

Lean Manufacturing Advisor

STRATEGIES AND TACTICS FOR IMPLEMENTING TPM AND LEAN PRODUCTION

Builders Seek to Demolish Inefficiency

Work is Completed More Quickly With Better Project Management

In the typical construction project, “all the research shows workers are standing idle 20 to 30 percent of the time,” says Gregory Howell, co-founder and COO of the Lean Construction Institute.

At the same time, huge piles of materials often sit at construction sites untouched for weeks because they cannot be installed until certain parts of the job are completed — and they arrive before that happens.

Chuck Greco, CEO of Linbeck Construction, Houston, adds that on the typical project, the rate of completion — meaning parts of the job being finished by the time the contractor said they would be finished — is usually only around 40 percent.

Why so much waste? “What you had on a project typically was a superintendent who would give orders, informing people about the general contractor — ‘here’s what we’re going to do this week, everybody follow us,’” explains Paul Reiser, vice president of production and innovation for Boldt Construction, Appleton, Wis. “There was a lot of fragmentation, subcontractors doing their work with a lot of disregard for the work of others.”

Howell agrees: “The problem that many people see in construction is litigation. But the reason litigation arises is because I’ve contracted my activity, you’ve contracted another activity, and our efforts to optimize our own parts put us at odds with one another.”

All this is beginning to change. A small but growing

movement — spearheaded by organizations like the Institute and companies like Linbeck and Boldt — is applying the principles of lean manufacturing to construction. With new approaches to scheduling designed to make construction work flow through a pull system, contractors and their cus-



Boldt Construction officials say they improved jobsite production and achieved other benefits by applying lean principles to construction of this \$182 million Cardiac Center project for St. Lukes Medical Center in Milwaukee Wis.

tomers are starting to see dramatic results.

“It’s not uncommon for our best lean projects to be characterized by 20 percent schedule improvement, significant cost savings and highly satisfied customers,” says Reiser.

While there have been efforts in the past to address con-

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Lean is the Right Formula for Rice Chemistry Building

At the beginning of 1998, Linbeck Construction was hired to renovate an 83,000-square-foot chemistry building at Rice University. Work on the building was scheduled to take 14 months.

But that was before a number of top executives of Linbeck and Rice attended a lean conference. The executives became convinced that lean was the way to go, and were also impressed by a conference speaker who said that in order for a project to work, you need a crisis.

So they created one: A Rice executive told senior project manager Kathy Jones that the job had to be done in 11 months.

After reviewing plans and deciding to negotiate with the major subcontractors to pursue a lean approach, she says, "I went back to my boss and said, 'I'm willing to attempt it if you are.' We took a hard look at the schedule. We all bought in that we could do it in 11 months."

The project included its share of challenges. For one thing, the building dated back to 1925. Most new buildings have 15 or 16 feet between floors, but this site had only 13 — and only 10 in the basement.

In addition, the original schedule assumed that the architect would supply complete drawings at the start of the project. But as things turned out, only the basement drawings were supplied at first, followed by the first-floor drawings a month later, and other floors after that.

"We went through rocky waters in the beginning," she relates. "It was all so new to us, foremen having to put schedules on paper and having to commit to what their manpower was. We developed a pull schedule. We started with the end date and worked backwards by defining major milestones."

In early stages, weekly completion rates were only about 50 percent. "But toward the end of the project, we were hitting in the high 80s," Jones boasts.

She describes the effort: "When these foremen were developing their work plans, they had to do a six-week lookahead, and a weekly plan. The six-week was more general, such as

put in sheet metal on the first floor. On the weekly, it got very detailed — hang the pin feed of duct work in room X, with how many men, how many hours it would take. They had to compare with major milestones to make sure they were still on track.

"We made sure that if there was a problem, we could identify it immediately. They have to tell us why they didn't meet items they had described in their weekly work plan. We kept track of what the major hiccups were. If we started to see trends, we could call the project managers and say 'get some guys to help your guys.' We tried to find the source of the problem."

In developing the initial schedules, at first "the plumber and the sheet metal guy were butting heads" because each wanted to do his work first, Jones notes. But because the plumber had to install considerable amounts of the glass pipe used in a chemistry building, "we kept trying to tell the plumber, you don't want welding sparks hitting your pipe."

The foremen were able to schedule delivery of materials better, with the plumbing foreman doing the best job, Jones says, explaining that normally he liked to deliver a year's worth of pipe up front, letting it sit at the job. With this project, he never shipped in more than a week and a half's worth of materials. And whereas he often hired a tractor-trailer to take away left-over pipe at the end of a job, in this case he required only part of the space in a pickup truck.

Once the subcontractors understood the benefits of lean, says Jones, "we had the backing of their companies to do it the lean way. They found out they made more money and it cost them less. And because we communicated with each other, there was very little rework."

"We did not extend our schedule," Jones relates. "We actually built it up in nine months, and got moved in in January (1999) on schedule. We were able to do it under budget, and at the end of the day, all the subcontractors were still friends. Everybody communicated a lot better. Everybody got to be really good friends. It helped build trust and respect that I think is uncommon for a construction job."

And today? "I wouldn't do it any other way," Jones says.

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struction inefficiencies, he adds, they typically focused on the productivity of individual tasks rather than the overall effort. The result: "You can pour concrete really fast, but you don't necessarily get the job done faster."

Applying lean principles to construction really means applying them to project management. This transformation may not utilize manufacturing cells or quick changeovers, but it does involve mapping the construction processes, determining the most efficient flow of work and establishing a pull system.

Leading Edge Efforts

The lean construction movement goes back to at least 1993, when the International Group for Lean Construction (IGLC) was founded. Much of that group's focus is outside the United States; "In some ways, the U.S. (construction) industry is not particularly a leading industry," observes Howell.

Howell co-founded the Lean Construction Institute in Ketchum, Idaho, five years ago with Dr. Glenn Ballard, who was also a founding member of the IGLC. Both men also do consulting work separate from the Institute.

Another arm of the movement is at the University of



BOLDT										Six Week Lookahead										Constraints Analysis																		
Project: Healthcare										Boldt Schedule Contact: e-mail: Phone: Fax:										Week of 05/14/01																		
Sort	Repeat	X = Repeated Items		Activity		Responsible Party		5/14		5/21		5/28		6/4		6/11		6/18		Safety	Contracts / C.O.'s	Submittals/Eng	RFI's	Materials	Labor	Equipment	Prerequisite Work	Space	Explanation of Constraints					Action Required By:				
		BASE BUILDING																																				
	X	Expedite stone production		BDI				x		x												x						Exterior stone was ordered 3/19/01; Expect on site early 5/28.					Dan J.					
		Brick Work		BDI				x		x		x		x		x										x		We need to wash brick for review on 5/30/01 & possibly re-do So. In-fill wall after that.					Dan J.					
	X	Roofing - curbs		Langer						x																												
		Curtainwall installation		Klein Dickert								x		x		x												Need north wall brick first					Joe B.					
		Cut new duct openings in existing roof/ 3rd floor		Boldt / Iling								x										x						RFI #18 - Verify locations					Richard S.					
		Install Louvers		Boldt/Iling								x		x														Boldt will install arch. Louvers; Ilingworth will install HVAC louvers.					Richard S.					
		Relocate CCTV and power lines thru new penthouse		Pieper						x		x		x		x										x		Need to coordinate w/security. PH wall needs to be rocked first					John W.					
NEW ORTHO OR'S 23 AND 24																																						
		Structural support in ceilings		Duwe				x		x		x										x				x		Review owner cut sheets for lights and med gas booms					Dan J.					
		Less Steel Top Lead-time		Streich																								Ordered 4/6/02; 8 wk lead-time					Dan J.					
		Hardware Lead time		Bl						x																		Items will be delivered to Site on 5/14/01; shipping 5/1/01					Dan J.					
												x																Relocate duct work					Dan J.					

BOLDT										Weekly Work Plan										Week of 5/14/01																			
Project: Healthcare										Boldt Schedule Contact: e-mail: Phone: Fax:																													
Sort	Repeat	X = Repeated Items		Assignment Description		Responsible Party		5/14		5/21		5/28		6/4		6/11		6/18		Make Ready Needs					Comments														
		Remember the Five Criteria for Release of Assignments Specific, Sound, Sequenced, Sized, Safe																				Work that Must and Can Be Performed Prior to Release of this Assignment																	
BASE BUILDING																																							
	X	Wash brick @ 2nd floor		Rick J.																										Will review w/ Brad, David on 5/16/01					x				
	X	Roofing - curbs		Joe B.																										x x x x									
		Curtainwall installation - E. Elevation Framing		Joe B.																										x x x									
		Curtainwall glazers prep North elevation		Richard S.																										x x									
		Cut new duct openings in existing roof/ 3rd floor		Duwe																										3rd floor will be cut on Saturday					x x				
		Install Louvers		Bud T.																										Price from Duwe					x x x x				
		Install angle in Gamma Knife ceiling																												x x x x x									
NEW ORTHO OR'S 23 AND 24																																							
		Review structural support in ceilings		Robert																										Need close					x x				

Boldt Construction uses the Last Planner production control system from the Lean Construction Institute, which involves creation of a Six Week Lookahead schedule (top) and a more detailed Weekly Work Plan (bottom).

California at Berkeley, where Ballard and Prof. Iris Tommelein, both within the university's Construction Engineering and Management Program, teach a pair of courses on lean construction. Tommelein maintains the mailing list for the IGLC.

The stated mission of Howell's Institute is "to extend to the construction industry the lean production revolution started in manufacturing." So far, Howell says, the movement has only reached a small segment of U.S. builders, commenting, "we're flying under the radar of the industry."

Tommelein agrees that lean in the construction industry is still in early stages, with a fairly low level of awareness among builders, though she adds that "a lot of people say they know what it is."

She stresses that "what we're talking about is very radical, the same as it was in the manufacturing industry, where the notion of reducing setup times, for example, was quite radical, compared to the long-held belief that setup times were a given. It's certainly a paradigm shift, a different way of thinking that has many implications."

But construction is an industry that nearly everyone agrees operates inefficiently and can achieve significant benefits by becoming lean.

Linbeck, for example, saw substantial gains in a lean pilot project at Rice University four years ago (see sidebar page 3). At Boldt, Reiser offers several examples:

- The company completed a \$14 million correctional facility in Wisconsin four months earlier than originally



planned, a 22 percent improvement over traditional project delivery.

- A \$12 million college fieldhouse was finished six months early, “at 20 percent less cost than our competition had on a nearby similar project three years earlier — at a high level of quality and architectural finish,” he says.

“Last year we compared concrete productivity on lean projects versus non-lean projects,” Reiser notes. “The results indicated a 25 percent improvement in concrete productivity. The improvement may not be completely attributed to lean, but we do recognize that eager adopters of lean on our construction projects also tend to be innovative thinkers when it comes to operations design. When you combine lean production with innovative operations design, the result is highly reliable and productive project delivery.”

Greco says that Linbeck has long been dedicated to efficient operations, with a process called TeamBuild. He sees lean as “the catalyst we could insert in our TeamBuild system as a science, and really gain the optimum from what our corporate knowledge had been building on.” Linbeck is gradually implementing lean processes and expects to be using them in all projects by next year. Greco says lean projects typically achieve 80 to 90 percent completion rates.

Benefits, he adds, include greater reliability in meeting schedules and containing overhead costs; during the design, being able to “capture and incorporate into the design a lot of value;” and a lower capital investment cost for the building owner.

Howell adds, “We see numbers in the range of a 10 to 30 percent reduction in cost and time. We believe we are seeing data that shows improved safety. The ‘hair on fire’ index goes way down — people rushing around like their hair is on fire.”

Planning and Pull

One key to making the construction process lean is creation of a pull system. Managers begin by looking at what the completed project should be, then work backwards, identifying each preceding step. Later processes determine what earlier ones will be, and when they should take place. That’s critical, says Howell, because “you can’t do things just in time if you don’t know what time it is. You have to get the work flow under control, and that happens only in planning.”

Linbeck and Boldt both use an Institute system called Last Planner for production control. The system involves both a six-week “Lookahead” schedule and a weekly work plan.

According to the Institute, front-end planning belongs in the project definition and design phases. That planning produces master schedules, which “are expressed at the level of milestones, typically by phase,” according to the Institute. “Phase schedules feed into lookahead windows, usually 3 to 12 weeks in duration.”

These processes make scheduled tasks ready for assignment; the tasks are placed in Workable Backlog. Weekly

work plans are formed by selection of tasks from Workable Backlog.

On the job site, teams review progress weekly, identifying whether all scheduled tasks have been completed and the reasons why any weren’t. Action is taken on root causes to prevent future problems.

“It forces people to get together once a week for an hour and do collaborative planning,” says Reiser. “They make commitments to each other based on pull. When we meet the next week, we track the reliability of our planning, how many of those commitments did we actually meet — the plan percent complete.

“One of the biggest benefits is a much higher level of communication and awareness. It becomes a highly collaborative process. There’s a new feeling of communication and participation for the people that are actually doing the work. We’ve empowered people on the job sites to make decisions.”

Everyone agrees that once subcontractors become a part of the process, they give it their full support because they also benefit when projects are completed earlier at lower cost. Greco says building owners are typically supportive as well, but he notes that designers may offer resistance because “many architects are not really production-oriented.”

A Lean Expansion

As contractors gain experience applying lean principles to actual construction, they gradually seek to extend the lean transformation.

“Because of the success we’ve had at the job site production level, we’re trying to drive lean further into the design phase,” explains Reiser. “Traditional project delivery is fragmented. Design takes place in a design office and the drawings are thrown over the wall, so to speak, to the contractor. We say it shouldn’t have been designed this way, and we throw the contracts back over the wall.”

He also notes that at Boldt, “we are mapping our job support processes including job setup, cost forecasting, payroll, accounts payable, purchasing, tool and material handling, and more. Value stream mapping these processes has revealed 30 percent to 60 percent waste in specific areas.”

Similar actions are being taken at Walbridge Aldinger, a Detroit construction firm that began a lean initiative not quite two years ago, but hasn’t yet applied the principles to projects. Employees are being trained in lean and internal operations are being streamlined, including invoicing, equipment storage and more, according to Remo Mastroianni, quality director.

Overall, the movement has a long way to go. As Greco observes, “You’ve got to have persistence to do this. This is not a natural thing for our industry, using flow charts and setting up the value and doing things other than straight implementation. We’re not only training our organization, but training the industry. It’s not an easy thing to do.”