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Status of **Lean** in the US Construction Industry

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Abstract

The term "Lean Construction" found its way into the construction industry in 1993. Two key organizations have led the thought leadership of the topic: The International Group for Lean Construction (IGLC) founded in 1993 and The Lean Construction Institute (LCI) founded in 1997.

This paper looks at the status of the implementation Lean in the United States of America Construction Industry as of mid 2012. Included is a discussion about Lean as a methodology, mindset and toolset; perspective on Lean Construction principles; key benefits, tools, and enablers to Lean Construction; and Lean tools applied in construction projects and organizations. The paper concludes with a look at some of the barriers to implementation and anticipated future direction of implementation.

Implementation of Lean Construction within the industry is still in its early adoption phase, with some sectors and geographical regions leading the way. This same variation exists relative to the incorporation of Lean in Construction Management, Construction Science and Construction Engineering curricula within the university system. Since 2006, Lean Construction implementation has increased, especially in the Healthcare sector.

What is Lean?

Lean is a customer-centric methodology to deliver value to a customer through the ***effective*** use of resources, engagement and respect for people, and continuous improvement. Its origins are from Toyota automotive manufacturing; it became known as Lean in the late 1980s when a group of researchers led by James Womack at MIT observed that the way Toyota conducted its business was "lean". Its principles and tools are applicable to a broad range of organizations, such as healthcare, service, IT, military and other governmental organizations, retail, non-profits, and other manufacturing sectors. Lean is also practiced throughout an organization to facilitate the delivery of value to the customer. Because Lean came from the manufacturing industry, it is sometimes narrowly viewed as a production management system or as applicable only to a factory. Lean is more accurately viewed as an operating system, applicable in all parts of an organization and value stream.

From a philosophical view, Lean is a journey not a destination. Toyota directs all improvement toward an ideal state, or True North, for Customer Satisfaction (zero defects, 100% value-added, 1x1 in sequence and on demand) and Human Development (physical and mental safety, security, and professional challenge). Lean is based on specific principles: customer value, value-stream analysis, everyday improvement, flow, pull, and perfection – all achieved through a respect for people by engaging their hearts, minds and skills. (Sayer and Williams, 2012)

Customers have a reason or purpose for buying value and are the only ones who can define it. For an activity to be deemed "value added" it must meet all three of the following criteria:

- Activity must transform the product or service.
- The activity must be done correctly the first time.
- The customer must be willing to pay for the product or service.

The customer may or may not be the ultimate consumer of the value delivered by an organization. If this is the case, then the contributing organization needs to understand where and how they contribute to the value-stream and to the value creation for the ultimate customer, or consumer. It is important to note that "value" is not just described in terms of cost or monetary units. Unfortunately, some organizations and practitioners have interpreted Lean as only a cost cutting technique and have ultimately failed at implementation as a result.

The ***value-stream*** includes every activity required to deliver value to the customer and the corresponding information flow to support those activities. The value stream covers all of the activities required to deliver value from concept through end of use; in an ideal world, it is comprised solely of value-added activities.

The aim of Lean is to deliver the customer's value when they want it, how they want it, where they want it, at a price they will pay, and using all resources most effectively – time, money, people, and so on. People practicing Lean develop a mindset and view of the world directed at ways to;

- eliminate waste,
- increase flow,
- prevent defects and
- flow resources where they are required at the precise time, quality level and quantity required.

To do this, they focus on the elimination of waste in the form of variation (*mura*); overburdening or stressing the people, process or system (*muri*); and general waste (*muda)* as defined by Taiichi Ohno, one of the pioneers of Lean at Toyota. Muda is comprised of defects, overproduction, waiting, ineffectively utilizing people, transporting, inventory, motion, and excess processing. It is commonly known by the mnemonic DOWNTIME.

A successful Lean journey requires a change in thinking and behavior from traditional methods. Lean holistically views the value stream, rather than the sub-optimization of parts. Lean Thinking is customer-centric; it is a continuous improvement mindset; and people are viewed as the most important resource. Within an organization, leaders make decisions based on the long term condition; problems are solved in the short term, but with the guidance of the long term vision. They focus on not only what the results are, but also how results are obtained. Lean cannot be delegated, and leaders actively practice Lean tools and they frequently "go to gemba" (gemba is where value is created). **Leadership's role is to build capability in the people; through this capability people are expected and empowered to solve problems and to improve the work, collaboratively.** In organizations, like Toyota, Lean becomes the operating system – or the way the organization operates its business.

Included in Lean is a large tool set to aid the elimination of waste. Value-steam maps show how the activity and information streams flow to create the overall value-stream. Analysis of these maps leads to the identification of blockages to flow; these blockages indicate waste. Kaizen is the philosophy of every day incremental improvement. Kaizen improvements follow the Plan-Do-Check-Act (PDCA) cycle. It is also practiced at gemba. When looking for improvements you go to the actual place where value is created, to view the actual process and gather actual data; then use those observations and data as the foundation for improvement.

One of the ways to eliminate waste, facilitate flow, ensure safety and reduce errors is to practice workplace organization and create a visual work environment. The tool for this is known as 5S: sort, straighten, scrub, systematize, and standardize. The aim of 5S is to have a place for everything and everything, when not in use, always resides in its place, in the quantity specified. Some organizations call this tool 6S to emphasize the importance of safety within their culture. Workplaces that use 5S are safer, have better control of inventories and faster issue identification.

The Lean toolbox includes a wide range of tools to the understanding of customer requirements, value creation and delivery and ongoing continuous improvement. Some of the common ones applied to design and construction projects include:

Customer requirements - Kano modeling to identify customer needs, wants and delighters, Quality Functional Deployment (QFD), Production Preparation Process (3P), and simulation/modeling

Flow and pull - quick-change over or SMED (Single Minute Exchange of Die), level schedules, pull scheduling using kanban to signal action, work leveled to customer demand, point of use storage, total predictive maintenance, modular design and assembly

Perfection - poka-yoke or error-proofing, statistical methods to reduce variation, 5Whys, Failure Mode Effects Analysis (FMEA), visual work places including display boards and tool boards, standardized work, A3 issue resolution, and basic quality tools.

For more information about Lean as a general methodology, consult *Lean for Dummies* (Sayer and Williams, 2012), *The Toyota Way* (Liker, 2003), or *Lean Thinking* (Womack and Jones, 2003).

What is Lean Construction?

The application of Lean thinking, principles and tools to the lifecycle of capital construction projects is known as "Lean Construction." The International Group for Lean Construction (ILGC) coined the term at their first meeting in 1993, with the intention of applying the production management methods of Lean used in manufacturing to the construction industry. (Note: while the accepted way of writing the term is "Lean", some organizations, like the Construction Users Round Table (CURT), write it as LEAN.)

The Lean Construction Institute as an organization focuses on the development of systems to deliver projects more effectively. On their website they define Lean Construction:

Lean Construction is a production management-based approach to project delivery -- a new way to design and build capital facilities...Applied to construction, Lean changes the way work is done throughout the delivery process. Lean Construction extends from the objectives of a lean production system - maximize value and minimize waste - to specific techniques and applies them in a new project delivery process. As a result:

- *The facility and its delivery process are designed together to better reveal and support customer purposes. Positive iteration within the process is supported and negative iteration reduced.*
- *Work is structured throughout the process to maximize value and to reduce waste at the project delivery level.*
- *Efforts to manage and improve performance are aimed at improving total project performance because it is more important than reducing the cost or increasing the speed of any activity.*
- *"Control" is redefined from "monitoring results" to "making things happen." The performance of the planning and control systems are measured and improved.*

The reliable release of work between specialists in design, supply and assembly assures value is delivered to the customer and waste is reduced. *Lean Construction is particularly useful on complex, uncertain and quick projects. It challenges the belief that there must always be a trade between time, cost, and quality. (LCI 2012)*

The term "Lean Construction" is intended to cover the application of Lean thinking, principles and tools to the entire process of a project from concept through decommissioning; however, the initial reaction to the term within the industry caused resistance and exclusion. Lean Construction was misinterpreted as applying only to the "construction" phase of a project, so constituencies like the owners and architects did not think the methodology applied to them – this is changing. To better reflect the intention of Lean Construction, the core methodology is called Lean Project Delivery or Integrated Lean Project Delivery. The term "Lean in Construction" is also used; this means the application of Lean tools (Like 5S, *Kaizen*, visual workplace, SMED, etc.) to the work on a job site or in a business process.

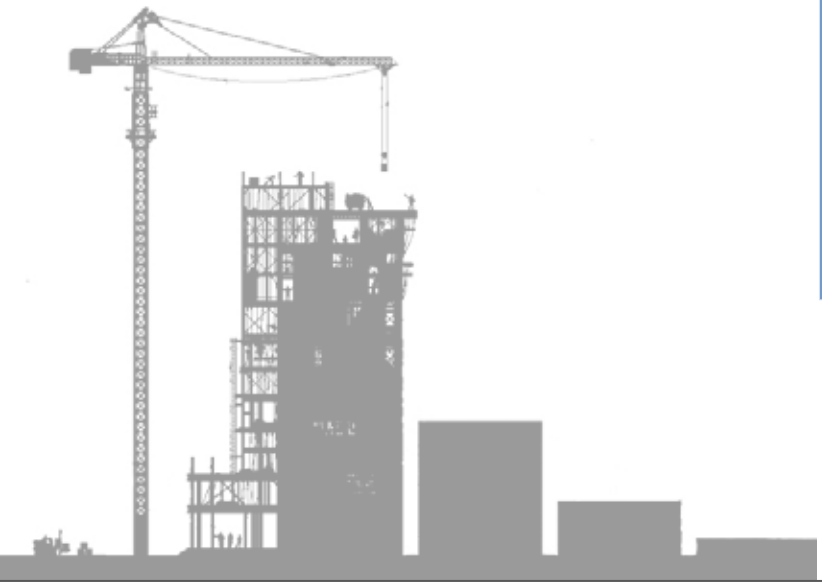
Table 1: Comparison of Traditional and Lean Projects

	Traditional Projects	Lean Construction Projects
Operating System	Critical Path Management (Push)	Last Planner® (Pull)
Organization Model	Command and Control	Collaborate/Distribute authority
Commercial Terms	Transactional	Relational – shared risk

Every project has an Operating System, an Organization and Commercial Terms. (Howell, 2011) Table 1 contrasts how these three elements exist in a Traditional Project versus a Lean Project. Lean Construction shifts the project delivery paradigm from a focus of "optimizing the piece" to one of "optimizing the overall project and flow".

When viewed as a methodology, Lean Construction has several key components:

- principles based on Lean;
- a focus on understanding the customer's purpose, defining associated requirements to meet those purposes and a project design to deliver and fulfill those purposes;
- holistic view of project delivery;
- communication and authority structures;
- project delivery structure;
- collaborative environments;
- "Last Planner" empowerment; and
- Lean tools that are applied to a job site or processes that support the delivery of the project and the elimination of waste.



Projects using Lean Construction have demonstrated;

- better budget performance,
- fewer change orders,
- higher on-time performance,
- fewer accidents,
- fewer lawsuits, and
- better value delivery to the customer.

Consider the following example of two similar healthcare facilities, characterized in Table 2, one traditionally delivered and the other delivered using Integrated Lean Project Delivery.

Table 2: Traditional versus Lean Delivered Project

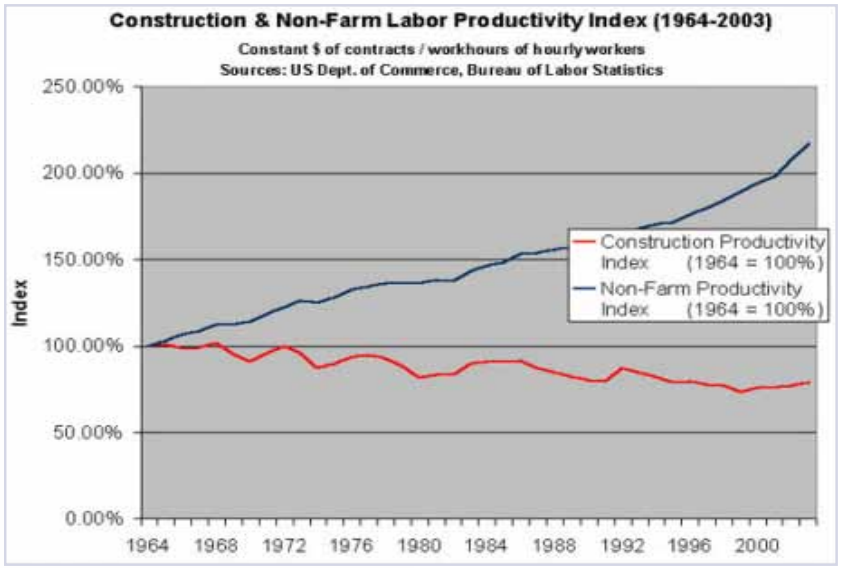
	Traditional Project Delivery	Lean Project Delivery
Budget Approval-Occupancy	2000-2014	2007-2013
Budget/ Projected, millions	$254/$780	$320/$315
Project status	Late, over-budget, team turnover, no collaboration, transactional contract	On-time, under-budget, collaboration, Integrated Form of Agreement (IFOA) among owner, architect and CM/GC

The need for a change in the industry

It is important to understand why a change to capital facility projects is needed.

1. Productivity in the US Construction industry has stayed level or declined since 1964, depending upon which study is used. Figure 1 represents one such study.

Figure 1
Labor Productivity Index for the U.S. Construction Industry and all Non-farm Industries



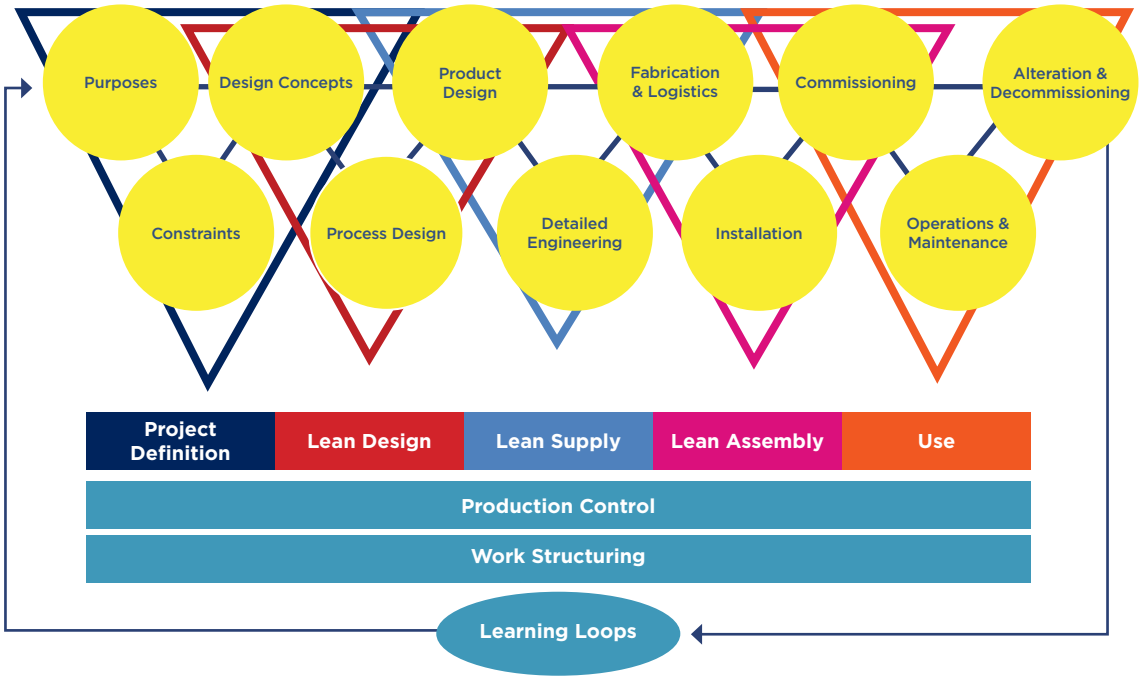
Source: Teicholz, Paul. "Labor Productivity Declines in the Construction Industry: Causes and Remedies." *AECbytes Viewpoint*. Issue 4. April 14, 2004

2. Building owners are looking for increased plan predictability and price stability in the way capital projects are delivered. (In a study by Ballard and Howell of over 400 weekly work plans generated by foreman with an average of 15 years of experience, compliance to the weekly plan was 54%, as measured by Percent Plan Complete (PPC). An increase in plan quality and performance will ultimately lead to improved project control and stability.)

3. Owners are requiring a change. As more owner organizations practice Lean in their core businesses, they are writing into their Request for Proposals (RFPs) requirements that Lean practices extend into their capital construction projects.

Previous attempts to change the industry, like Partnering, Value Engineering and Design Build Contracting, did not go far enough to truly sustain changes or they were improperly implemented and consequently summarily rejected. For example, when projects under Partnering Charters, ran into issues, the constituents would rely on the commercial terms, which generally did not support collaboration or shared risk. In other words, these initiatives did not change and align all three elements of the project: Operating System, Organization and Commercial Terms.

Figure 2: Lean Project Delivery System (Ballard, 2000 and 2006)



Lean Project Delivery

Lean Project Delivery or Integrated Lean Project Delivery, as it is sometimes called, is a collaborative process used to deliver capital facility projects. The process uses a delivery team throughout the process to align ends, means and constraints. (Ballard 2008) As depicted in Figure 2, it is a phased approach comprised of Project Definition, Lean Design, Lean Supply, Lean Assembly and Use; Production Control, Work Structuring and Learning occur continually throughout the project. Each phase contains activities and milestones to be fulfilled as the project progresses. The owner determines the allowable cost of the project, which is the maximum amount the business case can support. The team's mission is to understand and deliver the best overall value to the client. This effectively overcomes the hurdle posed by Anderson's Maxim that "Most projects with poorly conceived initial budgets never properly recover."

The Owner uses Integrated Project Delivery Agreements with the Architect and Construction Manager/General Contractor, and may include other critical project contributors such as the Chartered Quantity Surveyor (CQS) / Independent Cost Consultant. These agreements enable flexibility amongst the team to deliver value to the customer and create a shared interest/risk in the outcome of the project. The American Institute of Architects (AIA) has a guide and templates on their website for these types of agreements.

Lean Project Delivery is designed to resolve issues found in traditional project delivery (Howell), such as:

- Good ideas are held back
- Contracting limits cooperation and innovation
- Inability to coordinate
- Pressure for local optimization at the expense of the project as a whole

At the core of the project is a team comprised of the Owner, Design Team and General Contractor/Construction Manager representatives. This team steers the project, facilitates decision making, and breaks down project barriers.

Early in the Project Definition phase, key contributors are housed together in a Big Room. The Design Team, comprised of Architects, Engineers, CQS and Constructors (AEC professionals), works with the owners to define purpose and translate the purpose into requirements. During this phase, the Owner determines the Allowable Cost for the project; this is the maximum amount for the project defined in the business case. The team commits to their Target Costs; these are less than the Allowable Costs to spur innovation. Expected Cost is the amount that the project is expected to cost, and are usually higher than the Target Cost. (Allowable Cost ≥ Expected Cost ≥ Target Cost). (Ballard 2008) Additional targets are also used like constructability, assembly, flexibility, sustainability, durability and so on. At each major milestone, the owner decides if the project proceeds. Figure 3 is a model depicting the process (Ballard 2008). At the end of the Project Definition phase, the business plan is complete and validated.

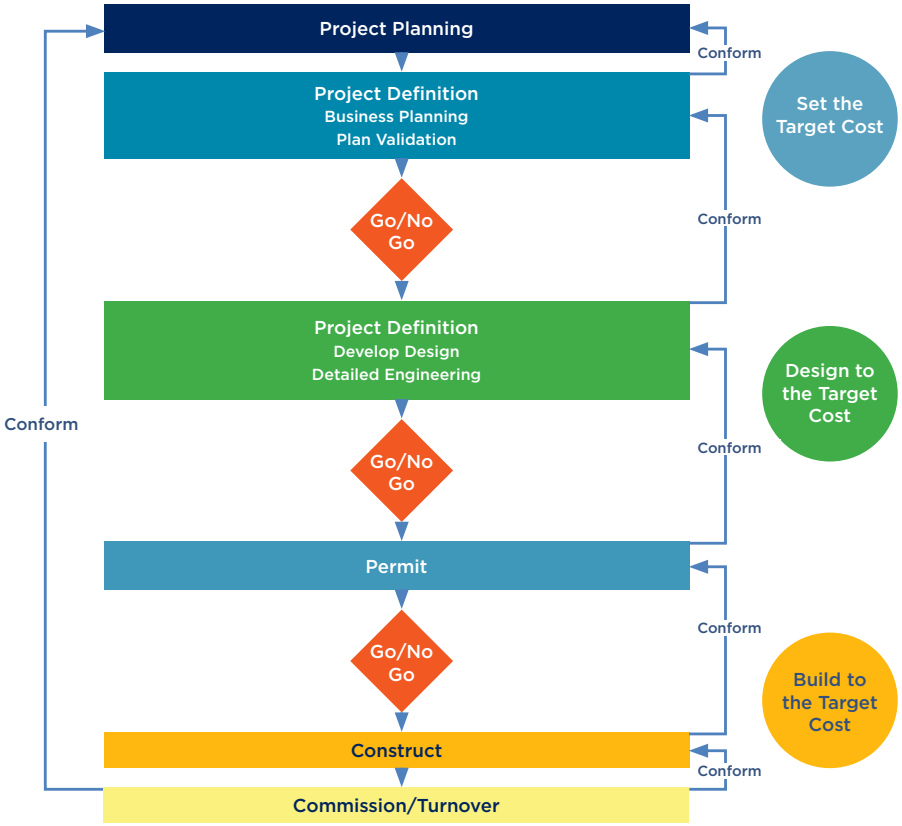
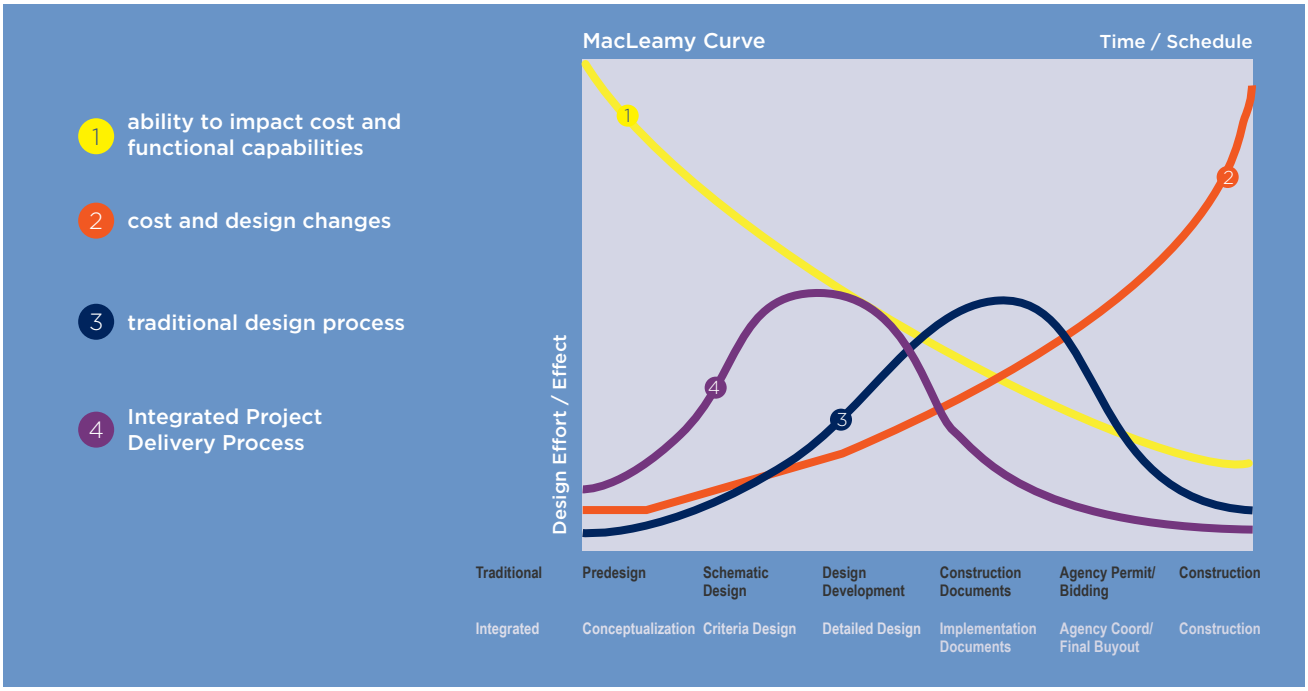


Figure 3 Project Phases and Target Costing

Diagram from "Lean Project Delivery System: an Update", Ballard 2008. Diagram originally produced for Sutter Health by the Project Production Systems Laboratory, University of California, Berkeley.

While the early involvement of key contributors adds to the design costs up front, the investment pays off in the end by the overall project savings. To embrace this early involvement requires a mindset shift to money as an "investment" in the whole, rather than a "control" of the piece. (Howell) According to an article in CURT's magazine *The Voice* Fall 2011, "Implementation on the front end can speed up a project 150-200 percent, but can increase initial costs in the design phase by 110-130 percent, although these costs are easily made up over the life of the project by condensing project schedules, improved design quality and fewer scheduling issues." The MacLeamy curve shown in Figure 4 depicts the advantages using an integrated delivery method, where more key people are involved in the early design process.

Figure 4: MacLeamy Curve



In the Design Phase, the team creates multiple design alternatives, based on the design requirements and project constraints, and costs them using Target Value Design (TVD). The purpose is to find the design alternative that will best fulfill the Owner's purposes and deliver the maximum value. When the teams can collaborate at this phase, many of the design driven contingency costs can be eliminated or minimized; those savings can go directly to profit or meeting more needs of the client. Throughout the project, rapid synchronized costing of alternatives is important to enable business case/project decisions. The project is viewed as a whole; costing is synchronized and cascaded through to a system and component level.

Also during the Design Phase, the Master Schedule development and Process Design are completed. While vetting the designs, especially in healthcare, physical or virtual models are built and reviewed by the end users/ customers to align actual use with the design. This enables the form to follow the functional requirements. The Lean process for this is called 3P (Production Preparation Process). For example, in a new hospital the team would like to standardize patient rooms to reduce risk and promote flow of the services they provide. Using the Value Stream Map, the nurses and doctors work with the AEC team to develop the best design from the perspective of the patient and the care givers. They look at standardization of the head wall, walk paths to the bathrooms, traffic flow inside the room, cabinet configurations for supplies, and so on. They are able to standardize to a design that not only facilitates the building process, but also, once built, facilitates their ability to deliver prompt, high-quality, safe care to patients.

Some of the Lean techniques, like modular design and build or component kitting, can be designed into the process. For example, a standardize bathroom design can be developed, the business case evaluated and a decision to assemble off-site modules or assemble on-site can be made. In general, modularizing assembly off-site leads to higher quality, consistent, and faster production. The installation time on-site may also be reduced. The team evaluates process alternatives that will eliminate waste in the supply and assembly process; waste comes from variation, defects, overproduction,

waiting, not effectively utilizing people, transporting, inventory, motion, excess processing, and over burdening/ stressing the people, process and system. During a project, change orders, schedule delays, and rework are some indicators of these wastes.

Master Schedules follow Critical Path Management. The Master Schedules are used to confirm timing feasibility and establish major project milestones. However, during the Lean Assembly phase, the Last Planner System is used to control production and keep the work flowing as it is pulled through the plan.

Throughout the entire development, design, delivery, assembly process the project is measured to the original targets established in the definition phase. The team continually evaluates ways to improve the design, process and project to eliminate waste and improve on the objectives - financial, sustainability, and so on . Intense collaboration happens throughout the process.

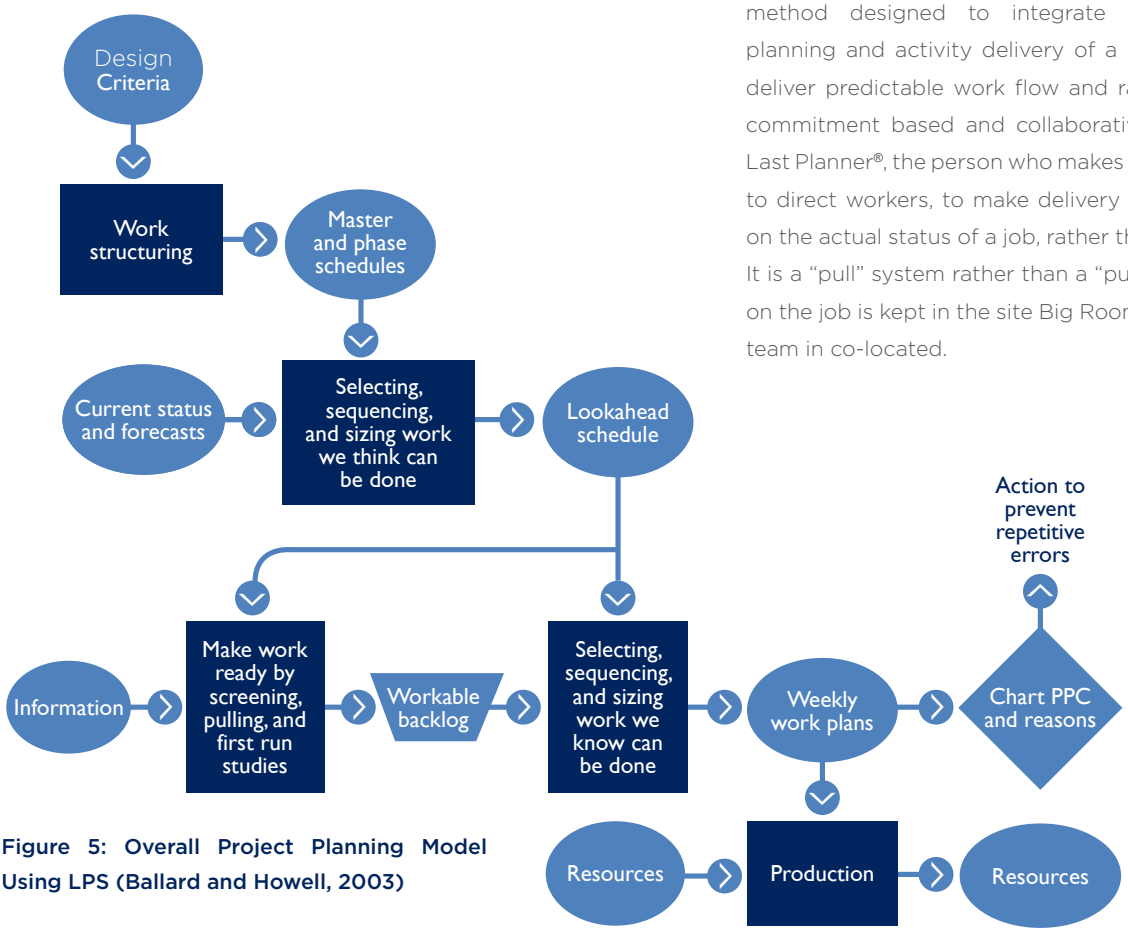


Figure 5: Overall Project Planning Model Using LPS (Ballard and Howell, 2003)

Supply Chain plans are designed to facilitate the just-in-time delivery of materials to the site. The philosophy behind these agreements is to deliver only what is necessary, at exactly the time required, in only the amount needed. For example, drywall may be delivered daily in only the quantities needed for that day's work. The drywall can be delivered directly to the place needed rather than being stored in inventory on-site, which is waste (inventory and transportation) and leads to damage exposure. The logistical plan includes pull planning/delivery, fabrication strategy (on/off-site), delivery terms/quantities/flexibility. Vital to the overall project delivery is the Last Planner System, which helps to bring stability to the project performance. This is a good place to start Lean Project implementation, because stable work flows enable many other types of waste to be removed.

Last Planner System®

The Last Planner System® (LPS) is a production control method designed to integrate "should-can-will-did" planning and activity delivery of a project. Its aim is to deliver predictable work flow and rapid learning. LPS is commitment based and collaborative. It empowers the Last Planner®, the person who makes the jobs assignments to direct workers, to make delivery commitments based on the actual status of a job, rather than theoretical plans. It is a "pull" system rather than a "push" system. The plan on the job is kept in the site Big Room, where the delivery team in co-located.

One of the key behavioral changes that LPS drives is the ability to say "No" if the pre-requisite work is not complete. The commitments are measured to Percent Plan Complete (PPC) a simple measurement to track if the work was complete as promised or not. PPC brings accountability into the plan quality and performance, as well as the identification of improvement and learning opportunities. Those lessons are used to improve work practices, processes and systems. Projects using LPS have demonstrated a planning reliability (PR) of 85%; compare that to traditional projects where PR is around 50%. Figure 5 shows a model of the LPS.

By having a focus on the overall project, LPS creates a system which ensures that every week people are delivering on their commitments to the weekly plan; this consistency enables the elimination of schedule padding, contingency plans, excess inventories and other non-value added activities. When workflows are more predictable, then subcontractors can take advantage of off-site assembly, where subassemblies can be produced in a controlled environment. This usually leads to higher quality assemblies, reduced cost and reduced installation time on the job site. Another benefit of project stability, is that the projects finish on time; by not extending, thousands of dollars can be saved a week in the cost of equipment, trailers and other resources to support an active job site.

Figure 6: Master Plan created using LPS

Photograph by Alan Mossman

The Master Schedule proves out the feasibility of the project timing and milestones. Once that plan is complete, it is put aside and phase plans are developed for each milestone. The people who actually do the work create a collaborative plan to deliver each project phase; this is essentially the production system to deliver the project. The team creates the phase plan for the entire project. That plan leads to the generation of a "Look Ahead Plan" (LAP), which ideally has a six week scope. The LAP enables the team to anticipate and obtain everything that they need to complete and obtain so the work is ready to start when required by the phase plan. The team also generates a weekly plan to identify what can be done related to what should be done and what will be done for the following week. Figure 6 shows an example of a Master Plan using LPS.

Relationship to Building Information Modeling (BIM) and Integrated Project Delivery (IPD)

Building Information Modeling (BIM) is technology that enables the team to design a multi-dimensional model of the facility, including functional characteristics; BIM enables Lean Project Delivery. When BIM is used to design the facility, the team can evaluate multiple design alternatives, make better design decisions, make better costing decisions, have more communication earlier in the project, and create production system plans directly into the model earlier in the process. BIM models can help end-users of the facilities interact and anticipate issues of the actual structures.

The acceptance and application of BIM still varies across the industry, but most early adopters of Lean Construction see the value of BIM and use it on their projects.

As BIM application grows, techniques like rapid prototyping, 3D printed components and structures can become part of the building process; building from 3D models reduces variation, increases quality and opens up innovation possibilities.

Integrated Project Delivery (IPD) and Lean Project Delivery are co-evolving. Most people distinguish the two by defining IPD as being related to the actual commercial agreements and Lean Project Delivery as a methodology to deliver projects. Some sources blur these lines. What they both aim to do is optimize the project and not the piece, and use collaboration to create the best overall solutions to deliver the project purpose and value to the client/owner. The IPD agreement gives people the opportunity to move money across boundaries to develop innovative solutions to improve the effectiveness of the project delivery.

IPD agreements usually contain a portion of shared risk. If the team can deliver effectively, they share in the reward. Incentives are at a project level, rather than a transactional level. One of the main points of resistance to these agreements comes from this shared risk, which is natural because it is difficult to align the varied interests of the different parties. Not everyone in the industry thinks that IPD agreements are valuable; however, those who are early adopters of Lean Project Delivery are supporters.

Resistance to Lean

Based on interviews and research, acceptance of Lean in the US Construction Industry is still not wide spread, but it is gaining momentum in some sectors and with some companies. No measure currently exists gauging the level of implementation in the industry. The two main areas where Lean is being successfully used are the construction of healthcare facilities and in projects where the building owner's organization is on a Lean journey. Additionally, building owners who are seeing some of the early project successes and who want better stability and value for their investment are willing to try Lean Construction, because the current system is still not delivering the results or value that they want.

Some of the barriers to implementation and acceptance include:

- A belief that it does not apply to "them" or it is just a fad.
- Lack of understanding what Lean Construction is and its benefits/value proposition.
- Lack of training.
- Lack of owner or top management involvement and commitment.
- Senior management behavior, language and support not aligned with commitment to Lean.
- The mindset that "it takes too much time" prevents many from starting.
- Poor communication and lack of collaboration among owners, contractors, clients, consultants.
- It is difficult to actually align the interests of the various parties.
- Commercial terms do not facilitate collaboration, shared risk, fund transfers across the project, innovation incentives.
- Resistance to up-front design costs to involve all key stakeholders, model the project, and iterate designs.
- Lack of an embedded culture of transparent synchronized cost management.
- Relational contracts are viewed by some as untested (in a court of law) and difficult to insure.
- Culture within in the industry is historically more adversarial, fragmented and authoritative. Lean requires behavioral and mindset changes not necessarily embraced by all.
- Lack of team member commitment or a refusal to change behaviors.
- Team members not comfortable with early decision involvement or accountability to plan performance.

Trends

Is Lean Construction a fad? While the industry has been slow to accept and adopt Lean Construction, indicators show that the trend is shifting. Mike Stark of the Association of General Contractors (AGC) believes Lean Construction is here to stay. Here are indicators that Lean Construction is gaining traction:

- In September of 2011, LCI and the Association of General Contractors (AGC) announced the development of a Lean curriculum for its members. Some of AGCs members who are early adopters to Lean (i.e. Boldt Construction, Walbridge, DPR and Linbeck) drove this initiative.
- More RFPs are including Lean requirements on projects.
- This year the third annual CURT Lean Summit will be jointly presented by CURT, the Associated General Contractors of America, the Lean Construction Institute and the American Institute of Architects. This is the first time that AGC and AIA have been co-presenters.
- Lean Construction is included in the curricula at the following universities in the Construction related programs: Arizona State University, Bowling Green University, Colorado State, Louisiana State University, Michigan State University, North Carolina State University, Purdue University, San Diego State University, Texas A&M, UC Berkley, University of Colorado Boulder, University of Texas-Austin, Virginia Tech, and Washington State University., The subject is taught either as a stand-alone course or as a module within a core course. In most cases Lean Construction is covered in graduate level courses; it is shifting to the undergrad curriculum in many universities.
- Broader application of BIM (Building Information Modeling) and IFOAs facilitate the implementation of Lean Construction on projects throughout the design build process.
- Growth in the number of LCI chapters in the US and globally.
- Conversation about Lean Construction is still very active.
- Regionally, California, Texas, and some areas of the mid-west are leading implementation.
- Organizations who are on the leading edge of implementation on projects are now expanding implementation to their internal organizations and business processes.

Who are some of the organizations using Lean techniques to deliver projects?

Organizations using some Lean techniques include:

- Alberici
- Boldt Construction
- CH2M HILL offers services in Lean Enterprise Solutions
- DPR
- HKS, Inc.
- Linbeck
- Messer
- Mortenson
- SmithGroup JJR
- Sundt
- Turner Construction
- Walbridge

Conclusions

Lean Construction is gaining momentum, yet is still not widely implemented in the industry. Early project results reflect:

- better schedule performance
- better budget performance
- improved safety performance
- ability to incorporate more customer value in the projects
- higher collaboration

The ACG is teaming with LCI to create training to help their members implement Lean Construction. They believe Lean Construction is here to stay and will transform the industry.

Lean Construction in the form of Integrated Lean Project Delivery (ILPD) and the use of the Last Planner System® are improving project performance: delivery, cost, quality, and safety. The Last Planner System® brings stability to project plan performance; while best used in conjunction with ILPD, it can be used in projects that have other term agreements. With stability in the work plan performance, the team is able to implement other Lean tools to eliminate waste and increase value.

Target Value Design with rapid synchronized cost modeling is a key tool to the ILPD process and overcomes the hurdle posed by Anderson's Maxim that "Most projects with poorly conceived initial budgets never properly recover."

By understanding the targets and rapidly evaluating design options, Owners and AEC people can make better decisions to improve value delivery and performance of projects. Investment of design and cost management resources, including downstream suppliers, fosters collaboration and innovation leading to better designs, value and project delivery.

Adoption of Lean and its principles across the industry would improve the industry, its productivity, its deliverables and its reputation.

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