

The Art and Philosophy of Lean Construction

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Preface

From 2018 to 2022, I posted regularly on LinkedIn and share my thoughts about the art and philosophy of Lean Construction. This book is a distillation of those thoughts. It was written naturally and over many years of thoughts and pondering on this topic.

If you apply Lean Construction long enough you will eventually become a philosopher. I am sharing my thoughts with you so that you do not have to reinvent the wheel. You can use these ideas to improve your understanding and implementation.

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Chapter 1. Why Start With Lean Construction Philosophy

Here is how I organize what I learned from Lean Construction. There are four levels of understanding.

1. Philosophy
2. Principles
3. Methods
4. Tools and Implementation

The Lean philosophy is pretty simple: 1) respect for people, 2) maximizing value while minimizing waste, and 3) continuous improvement. The philosophy is what we strive for and should **NEVER** change. We actively pursue the philosophies but cannot never fully achieve them. They exist as guiding North Stars for every lean organization to make decisions and provide a path towards better lean construction implementation.

Respect for people is the most important and most poorly understood Lean philosophy. When we talk about respect for people, we need to consider the whole person. We can't respect them at work while making them take months of overtime which deteriorates their personal lives and relationships outside of work. Respect for people extends beyond our organization. It includes suppliers, vendors, owners, architects, etc. The people that we work with on a regular basis as well as the end customer.

How many times have you had the conversation within your team about making the lives of your vendors, suppliers, etc. better? These conversations rarely ever happen. Have you considered that your procurement process is putting unnecessary strain on your supplier? How does your net 30, net 60, or net 90 payment terms affect the small business that is working on your project?

Respect for people also extends to the environment. Thinking about the long term environment, sustainability, and our impact on the planet should be part of respect for people. Our future generations will have to deal with the problems that we leave them. It is important to consider these hidden stakeholders.

These are all vital conversations that we need to have throughout our lean journey. There are many ways to cheat and cut corners when it comes to lean implementation. Without a grounded base to start, you will end up cutting corners when times get difficult.

The second Lean philosophy is "maximizing value while minimizing waste". We pursue this ideal through the application of lean construction principles, methods, and tools. We understand that the achievement of this philosophy is impossible. All we can do is strive to move closer and closer to perfection each and every day.

The third Lean philosophy is continuous improvement. Although continuous improvement is implied when we take into consideration "respect for people" and "maximizing value while minimizing waste", we have to be explicit about this philosophy. The main reason is that most companies that implement lean stagnant. They may understand the first two philosophies and apply several Lean Construction

methods. But they do not make any measurable improvement over time. Once all the easy wins and visible waste can be eliminated, they become complacent.

All three philosophies are important and they have a synergistic relationship with each other. You can't respect people if you don't continuously improve and actively help people get better because you are wasting human potential. You can't "maximize value while minimizing waste" without continuous improvement. And you can't continuously improve without taking into consideration your team, customers, suppliers, and the entire value chain.

The principles are concepts that help us achieve the philosophy and can include: continuous flow, single piece flow, pull, small batch size, fast switch over, visual management, etc. There are many Lean principles that we know of and there are many that come up over time. We will talk briefly about the lean principles that we are aware of. These principles exist in nature and are there for us to uncover. We do not and cannot invent any of these principles. Similar to mathematical proofs, they have always existed. It just takes us time and a bit of wisdom to realize them and be able to document them in a way that others can use.

There are several Lean Construction methods that we have developed to formalize the principles. These include the Last Planner System, Takt Time, Choosing By Advantages, Target Value Delivery, Integrated Project Delivery, etc. The methods are important because they create prescriptive processes that allow us to achieve the Lean principles. They are clear enough for us to understand how to apply them but are general enough that they can be adapted to different situations.

Some people ask the question, which came first, the principles or the methods? The answer is it depends. Sometimes you can use the lean principles to find gaps in current practices and use them to create methods. Sometimes, you create methods that just work very effectively. You break them down and try to uncover the principles behind them. Both ways are acceptable and as you can see, by understanding the philosophy and principles, you can enhance the methods that you are currently using. Or even create new ones. It is really that powerful once you grasp this idea.

Finally there are tools such as software, analog (aka stickies), and hybrid implementations that allow us to actually use the methods within our project or organization. Every project will implement Lean slightly differently based on the team's experience, preferences, and unique project conditions. As long as the implementation is aligned with the method, principles, and philosophy; you will get good results. We will talk more about the three forms of lean implementation in a later chapter. We will cover the relationship between the three. When you should go digital versus analog versus hybrid.

To the beginners, I teach tools and practices.

To the intermediate level students, I teach methods.

To the advanced students, I teach philosophy and principles.

The further you move along your lean construction proficiency, the more you need to focus on first principles, philosophies, and ways of thinking. In the beginning, tools and implementations are

important because they can help you move very far with templates and tried and true practices. They give you practical examples and inspiration to get started right away.

But over time, these tools and practices can become too rigid. The only way to get better is to increase your understanding and become more flexible in your thinking and implementation.

Many people approach Lean Construction by simply copying other people's implementation. If you don't understand Lean Construction holistically, then there will be a hard ceiling that you will reach with your progress.

The goal of this book is to introduce you to a deeper understanding of Lean Construction. To explore topics and areas that are hidden to most practitioners but once you understand them can have profound implications on your own lean construction implementations. We will focus mostly on the philosophy, principles, and ways of thinking about Lean Construction. There are many excellent books, blogs, and resources available on the Lean methodology and implementation that I recommend you read as a supplement to this book. This is NOT a how to DO book. It is a HOW TO THINK book.

Although the exploration of a philosophy seems theoretical, there is nothing more practical than a good theory. Let's get started.

Chapter 2. The Difference Between Philosophy, Principles, Methods, Tools and Implementation

In this chapter, I am going to start by asking and answering a few fundamental questions.

1. What is Lean Construction?
2. Where did Lean Construction come from?
3. What is the difference between philosophy and principles?
4. What is the difference between principles and methods?
5. What is the difference between implementation and methods?
6. Why do you need to understand the entire stack to be effective with your implementation?

What is Lean Construction and where did it come from?

The origin of Lean Construction started in 1992. The three people credited for creating the field of Lean Construction are: Glenn Ballard, Greg Howell, and Lauri Koskela. Although many more people such as Iris Tommelein, Rafael Sacks, Luis Alarcon, and Carlos Formoso, etc. joined early on and were instrumental in its development, these three are the godfathers of the field.

Glenn and Greg have been working together since the 1980s to improve productivity. They found that productivity was directly correlated with the reliability of the work plan versus work completed. They created a metric called Percent Planned Completed (PPC). It is simply a measure of the number of activities completed at the end of the week divided by the number of activities planned during the beginning of the week. During their collaboration in the late 1980s and early 1990s, Glenn and Greg lay the foundations for the first Lean Construction method which we now know as the Last Planner System.

In the early 1990s, Glenn was a lecturer at both UC Berkeley and Stanford University. Glenn met a visiting scholar by the name of Lauri Koskela. Lauri was working on revolutionary research at the time. Lauri asked the questions, “Is there a production theory for construction?”, “What would that theory look like?”, “How would construction be improved if there is a foundation theory to build upon?”.

Lauri’s research provided the theoretical foundation for Lean Construction¹. The Last Planner System provided an empirical framework of systematically improving construction through production planning and control. Together the idea of using production theory for construction and the ability to improve productivity by increasing PPC sparked the Lean Construction movement.

The first official meeting of the minds happened in 1993 at the first International Group for Lean Construction organized by Lauri, Glenn, and Luis Alarcón. At the conference, the group used the term Lean Construction to describe their work. At the time the book “The Machine That Changed the World”

¹ You can read Lauri’s technical report and dissertation here:
<https://leanconstruction.org/uploads/wp/media/docs/Koskela-TR72.pdf>
<http://lib.tkk.fi/Diss/2000/isbn951385566X/isbn951385566X.pdf>

was published by James P. Womack, Daniel T. Jones, and Daniel Roos. Glenn, Greg, and Lauri saw many similarities with the Toyota Production System (TPS) and what they were working on in order to improve the construction industry and thus the term Lean Construction was coined and used ever since.

What is the difference between philosophy and principles?

The philosophy is the bedrock foundation for Lean Construction. There are only 3 philosophies of Lean and they are the same regardless of if you are applying Lean in manufacturing, healthcare, etc. The three philosophies are: 1) respect for people, 2) maximizing value while minimizing waste, and 3) continuous improvement.

Learning what the philosophies are is very simple but truly understanding them and putting them into practice takes a lifetime. The main reason why we focus first on the philosophies is that they form the WHY of our lean journey. We undergo a Lean journey and apply Lean methods and tools in order to achieve these philosophies. Without an understanding of the philosophies, most company's lean implementation stagnant at a certain point. Once the low hanging fruit in terms of the obvious wastes have been eliminated, they revert back to business as usual.

The longer your lean journey is, the harder it is to find and make improvements. All the easy improvements have already been found. What is left is much harder to find and implement.

The philosophies are short and simple. They should NEVER change. I write about philosophy because they will outlive any tools, methods, or software.

If the philosophies are the WHY, then the principles are the HOW. Just because we know WHY we want to apply Lean, we still need to know HOW to do it. The principles are a set of timeless ideas which can guide your implementation. They include such concepts as: continuous flow, one piece flow, fast switch over (SMED), built in quality, poka yoke, kanban, takt, buffers, queues, visual management, etc.

Unlike philosophies in which there are only three. There are dozens of Lean principles. Perhaps hundreds depending upon your definition and I am sure that more principles will pop up over time. This book will speak briefly about the Lean Principles but we will not be able to create an exhaustive list. Creating an exhaustive list of all the Lean principles is in of itself a long enough journey which deserves its own book. I hope that by the 2nd or 3rd edition, we can include more principles and not miss any obvious ones.

By understanding Lean at its core fundamentals and first principles, you will be able to adapt your thinking and be able to more easily and effectively adjust your implementation from project to project, from one environment to another.

Without learning the philosophy, you may be applying lean on shaky ground. You may be building your skyscraper on clay. If you want your implementation to last, if you want your gains to be compounded,

you have to start by driving your piles to bedrock. Build your solid foundations from the ground up. Do the hard work which is invisible but lays the groundworks for everything else to come.

I focus on the lean philosophy and principles because they are hidden. Invisible to only those who seek them. Not easily found by most. Most people are impressed by nice photos, pleasing visuals, and on the surface level that they can see. Very few venture deep down to truly explore and understand. This book is for those that want to learn lean construction properly. You want to learn how to understand and think in the lean way. You want to make a long lasting change and create a truly sustainable lean culture.

What is the difference between principles and methods?

Principles in and of themselves are just concepts. They are not prescriptive enough for you to apply. By combining one or more principles together into a prescriptive HOW TO framework, you will end up with a Lean methodology. A good analog is that principles are vocabulary words. Methods are full sentences and paragraphs constructed by putting words together. Words are important because they are the building blocks of sentences. But sentences and paragraphs are necessary in order to communicate ideas.

Some of the Lean Construction methods that we use include: 1) The Last Planner System, 2) Target Value Delivery, 3) Choosing By Advantages, 4) Set Based Design, 5) Reliable Promises, 6) Takt Planning, 7) SCRUM, etc.

More methods will be developed over time but since developing a methodology takes more than a decade, these seven are the current foundational methods of Lean Construction. Many of the methods that we use in Lean Construction were not developed within the construction industry. Choosing By Advantages, Reliable Promises, and SCRUM are such examples. Set Based Design came from the Toyota Production System. Reliable Promises were developed by Fernando Flores based on the language action theory. Most people such as Jim Suhr take an entire lifetime in order to develop and refine one method - Choosing By Advantages.

The two methodologies that were developed and are unique to the construction industry are the Last Planner System and Target Value Delivery. Glenn Ballard and Greg Howell played an important role in the development and research of both methods.

For more information on these methods, you can read the free articles at the [Lean Construction Blog](#). We will not be able to go deeply into each of the methods in this book. Our goal here is to provide a map of the landscape so that you have a holistic view of Lean Construction and be able to productively explore on your own.

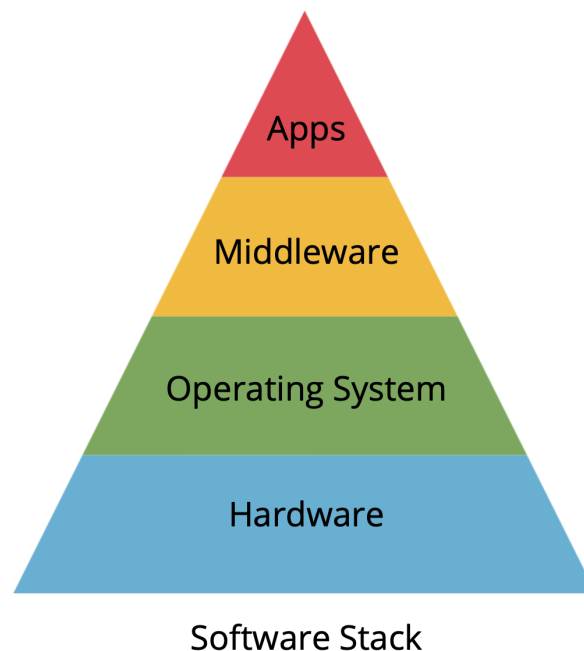
What is the difference between tools and methods?

A method provides a recipe and guidelines for applying Lean Construction. The actual application of the methods in the real world takes the form of Lean tools or implementations. You can think about a method like a cookbook with recipes, a list of ingredients, and a step-by-step guide. You can't actually eat the cookbook. You use the cookbook to bake your cake. Even though you will be working with real ingredients to bake your cake, you can't do it without a recipe.

A Lean Construction method should be agnostic about how to apply them. This is because the actual application will need to be adaptive to your particular project, team, and constraints. In terms of tools, there are only three types of tools: 1) analog, 2) digital, and 3) hybrid. We will touch on these three types in a later section. There are advantages to each of these and depending upon your situation, one of them may be more favorable.

Why do you need to understand the entire stack to be effective with your implementation?

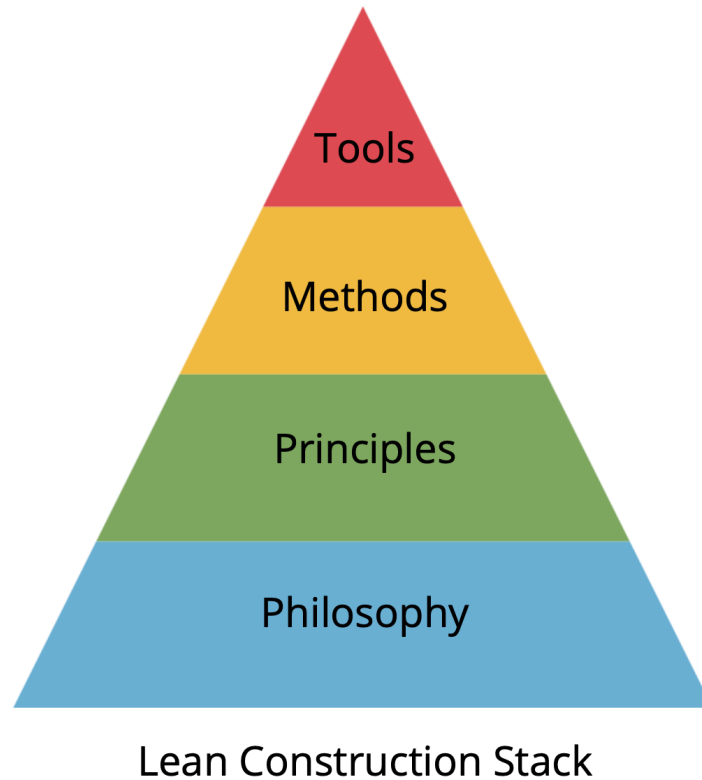
In software engineering, there is this concept of a software stack. There are many different layers of interconnected hardware and software that work together in order to run your computer. At the lowest level is hardware (RAM, CPU, Memory). Above that is operating systems (MAC OS, Linux, Windows), the code that runs your computer. On top of the operating system are middleware such as databases, memory management, etc. And finally the applications that we use on a daily basis sits on top. Without a full technology stack, your computer, phone, and devices will not work. All the layers in the stack need to work harmoniously together.



The stack allows software engineers to focus on one layer at a time. As long as they manage the interdependencies between the layers, they can use code from other developers. The layers allow software

to be specific and interchangeable. Without all of the layers, your computer will not be able to function. Much of the complexities of the modern world is hidden below the surface.

Using this analogy, your Lean Construction Implementation is also a stack as well. The different layers need to be in alignment with each other. When you visit a jobsite, you may be seeing just the surface level implementation in the form of stickies, a SCRUM board, or other visual signs of Lean Construction implementation. The project may look impressive at the surface, but the real work, the real mechanisms are happening below the surface.



People new to Lean Construction look at the impressive tools and then immediately try to copy what they have seen. This approach will yield limited success. You can't copy your way to excellence. There is no way to properly apply the Lean tools and methods without a strong understanding of the principles and philosophy behind them.

The only way to have a truly sustainable lean implementation is to align all four layers of the stack. As you are implementing Lean Construction, a search up and down the Lean Construction stack will help you uncover a vast wealth of knowledge and ideas to apply.

The best way to improve your implementation is to look at it holistically. Look for principles, methods, or tools that you are missing. Develop a series of experiments to incorporate them into your implementation. Use the Plan Do Check Act cycle to test your hypotheses. Use what works for your project and your team. Discard the ideas that do not work. The more cycles of hypothesis and experimentation that you do, the better your implementation becomes.

Chapter 3. Principles & Key Concepts of Lean Construction

The Lean principles are the LEGO blocks of your lean thinking. They are the ingredients for cooking your perfect cake. This is where you should be spending most of your time thinking and devising ideas to test and implement.

The Lean principles are broken down into four sources: 1) Concepts from the Transformation-Flow-Value Theory of Production (Lauri Koskela)², 2) Concepts from Factory Physics and Operations Science, 3) Concepts from the Toyota Production System, and 4) Concepts from Lean Construction which have been developed empirically. These concepts were discovered in order to solve the unique problems that the AEC industry faces.

1. Transformation, Flow, Value theory of production

Since 1992, Lauri Koskela has been working on a comprehensive theory for Lean Construction. In his research, he identified three interdependent perspectives to production: transformation, flow, and value.

The dominant theory of production in the 20th century is the **transformation view**. Production is the transformation of one set of resources into a second set. Turning less valuable inputs into more valuable outputs.

Under this theory:

- Total transformation can be decomposed into smaller transformations
- Cost of production can be minimized by minimizing the cost of each component
- It is advantageous to buffer production

The second perspective is to see **production as a flow process**. Some new concepts are introduced through this view.

- Understanding of waste
- Reduce non-value added activities (waste)
- Reduce lead time
- Reduce variability
- Minimize number of steps, linkage, parts, etc.
- Increase flexibility
- Increase transparency

² <http://lib.tkk.fi/Diss/2000/isbn951385566X/isbn951385566X.pdf>

The third perspective is the **value view of production**. The value of a product can be determined only in reference to the customer, and the goal of production is satisfying customer needs. From this perspective we have:

- Production based on the voice of the customer
- Ensure that all customer requirements, both explicit and latent, have been captured
- No value can be generated without an end customer.

The TFV theory of production states that all three perspectives of production are valid. By looking at just one or two of the perspectives, we will be missing out on an important part of the system. The goal is to integrate all three perspectives and simultaneously look at the three points of view: transformation, flow and value. Broadly viewed, there are three suggestions on how to proceed:

- Balancing the prescriptions from all three viewpoints
- Taking care of interactions between phenomena covered by the three viewpoints
- Using the three viewpoints at the same time as a lens into our production processes

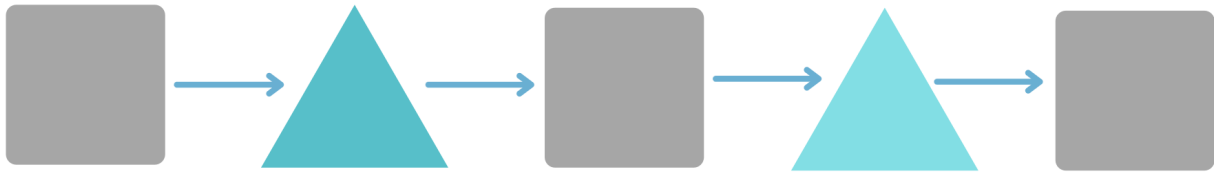
2. Factory Physics and the Science of Production

One of the biggest misunderstandings of production is that work occurs through a series of steps or processes. When you finish one step, work is moved to the next step.



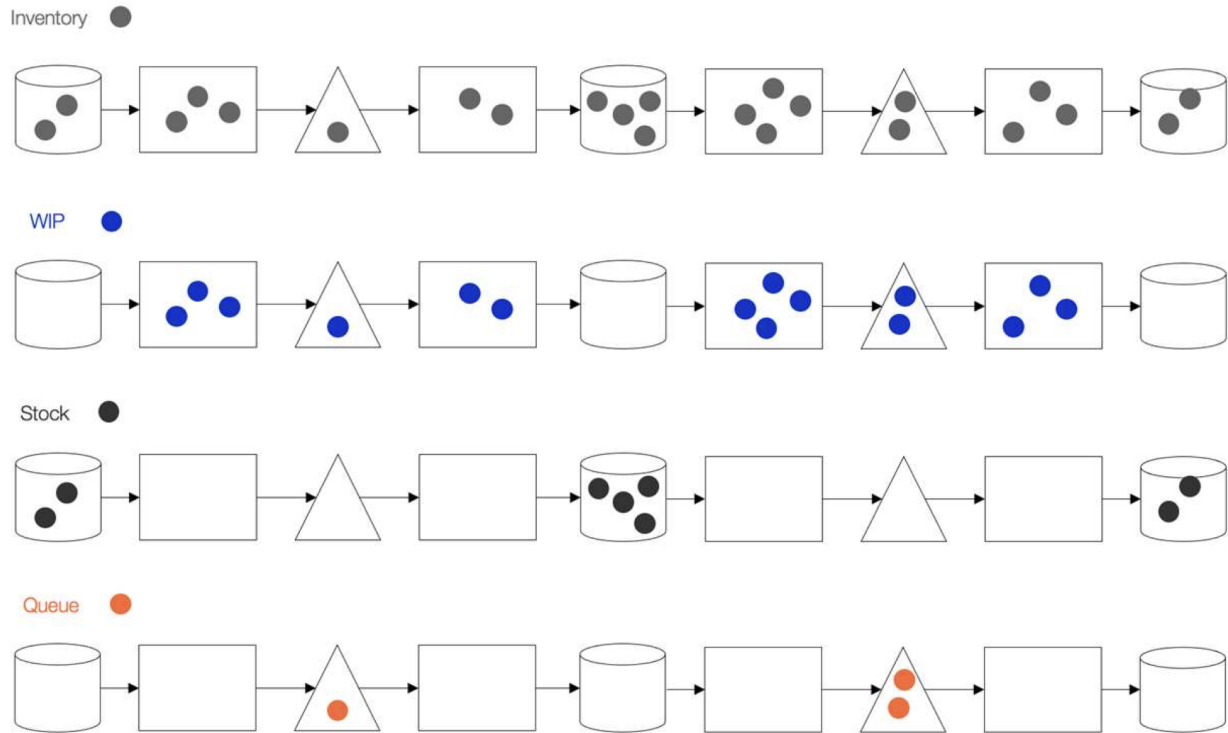
Series of Processes

A more realistic view of production is that in between each step or workstation, there are queues. Our work in progress (WIPs) are stored in the queues between the work stations. If one station is faster than the other, there will be an accumulation of WIP.



Series of Processes with Queues

Factory physics³ and operations science, takes this view of production and expands upon it. In the diagram below, you can see how inventory, WIP, stock, and queues are part of a production system.



4

In addition to this view of production, factory physics also have several key concepts to consider:

Capacity: max units/tasks that can be done per unit time

Throughput: units/tasks completed per unit time

³ The best book on this topic is [Factory Physics by Hopp and Spearman](#). A very long book but well worth the read.

⁴ Courtesy of the [Project Production Institute](#) (PPI). The PPI is a leading research organization on production planning and control.

Utilization: fraction of capacity that is used

Cycle Time: time from start to finish of a unit/task

WIP : the number of incomplete units/tasks

Little's Law: $WIP = TH * CT$

Inventory—units or tasks wait on demand

Stock - Completed or semi-completed products

Queues - Units waiting in between workstations

Buffer - excess inventory, time, or capacity to absorb variability

Bottleneck: The production unit with the lowest throughput (longest cycle time) of all production units in a system (the choke point) that is linear, sequential, and deterministic.

Variability - unevenness in demand or production

Regardless of how well you designed your production system, demand and production are never synchronized. There is always variability! Variability in a production system will be buffered with some combination of:

1. Inventory
2. Time
3. Capacity

Every project is a production system. In order to improve your production system, you must map out the processes and adjust the parameters such as capacity, queues, inventory, flow, WIPs, buffers, throughput, etc.

The project doesn't get faster just because you want it to. Throwing extra labor at the problem doesn't make it better. If you want to change the outcomes of your project, you have to understand these parameters and be able to tweak them.

Lean Principles from The Toyota Production System (TPS)



1. Define Value

To better understand the first principle of defining customer value, it is important to understand what value is. Value is what the customer is willing to pay for. It is paramount to discover the actual or latent needs of the customer. Sometimes customers may not know what they want or are unable to articulate it.

2. Map the Value Stream

The second Lean principle is identifying and mapping the value stream. In this step, the goal is to use the customer's value as a reference point and identify all the activities that contribute to these values. Activities that do not add value to the end customer are considered waste. The waste can be broken into two categories: non-valued added but necessary and non-value & unnecessary. The latter is pure waste and should be eliminated while the former should be reduced as much as possible. By reducing and eliminating unnecessary processes or steps, you can ensure that customers are getting exactly what they want while at the same time reducing the cost of producing that product or service.

3. Create Flow

After removing the wastes from the value stream, the following action is to ensure that the flow of the remaining steps run smoothly without interruptions or delays. Some strategies for ensuring that value-adding activities flow smoothly include: breaking down steps, reconfiguring the production steps, leveling out the workload, creating cross-functional departments, and training employees to be multi-skilled and adaptive.

4. Establish Pull

Inventory is considered one of the biggest wastes in any production system. The goal of a pull-based system is to limit inventory and work in process (WIP) items while ensuring that the requisite materials and information are available for a smooth flow of work. In other words, a pull-based system allows for Just-in-time delivery and manufacturing where products are created at the time that they are needed and in just the quantities needed. Pull-based systems are always created from the needs of the end customers. By following the value stream and working backwards through the production system, you can ensure that the products produced will be able to satisfy the needs of customers.

5. Pursue Perfection

Wastes are prevented through the achievement of the first four steps: 1) identifying value, 2) mapping value stream, 3) creating flow, and 4) adopting a pull system. However, the fifth step of pursuing perfection is the most important among them all. It makes Lean thinking and continuous process improvement a part of the organizational culture. Every employee should strive towards perfection while delivering products based on the customer needs. The company should be a learning organization and always find ways to get a little better each and every day.

In addition to these principles, TPS has introduced several important concepts for us to use. I will not cover these principles in depth since there are already many good books on them.

Gemba

Heijunka

Hoshin Kanri

Jidoka

Just-In-Time

Pull Versus Push

Single Piece Flow

Continuous Flow

Kanban

Poka Yoke

Last responsible moment

Muda (Waste)

Mura

Muri

Lowering the river to reveal the rocks.

Stopping the line rather than letting defects pass through (pulling the andon cord).

Quality control as part of every work station rather than quality control at the end.

Going to Gemba and investigating problems at the root cause.

The emphasis on problem solving.

Problems need to be actively uncovered rather than swept under the rug.

Leadership's role is to challenge and develop people.

Extending respect and training to suppliers.

Make small incremental changes every day rather than large changes once in a while.

The need to have standardized work. Standardize work is the foundation of continuous improvement. Without stability there can not be room for improvement.

Other Lean Construction Principles

Projects are a network of commitments⁵ / Reliable promises⁶ - projects are delivered by people and people work through making and keeping promises. Reliable promises is a set of language tools to improve communication and the reliability of commitments.

Optimize for the whole

Collaborate really collaborate

Tightly couple learning with action

Increase relatedness

⁵ These are part of Sutter Health's 5 Big Ideas. The 5 Big Ideas were developed by Hal Macomber.

⁶ Reliable promises are based on the works of Fernando Flores.

Make ready and constraint removal - unless an activity has been made ready and the constraints has been removed, you cannot start the work. The goal is to prepare work before you start it so that there will be limited stop and go instances.

Collaborative planning - with lean, the project schedule is developed collaboratively with the people doing the work. Most of the industry has a scheduler which creates a plan in their office and without communicating with the people onsite. These schedules are often unrealistic and cannot be executed by the field.

Collaborative decision-making - project delays occur not because problems come up. Delays occur because it takes the team a long time to make decisions. If you can make better group decisions, more collaborative decisions, and faster decisions; you will be able to create more resiliency in your project.

Early involvement of trade partners in the design phase.

Spend money when it is cheap during the validation and design phase rather than making changes when it becomes more expensive during construction.

Aligning the business model and financial incentives of the project with the business model and financial incentives of the people involved.

Decreasing cost through collaboration. Cost can decrease as more of the project is designed and proceeds in construction. The current convention is that costs always increase over time.

Principles are discovered all the time. If there is a principle that is missing from this list, please let me know. Send me suggestions to doanh@leanconstructionblog.com.

Chapter 4. Lean Construction Methods Explained In Plain English

In this chapter, I will give the simplest explanations of the Lean Construction Methods. I will start with a definition of each method, the goal of the method, and the principles behind them.

What is the Last Planner System?

The collaborative, commitment-based planning system that integrates should-can-will-did planning. It includes master scheduling and phase planning to define what SHOULD be done, lookahead planning based on constraints identification and removal (the make-ready process) to establish what CAN be done, weekly work planning based on reliable promises reflecting what WILL be done, and learning based upon analysis of PPC (comparing DID against WILL) and reasons for variance⁷.

What is the goal of the Last Planner System?

The goal of the Last Planner System is to improve PPC. PPC is the measure of the reliability of the work completed versus the work planned. Every step of the Last Planner System has been to improve PPC. PPC is directly correlated with productivity so if we can increase PPC we will get better productivity and safety.

A misunderstanding amongst lean practitioners is the target for PPC. Many people set the target at 80% or 90% because they believe that if PPC is 100% then the team's targets are undereaching. Glenn Ballard spoke out about this several times. According to Glenn, the target for PPC should be 100%. The goal is to plan collaboratively and have a reliable workflow.

What are the principles behind the Last Planner System?

All plans are forecasts; all forecasts are wrong⁸.

The longer the forecast, the more wrong it gets.

The more detailed the forecast, the wronger it is (first formulated by Ballard ca. 1991).

The implication of these principles are that it is important to:

- Plan in greater detail as you get closer to doing the work.
- Produce plans collaboratively with those who will do the work.
- Reveal and remove constraints on planned tasks as a team.

⁷ Definition of the Last Planner System from P2SL's Glossary developed by Iris Tommelein and Glenn Ballard.

⁸ Last Planner principles are based on the work from Glenn Ballard.

- Make and secure reliable promises.
- Learn from breakdowns.

In addition, it is important to:

- Measure promises kept and improve by learning from early, late or incomplete deliveries and workflow disruptions.
- Improve workflow as a team based on what has been learned.

Fundamentally the Last Planner System is a way of thinking and a well developed methodology for improving the reliability of project planning.

Most construction plans/schedules are not developed with the people doing the work onsite. The plans are often pushed to workers. This leads to plans that are unrealistic, overly optimistic, and missing in hand offs between the different trades. With the LPS, we are doing some small things differently.

1. Plan the work with the foreman and superintendents
2. Have trades commit to their work by making reliable promises
3. Plan the whole project backwards in order to not miss any details
4. Remove constraints before we put an activity on the weekly work plan
5. Measure how much of the planned activities did we actually complete at the end of the week. This allows us to learn and improve.
6. Use location based or Takt time to optimize production flows and space allocations.
7. Do short 15 minute meetings with the trades to go over the plan and keep everyone on the same page.

What is Target Value Delivery?

Target Value Delivery (TVD) is “a management practice that drives the design [and construction] to deliver customer values within project constraints” (Ballard, 2009). It is an application of Taiichi Ohno’s practice of self-imposing necessity as a means for continuous improvement (Ballard, 2009). Using TVD, the design and construction is steered towards the target cost. A continuous and pro-active value engineering process is utilized during the design phase to quickly evaluate the cost implications of design options. Cost is a [one of many] constraint rather than an output of the design process.

What is the goal of Target Value Delivery?

The main objective of TVD is to achieve the “holy grail” of construction management - to have reliable cost, schedule, and scope⁹. The Last Planner System has helped countless projects deliver to a reliable schedule. The goal of TVD is to address cost reliability, value delivery, and continuous improvement on

⁹ For more information on TVD, you can read the Lean Construction Blog articles on this [topic](#).

large capital projects. With TVD, projects have lower likelihood of cost overruns, better cost predictability, and a more predictable investment for owners.

What are the principles behind Target Value Delivery?

1. Early involvement of the builders in the design phase
2. Alignment of commercial incentives of the project delivery team (owner, contractor, architects, etc.). There needs to be an incentive for cost savings.
3. Continuous cost estimating throughout the project (BIM & VDC)
4. Breaking down the total cost into cross-functional clusters (MEP, core and shell, etc.)
5. Co-location and Big Room Meeting
6. The ability to move money and scope between the team. Reallocate scope, responsibility for scope, and work sequence (process design)
7. A risk and opportunity log, cost tracking, spending to date, and profit tracking
8. A collaborative decision-making process
9. A focus on product, process, and organizational design
10. Using positive iterations and multiple cycles of re-design to eliminate waste

What is Choosing By Advantages?

“Choosing By Advantages (CBA) is not an individual tool or technique. CBA is a decision-making system. It is also a decision making process, not just a step in the process. The CBA system includes definitions, models, and principles, in addition to tools, techniques, and methods of decision-making. The principles are central. The definitions and models help explain the principles, and the methods apply the principles. The CBA system includes methods for virtually all types of money and non-money decisions, from the simplest to the most complex. Sound decision making is the foundation of the CBA system.” Jim Suhr¹⁰

What is the goal of Choosing By Advantages?

The goal of CBA is to improve the quality, speed, and effectiveness of our decisions. CBA can be used by individuals or as a group.

METHODS → DECISIONS → ACTIONS → OUTCOMES

This is the cause and effect model of CBA. The model shows that our outcomes are largely caused by the actions we take. Our actions, of course, are largely caused by the decisions we make. We make the decisions we do based on the methods we use. If we want to improve our outcomes, we need to

¹⁰ For more information on CBA, you can read the blog posts by [Rebecca Snelling](#) on the Lean Construction Blog.

change our actions. In order to do that effectively, we'll want to change the decisions we make, and in order to do that, we'll want to improve our methods.

What are the principles behind Choosing By Advantages?

Sound decision making has four cornerstone principles:

- **The Pivotal Principle** – decision-makers must learn and skillfully use sound methods
- **The Fundamental Rule of Sound Decision-Making** – decisions must be based on the importance of advantages
- **The Anchoring Principle** – decisions must be anchored to relevant facts
- **The Methods Principle** – different types of decisions call for different sound methods of decision-making

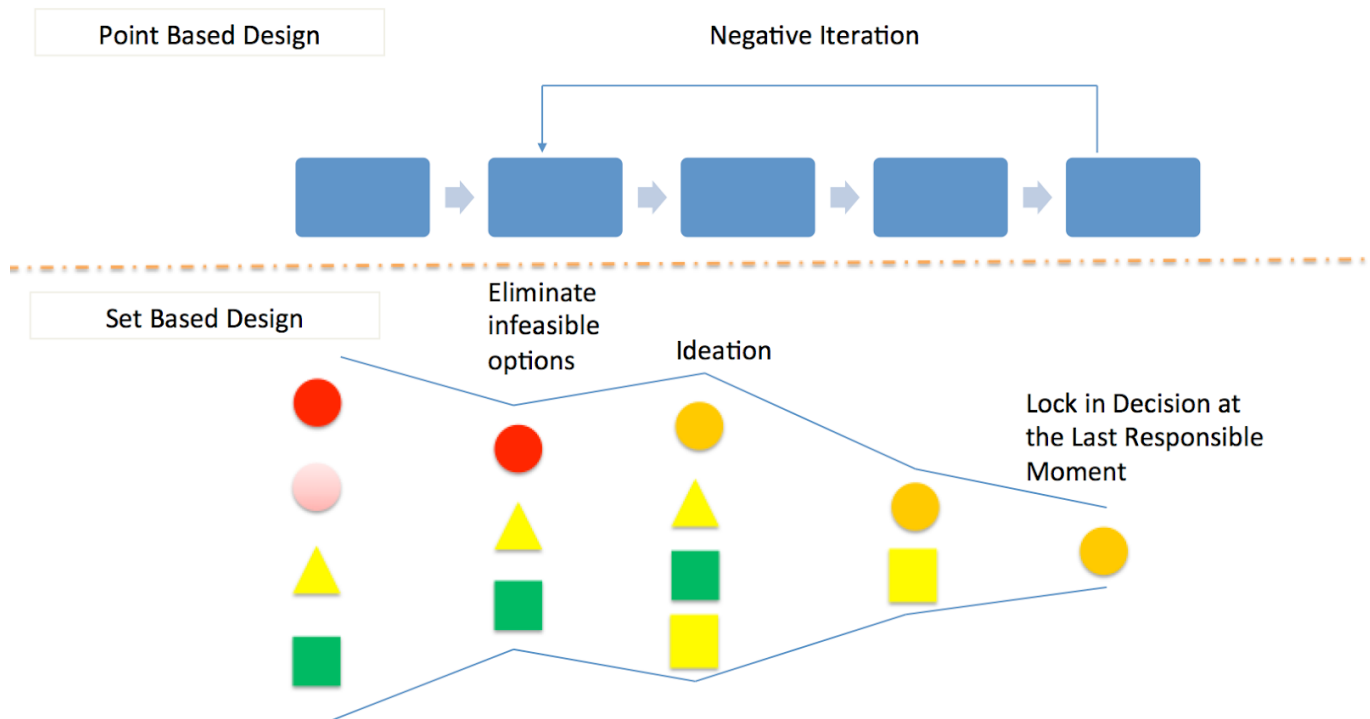
What is Set Based Design?

Set-based Design (SBD) is a design methodology that has many applications in the architecture, engineering, and construction (AEC) industry. It was discovered when researchers studied the engineering and design process at Toyota. Known as the “second Toyota paradox”, the researchers were surprised to find that Toyota considered a broader range of possible decisions, produced more physical models, delayed key decisions longer, and yet they had the fastest and most efficient vehicle development cycle in the industry.

In order to better understand SBD, we need to first consider the traditional design process. Most design professionals (and most people in general) who have not been exposed to SBD follow a linear process. Known as point-based design, this linear process starts with an initial concept and then progresses towards greater and greater detail of the concept. At first, this process seems very efficient since you are only working on one concept from start to finish. In an ideal world, this would be the perfect design process.

Unfortunately, the world isn't linear and is often more complex. With point-based design, if at any point in the design process a new constraint comes up or a new customer requirement is added; you have to start all over again. Sometimes you move all the way back to square 1.

Point Based vs. Set Based Design



Rather than selecting one promising option and working on it further, set-based design looks at a wide range of possible options. The sets of possible solutions are gradually narrowed down until it converges on a final solution. Along the design process, some options are eliminated due to hard constraints, infeasibility, or lack of fitness. Ideation can also be used to generate more options. At the Last Responsible Moment (LRM), the decision needs to be made and one of the options is selected.

By starting with a wide set and gradually eliminating weaker solutions, more options can be evaluated and better solutions can be found. In the event of an unexpected or a new constraint, there is a less likelihood of having to start from scratch since one or more of the options will already meet the new requirements. If necessary, you move back one or two paces. This is much better than starting again from the beginning.

What is the goal of Set Based Design?

The goal of SBD is to improve the quality of design work by reducing the impact of negative iterations and later changes. SBD allows for the team to consider more options, detail them as they go, and lock in decisions at the last responsible moment.

What are the principles behind Set Based Design?

For those that want to apply Set-based design, here are few principles of the process¹¹:

1. Define feasible regions.
2. Explore trade-offs by designing multiple alternatives.
3. Communicate sets of possibilities.
4. Look for intersections of feasible sets.
5. Impose minimum constraint.
6. Narrow sets gradually while increasing detail.
7. Stay within sets once committed.
8. Make decision / selection at the Last Responsible Moment

What are Reliable Promises? ¹²

Routinely, projects are late, over-budget, or fail in some way to satisfy the client. And all this in spite of the training and tools deployed on projects. However, there is a practice for increasing the reliability of completion of project tasks. This practice is the securing of reliable promises.

Most of us are so interested in getting our requests satisfied that we latch on to the first utterances of a would-be performer, thinking we got the promise we were looking for. All too often we receive just the opposite. The individual is trying not to promise, but doing a very bad job even of that.

A promise is made in response to a request. In the absence of a request, a promise can also be made in the form of an offer. Either way, our everyday promises generally take the form:

I (the performer) will deliver "X" for you (the customer) by a specific time in the future.

What is the goal of Reliable Promises?

Projects are performed by people. Projects are performed through a network of commitments between the people involved. In order to increase the reliability of the workflow, you need to have reliable promises with the people doing the work.

What are the principles behind Reliable Promises?

According to well-respected work in linguistics only five coherent replies can be provided to any request.

¹¹ Introduction to Set Based Design - <https://leanconstructionblog.com/introduction-to-set-based-design.html>

¹² Reliable Promise By Hal Macomber - https://leanconstruction.org/media/learning_laboratory/Reliable_Promising/Securing%20Reliable%20Promises%20on%20Projects.%20v%203.11.pdf

1. The promise, “Yes.”
2. The Promise, “No.”
3. The Promise That The Speaker Will Promise Later, i.e., the ubiquitous parental “We’ll see...”
4. The request for more information about what’s been asked—with the (only implied) commitment to promise when the speaker has the information.
5. A counteroffer to the request.

The following five points are the additional characteristics of a reliable promise:

1. The conditions of satisfaction are clear – mutually understood – and agreed to by both performer and customer.
2. The performer (promissor) is assessed as competent to perform or has access to that competence (materials, tools, instructions, etc).
3. The performer has estimated the time to perform the action for completing the promise and has allocated (blocked) that capacity on the schedule (calendar).
4. The performer is sincere in making the promise. In the moment the promise is made, the performer is not having a private, unspoken conversation which contradicts fulfillment.
5. Regardless of what the future holds, the performer will make good on the promise – particularly if the promise cannot be performed, taking responsibility for whatever consequences that may ensue.

What is Takt Planning?¹³

Takt time planning is a work structuring method. ‘Takt time’ is a term used in manufacturing to describe pacing work to match the customer’s demand rate. ‘Work structuring’ is the practice of scheduling out work and is a part of designing a production system. Takt time planning then, is one method for work structuring around a set pace of work. The goal of Takt time planning is to create a reliable plan, with the input of the entire team, which balances workflows for specific phases of work.

Setting the paces of work is an iterative design problem with several related questions.

What work should be paced?

What should the pace be?

How big are the spaces to work through?

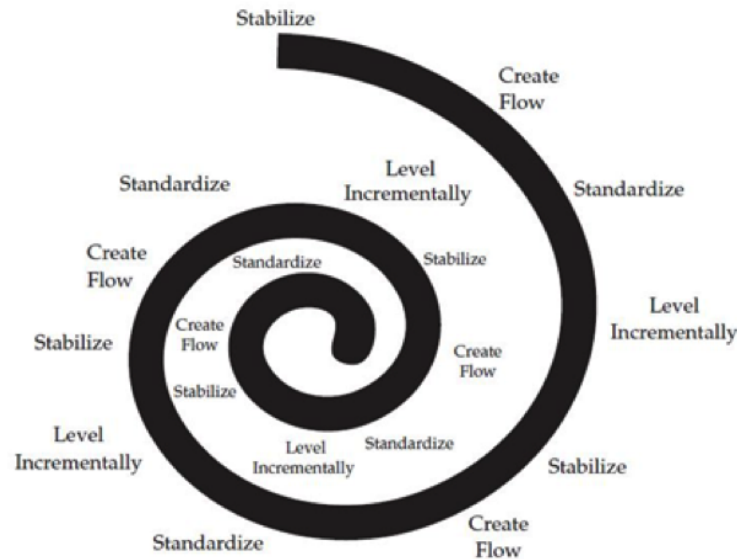
How should different sets of work be paced?

What is the goal of Takt Planning?

Simply put, we need a systematic way of improving production if we are to improve over the long term. When activities are all moving at different paces, then projects naturally become more chaotic. Stable

¹³ Dissertation on Takt Planning by Adam Frandson <https://escholarship.org/uc/item/6dp4n4fz>

flows help reveal bottlenecks, which are the areas to improve upon. This is not a new idea. Liker and Meier describe this as part of the continuous improvement spiral. The spiral shows the relationship for how improvement can occur in an iterative fashion through creating stability, pacing work, and standardizing.



What are the principles behind Takt Planning?

Some principles of Takt Planning include¹⁴:

- A visual location-based schedule showing time and space¹⁵
- A plan that can usually be shown on a single page.
- Scheduled on a rhythm, targeting continuous work in each area, with the intent to plan and level consistent work.
- Visualize the sequence of the trades. Showing work, trade, and logistical flow (when, what, where, who, how)
- Must include three types of flow; workflow, trade flow, & logistical flow.
- Optimize with the appropriate buffers. There must be buffers in the plan. There are three types of buffers that can be used within Takt plans which include material inventory, capacity, and time.
- That stabilizes the pace of work with one-process flow and limiting work in process
- Avoid batching
- Lowering the river to reveal the rocks
- It is a system that creates stability in the field which enables¹⁶
 - Additional team and builder capacity
 - Consistent crew sizes

¹⁴ Takt Planning Blog Posts from the Lean Construction Blog. <https://leanconstructionblog.com/takt-time.html>

¹⁵ What is a Takt Plan <https://leanconstructionblog.com/What-is-a-Takt-plan.html>

¹⁶ Creating a Takt Plan <https://leanconstructionblog.com/Creating-a-Takt-Plan.html>

- Consistent material inventory levels
- The ability to find and remove roadblocks ahead of the work
- A solid quality program

What is SCRUM?

Scrum is a lightweight framework that helps people, teams and organizations generate value through adaptive solutions for complex problems.¹⁷

In a nutshell, Scrum requires a [Scrum Master](#) to foster an environment where:

1. A [Product Owner](#) orders the work for a complex problem into a [Product Backlog](#).
2. The [Scrum Team](#) turns a selection of the work into an [increment](#) of value during a [Sprint](#).
3. The Scrum Team and its stakeholders inspect the results and adjust for the next Sprint.
4. Repeat

Scrum is simple. Try it as is and determine if its philosophy, theory, and structure help to achieve goals and create value. The Scrum framework is purposefully incomplete, only defining the parts required to implement Scrum theory. Scrum is built upon by the collective intelligence of the people using it. Rather than provide people with detailed instructions, the rules of Scrum guide their relationships and interactions.

Various processes, techniques and methods can be employed within the framework. Scrum wraps around existing practices or renders them unnecessary. Scrum makes visible the relative efficacy of current management, environment, and work techniques, so that improvements can be made.

What is the goal of SCRUM?¹⁸

Scrum is an agile process that allows us to focus on delivering the highest business value in the shortest time. It allows us to rapidly and repeatedly inspect actual working software (every two weeks to one month). The business sets the priorities. Teams self-organize to determine the best way to deliver the highest priority features. Every two weeks to a month anyone can see real working software and decide to release it as is or continue to enhance it for another sprint.

What are the principles behind SCRUM?

Scrum is founded on empiricism and lean thinking. Empiricism asserts that knowledge comes from experience and making decisions based on what is observed. Lean thinking reduces waste and focuses on the essentials.

¹⁷ SCRUM definition from https://www.michaelvzdos.com/interactive-scrum-guide#scrum_definition

¹⁸ SCRUM explained in 100 words

<https://www.mountangoatsoftware.com/agile/scrum/resources/a-reusable-scrum-presentation>

Scrum employs an iterative, incremental approach to optimize predictability and to control risk. Scrum engages groups of people who collectively have all the skills and expertise to do the work and share or acquire such skills as needed.

There are four formal events: Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective.

Some of the principles behind SCRUM include:¹⁹

- **Transparency** - the SCRUM framework is designed to maximize transparency of key information
- **Inspection** -sprints can be inspected in order to understand progress and make improvements
- **Adaptation** - SCRUM provides the flexibility for teams to make adjustments as changes are made
- **Commitment, Focus, Openness, Respect, and Courage**
- **Incremental delivery** - work in incremental sprints, small batch size
- **Cross-functional teams** - the members have all the skills necessary to create value each [Sprint](#).
- **Sprint** - Working in [Sprints](#) at a sustainable pace improves the Scrum Team's [focus](#) and consistency. They are fixed length events of one month or less to create consistency.

Lean Methods from Toyota

In addition to the Lean Construction Methods, there are also several methods from the Toyota Production System that have translated well into design and construction. A good exercise to truly understand these methods is to write down what they are, the goal behind each of them, and how these methods connect with the lean principles and philosophies that we went over in the previous chapter.

- 5 Whys
- 5S
- A3 Problem Solving
- PDCA (Plan, Do, Check, Act)
- Poka-Yoke (Error Proofing)
- Single Minute Exchange of Die (SMED)
- Standardized Work
- Value Stream Mapping
- Visual Management

¹⁹ SCRUM guide <https://scrumguides.org/scrum-guide.html#adaptation>

Chapter 5. Lean Tools and Implementation

There are three ways of implementing Lean Construction: Digital, Analog, or Hybrid. Digital applications are software products. They can be single purpose applications such as [Paramount Decisions](#) for Choosing By Advantage or [Bosch RefinemySite](#) for the Last Planner System.

Digital applications can take the form of general purpose applications such as using Mural for Last Planner System or Trello for SCRUM.

Single purpose applications are more straightforward and the developers are using their own interpretation of the Lean methods in the software workflow. General purpose software is more flexible but requires that the user understands the principles and steps in applying the Lean methods. The most general software is a spreadsheet.

Analog implementations are physical implementations using whiteboards, stickies, pen and paper, etc. The analog implementations are the most flexible but they require the users to have the most knowledge about the method.

Why should you use analog?

Analog is the easiest to use as an expert practitioner. You have complete freedom when using stickies, a whiteboard, and paper. You can experiment and make changes very quickly.

The downside is that you do need to really know what you are doing. You can be making mistakes that are hard to realize. If you choose to go analog, be sure to have a good mentor or coach to validate your implementation.

Even if you plan on using digital, you should spend some time learning how to use analog methods. You can simulate any digital workflow in an analog manner. And in doing so, you can better understand the methods and discover shortcomings with digital tools. Analog pull planning incorporates a more social element to making commitments. Many superintendents are more hands-on and so they prefer to start with analog first.

Why should you use digital?

With digital, you are relying on the vendor of the software to understand and implement the software based on the lean methods and principles. There will be different interpretations and no software vendor or product is perfect. Critical features may be missing and workflows that are congruent with the lean methodology may be missing. For example, Procore and Oracle P6 do not have many of the elements that are necessary to apply the Last Planner System.

For larger organizations, I would recommend a digital approach. The main upside of digital is the data. Data, machine learning, and automation; can have a profound impact on your organization's productivity. The larger your organization, the more data you can generate and be able to mine. Many AEC companies are starting to hire data scientists to mine their data. I see that this will be a continuing trend as your data becomes more and more valuable.

For larger sized organizations, a digital workflow can standardize your processes across thousands of employees. It is infeasible to train thousands of employees yourself without a scalable deployment system. This problem has not yet been solved. Even if the digital implementation is lacking the same level of depth as the analog version with a dedicated expert, you will get more value from an imperfect standard across your organization than from a few select perfect implementations. Your lean implementation will never be perfect and it is really a matter of tradeoff.

As a rule of thumb, I always start with analog first for a few months. Once I understand the analog way of working, I will choose a digital tool that best aligns with my interpretation of the lean method as well as the particular context and requirements of my team and project. Without starting from the analog, you will not know the methodology deeply. Don't rely on a software vendor to get the methodology correct. Validate the methodology yourself and then use the vendor which aligns best with your interpretation and team's requirements.

Why should you use a hybrid approach?

Sometimes digital products are good but they do not fully encapsulate your entire workflow. A hybrid approach combines the best of both worlds. The flexibility of analog and the data and consistency of digital.

For the Last Planner System, I usually recommend teams use a hybrid approach. Master Planning and Pulling Planner can be done in an analog manner. These activities occur infrequently enough that you can get together and apply them in an analog manner.

Once you have the data on the board, you can input them into your digital software and use it for weekly workplan, tracking PPC, etc.

Having people physically put stickies on the board and talking about their requirements and sequences is important. Digital solutions for the LPS haven't been able to capture the "magic" of this interaction just yet. If your jobsite does have enough room, a hybrid system can help you apply the best of both worlds. Many software vendors miss important workflows that the hybrid method can fill the gap of. If your jobsite has no space for planning and your team is distributed, a digital workflow can be more effective.

All three implementations are valid and depending upon your situation you can use one or more of them.

Chapter 6. Why Lean Construction Is A Paradigm Shift For The Industry

What is a paradigm and why are paradigms so important?

Thomas Kuhn introduced the concept of paradigms in his seminal book "The Structure of Scientific Revolutions". According to Kuhn, science and advancements are not achieved in an additive manner, rather through **scientific revolutions**. Within a given field, there are **fundamental assumptions that we hold true**. We build our thinking and practices around these assumptions.

A summary of Kuhn's ideas include:

1. **A scientific community cannot practice its trade without some set of beliefs.**
2. *Normal science* "is predicated on the assumption that the scientific community knows what the world is like". **Scientists take great pains to defend that assumption.**
3. Normal science often **suppresses fundamental novelties that do not agree with its paradigm.**
4. *A Scientific Revolution* occurs when **there are enough anomalies that contradict the existing tradition.**
5. New assumptions (paradigms/theories) **require the reconstruction of prior assumptions and the reevaluation of prior facts.**

In the time of Galileo, most people believed that the sun orbited around the Earth. All of the astronomy and mathematical models of the sky were built based on this assumption. As telescopes became more available, there were more and more discrepancies between the observations and the theory that the sun orbited around the Earth. People started to question the paradigm and discovered that a better model of the solar system is that of the Earth and all the planets orbiting around the sun.

The transition from a Geocentric (Earth at the center) to a Heliocentric (Sun at the center) was met with great resistance and violence. The Catholic Church's teachings were rooted in the Geocentric model and they went through great lengths to defend their paradigm.



The history and progress of Lean Construction follows in the same manner as Galileo's discoveries. In fact, most of the greatest discoveries of science such as Einstein's theory of relativity forced us to rethink our understanding of physics. In Einstein's case, it was a transition away from Newtonian mechanics which had been the prevailing way of thinking since the 17th century. Although Newtonian mechanics worked well in most places, it breaks down at certain points when we go deeper within the subatomic level and as we approach the speed of light.

Our mental models affect us because

- They influence what **we can and cannot see**.
- They influence what **we look for and what we ignore**.
- They influence **the questions that we ask and the answers that we are able to find**.

Lean Construction was invented because there were many discrepancies between how we thought projects were supposed to be managed and the processes that gave better results.

Glenn Ballard and Greg Howell found that the key to productivity was the reliability of the weekly work plan (PPC). They worked on this problem to discover practices that helped increase PPC and maintained high PPC throughout the project. By “shielding” workers from the uncertainties of the project through a make ready process, constraint removal, and successive levels of planning, they were able to create stability in the workflow. This led to the invention of the Last Planner System, a system of production planning and control. In developing the Last Planner System, the discrepancies between how people were taught to run projects versus what was optimal became wider and wider.

Lauri Koskela discovered that there was no theory for construction. People made assumptions about how to run a project based on past experiences and heuristics. The dominant thinking at the time was that projects can be broken down into small pieces and each can be managed independently. There was no flow in between the processes, no involvement of the people doing the work, and communication was not an area of interest.

Rather, most projects were run via a combination of critical path method (CPM) schedules that were pushed from the office, a financial model based cost plus profit, and contractual language that binds the parties together. Most projects are delivered late and over budget because people did not have the means to control cost and schedule.

In Lean Construction, we have found that optimizing for value, flow, customer, eliminating waste, improving transparency, and involving the key stakeholders all lead to better project outcomes. Many of the concepts in this book, including the Lean Philosophy, Principles, Methods, and Tools; are not part of traditional project management. Even if you attend a top tier University, are a certified project manager; you most likely never have heard about these concepts before.

The paradigm that you live in becomes your environment. Fish live in water. After long enough, they don't question what water is. They are no longer aware of the concept of water because they have been so immersed in it.

For people with pets, dogs are color blind. Imagine being the only dog that can see color and trying to explain a rainbow to other color blind dogs. The concept of color is literally not part of the vocabulary and imagination for dogs.



Lean Construction concepts, while simple and straightforward to understand; are alien to most people working in the AEC industry. Lean Construction is not a cosmetic enhancement of the construction industry. It is a totally different paradigm and transformative way of doing work.

Many companies start their lean journey assuming that they just need to go through a week of training and adopt a few techniques and then they would be complete with their “lean” efforts. They could fulfill the checkboxes that their clients are asking for and move on with their lives.

In reality, the LC is a different paradigm than traditional construction management. The longer you are in your lean journey, the more you understand the differences in the paradigms. You will realize that many of the software and processes that you are using to manage your organization were not built for the lean paradigm. Many of the processes that you use on a daily basis were designed for the traditional paradigm.

Why Lean Construction? Why Now?

Nothing is as powerful as an idea whose time has come. For most of the construction industry, delivering projects is an adversarial process. They have to fight each other in order to get work done. People end up working long hours and weekends to compensate for all the waste that has happened

on the project. In the field, long hours, overtime, acceleration, and the inability to make personal commitments are the norm in the industry.

These types of behaviors lead to poor performance, mental health issues, and deter people from entering the AEC industry. Waste adds up. We all end up paying for it. In one way or another. It might not be immediately but the impact ends up being absorbed by the people working in the field.

Although we have a housing crisis and our infrastructure needs to be updated, the availability and quality of our labor force keeps shrinking.

With Lean Construction, we are seeking collaboration. We are seeking involvement and better communication. By empowering people to eliminate waste, find new value, and continuously improve; we are giving control back to the people in this industry.

Better planned projects, higher quality products, and greater efficiencies means that people earn more money while being able to keep a healthy personal life. They can keep commitments to their family, attend their kid's soccer game, and be a happier and more productive individual.

If you have read this far, you will notice that Lean Construction allows for a deeper way of thinking about projects. The wider industry does not talk about flow, buffers, capacity, pull, work in progress, continuous improvement, etc. Lean Construction provides an actionable prescription to solve many of the industry's problems. We talk about problems openly rather than sweep them under a rug.

What are some of the things holding back the construction (AEC) industry?

In the construction industry, there are two phenomenons that do not exist anywhere else. They are Hollywood BIM and Fake Lean. Hollywood BIM is when teams apply BIM for the sake of doing so rather than using it for virtual design and construction (VDC). The BIM process is not used to coordinate work or resolve design and construction issues. The output is a pretty (and expensive) animation for the client to see and for their marketing department to use.

On the Lean Construction side, Fake Lean occurs on more projects than Real Lean. Fake Lean is when teams pretend to use Lean processes but they don't actually use it correctly or adopt the principles and philosophy. It's easy to buy Post-It Notes and set up a Big Room. It is a whole nother story to develop the Lean culture, plan collaboratively, find root causes to problems, etc.

At first sight, Hollywood BIM and Fake Lean seem innocuous; however, these things are preventing the AEC industry from adopting truly beneficial practices. Clients and staff who have been exposed to these things now have a distorted and negative view of BIM and Lean. As a result, it is difficult to convince people to apply the real processes after they had a bad experience.

What is wrong with the existing construction paradigm?

We chase cash flow and resources utilization rather than pursue material, processes, and product flow.

Many of the work that is performed out of sequence are done because when the project is behind schedule, the different parties are looking for work packages that can be completed as soon as possible to get cash flow and stay afloat.

The only way to fix this problem is to collaboratively plan the work, align financial incentives, and focus on creating REAL flow in the work. You can use the Last Planner System, Takt Time, Location Based Management, or a combination of these methods to create the flow in material and work which will lead to better project results.

If you focus on optimizing for cash flow, you will create waste, get lower margins at the end of the project. It might sound obvious but project management should be performed by project managers. Not by the accounting department.

Remember that cash flow is not the same as REAL flow.

For a project team to save money and reduce costs, they must be incentivized to reduce cost. Most project contracts are not aligned and incentivized for spending more money.

For a team to reduce waste, they must be paid more to reduce the waste than to carry on with wasteful activities. The enemy of waste is not people's inability to see waste. It is incentives that work against removing that waste.

The best LC practitioners are also the most skeptical of it at first

This may sound counterintuitive but all of the top advocates for lean today had to work within a broken paradigm for years.

They see that what they were doing was not working. Projects were behind schedule and over budget despite the team working 60 to 80 hours per week. Delays were a consistent problem and designs were riddled with errors.

There has to be a better way. This is what they thought and as they wander around looking for a better way, they are introduced to lean construction. At first they couldn't believe this would work. It sounds so simple. It is completely different from what they were taught. How can adding trust, planning collaboratively, and letting go of command and control result in better project outcomes?

They have tried everything else and this is the last thing to try. Mind as well. What is the worst that can happen? Things are already pretty bad as is.

After trying a few concepts from lean construction, the project started getting better. People start collaborating more. There is less yelling and curse words at the weekly meetings. People weren't sending emails with RFIs as a means to cover their butt. With initial success comes further experimentation and learning.

And then one day, it suddenly hits them. Lean is so obvious. This is how the whole industry should operate. They make it their mission to improve their project and tell others about it.

This is a typical journey from a skeptic to an advocate. Tens of thousands of people have taken this journey.

Because this is a recurring part of people's lean journey. I am super super patient with everyone. No matter how skeptical or how against lean someone is, I am always patient. The reason is that the most resistant person will end up being the biggest advocate. It just takes people time to learn, try for themselves, and change. We can't rush it. We just have to be there and provide the resources for people to make up their own mind.

Construction is a trust business

If you are in construction, you are not in the building business; you are in the trust business.

Your project outcomes depend on your ability to build, maintain, and grow trust. The more trust you have, the more productive you are because you don't need to watch over your shoulders and know that work gets done even when you are not physically present.

Nothing stops a project and makes it unbearable like not having trust as a team. People are constantly looking out for themselves, preparing for litigation, and spending time on unnecessary conversations.

If you want to master your craft, you will need to master building trusting, you will need to master building a collaborative culture. These are lessons that many people learn only after working for several years in the industry.

It's not about the power tools, equipment, or concrete. It is about the people that you work with. Optimize for the people and you will optimize the project.

Many of the complexities of construction are rooted in the people

Construction is complex. There is complexity in building a high performing structure that accomplishes the goals of multiple stakeholders. But contrary to what most people think, the complexity is not due to math, science, or engineering. We know how to build complex buildings and most projects do not push the boundaries of science and technology.

The biggest source of complexity comes from the people involved. Oftentimes, a group of strangers come together to design and build together. People's trust in each other needs to be developed, communication and coordination processes need to be formalized, the project's culture needs to be built and maintained.

If you want to increase the reliability of your project delivery, focus on the source of complexity. Focus on the people onsite. The team's culture, morale, and happiness directly affects your project's outcome. This is an area that has been underappreciated and underinvested in construction projects.

Dominant resource is knowledge, ideas, and human capital

The dominant resources in 2022 are not oil, coal, minerals, or natural resources. The dominant resources are knowledge, ideas, human capital, and people.

The quality of your team, their capabilities, is more important than any equipment or machinery that you can purchase. And this is for the construction industry where people like to show off their fancy cranes, trucks, and heavy machinery.

Your focus should be less on physical things and more on human capital. Less on the accumulation of inventory and more on creating flow between processes. If you want to accumulate anything it should be knowledge, new ideas, and better methods for managing your projects.

Respect for people is becoming more important because people are your most important resource. While there are many short term trends with promise to improve the industry, the people side, cultural side, and science of production in construction are often not addressed anywhere else.

Traditional management measures tasks and compliance. Lean measures improvement

Traditional companies measure tasks, activities, and compliance to those activities (how fast you complete a task, how many tasks you complete in a shift, etc.). Lean companies measure improvement (how much waste you remove, how much faster you can make a process, how much higher in quality, etc).

The thing is that if you just measure tasks and compliance you will in the best case scenario get the best results for that particular system. In this way of thinking every day is the same. There is little or no change to the process. Your goal is to produce as much as you can without altering the assembly line.

With lean, you focus on continuous improvement. If you work on continuous improvement every day, within a month you should be many times better than you started. Continuous improvement allows you to change the system, reorganize how work gets done, reconfigure or eliminate unnecessary processes.

Both systems have a standard procedure that an employee should follow. Lean allows for fast iterations and changes to standards. Traditional systems make changes very difficult. Lean empowers front line workers to make improvements. Traditional relies on smart managers to design a system that workers should follow. Workers are not encouraged to think. They are encouraged to follow orders. Deviations to the plan are not encouraged.

The question is “does your organization measure improvements or just compliance?”.

Entrenched players have financial incentives for the status quo

The truth is that most software and processes that we use in the construction industry are built for traditional project management. The only way to move further along is to transition away from them. This is very painful and difficult so many companies stagnate somewhere in the middle. The only way to get the full benefit of Lean Construction is to commit fully to it and be willing to make the changes necessary for it.

Changing your ERP system and accounting system is not fun. If you advance long enough, you will need to find Lean alternatives to your software or develop your own system.

Two paradigms can't coexist

In the long run, it is impossible for two paradigms to coexist within the same team. One will prevail and you will need to make the hard decision of which one to pursue.

In the long run, two paradigms can't coexist within the same company. You will need to make a difficult decision on which direction to take.

By transitioning, you will leave some people behind. Some of your BEST people will not survive the change.

Chapter 7. How To Start Your Lean Journey

Here is my formula for starting:

1. Create flow
2. Make work visible
3. Create plans with doers (the people doing the work)
4. Try to get better every day.

From these foundations, you can add-on more principles and methods.

As a practical guide to learning anything in a new field, I always do the following:

1. **Do a survey of the landscape** - before you get started, you should try to understand the landscape. Attend a few events, speak with some people, and read up on Lean Construction, etc. You will not understand everything, but you should get a good understanding about what LC can and cannot do for you. This should take less than 3 months.
2. **Start small** - whatever you decide to implement, the next step is to start small. This can be a small pilot project or applying a LC method with a small team. You want to go for low-risk opportunities in order to learn and experiment. After 6 to 9 months you should be able to get some positive results. You will learn that not everything that you read will work for your situation and you will need to adapt the Lean principles to your own specific business model.
3. **Find a mentor** - you can only get so far on your own. To get to the next level, you will need to find a mentor. Ideally someone who has success implementing Lean Construction in a similar business.
4. **Go big** - once you have realized that LC is the right path, you should increase your commitment in learning and implementation. If you have been successful, it doesn't make sense to stop in the middle.

There are four levels of learning about Lean Construction.

1. Books, blog posts, podcasts, online content
2. Conferences and in-person training
3. Mentorship
4. Immersion

The right information is very valuable. It can help you do things that you would not have thought of. Give you results that you couldn't dream of. Poor or mistaken information can be a liability.

The first level of learning is the least expensive. You can get started for free and many good books are fairly inexpensive.

The most effective and time-efficient way to learn LC is through mentorship and immersion. A mentor is by definition someone who has already done what you want to do. A mentor can accelerate your learning curve.

If possible, you should seek immersive learning experiences. This includes going to job sites and visiting companies that are actively applying LC methods. When you see the methods applied in-person and can talk to the people doing it everyday, you will learn things that cannot be captured in any book.

In my opinion, the two most effective ways of learning lean are: 1) learn by doing, and 2) learning through mentorship.

You can attend as many conferences, workshops, seminars, and read as many books and articles as you want. Until you actually apply the LC methods yourself, you will not truly understand it. Books, blogs, and conferences are a great way to introduce you and your team to knowledge and ideas that you are unfamiliar with. They can help you get excited about the topic and show basic information, but they will not get you to your final destination. To get results, you need to apply the methods yourself, make mistakes, and learn from them.

Mentorship is by far the most productive and effective method of learning Lean Construction. If you are able to work with someone who has actually accomplished what you are trying to accomplish then you will reach your results much faster than on your own. A good mentor will challenge you, steer you away from a time-consuming dead-end, and will help you FOCUS on what is most important.

Simple step by step approach

If you are just beginning and want a simple step by step approach, you can use the one below. It is not perfect but should work well for most companies.

1. Cleaning and 5S
2. Daily huddles
3. Last Planner System
4. SCRUM
5. 2 second lean
6. Learning and reflection

These 6 practices should get you 80% of the results that you are seeking.

For more advanced practitioners, you should include:

1. Choosing By Advantages
2. Takt Planning
3. Target Value Delivery

Target Value Delivery and Choosing By Advantages are the most powerful lean methods and are also the most difficult to apply. They are advanced methods reserved for those that have completed the first 6 steps. If you apply lean out of order, it will not work. You will create more frustration.

Simple rules for lean implementation

In order to simplify Lean Construction in a manner that everyone can understand, I have devised a few rules. I hang these rules in my office and on the jobsite. If you follow these rules, you will move your company closer to lean. Here is my list of rules.

1. Spend the first 30 minutes of every work day cleaning / doing 5S
2. If you work with a team, do a 15 to 30 minute stand up meeting with them each morning (after your 5S)
3. Spend at least 1 hour learning each day. Learning and improving is part of the job.
4. Focus on delivering QUALITY. If you don't know how to do something, STOP. Ask for help and make sure that you are doing it correctly. Prioritize QUALITY over speed.
5. If you are doing work for someone else to receive, you need to ask them what they want, how they want it, and how they will use your work. If you don't have a customer to deliver to, STOP. You are not actually doing any real work.
6. When you receive work from someone else, INSPECT it for quality first before proceeding. Always double check. Don't assume that it is correct without verification.
7. COMMUNICATE. When working with a team or on something with many steps involved, talk with everyone involved so that you know the game plan. If you don't look at the whole process from beginning to end, you will optimize only for the portion that you see.
8. Go out and SEE. Go to where the work is done to understand how it is done. Work problems need to be solved at the work site, not in the office.
9. Whenever you encounter problems, write them down. Create a log of ALL your problems. Investigate at the root cause and find permanent solutions. Raise problems right away and be open to talking about all problems that you find.
10. Never do work just because you have free time. Only do work if there is a CUSTOMER that requests it. If you have no customers, it is your job to find customers.
11. Never do work out of order. You should have a process map of all the activities that you do on a regular basis.

12. Focus on one thing at a time. No multitasking.

13. Keep as little work in progress (WIP) as possible.

Chapter 8. How To Scale Your Lean Organization

Lean construction does not work. Unless you do the following:

1. ***Start with the intention of improving people's lives.*** Your motivation for applying lean should be for the benefit of your team and respect for people.
2. ***Understand the science of production.*** Without understanding key production concepts such as flow, buffer, Takt, cycle time, etc., you will not be able to make any systematic improvement. Collaboration without understanding the science of production will lead to great team morale but terrible performance. It is not lean unless you have the performance and outcome to back it up.
3. ***Focus on developing your team's capabilities and knowledge.*** You can only go so far on your own. Long term sustainability requires your team to be involved and well trained in LC methods.
4. ***Be willing to put in the effort each and every day to improve.*** Most people apply lean construction and get some results. Then they get complacent and revert back to old habits. For lean to be effective, you have to approach each and every day as a new challenge. This is actually the most difficult because the hard work does not go away. It cannot be outsourced.
5. ***Be willing to rethink your perspective with the world.*** Continuous improvement requires having humility and being able to find our own flaws each and every day. We are always wrong and we are wrong multiple times each day. The only way to improve is to confront these mistakes, actively look for them, and be willing to change on a dime.

Small wins and better working conditions will lead to more people coming over to your side.

Doing the math.

The most important number for creating a sustainable lean culture is understanding your churn rate / retention rate - ***how long do people stay with your company on average.*** For your lean culture to be sustainable, you MUST train more people than your natural churn.

If your company has 5000 employees and the average person stays for 10 years, every year 500 people leave and 500 new people join. If you train less than 500 people per year, you will never be able to scale out your lean program. You will have a leaky bucket where more people leave than you can train.



A good measure is to train 2x to 3x your churn.

With a corporate lean construction deployment, you have to start with basic math. If you underinvest in your program and train too few people, ***you may feel like you are winning the battle but are actually losing the war.*** You can spend years on your lean development and only have pockets of practitioners, not a company wide adoption that you'd hope for.



Upper management will be dissatisfied with the outcomes and may even decide to kill the program. I have seen this happen with several lean implementations that were successful but understaffed.

Using this 5000 person company example, if you train less than 500 people per year, you will never have a sustainable lean culture. If you train 1000 people per year (2x your churn rate), it will take 10 years to scale your lean implementation. If you train 1500 people per year (3x your churn rate), it will take 5 years to scale your lean implementation.

You will need to adjust the math based on your company size and churn rate. For most organizations, it is very difficult to train more than 3x your churn rate. At this scale, your limitation is qualified internal and external resources and human capital. For smaller organizations with less than 200 employees, you can successfully train your entire company within 2 to 3 years.

Rather than think of budgets, think in terms of investment

A common approach to thinking about scaling out your lean implementation is to create a budget. You might consider budgeting \$100 to \$2000 per employee. For a 1500 people program that would be \$150k to 3M per year.

Rather than think about budgets, I like to think about lean implementation as an investment. Here is why.

Investments have a return. Your lean implementation should be profitable right away. If you can't get at least a 5:1 to 10:1 return on your lean investment you are doing something wrong. In investment terms, this would mean that for every one dollar you put in your lean program, you should be getting back five to 10 dollars of profit at the end of the year. Few investment vehicles can yield such a result. To put this in perspective, most companies are looking for a 10% to 20% return.

When you frame your lean program as a cost, you will scare people. How can you ask for 150k to 3M budget on a new and unproven process? Rather than frame it as a cost, you should frame it as an investment. Companies understand investments. **People approach investments more logically** because they are willing to put in money today if they can get a return in the future. ***A budget limits what you can do. An investment has unlimited potential*** as long as you can get the results and a positive return on your investment.

Another reason for framing your lean implementation as an investment is that it forces you to be more disciplined in your spending. It forces you to develop KPIs early on and track those KPIs. The only way to know what your return on investment is through good data. It might seem like a lot of work at the beginning but having **good data on your lean program will allow it to thrive**. If you don't have good data, your program can be terminated at any time and on a whim. Good data allows you to justify and grow your lean program.

Getting started even if you have no money

Lean doesn't require a lot of capital to get started. Even with no money, you can start implementing lean methods and see a drastic improvement in safety, quality, satisfaction, and efficiency.

Even if you have no budget, start where you are with what you can do. As you make wise investments, you should see a return and be able to use those gains to continue to invest in your lean program. Over time, money should not be the limiting factor for your lean program.

Your people should be the limiting factor. Their skill level, capabilities, and ability to teach others will be the limiting factor.

If you did the math on your churn rate, you might be surprised to see how many people you need to train each year. With such a large group of people, it is impossible to teach them one by one or in small classes. You will need to rely on technology, YouTube videos and other scaleable teaching methods.

Finding reliable and high quality teaching materials becomes more important. You won't have time to develop all the materials yourself and you do not want people to learn lean incorrectly from the wrong sources. This is where free or low cost materials such as the Lean Construction Blog are so important.

As you get more results from your lean implementation, you should also increase your investment in it. I have seen companies that expect their lean group to deliver outstanding improvements year after year without supporting them financially. Over time, this can be exploitative and will lead to a backlash.

Gathering allies

For a sustainable lean implementation, you need a few different people in place: 1) Lean Leader, 2) Lean Champion, and 3) Lean Advocate.

What is a Lean Construction Leader?

A Lean Leader is someone that elevates the people around him or her. They set a higher standard and help others achieve that standard. They coach others and genuinely want others to succeed. They focus more on people development and not just on the Lean tools.

What should a Lean Construction leader do?

Teach, mentor, ask hard questions.

What is a Lean Champion and what should they do?

A lean champion helps teams apply lean principles. They are the primary educators and internal consultants.

A lean champion is someone that: 1) teach others about lean principles and methods available that can improve the way they manage projects, 2) mentor their team in understanding waste, inefficiencies, and how to solve problems at their root cause, 3) apply these methodologies on their own projects, and 4) advocate for Lean Construction within the organization and within the wider industry.

Remember that the goal of a lean champion is to help people improve their work processes and life. A lean implementation that requires a push effort by the lean champion will lead to the team depending on you to improve. As with raising children, you want your students to think for themselves, make their own mistakes, and eventually be able to succeed on their own. ***The key to sustainability is to develop lean thinkers.***

What is a Lean Construction advocate and why are they so important?

A lean advocate is someone on the project that advocates and practices what you teach. A lean leader might coach 20 champions. The champions might coach 5 to 10 projects each. As a lean leader or a lean champion, you can't be present at every project, at every meeting, etc. You need to develop the lean advocates who will carry on with the culture and practice when you are not around.

A lean advocate can be the superintendent that gets lean and is passionate about it. They can be the new hire that thinks lean construction is the way to go. They haven't been around long enough to know a different method of working.

Teaching lean construction

After teaching 20 people about Lean Construction, I have 20 different ways of teaching the content. With LC, the hardest thing is not understanding it yourself. The hardest thing is getting your team to understand it, buy into it, and apply it consistently.

One teaching style does not fit all. You will need to try different approaches depending upon the person. You need to be willing to make mistakes and try a few things that do not work. Only through experience can you get better at teaching others and know which approach will give results and which ones sound good but do not work.

The problem is that most people are actually Lean Lecturers rather than Lean Leaders. A Lean Lecturer understands the Lean Construction methods and principles; however, they view their job as mainly teaching and disseminating knowledge.

A Leader is someone that empowers and uplifts others. Most Lean Leaders start off as Lean Lecturers and only when they realize that their approach isn't working do they seek a different path through Leadership.

If you are an aspiring Lean Leader, ask your the following question:

1. To what extent am I lecturing versus leading?
2. How can I change my approach for it to be more effective?
3. How can I better serve my team and make them more effective?
4. How do I make my Lean Construction program more engaging and self-sustaining?

Deploying training

Here are my simple tips for making training and deployment better in your company.

- 1. Use high quality materials as a basis.** You don't need to create your training materials from scratch. Start with the blog, webinars, and conference materials from the [Lean Construction Blog](#) and add in your own ideas to it. This will make creating training much easier.
- 2. Try to keep the first few sessions short. 20 to 40 minutes max.** After the first few months, you can bring your training to 1 hour. Do not exceed the hour mark since people's attention and ability to absorb information diminishes rapidly.
- 3. Bring good food.** Most people do not look forward to training. You can change this by providing good food for the sessions. No one has ever complained that the food was too good. Food also helps build culture. Don't be cheap and invest in good quality food that everyone can enjoy.
- 4. Don't aim for perfection right away.** Start somewhere and try to get better each time. No training program can be perfect on the first attempt. It is better to start somewhere than to wait until the conditions are perfect. They never are.
- 5. Remember that you are not only there to share knowledge.** 50% is about sharing knowledge and 50% is about convincing your team to try something new.
- 6. Make training a regular part of your company's culture.** Every week, devote 1 hour to training and sharing best practices. This helps bring people away from the stress of managing their own projects and helps bring the team together. Remember that the only way to get long term results is through consistency.

7. Make training day fun. If you do it right, the training days should be the days that your team looks forward to the most. Not only will they have good food, be able to interact with their colleagues, but they will also get new ideas to improve their project.

I hope you use these tips to improve your own lean construction training. Successful lean construction deployment cannot happen without training. It is up to the lean champion of each company to create a sustainable and engaging training program.

Sustaining your lean culture

Companies that have been able to sustain their lean construction practice approach two things differently than the rest of the industry: 1) problem-solving, and 2) learning.

Continuous improvement requires constant awareness of problems and countermeasures to make things better. There are two ways of thinking about and raising problems.

The first is to sweep problems under a rug and not deal with them unless they are big enough or "worth" the time to investigate. If the problems are too small or seem insignificant, they will be passed over for more urgent revenue generating activities. The second is to raise all problems right away. Early and often. Talk about all problems that we see and find root causes for them, no matter how small or insignificant they seem. Most companies operate somewhere between the first and second philosophy.

It might sound counterintuitive but the second approach will yield more efficient results and higher quality products and services. How many times have you witnessed a problem that seems "one-off" but keeps happening over and over again in different places. If you solved the problem at the root cause in the first place, this "one-off" problem will not occur again.

Most companies invest in training for their staff on an annual or quarterly basis. The truth is that training needs to occur every single day. Every breakdown and problem that occurs is an opportunity for learning.

Oftentimes, we focus so much of our time on fixing the problem in front of us so that the work can proceed. We do not spend enough time investigating and learning from those problems. This is a big waste because we are not getting value from our mistakes. We need to make mistakes multiple times before we learn from them.

For most organizations, lessons learned are not recorded or shared across projects. All lessons learned come with a high price that we had already paid. By not sharing the lessons learned, we are throwing away one of your most valuable assets. Non physical assets such as lessons learned (and data in general) are as valuable or more valuable than the physical assets (e.g., equipment, machinery, tools).

Freedom to experiment and fail

I have never seen any organization which has a long term and sustained history of innovation without embracing failure. The tolerance and forgiveness of failure is a required ingredient for continuous improvement and innovation.

You can't ask your team for innovation without giving them the ability to try new things, failing at some of them, and succeeding at a few big wins.

Change is hard

Learning is EASY. Applying what you learned is HARDER. Changing for the long-term based on what you learned is EVEN HARDER.

If you want REAL results you should not stop at just learning and acquiring knowledge. Application and change are much more difficult. They are required to get the full benefits from your learning.

No reflection equals no improvement. If you are not improving every day, you are not properly applying lean construction. If you do not allocate time for reflection, you will not have any improvements.

Construction is an information business, not a physical one.

Contrary to what most people think, construction is not a purely physical field. It is an intellectual field where the common medium is information. We work every day to transform the needs, desires, and wants of our customers (aka society) into tangible solutions (aka structures and infrastructure).

Clients pay you because of the knowledge, expertise, and information that you have to contribute and for the value that you can generate from it.

If construction was purely about physical products, your client should be able to go to Home Depot and purchase what they need for the lowest cost possible. The reason why they don't do this is because of the value-add that you provide that cannot be purchased in bulk at the hardware store.

As an informational business; knowledge, expertise, and training becomes much more important. The main work in construction is understanding latent user needs, problem-solving, and decision-making.

Thinking and improving holistically

The three main areas of improvement are in:

1. Health
2. Wealth
3. Relationships

What can we do to promote better health, more profitable enterprises, and better relationships?

If we focus on just the financial benefits of lean, are we ignoring the other two important pillars? When was the last time we talked about healthy habits, better personal relationships, and psychological safety? If a person is healthier and happier, wouldn't they also be more productive? If we are optimizing for the whole, shouldn't we optimize for all three?

Although Lean Construction can provide great financial benefits, you should not stop at just the financials. Your team's health and relationships are just as important. It is important to look at a broader and more holistic perspective.

Construction is not about big equipment, nice tools, or fancy software. Construction is fundamentally about people. It is about creating value for customers and working with other professionals to deliver the project that is within budget, schedule, and with the intended value for the end user.

This is why if you want to improve your construction project, you need to improve the way that you work with other people. This includes: communication, problem-solving, coordination, decision-making, negotiation, developing your team's capabilities, and learning.

Chapter 9. Common Misconceptions of Lean Construction

There are many misconceptions about Lean Construction which I would like to share with you.

Misconception #1: Lean Construction is basically Lean manufacturing applied to the AEC industry.

This is incorrect. Lean Construction as a field developed independently from Lean manufacturing. The founders of Lean Construction (Glenn Ballard, Greg Howell, and Lauri Koskela) started investigating methods for making the construction projects more efficient in the early 1990s. They started the field by developing a theory of production for the construction industry.

Unlike manufacturing where the production system is long-lasting, a construction project is by definition temporary. As a result, Lean Construction has its own methods and solutions for problems unique to the AEC industry. Although we do borrow some of the tried and true methods from Toyota such as VSM, 5 Whys, etc., these are not the entirety of Lean Construction. The methods that are unique to Lean Construction include the [Last Planner® System of Production Control](#), [Target Value Delivery](#), [Choosing By Advantages](#), and [Location-based Planning](#).

Misconception #2: Lean Construction is about being more efficient.

There are many mistakes that people make. The most common and worst mistake is believing that Lean Construction is only about making things more EFFICIENCY. The goal of Lean Construction is to deliver greater VALUE to all project stakeholders (owners, end user, architects, GC, trades, etc.). Value is contextual and depends on the situation, stakeholders, etc.

The Lean methods, philosophy, and principles that we apply are geared towards increasing VALUE generation. In some cases, the value is clear and increasing production efficiency is the best way to deliver the intended VALUE. Although most people spend their time working on EFFICIENCY, it is a means to delivering VALUE, not the end goal. There is nothing more wasteful than being efficient at something that does not matter. When you start your project, you need to think about the customer and their value. Only once value is understood and well-defined you can work on efficiency.

To become more efficient, don't focus on SPEED. Focus on QUALITY. With QUALITY in place, SPEED will come naturally. When you focus on SPEED and neglect QUALITY, you will create more rework, pile up more work in progress (WIP), do work out of order, and create more waste.

At the end of the day, you will have to deliver QUALITY. The question is whether your processes are designed to deliver it in the first place or require additional efforts later on to fix issues to meet that QUALITY standard. By the end of the project, you will need QUALITY. Do you prioritize it first or last?

"First do it right then do it faster."

Misconception #3: FOCUS on FLOW or reducing WASTE rather than VALUE

Lean is about creating and delivering VALUE. FLOW is a means of ensuring that the VALUE delivery system aka the production system is efficient. FLOW in of itself without prioritizing VALUE will lead to super efficient production. However, you will not be producing what the customer wants or needs.

In the developed world, most things are in abundance. High quality and valuable things are scarce. When customers have lots of choice, VALUE is what makes your offer stand out from the crowd.

Another misconception about Lean is that it is about eliminating or reducing waste. While this is true to some extent, the key driver is still VALUE. The reason why we are eliminating waste is NOT just to remove waste. The reason we do this is to separate VALUE from WASTE.

Lean forces us to ask hard questions. What is VALUE? What does the CUSTOMER want? What does the customer NEED but cannot articulate?

I have seen several organizations that have implemented the 5S process and after a few months when everything LOOKS clean and efficient, they stagnate. The reason why they stagnate is that they were only focused on finding the 8 wastes and eliminating / reducing them. They did not go deep enough to uncover VALUE. They did not ask the right questions and started a discussion around VALUE.

The key idea is that once you have eliminated the visible waste, you really need to FOCUS on value. You can't implement Lean without focusing on value.

If you talk about VALUE, your lean journey will be completely different than if you just talk about WASTE.

Misconception #4: It takes many years of applying Lean Construction to get results.

This is FALSE. If you know what you are doing, you should be able to get results within the same day or same week. The only way to measure the effectiveness of your Lean implementation is to measure your PROGRESS. If you are not making PROGRESS then you are not doing it right.

Misconception #5: You can learn everything about Lean Construction in a few weeks or months.

Lean is a multi-year journey where there is no end. As you progress in your journey, you see more of the landscape, your team is generally more productive, and you realize how much more there is to learn. A Lean practitioner is by definition a continuous learner. There is always more to learn and more ways to do things better.

Misconception #6: Knowing the concepts and the terminology is enough.

Lean only works if you actively apply it. Think about eating healthy and exercising. Just because you know what to do and have the right knowledge; if you do not apply what you know, you will not get any results. If you want to gauge someone's Lean understanding, don't ask them what they know. Ask them

what they have done. Only through real-world experience can you truly get the benefits of and know how to use Lean.

Misconception #7: A Lean Construction expert should know everything about the field.

Lean Construction as a field is very wide. It is impossible for a single person to know everything. Most Lean experts specialize in a few areas such as Last Planner, Pull Planning, Takt-Time, Choosing By Advantages, Target Value Delivery, Lean in Design, etc. There are a handful of people that know the extended landscape and how to apply the full system. They are the exception and not the norm.

Doesn't standardization work hurt creativity?

No it does not. Standards are designed to streamline work, remove inefficiencies, and encourage learning.

When you go camping, you don't have any of the convenience and standards of modern life. Everything that you want to do takes longer, is harder, and requires more time and thinking to achieve. Standards are everywhere in the modern world and allow you to get value quickly with minimal effort.

Imagine entering a well run conference room where your computer just works. You don't have to look around for wires and log in to the WiFi. This can only happen because of standards.

If you don't want standards you will have to embrace the struggle and difficulties. Without standards, everything will seem one off and there are no opportunities for learning and improving. Only with good standardized work can you put your energy into optimizing the little things that count and making things a lot better over time.

When I introduce Lean Construction to a new team, someone always asks me this question. "You're going to make us do more work right?"

The answer is NO. We are going to do BETTER work in the same amount of time that you have used the past. We are not asking for anyone to work extra hours or do overtime. We are asking people to think more critically about their work, create flow in production processes, look for ways to reduce and eliminate waste, be open to try out new ideas, and improve every day.

Lean is about doing BETTER and higher QUALITY work. It is not about doing more work or asking people to spend more time working. It is about improving the work processes so that we can be more efficient, make more money while spending less resources.

Chapter 10. Common Pitfalls To Avoid

Some reasons why people fail in their lean implementation

1. They focus too much on the tools
2. Pushing Lean on people rather than pulling
3. Copying without fully understanding
4. Believing that lean application is binary
5. Try to apply all Lean methods at once
6. Implement in the field and ignore the office and vice versa
7. Focus on reducing cost rather than increase value
8. Too optimistic about the timeline to implement lean
9. Stopping halfway through
10. Vastly underestimate the importance of culture
11. Teaching lean in the same way that you have learned it
12. Implementing Lean with only a focus on ROI

1. They focus too much on the tools

Lean is more than just the tools. It involves understanding the philosophy, the principles, and the tools. Unfortunately, most people focus on the wrong thing. They focus too much on the tools and not enough on what problems the tools are meant to solve or the principles behind the tools. The goal of this book is to help you avoid this problem. You should understand widely the Lean principles, tools, and methods available to you. But never fall into the trap of saying that you are a practitioner of JUST the Last Planner System, Takt, SCRUM, CBA, etc. If you do so, you are missing out of the larger and richer pool of knowledge that you can use.

2. Pushing Lean on people rather than pulling

The hardest part of applying Lean Construction in your company is not figuring out how to teach people. This is the second hardest part.

The hardest part is getting people to WANT to learn and improve. If you cannot get your team to want to learn, teaching them is a waste of time.

The truth is that no one wants to change. It's easy to tell people to change but when we have to change ourselves it is much harder. To apply Lean in your project or organization, you should focus on making PROGRESS rather than CHANGE.

People naturally want PROGRESS and are drawn to it. They want to progress in their careers, get recognition for the work that they do, and have more opportunities to contribute. When applying Lean, if you ask people to change you will have a hard time. If you ask people how they can use their creativity

to make things better, more efficient; you will find more supporters for your cause. Here are some questions that I ask my team:

1. What is our mission/objective with this project?
2. What are some of the strengths and unique capabilities of our team?
3. How can we use our unique talents, experiences, and expertise to make this project/organization better?
4. How can we measure and ensure that we are making PROGRESS?

When applying Lean, change is inevitable. There can be no progress without changing the way that we do work. The mistake that many people make is to lead with CHANGE rather than PROGRESS.

3. Copying without fully understanding

If you copy a process that you see from another lean practitioner without taking the time to understand the underlying problem that it solves, you will make life harder for your team. When this happens you will generate frustration and lose momentum in your lean implementation.

Lean is subtle and everything about it depends on the context. Advanced practitioners understand the context and problem that needs to be solved. They use lean methods to solve them. They don't push methods and processes onto people. That would be wasteful.

4. Believing that lean application is binary

Lean Construction is not binary. It is not whether you are doing lean or you are not doing it. Lean practice and implementation exists on a continuum. The real question you should be asking is "How well are we implementing LC and living the lean philosophy? How much better can we get?".

Again, this is a BIG mistake that beginners make about LC. They think that LC is just a series of checkboxes, a todo list. If they check all the boxes, they can say that they are Lean, are done, and can move on.

The truth is that Lean is a journey. Yes, it is an actual, literal journey that never ends. The longer you do it, the better you get. The longer you do it, the more difficult it takes to progress further.

Most people give up too quickly and don't have the endurance to stay in the race. They are content in saying that they have "done it" which is counterproductive because this means that they cannot improve further.

I would rather be weak and get stronger over time than be strong and stagnant.

5. Try to apply all Lean methods at once

The best way to fail in your lean implementation is to do everything at once. You will stretch yourself and your team so thin that negative progress gets made. While Lean methods are effective, it takes time to implement them properly. Don't start with too many projects at once. Take on what you can handle and let the results speak for themselves.

There are many lean methods and it takes decades in order to master them all. You will not be able to apply all of them at once. Most people start with the last planner system, 2 second lean, 5S, or SCRUM and then proceed from there. It's better to focus on fewer methods and get results than to try everything at once and wear out your team.

6. Implement in the field and ignore the office and vice versa

I have seen companies that implement lean in the office and ignore the field. I have also seen companies that implement lean in the field and ignore the office. These are two sides of the same coin.

You cannot implement lean in one side of your business. When your team sees that others within the company are not implementing it, they will become demotivated and there will be tension within your company. It's best to be consistent across the whole organization. It is better to implement fewer lean methods but involve the larger organization than to just focus on a small group.

The main reasoning behind this logic is the concept of paradigms that we spoke about earlier. Lean is a completely different paradigm than the industry. The longer you apply lean the greater the understanding of the misalignment of the two paradigms becomes. If you implement lean in only one part of the organization, tension and conflict will arise from the lean and non lean side. Rather than create tension and conflict, it is better to transition the whole organization at the same time.

7. Focus on reducing cost rather than increase value and quality

With cost reduction there is a finite limit to it. With value creation, there is no ceiling.

The primary reason for going Lean is not and should not be to reduce cost. The reduction of cost is an outcome of the Lean processes that you implement and not the main driver of it. The primary driver should be to increase VALUE and QUALITY. Lean is not about cutting costs. It has always been about earning more. It is about creating MORE value and MORE revenue with FEWER resources.

By increasing QUALITY and VALUE, you will increase revenue, reduce re-work, and reduce the time it takes to do the same work. As a result, you will see a reduction in your overall cost. This is why most Lean practitioners focus mainly on QUALITY and VALUE.

When I say QUALITY, I am also including SAFETY into it. Most people see QUALITY from the perspective of the end product. I see QUALITY from both the perspective of the end product and the PEOPLE working to put the product together. QUALITY includes having a product that fits the needs of the end user while causing no harm to the workforce that assembles it together.

8. Too optimistic about the timeline to implement lean

People who start their lean journey are too optimistic about the timeline. The main reason is that they have never been on a transformational journey before so they have nothing to compare it to. It takes decades for companies to adopt lean and most that have been on the journey for decades have merely just started.

Understanding LC yourself is just the first step. Getting your team to buy-in, building the culture, and overcoming resistance is an every day challenge. The longer you are on the lean journey, the more you realize how far behind you and company is from the ideal state. Even with a fully committed and a fully funded lean program, it would take you 5 to 10 years to complete the first transformation. There will be more and different challenges the longer and further you get.

9. Stopping halfway through

Most people that apply Lean only go 10-20%. You should not stop when you get results from your Lean implementation. This is just the beginning. Unfortunately, most people apply Lean for 6 months to a year. They get some tangible results right away but stop going further. As a result, they have some results but their implementation stagnates and they are not able to realize their full potential.

Some people stop their lean implementation when they are able to create standards and stability. Creating standards and stability is NOT the goal of your lean implementation. It is a means to achieving the ACTUAL goal of creating and sustaining continuous improvement.

Continuous improvement cannot occur without stability and standards. But what people do wrong is that they chase standards and stability and then REMAIN the same.

If you are improving, ALL your processes and procedures will break. It is just a matter of time and this is natural. Things should BREAK if you are improving. If they are not breaking, you aren't moving fast enough or far enough. The key is to break them in strategic ways so that there is enough controlled chaos.

The goal of lean is continuous improvement. Standards are nice and necessary. But don't rest on your laurels. Some people think that they are lean because they have standardized processes. Remember that standardized processes can include a lot of waste. Lean only happens when you are in motion. If you are practicing lean, you NEED to improve and get better.

10. Vastly underestimate the importance of culture

People vastly underestimate the cultural component of lean. Culture is the most important and the most difficult thing to manage and cultivate.

Since projects are delivered by people and not robots. The promises that they make to each other and their ability to keep those promises affect the reliability of the work on the job site. If you want to improve project performance, focus on the people. Focus on helping them make and keep reliable promises.

Cultural topics such as trust, psychological safety, team health assessments are an important part of measuring your lean implementation. Culture is an important part of your lean implementation that cannot be overlooked.

11. Teaching lean in the same way that you have learned it

The most common mistake is teaching LC in the same way that you learned it. As a Lean champion, you are a rare breed. You are curious, you seek out knowledge, you enjoy figuring things out, and you are willing to read books. Unfortunately, not everyone in your organization is like you. In fact, a very small minority of people within your company thinks and learns like you.

It is a mistake to teach them LC in the same way that you learned it. Most people learn by doing. Most people will do things if it makes their lives better regardless of what you call it. This is why when I teach my team LC, I don't use any terminology or formal training for the first couple of months. Only after my team starts asking questions and wants to learn more do I start with the source materials.

There are some people that are interested in learning concepts from the beginning. If you identify them then by all means start with the formal training because they are already READY.

You need to meet them where they are at. Start your lean implementation by making their lives easier first. When they are READY that is when the real training can BEGIN. Once your team and culture is READY, you can and should go all in.

12. Implementing Lean with only a focus on ROI

If you are implementing LC with the sole purpose of a financial return, your lean implementation will fail. Here is why.

There are two approaches to fixing problems. The first approach is to only fix problems that are big enough and worth the effort. Unless there is a positive ROI, there is no need to address the problem. This is a finance first approach.

The second approach is to fix all problems that you see, go to the root cause, and create a permanent solution. If there is a way to improve, you do it. No questions asked. The second approach is the lean approach and although it looks less efficient, it will yield much better results over time. The reason is that when you solve a problem, you will end up discovering more problems and more things that can be improved.

If you look at problems only on the surface and calculate an ROI first, you will be missing all the opportunities below that you cannot see right away. With LC, the ROI is not obvious at first. You don't know the exact return on investment of each improvement. However if you continue to improve each and every day, a positive return will pretty much be guaranteed.

You should measure your ROI retrospectively rather than before undertaking an improvement. Measuring the financial performance of your lean program is important but it should be done AFTER you implement improvements, rather than using the ROI as an analysis to determine which improvements are worth the effort.

Experienced lean practitioners know practices that will yield better results; however, communicating why and how this can happen is very difficult to those without proper lean experience. Many of the things that we value with lean such as respect for people, etc. cannot be easily quantified.

Barriers that get in the way

What stops people from learning and improving?

1. Ego
2. Culture
3. Ignorance

The first barrier is ego. Not everyone wants to admit or is comfortable admitting that they don't know everything. As a professional, people feel that they need to defend their territory. Unless someone is willing to let go of their ego, they cannot improve.

The second barrier is culture. Some organizations and projects do not have a collaborative culture that facilitates learning, improving, and being open to failure. The role of upper management is to create and nurture the right culture and working environment.

The last barrier is ignorance. Not everyone has the knowledge to improve their work. Many people are unaware of Lean Construction and the fact that improving the process is part of their job.

Most of the gains from your LC implementation comes from the long-term cultural change in how your team works together.

The short term benefits of applying a LC method such as the Last Planner System, Takt Time, CBA, 5s, etc, will yield significant gains but they only make up less than 10% of your total gains.

Long-term cultural shifts and continuous improvement makes up 90% of the gains. If your company has been applying LC for several years, have you stopped too early at just the methods and surface level implementation? Have you put in the work to transform the culture and get the full benefits from LC?

The Lean Construction philosophy is not just something that we talk about or do training on. It has to be ingrained in our thinking, actions, and be a part of the way we live our lives. The lean philosophy is not just an idea, it is a way of life.

Chapter 11. What Should Success Look Like

If you are successful in your lean construction application, you will notice that:

- Each successive project becomes more efficient through applied lessons learned and kaizen
- There is proactive rather than reactive problem-solving
- Less fighting and more 'real' collaboration
- Better value delivered for the money
- More satisfied clients - designs that fit stakeholder values
- Better work-life balance for your team and partners
- Continuous improvement and kaizen within projects and between projects
- Better questions being asked

What to look for on a Lean jobsite

Here are a few things that I look for in a jobsite.

1. **Evidence of collaboration and trust.** The KPIs of the project are shown, sticky notes with multiple collaborators, desks set up for effective communication, big room, etc.
2. **Transparency of the state of the project.** Even if I am not part of the project, I can clearly see the current state of the schedule, cost, and targets that the team is trying to achieve.
3. **There is Flow of the work on site and a clear production strategy.** The trades are sequenced properly and everyone knows what they are expected to do for the next 6 weeks. Milestones are understood by the team and there is a lookahead / make ready of work before it is supposed to be performed. Material deliveries are planned and balanced to what is needed.
4. **Learning, problem-solving, and growth.** Evidence that the team is talking about mistakes that they have made and are working together to improve. Evidence that the team is getting better and are performing at a higher level.

Some qualities that are important for Lean success are:

- 1) Discipline
- 2) Leadership
- 3) Long-term thinking

Discipline is the most important quality. Just because we know what we 'should' do, we still need to have the discipline to do so in a consistent manner.

Leadership is important because adopting LC requires change that is not easy or comfortable. The organization's leadership must understand Lean and be bought into it.

LC is a long-term investment in your processes and your PEOPLE. You can get some benefits quickly in the short-term but the real results come from long-term thinking, investment, and education.

Making Lean quantifiable

The best way to assess the success of your Lean implementation is to look at the improvements that you and your team have completed in the last 90 days. If there are no improvements or no business impact of your improvements in the last 90 days then you haven't / aren't implementing Lean.

Some people say that Lean is a journey and I agree. It's a journey but you still have to keep on moving otherwise you end up in the middle of nowhere.

Personality and character traits

Signs that your lean implementation will be successful, you have: humility, focus, determination, and curiosity.

Humility is the most important trait. You need to admit that there is a better way of doing things, that you don't know everything, and that there is always room for improvement. Without humility there can be no lean.

A successful implementation requires FOCUS. Intense focus on what is important and ignoring what is not. You need to focus on the customers and understand what brings them value and what does not. Waste can only be eliminated once Value is clear. Knowing the difference between value added activities and waste is a lifelong journey.

You will need determination because not everything you try will work out immediately. Some of your lean implementation will be against how things have been done before and there will be skeptics, resistance, and doubters. You need to understand why you are doing what you are doing and have the courage to stick with it.

Lastly, I have never met a successful Lean practitioner who is not curious. Curious people seek new knowledge, find ideas, and try to better understand the world. Without a good understanding of how the world works, your lean implementation will have limited success.

The most powerful economic force is compound interest. All long-term growth is exponential rather than linear.

The main problem is that few people have the courage, conviction, and vision to pursue something where the initial return is very low or even zero in the beginning. As long as you can maintain a high growth rate, no matter how small the initial base is, the result will be very large over a 10 to 20 year span.

The key is to stay focused, ignore others with shinier things, and keep pressing forward.

Chapter 12. How to Continue Your Lean Journey

"I fear not the man who has practiced 10,000 kicks once, but I fear the man who has practiced one kick 10,000 times." - Bruce Lee

The longer you apply Lean Construction, the less you know.

You will be humbled by how little you know and how complex things really are. You will be able to ask better questions, deeper questions. Which ultimately leads to better overall solutions.

The quality of your work is directly proportional to the quality of the questions that you ask. If you don't wonder about an idea, it is invisible to you. It is there but you cannot see it.

The sign of an expert is not someone that knows everything in a given field. An expert knows the boundaries of knowledge, knows how deeply the rabbit hole can go, and uses this information to help their teams perform better.

How to become an expert

To be an expert in a field you just need to do 4 things:

- 1) *Read the top 100 books within your field*
- 2) *Study at least 100 years of history to get context on how the field developed*
- 3) *Spend at least 10 years experimenting and trying out ideas.* Not everything you read works in the real world. It is not real unless you can apply it yourself.
- 4) *Join a group of like minded individuals which are part of a community which seeks to get better, are open to sharing, and can talk about mistakes.*

It is so simple yet few people are willing to put in the effort to be the best. Of all the 4, the last one is the most important. Every field grows extremely quickly and innovation happens on a daily basis. It is important to be part of the right community to keep up to date and get better.

How advanced is your lean implementation?

The simplest way to know how advanced you are in your lean implementations is to think in terms of what/how/why/when.

1. What (beginner level)
2. How (intermediate)
3. Why (advance)
4. When (expert)

The first level of understanding is knowing WHAT the lean concepts are. This is the process of becoming aware. The second level is understanding HOW to apply them and the step-by-step mechanics. Understanding the fundamental principles of WHY the lean methods work will lead to deeper understanding and better results.

The last level is knowing WHEN to use the lean methods. A construction project is a temporary endeavor and so timing is very important. If you can understand WHEN to use each method, the context within which they are applicable, and the level of detail needed in each implementation; you will take your lean processes to a whole new level.

Oftentimes people make the mistake of just knowing the “what” and “how” of lean construction. They do not see the importance of the “why” and “when”. I have seen several instances where using lean methods at the wrong time and in the wrong context led to inefficiencies and waste.

I am beyond the basics, how do I get better?

1. Ask better questions
2. Listen carefully and gather appropriate data
3. Make informed decisions based on informed data
4. Implement your new idea and measure its effectiveness
5. Reflect on the results and do more iterative cycles starting at asking more questions

Everything starts with the questions that you ask. The quality and depth of your questions will ultimately determine the quality of your implementation. Learning how to ask better questions is difficult and I still haven't cracked the code on this yet. My suggestion for the time being is to deeply understand Lean principles. Whenever you see a deviation of it from current practice, there is an opportunity to ask why it is different and how you can improve based on this difference.

Once you have your questions, you will need to listen very carefully to the people doing the work. They will have more knowledge and more facts than you can ever imagine. Clever people have great imagination. For this step, do not rely on your imagination. It is 10x better to gather real facts from real people.

The next step is to make an informed decision based on your data. This decision will determine what to test and try out. You will need to implement your new idea before trying to scale it across your company.

It is important that you gather data on your implementation, do a reflection, and then start all over again with asking new and better questions.

Lean implementation is a feedback loop. It is a cycle of very simple steps but those steps will lead to powerful results. It all starts with asking better questions.

Look around the world

Continuous improvement cannot occur if you are not willing to LOOK around the world and learn what the best practices are.

It also cannot occur without your own HUMILITY to acknowledge that you don't know everything.

It also cannot occur without the COURAGE to experiment, fail, learn, and try to get better.

Do spend time to travel and learn from other projects and other practitioners. They will have some ideas or interpretations that you can use to enhance your own project.

Practice what you preach

You can't say that you know Lean Construction or your company is Lean. You can only say that you practice LC. As soon as you stop practicing, you will stop getting results. No matter how much you know, how much experience you have, or how successful you were in the past.

You can't convince everyone

No matter how good you are, you can't convince everyone. You can only work with people that choose to opt-in and listen. There will always be people that have found success in the traditional paradigm and do not want to adjust to the lean paradigm.

You should focus on helping the people that want your help. There is more than enough work to do already. Trying to convince people who aren't convinced is not worth the time.

Understanding the true nature of work

The most profound thing that I have learned in my Lean journey is understanding the true nature of work and what constitutes "real work". If you have been practicing Lean for a while, whether it is [#LeanConstruction](#), [#LeanManufacturing](#), [#LeanHealthcare](#), or [#LeanStartup](#); one of the most important concepts is the "customer".

In Lean, all work that we perform is for the benefit of a customer or customers. The customer(s) can be internal or external. The customer(s) can be a paying customer or a non-paying customer. Regardless, if there is no customer then by definition there is no work being performed.

You can go through the motions and work long hours. All of that would be wasted if you do not understand your customer and do not produce something of value for that customer. Some of the questions that I ask to gain clarity include:

- 1) Who is our customer?
- 2) What does the customer want?
- 3) How do we know that is what the customer wants? (What data do we have? What is known and what is a hypothesis?)
- 4) What are we doing to satisfy our customers?
- 5) Why are we doing it that way?
- 6) Can we satisfy the customer while doing it better, faster, higher quality, higher reliability, safer, etc?

Work is not about spending time doing something just for the money. It is an art of living. An art of creating. The goal is not to seek comfort. It is to make progress and a meaningful contribution. It is about being useful to oneself and to others.

Your Lean Journey is not about learning and applying methods

Your lean construction journey is not about learning and applying as many lean methods as possible. It is really about becoming the person that seeks improvement every day. The person that is willing to learn from others. That is humble about what you know and don't know. That is willing to try new things, experiment, fail, and learn from those experiments.

If you are not trying new things every day, you are not improving. If you are improving every day, you will also:

- Change your character trait.
- Being more calm.
- Being more reflective.
- Letting go of waste.
- Seeking value.
- Understanding the true nature and purpose of work.
- Having the means to improve the world around you

Your outcome is the summation of who you are and everything that you do.

What people falsely believe is that they can get better results without changing who they are and how they operate.

All improvement requires change and all change is difficult. Change is personal and starts first with yourself.

Personal growth is required for continuous improvement. In order to grow personally, you need to expose yourself to discomfort, be willing to try new things, be willing to fail, and learn from your failures and successes. Over enough iterations and cycles of thought, the thing that will change is yourself.

Your lean journey starts with an external journey where you are trying to improve your processes, your team, and your project. Over time, it progresses into an internal journey. Where the thing that you are trying to improve is yourself. Your personality, character trait, and wisdom increases and changes as you progress through your lean journey. The final destination of it all is internal.

Chapter 13. Learning and Reflection

Learning requires unlearning.

The most difficult part of learning is not understanding new concepts. The most difficult part is unlearning previously held beliefs and misconceptions.

Just as your bedroom only has room for one mattress. The only way to bring a new mattress in is to remove the old one. Having two mattresses in one room is both weird and can lead to more problems.

In order to learn and internalize new ideas, you must be willing to admit that you don't know everything. You must admit that you are making mistakes every day. You must want to seek the truth and have the flexibility to change for the better.

Learning from the wrong source is detrimental because you might take in the wrong information. Unlearning wrong information is a lot more difficult than learning the right information the first time around.

The greatest enemy of knowledge is not ignorance. It is the illusion of knowledge.

Knowing is not enough, we must APPLY. Willingness is not enough, we must DO. We really don't know something until we are able to apply it consistently. Only by DOING can we verify and get VALUE from what we know. Knowing or the illusion of knowing without doing is a form of WASTE.

Knowledge without action = waste.

Pain + Reflection = Progress²⁰

The key to happiness is progress + compassion.

Life begins at the end of your comfort zone.

There cannot be any progress without pain. To grow you must endure pain and discomfort. Although pain is undesired, it is necessary for growth. Each time we make a mistake, we have an opportunity to learn from it and get stronger.

The best time to reflect is when we are experiencing the greatest pain because it is when we most strongly feel the consequences of our mistakes. Only through pain and reflection can we make progress and get better at what we do. You will make mistakes every day. It is up to you to turn those mistakes into valuable lessons.

²⁰ Ray Dalio (Principles)

There is no experience without reflection.

Most people think that experience comes with time. It does not.

Time allows you to get better data, to know when you are right and when you are wrong etc. It does not automatically lead to experience because there are some people who keep doing the same thing over and over again without getting better results.

If you are not improving, take some time to reflect. Avoid being too busy to think for yourself. Take the time to reflect so that you can turn what you have seen into valuable experience.

Don't believe everything in this book. Think for yourself. Use your own reasoning, experience, and reflection to validate the claims. I want you to come away with your own conclusions. Based on your own thoughts.

Knowledge is knowing what things are and how they work together. Wisdom is knowing what to ignore. Strategy is knowing what not to do.

Without knowledge there can be no wisdom. Unfortunately most people stop learning when they have acquired the surface level knowledge. True wisdom requires reflection, experimentation, failure, and learning.

Knowing is not enough, we must apply. Willingness is not enough, we must do.

As you progress in your lean journey you will be more productive because you will be able to see and avoid time wasting, non-productive, and dead end traps that most people are unaware of. By knowing what to avoid, what you SHOULD do becomes obvious.

Waste can only be eliminated once VALUE is clear.

Knowing the difference between value added activities and waste is a lifelong journey.

Conclusion

Lean does not occur within just one person or one company. It occurs within an ecosystem. You are not alone in your lean implementation. One company can't fix the entire industry. You need partners and people from different organizations. The best way to promote the practice of Lean Construction and make it sustainable is to view it as a community.

For Lean to really take off in any country or city, you need the following:

- 1) **Owners who are not satisfied with the way that construction projects are delivered.** They seek a better way to deliver more value with less fighting, litigation, and waste.
- 2) **General contractors and trades that want to work collaboratively and want to find a sustainable way to improve their profit margins.**
- 3) **Architects and engineers that want to work collaboratively with the GC and trades and view the trades as equal.**
- 4) **Local universities that support research and education on Lean principles.**
- 5) **Local community of practices (either physical or virtual) where ideas and best practices can be exchanged.**
- 6) **Qualified consultants / service providers**

If you are trying to promote LC in your country, you cannot do it alone. You should not have to do it alone. You need to identify the current state of your ecosystem and involve people who can help strengthen it. Only by looking at the problem holistically and through the lens of an ecosystem can you make a long-lasting impact.

"If you say this is mine, you have less. If you say this is ours, you have more." These are words of wisdom to live by.

This is why the Lean Construction community is so open to sharing their best practices, lessons learned, struggles, and triumphs. While some people hold their practices as trade secrets, others in the community openly share everything they know in order to improve the community, the industry, and themselves.

Why I wrote this book

We now have the knowledge to significantly improve how construction projects are designed and built. Our limitation is no longer knowledge or information. The current limitation is the number of people who are aware that there is a better way to do things.

The construction industry is one of the largest industries on this planet with roughly 10% of the world population working in it. It's a big industry and the problems of low productivity, poor quality, safety, etc. are well known.

It is easy to keep these ideas a secret and help only a few projects at a time while charging a high fee for each project. This strategy would maximize revenue for a few people and help only a few projects.

The problem with the construction industry is a global one. We need millions of people to become aware of the Lean Construction methods and apply them if we want to make a significant impact. By sharing, I believe that more people can learn and use Lean practices on their project. If you found value in this book, please share it with your colleagues and customers. This book is completely FREE.

My goal is not to convince anyone anything. I just merely present data and let people interpret it themselves. For any comments, feedback or criticism, you can email me at:

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