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# An Introduction to Lean Construction for Today's Construction Professionals

What it really means when construction teams decide to go Lean



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# Introduction

If you attend a conference or participate in professional development related to productivity in the construction industry, you will surely hear Lean Construction come up. It's become a popular buzzword in reference to the many different ways to boost productivity on a construction site—but what does it really mean?

Lean Construction is the application of Lean production management and manufacturing practices to construction project delivery. This includes the entire construction industry (owners, designers, architects, engineers, general contractors, subcontractors and end users) and not simply the work that occurs during the construction portion of a project. In the 80s and early 90s, Lean production techniques changed the efficiency and profitability of manufacturing across the world. These techniques are now enthusiastically being applied by progressive teams to a broad range of industries ranging from healthcare, services, retail and more.

Today's construction professionals are looking for ways to maximise value and efficiency and minimise waste, essentially doing more with less. Applying Lean Construction management principles to a project and continuously assessing ways to eliminate waste and inefficiencies achieves:

- Increased productivity
- Reduces waste
- Enhanced quality
- Advanced execution—less fire-fighting
- Improved operations—smoother flows
- Reduced operating costs



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"It's estimated that construction teams in the US will lose \$177 billion in non-productive labor activities. The loss includes looking for project data and information, conflict resolution and dealing with mistakes and rework."



# Productivity Has Flatlined

Productivity improvements in the construction industry has flatlined in recent decades compared to other industries like information technology, manufacturing and agriculture. PlanGrid recently conducted research in the US construction sector with FMI, and the resulting report, "[Construction Disconnected](#)," estimated that construction teams in the US will lose \$177 billion in non-productive labour activities. The loss includes looking for project data and information, conflict resolution and dealing with mistakes and rework. Additionally, the report estimates that poor data and communication contributes to \$31 billion in rework. With this level of waste replicated across the globe, it's no wonder that many organisations are looking for ways to positively impact productivity, and ultimately their bottom line.

## **This is a Problem That Can Be Solved**

If we assume that significant productivity gains are possible in construction, then there must be opportunities for improvement that are not currently being addressed. Project owners are likely overpaying for projects due to poor productivity and general contractors suffering from increasingly low profit margins due to inefficiencies. What should be most alarming is that many industry

professionals don't perceive that there is a need for a change or acknowledge that there is even a problem.

Nonetheless, looking at how Lean principles have revolutionized productivity in industries such as manufacturing, construction teams can begin to understand how Lean Construction is a framework that can boost efficiency and profits.<sup>1</sup>





# The History of Lean

The first person to begin really streamlining the production process was Henry Ford in the early 1900s.<sup>2</sup> In 1913, he pioneered what he called flow production, which was later referred to by the public as the moving assembly line. Ford was the first to line up fabrication steps in a process sequence to better fabricate and assemble the components of a vehicle in a matter of minutes. This was a revolutionary change in contrast to practices of the time where general purpose machines were simply grouped by process.

## Modern Usage of Lean in Manufacturing

The term Lean was first used to describe the production principles applied in automobile manufacturing. It was coined by John F. Krafcik to describe a production policy he observed at automotive manufacturing plants. The plants were able to produce a wide range of models, while still maintaining the highest levels of productivity and quality.

Krafcik asserted that the use of technology did not yield the desired impacts on quality and productivity if it's applied without proper production management policies. Krafcik defined the key policies applied at the most productive plants, which have become the basis for Lean production principles and the last 30 years of Lean studies:<sup>3</sup>

- Workflow standardization → removing waste
- Decentralized process improvement responsibilities – workers as more than cogs in a machine → adaptability and flexibility towards improvements
- Just-in-time inventory system → remove waste
- High emphasis on teamwork → respect, mutual trust and peer development

In manufacturing, a team can analyse the efficiency and productivity of a product over and over again until they are able to nearly perfect the process and the product's quality. In construction, most aspects of a project are essentially a prototype. There is no other previously assembled copy to refine that has the same conditions, same people and same process. Even so, there are still many lessons and principles from Lean manufacturing that can be applied to construction in an effort to achieve higher levels of productivity and quality.

# Five Principles of Lean

The Five Principles of Lean originate from a book titled “The Machine That Changed The World.” This includes defining value, mapping the value stream, creating flow, using a pull system and pursuing perfection. The goal of these five principles is to encourage creating a better flow in work processes and developing a continuous improvement culture.

## Principle 1 - Define Value

The first Lean principle defines value as the customer's needs for a product. It is vital to fully understand your customer's needs. By using qualitative and quantitative techniques (interviews, demographic information, web surveys, etc.) you can uncover what customers want, how they want it and the price they're willing to pay.<sup>4</sup>

## Principle 2 - Map the Value Stream

Identifying and mapping the value stream is the second principle of Lean. The goal of this principle is to use the customer's value as a reference point

to identify all activities required to take a project from raw materials to the final delivered product. Activities that do not add value to the customer are considered waste. Waste can be broken into two categories: non-value added but necessary and non-value added and unnecessary. Non-value added and unnecessary activities are pure waste and should be eliminated. Non-value added but necessary should be reduced as much as possible. Reducing and eliminating waste ensures that customers are getting exactly what they want for the lowest possible cost.<sup>4</sup>







### Principle 3 - Create Flow

The third principle of Lean is creating flow. Once waste has been removed from the value stream, it's important that the remaining steps flow smoothly without delay or bottlenecks. Strategies to achieve this include breaking down steps, reconfiguring production processes, leveling out the workload, creating cross-functional teams and training.<sup>4</sup>

If your flow is improved, the time required to deliver to the customer is also improved. A pull-based system allows for just-in-time delivery and manufacturing where materials are delivered in only the necessary quantities and work is completed at exactly the right time for the next step in the process to begin. A pull-based system is driven directly by the needs of your customers.<sup>4</sup>

### Principle 4 - Establish Pull

Establishing pull is the fourth principle of Lean. In a pull-based system, the goal is to manage inventory and in-progress work items to ensure that the materials and information needed for a smooth flow of work are available.

### Principle 5 - Pursue Perfection

The first four Lean principles prevent waste, but the fifth step of pursuing perfection may be the most important step. Pursuing perfection means making the Lean principles and process improvements a part of your company culture. This empowers your entire team to strive for perfection and deliver exactly what your customer needs.<sup>4</sup>



# Leveraging Lean Principles in Construction

In order to make Lean work for your organisation, it's important to remember that this is a long term strategy. It makes much more sense to apply Lean techniques globally instead of on a project by project basis. Your employees will learn the benefits of Lean over time, making the techniques easier to apply on future projects. More importantly, concepts like waste reduction need to occur on an ongoing basis and your employees will further improve when they are empowered to act on Lean principles.

## Lean Construction is Different

When contrasting how Lean is applied in manufacturing versus construction, it's easy to recognise how different a construction project is from the majority of manufacturing plants. In manufacturing, a team can analyze the efficiency and productivity of a product until they are able to perfect the process and quality. In construction, each project is different and the lessons learned today may not apply to the next project down the road.

Today's typical construction models utilise the mass production mindset. This means that every job is allocated to just one group with little or no interaction between stakeholders (owners, architects, general contractors, subcontractors, etc.). The siloing of work goes against all the Lean Construction guiding principles.

The lack of predictability is the crux of the typical construction model. Unpredictability results in lost time, waste and stress. Lean Construction is focused on predictability and flow, thus eliminating most negative aspects from the typical construction model.<sup>5</sup>

Lean Construction forces all parties to have clear goals, benchmarks and objectives from end to end of the construction process. Lean philosophy ensures the team is maximising performance at every level, focused on the goals of the customer. The silo effect of the traditional construction model is eliminated, forcing everyone on the project to collaborate as a single customer-focused group.<sup>5</sup>





## Integrated Project Delivery

To defeat the silo effect in typical construction models, a new project delivery method has started to become popular called Integrated Project Delivery (IPD). IPD is a cost and profit sharing delivery method that eliminates typical contract barriers and incentivises all team members to make “project” decisions rather than “trade” decisions.<sup>6</sup>

IPD allows you to create mini-organisations that last for the length of a single project to power that project to success. When you bypass the traditional methods of running a project, you can streamline it. IPD is uniquely suited to put Lean Construction principles into practice because it has solved the contractual issues that prevent true collaboration—empowering team members in the sharing of ideas, materials and manpower.

The main goal of Integrated Project Delivery is to create a team that can work together well enough to power the project for success. This team works together for the length of the project and may include members from a variety of disciplines including owners, contractors, subcontractors, architects and others.

Note: An effective Lean strategy to implement is holding daily pull planning huddles. Get your team together each morning for a 6 minute huddle where all the trades come together and update their items on

the pull plan. This also gives them a forum to formally hand off work and ask for help when necessary.

For step by step instructions on how to get your team set up for IPD, see the American Institute of Architect’s official guide titled “[Integrated Project Delivery: A Guide.](#)”

## Last Planner System and IPD

One of the key tools of Lean is the Last Planner System (LPS) (also known as Pull Planning), which is a work plan method that is based on the following:

1. Creating a backlog of tasks that are ready for execution (make-ready)
2. Committing on tasks that will be achieved in the next sprint—weekly work plan (e.g., one week, two weeks, three weeks, etc.)
3. Reviewing and assessing the success of those commitments—track progress, remedy issues, feedback and learnings

When implementing the Last Planner System, detailed knowledge of exactly where your team is at every stage of the project (progress tracking), and where they can execute most productively in the next sprint (look-aheads) is required.

When a team can closely monitor their progress against the planned commitments, it allows decision makers to identify potential upcoming risks and work towards mitigating or eliminating them before they occur. This process is very different from the status-quo,

where the people that are able to make course-correcting decisions are the last to know when a commitment or plan isn't progressing as expected. In traditional methods of planning, the project manager or superintendents frequently find themselves reacting to fires and inefficiencies after they've impacted the project, rather than having the opportunity to eliminate problems proactively.

Industry expert Michael Carr breaks down and defines the five steps of The Last Planner System as<sup>7</sup>:

### **Master Scheduling**

Teams should begin building their master schedule as soon as possible. All work will be based on this schedule, so it's vital to complete it early. Master scheduling is the process teams use to schedule a project from start to finish. It's important that the full project is captured, with early phases being well defined from the onset of the project.<sup>7</sup>

### **Phase Scheduling**

Phase scheduling is a collaborative planning and sequencing of tasks to complete the phases of work defined in the master schedule. This is typically accomplished with Pull Planning as a team where they work backwards from clearly defined milestones and identify all tasks in detail required to complete the milestone with satisfactory handoffs occurring between tasks.<sup>7</sup>

### **Look Ahead Planning**

During look ahead planning, teams identify clear constraints that will prevent upcoming work from being completed as planned. The goal is to mitigate these constraints before they become a problem to the project. Ideally this is occurring four to six weeks out to best prevent problems from occurring.<sup>7</sup>

### **Commitment Planning**

On a weekly basis, teams should meet to discuss current and future work in progress. The goal should be to commit to the approach to achieve completion of all work for the upcoming week. It's important to meet on a weekly basis, with daily huddles in place to fully support the weekly meeting.<sup>7</sup>

### **Learning**

One of the most crucial points of Lean and Last Planner is learning. Teams must continually improve by taking notice of what went well (pluses) and what did not (minuses) and actionably managing their projects based on the successes and challenges they've encountered.<sup>7</sup>

For more detail on getting started with the Last Planner System, check out the PlanGrid Blog "[An Intro to the Last Planner System](#)" written by industry expert Michael Carr.





## Prefabricated Construction

Since Lean Construction leverages prefabrication wherever possible, reduction in material waste is also a great opportunity for gains in profitability. More controlled production environments allow for analysing the materials and the processes much closer and maximising the use of all raw materials. Minimizing the need for inventory and surplus materials generates savings that can then be invested back into the business.

By using prefabrication, laser scanning and augmented reality—hospital owners are able to apply Lean principles and modularise how they fit out their new facilities. Teams can take a kit-of-parts approach by leveraging 3D modeling to design repeatable and reusable equipment, furniture, interiors, above-ceiling components and in-wall components. These design features are created to be reusable in any new facility, going against the traditional ‘one off’ design process that most hospitals have undergone in the past. By introducing this level of repeatability, the cost and design time for future hospital facilities decreases significantly. This strategy is useful for any type of owner that builds multiple facilities with similar design requirements.



# The Benefits of Building Lean

One of the most important principles of Lean Construction is that when you optimise a single step in a process, you de-optimize the rest. Traditional construction contracts divide each team member on the project into separate silos solely focused on optimising their own part of the work, which de-optimises the whole.<sup>6</sup>

Lean Construction principles help optimise the entire project by maximising value and minimising waste by applying specific techniques to the project delivery process. This results in:

- The project and its delivery process are designed together to better reveal and support the customer's intent. Positive iteration within the process is supported while negative iteration is minimised.
- The work process is structured to maximise value and reduce waste at the project delivery level.
- Efforts to improve total project performance are amplified because it's a more important goal than reducing the cost or speed of one single activity.
- Control over the project is defined as "making things happen" instead of simply "monitoring the results," with planning and control system performance being measured and improved.

Reliably managing work between specialists in design, supply and an assembly means value is delivered to the customer and waste is reduced. Lean Construction principles are especially useful on complex, unclear and fast-track projects. These principles challenge the common belief that there will always be a tradeoff between time, cost and quality. When applying Lean Construction management principles, the key benefits that can be achieved include:





### **Improves Work Quality**

Lean principles and the integrated project delivery process relies heavily on trust and respect of all people involved, resulting in a higher emphasis on communication and team performance. When a team is working as a unit and not in the traditional adversarial way that has existed in the construction industry—every stakeholder feels empowered to highlight areas where more value and quality can be obtained.

### **Increases Employee Collaboration and Accountability**

Lean Construction management relies heavily on the collaboration of the entire team. Managing a Lean Construction project involves empowering all teams to contribute to the continuous improvement process through collaborative problem-solving.

One way to achieve streamlined, open collaboration between all stakeholders on a project is by utilizing technology and software that facilitates communication and problem-solving.

### **Boosts Project Satisfaction**

Knowing which aspects of a project are regarded as the most valuable to the owner and end users allows teams to make the best, quickest

decisions without jeopardising the outcome. When owners know that their best interest is at the core of every decision that is made on the project, the speed at which issues are resolved is significantly increased. Decision making and contributions are decentralised, which allow the project to move quicker towards closeout.

A project team that can promptly resolve any blockers has a better chance of staying on schedule and tracking to budget. All of these factors lead to a happy owner—and ultimately to more contracts, work and profit for everyone involved.

### **Increases ROI**

Companies have reported an increase in productivity through the application of Lean Construction management principles to a project, translating to an increased return on investment. Production rates are the core measurement units that a subcontractor or any “producing” party on a project base their estimates on. Ultimately, meeting the production rate used for an estimate is the key to being profitable. Any increase in productivity reduces the risk of losing profit. Apart from the increase in productivity, any reduction in waste—whether actual material waste or procedural waste—results in overall efficiency of the project.

# Modern Tools Facilitate Lean Construction

The good news is that software tools can help facilitate going Lean on your projects. The core of many construction software solutions (like Autodesk Construction Cloud™) can help facilitate the level of collaboration needed for Lean and IPD. When all members of the team can communicate, collaborate and contribute with real-time information and access, many of the traditional problems associated with construction project management are drastically reduced.

The right technology can help with project planning (scheduling, estimating, constructability), communication (bidding, meetings, etc.), document management (sheet management, shared documents), reporting (daily reports, asset tracking, time tracking), snag/defect lists and facility management.<sup>8</sup>

Using collaborative tools to enhance and overcome IT and communications challenges improves both efficiency and productivity. Data and documentation flow are improved, and workers on-site are better able to convey needs and concerns to those in the office in real time. By facilitating this communication, construction brands can improve their customer experience and increase revenues and profits.

Today's construction tools enable teams to focus on the Lean tenant of pursuing perfection by more easily facilitating continuous improvement and learning. Modern technology is one of the most strategic tools you can employ to create value and eliminate waste on your construction projects.<sup>9</sup>





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# Conclusions

It's clear that the decision to implement practices like Lean Construction, Integrated Project Delivery or the Last Planner System should not be taken lightly. There are costs of time and money to consider and the rollout of any of these systems should be planned thoughtfully with participation from everyone that will be impacted by the changes.

Traditional construction practices have remained the same for many years, so getting buy-in from your team may initially be a challenge. Consider a pilot project to showcase how Lean can work for your organisation, allowing you to build momentum and expand the program over time. During the pilot it's important to emphasise the benefits of Lean practices (greater project autonomy, less waste, clearer workflows, easier handoffs of completed work, etc.). This is an opportunity to show your team that going Lean will not make their jobs more difficult and will ultimately give them a better platform for success.

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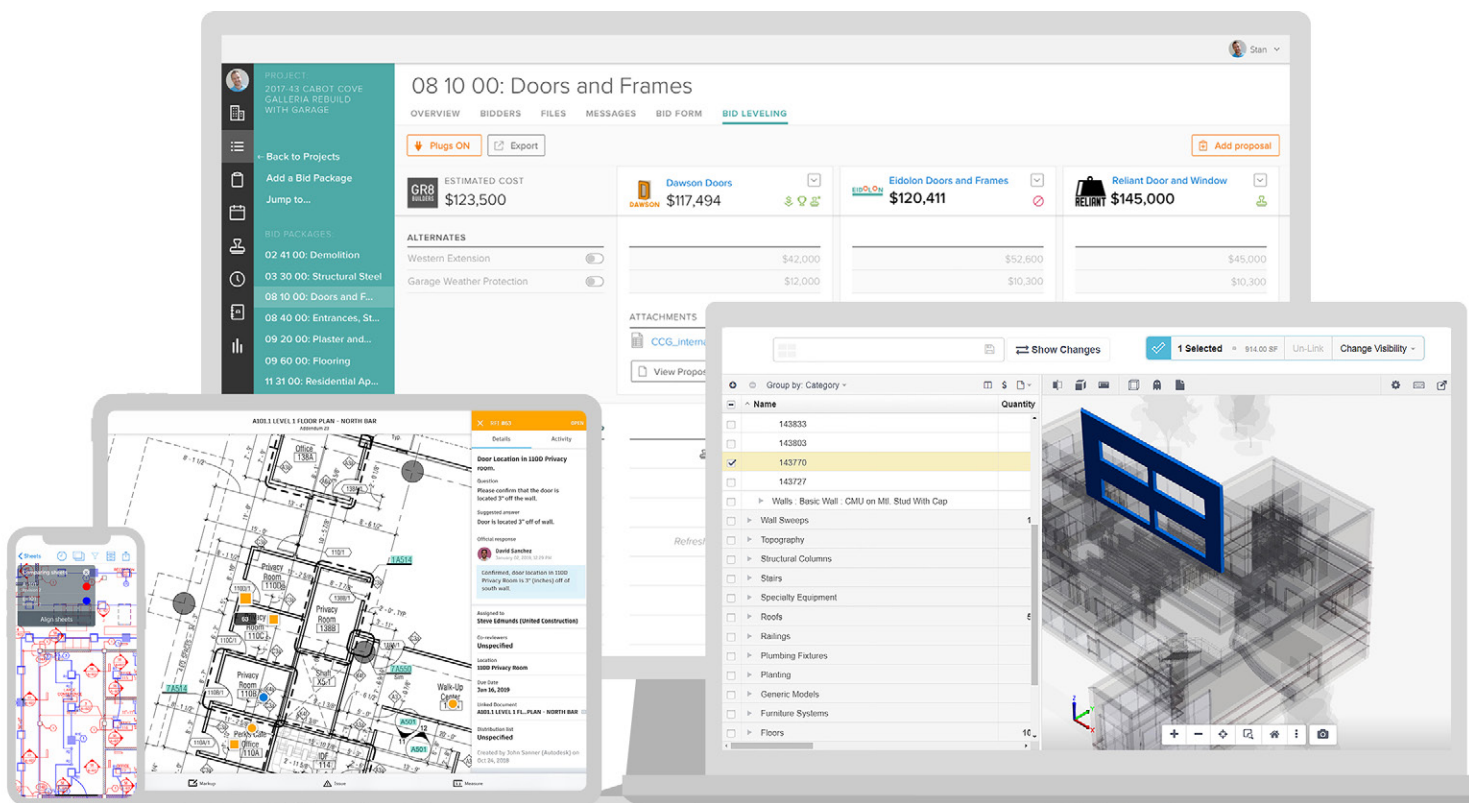


# See the Future of Connected Construction

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In 2018, Autodesk announced that construction would be a key focus area to help our customers on their design and make journey. To capitalize on the opportunity, Construction became its own CEO-staff level organization, Autodesk Construction Solutions. This unique structure is comprised of product development, customer success, marketing, and field operations. The organization is designed to move at the speed of the market and serve customers on a level playing field with other solution providers. Autodesk Construction Solutions offers products that cover the entire construction lifecycle, from design through plan to build and operate, including the Autodesk Construction Cloud which brings together our cloud-based solutions Assemble, BIM 360, BuildingConnected and PlanGrid.

Our vision is to create a vibrant construction industry where predictability and productivity are exponentially increased, while jobsite waste is proportionately reduced. The time has come for platform that will empower an industry transformation. Our mission is to help construction teams meet the world's rapidly expanding building and infrastructure needs, while making construction more predictable, safe and sustainable.





With Autodesk software, you have the power to Make Anything. The future of making is here, bringing with it radical changes in the way things are designed, made, and used. It's disrupting every industry: architecture, engineering, and construction; manufacturing; and media and entertainment. With the right knowledge and tools, this disruption is your opportunity. Our software is used by everyone - from design professionals, engineers and architects to digital artists, students and hobbyists. We constantly explore new ways to integrate all dimensions of diversity across our employees, customers, partners, and communities. Our ultimate goal is to expand opportunities for anyone to imagine, design, and make a better world.

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