



*Workers building cars in a factory, 1930s.*



# From **That** to **This**:

Other Industries Have Perfected Modern Production. So, When Will Construction?

Like most other industries across the United States, the construction sector is becoming increasingly digitized as its leaders strive for success in the information age. And, although the engineering and construction (E&C) industry may have a long-standing reputation of being somewhat of a laggard in regard to innovation in comparison to other industries, the companies that lead the trend and choose to invest wisely in

digital innovation today, will absolutely have the competitive advantage tomorrow.

This desire for the construction industry to bring its best practices in line with the high-tech demands of the 21st century can be evidenced by the large – more than \$20 billion – amount of venture capital that has been entering the space over the last few years, accompanied by a rapid growth in



construction technology firms and greater focus on integrated data management systems.

“Many investors are looking to our industry as a place of opportunity because it is a large industry that is estimated at about \$10 trillion each year globally,” says Pete Dumont, Executive Advisor at The Premier Resources Group, and Principal of PrairieDog Venture Partners. “Yet, it is also one of the most inefficient and is highly fragmented, complex, and dysfunctional. We often still operate and behave in much the same way we did decades ago; characterized more by combat than collaboration and burdened by a highly inefficient supply chain structure.”

There are many challenges to increasing productivity in the construction industry.

However, when talking about this topic rarely does the conversation question – or even consider – the method of production currently being used.

“We would still be building cars by hand and piece by piece if someone didn’t stop to question the methods of auto production,” says Stephen Mulva, Director at the Construction Industry Institute (CII). “But the problem with the construction industry is that we simply don’t do that. We refuse to question our current methods of production and seem willing to do the same things that we’ve always done and in the same ways, just pushing everyone to do everything faster. We won’t see any big gains in productivity doing that.”

To ultimately improve, the construction industry must begin to reflect on innovative and modern production methods that improve efficiency and effectiveness, and not just focus on productivity itself. Currently, there are three main modern production methods that are beginning to steer the conversation in that direction: Lean, Advanced Work Packaging, and Project Production Management.

### Lean and Integrated Project Delivery

Today it is not unusual to have several dozen different companies working on a job site to deliver a single project, and almost all of them are working under two-party contracts. The multiple layers of these two-party contracts promote a culture of

intense competition, where everyone can see the issues but few are willing to challenge the status quo. Owners who are close to the work see the inefficiencies and waste and don’t want to pay for it. They are willing to try something else.

For Procter & Gamble (P&G), this meant adopting the principles of Lean and Integrated Project Delivery (IPD).

There is no need to look further than the manufacturing sector, which went through a similar time of transitional crisis years ago, to see the benefits of Lean. Manufacturing companies that adopted Lean principles and practices saw better quality, lower costs, and higher margins. Those that chose not to are no longer in business.

“Lean will be the ante for anyone wanting to stay in business,” says Mike Staun, former Associate Director – Global Capital Management at Procter & Gamble, now retired. “But simply doing Lean – while essential – is not sufficient, and the degree to which it’s adopted will be the determining factor to a company’s eventual fate. Just as every car manufacturer now embraces Lean to some degree, the most successful, such as Toyota, have taken Lean to a completely different level.”

Lean practices like Target Value Design, Last Planner, and co-location in a Big Room integrate the E&C project team and enable collaboration. As a result, project teams deliver better cost, schedule, quality, and safety results.

The IPD Agreement is the contractual arrangement that boosts project results and enables project teams to collaborate at unprecedented levels. The 2016 Motivation and Means study, *How and Why IPD and Lean Lead to Success*, by Renee Cheng and Andrea Johnson from the University of Minnesota, explored 10 major construction projects across North America and demonstrated a striking uniformity of success for all projects because of Lean / IPD. IPD provided the motivation, and the Lean practices provided the means for teams to achieve superior results.

“This is exactly what we saw on the Lean / IPD projects we did at P&G over the past three years,” says Staun. “The design itself became better and easier to construct with the early engagement of key trade partners and the build went better, as the entire team, including the designers, found ways to eliminate waste and improve the work flow with pull planning, extensive use of pre-fabrication and modularization, and with unprecedented levels of collaboration. All combined, this resulted in lower costs and faster schedules, as well as better overall build quality and safety.”

P&G’s results to date with Lean / IPD have been so encouraging that it is now the company’s default project delivery method. “It became obvious that Lean IPD outperformed traditional project delivery methods in both cost and schedule,” says Staun. “Additionally, we saw more constructive relationships with – and between – our E&C partners. And the P&G people who worked on these projects found them so much better that many commented that they’d never want to work in the ‘old way’ again.”

Lean / IPD allows owners to engage the right people at the right time to work on their most challenging projects. And while the work is still bid upon, partners are selected at the beginning

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*Lean is a better way to design and build. It is a comprehensive system of principles, tools, and a culture built on collaboration. Image courtesy of the Lean Construction Institute.*

of the project based on qualifications, such as an interest in doing the work and in working this way, as well as pricing factors such as wages, benefits, mark-ups, overheads, and profit expectations.

"Once the team has developed and validated the design and agreed upon the Target Cost, they can focus on driving value from the build," says Staun. "And the risk-reward nature of the IPD Agreement promotes the collaborative behaviors we, as an owner, want to see. Not every owner is willing to challenge the status quo but, for those who do, the benefits will be well worth it."

### **Advanced Work Packaging**

Broadly speaking, traditional large capital projects have an authorization decision gate preceded by detailed scope defining and estimating work referred to as front-end planning or

programming. While there will always be value in early planning, the complexity of modern projects tends to diminish that value as different project elements change throughout a project's lifecycle. Advanced Work Packaging (AWP) helps with this.

Established several years ago by CII and the Construction Owners Association of Alberta (COAA), AWP is a relatively new approach to the improvement of overall project productivity and predictability. It accomplishes this through the calculated upfront alignment of planning and execution activities across the entire lifecycle of a project – start to finish – and covers things such as supply chain management, procurement, and operations.

"AWP is the strategic packaging of a project and the management of those packages," says James O'Connor,

Professor in Civil Engineering at the University of Texas at Austin in the Construction Engineering and Project Management (CEPM) Program. "With AWP you are more prepared to execute the work when and where you need to, which allows for greater productivity. Industry has finally come to realize that we have made few gains at the production management level, and that it's time to now get serious, instill some discipline, and become more methodical on how we do that."

AWP is a more comprehensive set of work packaging practices than field planning for construction. Limiting planning to the field may give a 10 percent improvement in productivity, whereas more comprehensive planning has been shown to provide up to a 25 percent improvement. AWP does a much more efficient job of connecting the upstream with what's happening in the field and makes it possible to roll with the unexpected.

"Failure to plan allows you to sleep well at night because failure comes as a complete surprise," says Bill O'Brien, Associate Chair of Architectural Engineering and Professor at the University of Texas. "When you have a plan – and AWP certainly makes it so that you plan well – you are better able to assess the impact of inevitable changes, track any deviations, and then mitigate them. Without a detailed plan, everything that goes wrong is all just noise and you have no real idea what's happening."

Through CII's research publications on AWP, such as Implementation Resource 272, *Advanced Work Packaging: Design through Workforce Execution*, ExxonMobil recognized that AWP's comprehensive and structured methodology could foster a more organized and positive team environment and a culture of productivity for achieving project objectives across the entire lifecycle.

And while the industry is still early in its journey with fully applying AWP fundamentals, benefits have already been found in various project performance areas, including safety planning, team alignment, work sequencing, constraint

management, and collaboration. AWP provides a common language between owners, contractors, and suppliers around work packaging that can improve project effectiveness and efficiency.

"You could say that AWP acts as a valuable safety, alignment, and collaboration improvement approach," says Jamie Gerbrecht, Construction Global Technology Sponsor with ExxonMobil. "It really brings a more enjoyable project experience that can motivate individuals and improve the project team's overall morale. Ultimately, the framework and guidelines of AWP can help reduce confusion and unknowns during project execution and further equip the current and next generations for managing projects."

### Project Production Management

Operations science (OS) attempts to explain the behavior of different types of activities involved in the production of physical goods and services across many industries, such as agriculture, retail, logistics, and manufacturing. It

studies "production systems," which are systems of interconnected tasks, human or automated, happening in sequence or in parallel, with each task transforming inputs, such as materials and information, into outputs, such as partly or completely finished products or services. Project Production Management (PPM) is the application of operations science to project delivery.

"We like to talk about operations science describing 'the physics of how the work gets done,'" says Ram Shenoy, Executive Director of the Project Production Institute (PPI). PPI exists as the technical authority on PPM to inform, educate, and support research into leading PPM's application to transform the project delivery performance of the E&C. "Other project management methodologies worry about the 'What,' the 'Why,' and the 'When.' They even explicitly exclude operations science from their scope. To our knowledge, we uniquely focus on the 'How.'"

Understanding the underlying science and engineering foundation of different forms of production provides

greater insight into how to improve construction project delivery, compared with drawing simple qualitative analogies with factory manufacturing. All manufacturing systems are some form of production system, but not all production systems are manufacturing systems. By viewing all the activities in a construction project as a production system, PPM applies the governing equations of operations science to predict, control, and optimize project delivery, just as many industries outside the traditional E&C industry routinely apply operations science to optimize their operations. Understanding where data affects production system behavior allows PPM to be a platform for applying digital technologies to construction, including artificial intelligence, machine learning, robotics, and 4D visualization.

A recent survey by McKinsey & Company suggests that 98 percent of all major (>\$1 billion) capital projects either have budget overruns or schedule overruns or both. Those overruns tend to be substantial, with the average budget

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overrun being 40 percent of the original budget and the average schedule overrun being 20 months. What are other industries doing that E&C is not?

This is a question that recently faced Chevron Corporation.

“When we looked back at our performance through the lens of operations science, it became clear that OS should be applied to our projects,” says Gary Fischer, General Manager, Special Projects at Chevron. “So we chose to adopt PPM, are currently incorporating it into the Chevron playbook, and are implementing it across Chevron’s major capital projects going forward.”

The first component of PPM for Chevron is Production System Optimization (PSO), which uses quantitative and qualitative methods to determine best options for design of project delivery.

The next component is Project Production Engineering (PPE), which ensures designs are easily fabricated or constructed. This is similar to what

manufacturing refers to as “Design for Manufacture” or “Assembly,” rather than “constructability,” as practiced by today’s construction industry.

The final component is Project Production Control (PPC), which engages those responsible for doing the work in planning and then controlling the work. Applying equally to both engineering and fabrication/construction, this component also helps to synchronize the flow of materials to the job site when and where needed.

According to Fischer, “When we launch PPC on a project in construction, commitment reliability (meaning work planned for the next day versus actual work done) quickly jumps from 50 percent up to 80 or 90 percent. However, more importantly, we see reductions in the hours and time it takes to complete the work. For example, on one of our current projects we are seeing 40 percent fewer hours and 60 percent less calendar time to complete work under PPC. I am confident, based on the early work that we have done thus far, that the ultimate impact of PPM will be dramatic.”

## The future is now

The construction sector is currently experiencing its long overdue transition to the information age, and this transformation will demand the unlearning of decades of embedded project management doctrine. While this will be a significant undertaking for the industry, leaders like CURT and CII are well-positioned to help their membership thrive amid the disruption.

“Everyone working in the construction industry must be frustrated with the slow pace of change; I know I am,” says Dumont. “When we can leverage the power of new technologies, simplify our contracts, drive the excessive transactional waste out of our inefficient supply chain structure, and then implement modern methods of production like Lean, AVVP and PPM, we will be well-positioned to really transform our industry and make step change improvements. The construction industry seems ready for pervasive change, and now is the time to drive it from within.” ●



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