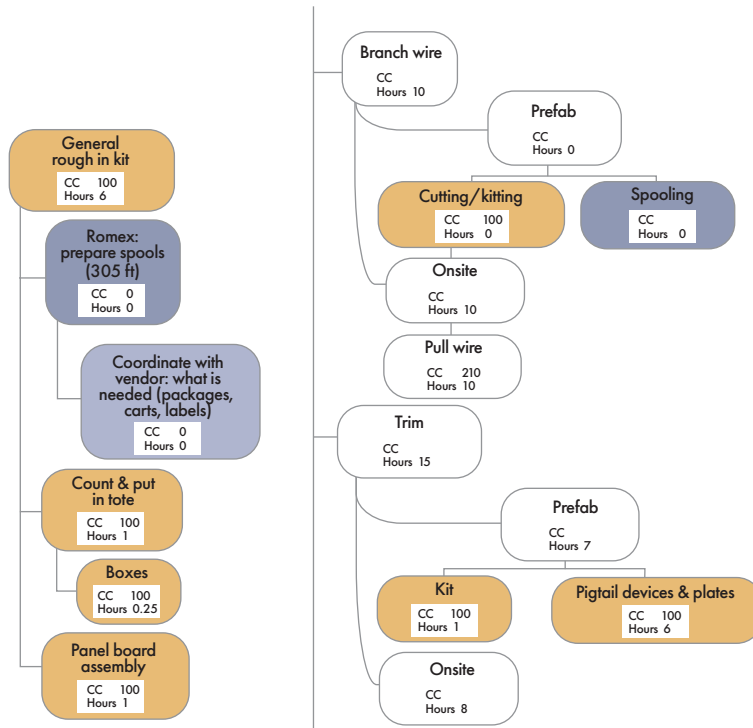
**Exhibit 4: Productivity Measurement**



Update Dates

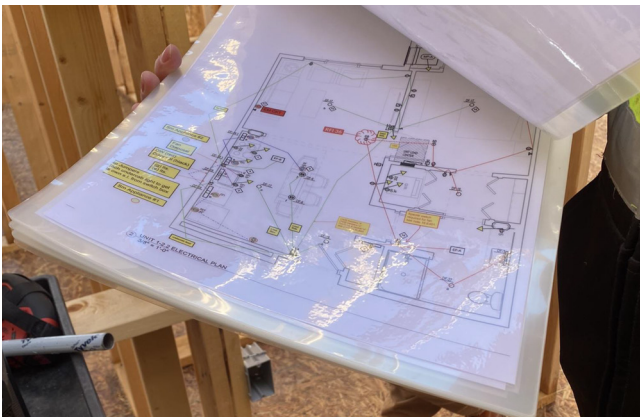
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## Exhibit 5: Using the Work Breakdown Structure (WBS) to Identify Prefab Opportunities



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## Exhibit 6: Room Layout for Prefab Install



Field layout to translate Prefab Thinking™ into installation instructions.

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## Exhibit 7: Installed Prefab

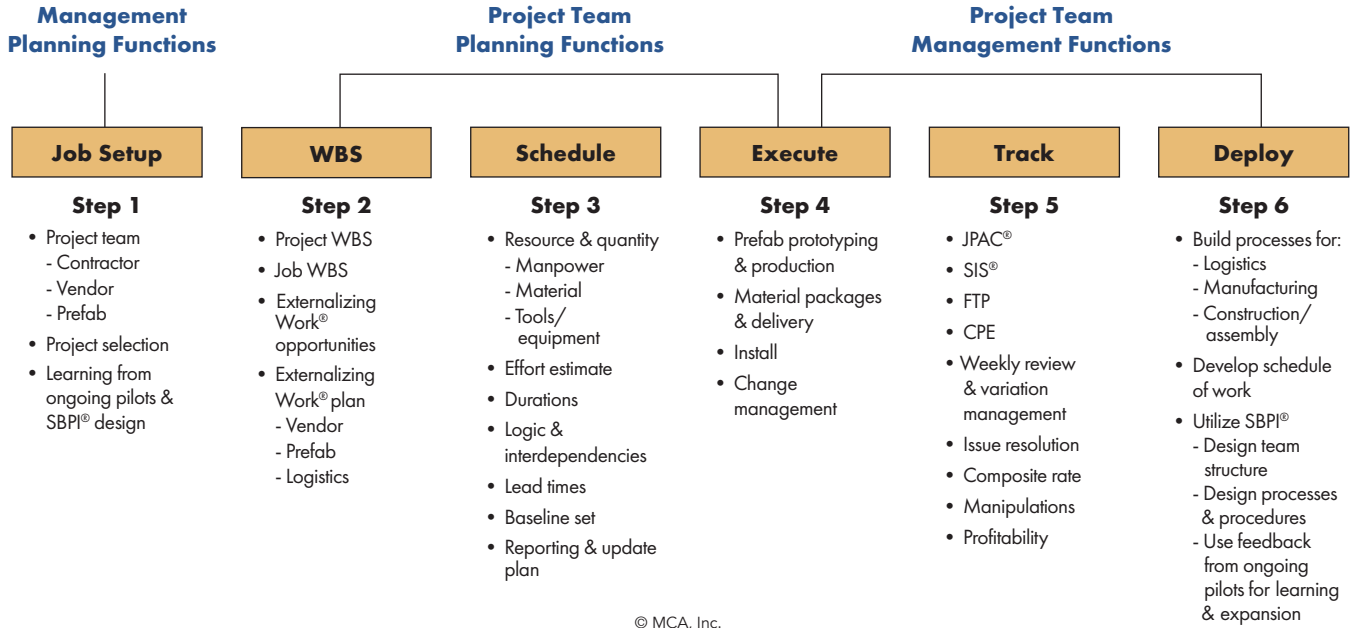


Field install of prefabricated panels, romex coils, and feeders that were not seen "possible" to prefab at the onset of the job.

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### Exhibit 8: Integrated Material Logistics Solution (IMLS®) Process



### Exhibit 9: Integrated Schedule Between Building Information Modeling, Prefab, Vendor & Jobsite

Task Name	Days	Hours	Resource Names	2/18/2018		5/20/2018		8/19/2018		11/18/2018	
				21	5	18	30	12	24	6	19
<b>Jobsite Material Logistics/Packages</b>	<b>207.35</b>	<b>11,848</b>		0%							
<b>OH Conduit Package</b>	<b>154</b>	<b>3,493</b>		0%							
<b>Area 2</b>	<b>154</b>	<b>3,493</b>		0%							
<b>3rd Floor</b>	<b>39</b>	<b>482</b>		0%							
<b>Order Received</b>	<b>15</b>	<b>200</b>		0%							
Design	10	160	Prefab, BIM	0%							
Components ordered	4	32	Prefab	0%							
Components received	1	8	Prefab	0%							
<b>In Production</b>	<b>15</b>	<b>176</b>		0%							
Material order from vendor	7	56	Vendor	0%							
Assembly prefabrication	15	120	Prefab	0%							
<b>Shipped</b>	<b>12</b>	<b>56</b>		0%							
From vendor to prefab	3	24	Vendor	0%							
From prefab to jobsite	4	32	Vendor	0%							
<b>Received Onsite</b>	<b>4.25</b>	<b>18</b>		0%							
Identify routing to installation location	1	8	Vendor	0%							
Schedule delivery – crane/hoist	1	8	Jobsite	0%							
Receive and move to staging on floor	0.25	2	Vendor	0%							
<b>Installation</b>	<b>4</b>	<b>32</b>		0%							
Stage	1	8	Vendor	0%							
Install on site	3	24	Jobsite	0%							
<b>4th Floor</b>	<b>40</b>	<b>1,018</b>		0%							
<b>2nd Floor</b>	<b>40</b>	<b>1,021</b>		0%							
<b>1st Floor</b>	<b>39</b>	<b>972</b>		0%							
<b>OH Conduit Package</b>	<b>189.35</b>	<b>4,340</b>		0%							
<b>OH Conduit Package</b>	<b>141</b>	<b>4,015</b>		0%							

Exhibit 4 shows the results in JPAC® with positive and stable productivity. Exhibits 5, 6, and 7 show examples of how the prefabrication was planned (using the Work Breakdown Structure (WBS) in Exhibit 5), laid out for the field crews (Exhibit 6), and installed (Exhibit 7).

The foreperson who did not think anything could be pre-fabbed mid-way through the job quantified the savings as being 3-4 times faster on the installation alone, as well as savings in unnecessary material and tools stored onsite (before, during, and after the install), material handling, and mobilization.

### LOOKING TOWARD THE FUTURE

Looking ahead to 2023 and beyond, the following aspects have been outlined as the next five steps for construction toward industrialization.<sup>10</sup>

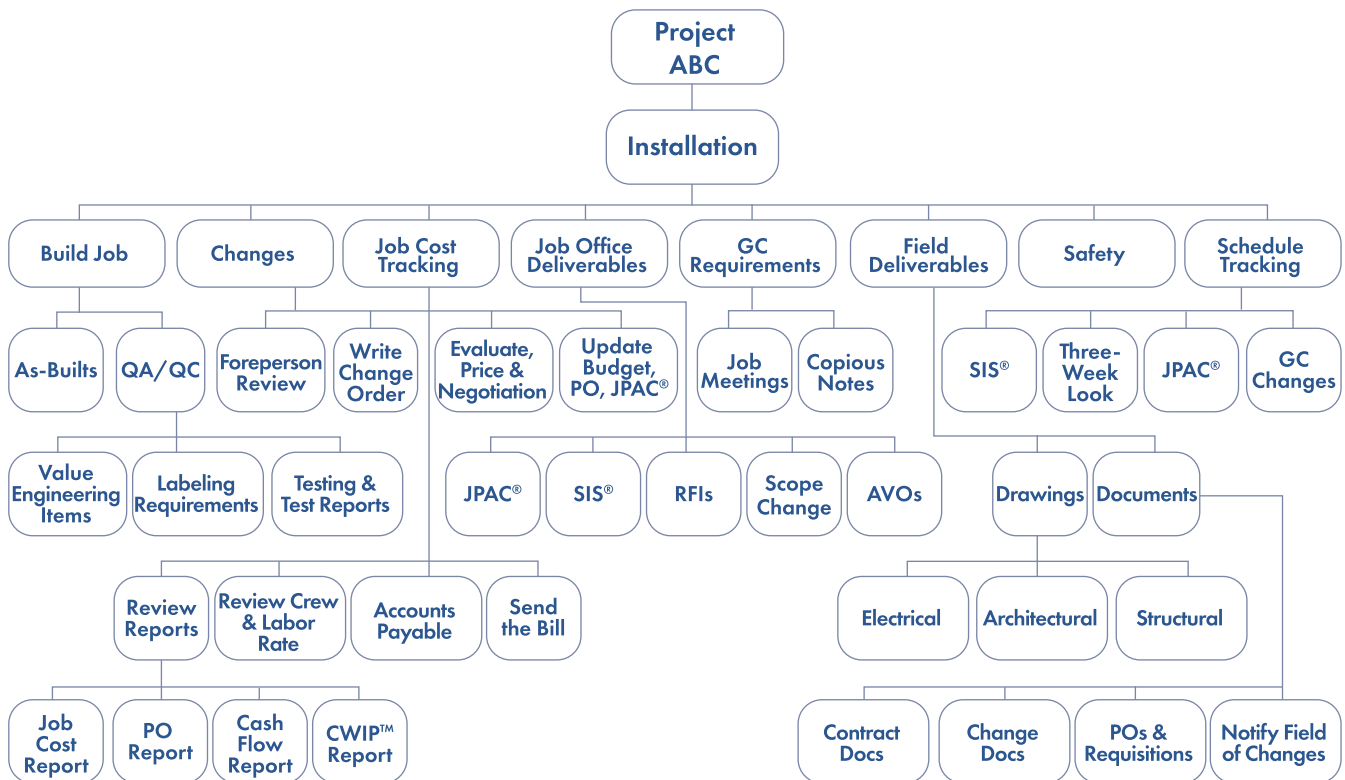
- 1) A new generation of contractors will be forming to replace the traditional ones.
- 2) Through the use of the Toyota Production System, a new era of distributors will take the place of current distributors that have a low first-time pass in their warehouse and focus on project management only with brute force.

- 3) Digitalization, commonization, and interconnectivity (DCI Construction™) will seamlessly connect distributors, manufacturers, and contractors.
- 4) A global architecture, engineering, and construction consortium will replace the currently segmented industry.
- 5) Cost, time, and quality of shelter, which is the main objective of construction to satisfy the basic human needs, will be reduced to affordable levels of 25-30% of annual income vs. the current 300-600%.

The first step has been covered, and the following are trends related to the second and third metrics, moving the industry along the trajectory of industrialization.

### FIRST SPARKS OF INTEGRATED MATERIAL LOGISTICS SOLUTIONS

The IMLS® (Exhibit 8) outlines a process for a contractor and distributor to work together throughout the department to optimize logistics, particularly for an industrialized application where nothing arrives to the jobsite needing manipulation.





Imagine:

- If trade contractors (including their BIM and virtual design and construction departments), distributors, and manufacturers were all working off of a common project schedule that matches the way the work is planned and executed by the skilled trade.
- If the jobsite has full and accurate transparency to the status of every piece of equipment and material needed for the build.
- That packaging, labeling, kitting, staging, and removal are planned for each day of the jobsite's duration with zero returns and only touching the ground once at the final installation location.

These conditions are the objectives of IMLS<sup>®</sup>, which is a six-step data-driven, pragmatic, and non-emotional solution to the current hurdles keeping contractors and their material suppliers working together efficiently.

Exhibit 9 shows early stages of this solution, with a schedule that reflects the jobsite work as well as the procurement and logistics touchpoints for the material supplier. It's easy to see the impact of a single day's delay in design decisions as well as on installation efforts months later. By connecting work, effort, and time using Agile Construction<sup>®</sup> methods, the IMLS<sup>®</sup> brings visibility to the entire supply chain.

Some of the expected outcomes of using IMLS<sup>®</sup> include:

- Reduced manipulation of material/parts, thereby reducing the variation in the outcome of the final installation.
- Reduced material handling, with a direct impact on the contractor's bottom line and reduced time/duration needed on the jobsite.
- Reduced manpower presence onsite, with more effective use of the resources off-site in a controlled environment.
- Increased capability and throughput of the supply channel, improving first-time pass for the material suppliers and reducing inventory and handling costs.

New technology will be required for this solution to make visible and measure the state of the project that is digitized to several off-site locations.<sup>11</sup> Only distributors and manufacturers that are willing to work on reducing their own internal costs and commit to Agile Distribution<sup>®</sup> (as opposed to just selling and buffering the material supply) will be able to provide the IMLS<sup>®</sup>.

### EXPANDING ON DATA-DRIVEN APPROACHES TO PROJECT MANAGEMENT & BUSINESS MANAGEMENT

Industrialization requires more data-driven solutions, followed by seamless interconnection within and without construction organizations. But just because the word *digitalization* is used does not mean these are simple software solutions or apps.

True digitalization means breaking down the means of work and process flow to allow it to go from tacit to explicit. The container of these solutions will likely be computerized, but its backbone relies on construction market realities, as well as knowledge and experience of construction trades and industrialization outside of construction.

Exhibit 10 shows a sample of the type of data and information needed in the installation phase of construction. Currently, a majority of these needs are met with spreadsheets, job-specific reports, and person-specific file structures. The goal of DCI Construction<sup>™</sup> is to make this entire suite of project life cycle needs interconnected and commonized.

### CONCLUSION

Momentum is the product of mass and speed; for Industrialization of Construction<sup>®</sup> to gain momentum, certain conditions can help catalyze the transition. However, individual steps by forepersons, PMs, accountants, estimators, and executives can all help in getting the industry closer to better, faster, and lower-cost construction. ■

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## Endnotes

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