Speaker Profile

- Lean Construction Coach
- 20 years as a subcontractor
- Began Lean journey in 2001
- 1st Lean project 2007
- Coached 100+ project teams in Lean and Last Planner®

Objectives

Participants should understand ...
- the fundamental principles of Lean
- the value of reliable workflow
- how the Lean tools help
  - minimize waste
  - increase value
Desert Survival

Roots of Lean: Assembly Lines
(1901-1913)
Roots of Lean: WWII (1936-1939)

Root of Lean: WWII (1941)
Roots of Lean: The Problem

Boeing’s Challenge

- Rush order for B-17 bombers
- Limited to existing production facilities
- Hired 33,000 unskilled workers:
  - ½ made up of cowboys, fishermen, farmers, lumberjacks
  - ½ Seattle area housewives
Enter Training Within Industry (TWI)

- Production in 1941 – 75 planes/month
- Production in 1944 – 364 planes/month
- **485% increase** (1.6 planes per hour)
- **60% reduction in manhours per plane**
- Cost per plane 1941 - $242,000
- Cost per plane 1944 - $139,000
- **43% reduction in 32 months!**

Lean Construction Background

- Historical focus on productivity
  - Refinery in Venezuela
- Spot improvements produced little or no improvement to project as a whole
- Problem defined as “foreman planning”
- Question arose – How do they plan now?
Lean Construction Background

- Interviewed 475+ superintendents and foremen and asked:
  - *What tasks do you plan to complete by the end of next week?*
  - At the end of the week, they went back and checked on the progress
  - What % of tasks would you guess were actually completed?
  - Actual Result: **54%**

The Opportunity...

<table>
<thead>
<tr>
<th>Manufacturing</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productive</td>
<td>Productive</td>
</tr>
<tr>
<td>Waste</td>
<td>Waste</td>
</tr>
<tr>
<td>88%</td>
<td>43%</td>
</tr>
<tr>
<td><strong>12%</strong></td>
<td><strong>57%</strong></td>
</tr>
</tbody>
</table>

2004 Construction Industry Institute (CII) Study

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So, what is Lean?

- Not an Acronym
- Not LEED, Green, or Sustainability
- Little or No Waste

Lean Burrito

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What Lean is **NOT** about:

- Cost Cutting
- Slashing prices
- Workforce reductions
- Beating up subs & suppliers
- Being Spartan or stingy

Why Lean Construction?

- Projects take too long
- Projects cost too much
- Projects kill & injure too many
- Huge risks to stakeholders
- Performance disappointments
“Suddenly, a heated exchange takes place between the King and the Moat Contractor…”

- The Far Side 1990

---

**2014 Lean Metrics**

*New UHS Temecula Hospital*

**30% schedule savings**

3.5 years vs 5 years

**40% cost savings**

$250MM Market Value

$150MM Actual Cost
2014 Lean Metrics

Subcontractor Manhour Savings

11% Flooring
19% Painter
26% Framing & Drywall
30% Electricians

Future

4
IPD & IFOA

3
Target Value Design (TVD)

2
Last Planner® System

1
Awakening New Possibilities

1-day Intro

Network of Commitments
Dependence & variation

Production System & Work Structuring

Project as a Collective Enterprise

Past
The Road to Mastery

- Unaware
- Awareness
- Understand
- Competence
- Mastery

Toyota Production System

- Long-Term Philosophy
- Process
- People and Partners
- Problem Solving

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Fundamental Principles

- Specify **value**
- Identify the **Value Stream**
- Make work **flow**
- Work at the **pull** of the customer
- **Pursue perfection**

Plan–Do–Check–Adjust (PDCA)

**PLAN**
- Improve the System
- Predict

**DO**
- Take Action, **Try it Out**

**CHECK**
- Reflect/Study the Results

**ADJUST**
Goals of Lean Design & Construction

- Minimize waste
- Achieve reliable workflow
- Maximize value to the customer
- Optimize the whole, not the parts
- Develop a discipline of learning and continuous improvement (PDCA)

Non-Negotiables

- Continuous improvement
- Respect for people
The Key to Becoming Lean...

“...is not any of the individual elements... but what is important is having all of the elements together as a system. It must be practiced every day in a very consistent manner – not in spurts.”

- Fujio Cho, President, Toyota (Kentucky)

Benefits of Lean

• Safer – fewer incidents and injuries
• Faster – finished sooner
• Lower cost – higher productivity
• Less stress on the participants
• Far more satisfied stakeholders
Lean Zone® Production Methodologies

An Exercise in Production System Design

The Airplane Game

Airplane Game Lessons

• Release work from one trade to the next by pull instead of push
• Minimize batch sizes to reduce cycle time
• Make everyone responsible for QC
• Balance the workload between trades
• Encourage and enable performers to collaborate with one another to maintain steady workflow
The Heart of Lean Systems

Eliminating:

• Waste
• Unevenness
• Overburdening

The Seven Original Wastes

1. Overproduction
   Producing more than is needed

2. Waiting
   AGC: Workers waiting for work OR Work waiting for workers

3. Transportation
   Unnecessary movement of materials

4. Over Processing
   Spending more time & expense than customer requires

5. Inventory
   Extra material

6. Motion
   Unnecessary movement by people

7. Defects
   Rework because of mistakes

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Additional Waste #1:

• Underutilizing the creativity of:
  • Project Team members
  • Coworkers

Additional Waste #2:

• Workarounds
• Firefighting
• Making Do
Unevenness

• Unevenness is variation
  • Hurry up and wait
• Variation creates unpredictability, firefighting, and workarounds
• Last Planner® reduces unevenness by structuring predictable workflow

Overburdening

• Overburdening People:
  • Physical wear and tear
  • Unnecessary movement and strain
  • Extreme losses of productivity due to extended overtime
• Overburdening Equipment:
  • Machinery
  • Rigging
Overburdening Equipment

The 3 Types of Waste

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Construction Institute
Value Creation

• If it is not something the customer is willing to pay for, it is Non-Value Added.

• Everything else is waste - and should be eliminated, simplified, or reduced

Value Examples

• Value Added
  • Foundations, windows, HVAC Units

• Non-Value Added – Necessary
  • Loading/unloading materials
  • Approvals
  • Payroll

• Non-Value Added – Waste
  • All of the 9 Wastes
Value Pie

- **Value**: 43%
- **Waste**: 57%
- **Non-Value Added**: 0%

Impact of Variation

- SHOCKWAVE TRAFFIC JAMS RECREATED FOR FIRST TIME
- Footage courtesy of University of Nagoya, Nagoya, Japan

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Last Planner® System

What you do

Learning
Weekly Work Planning
Make Ready Planning
Pull Planning
Milestone Schedule

Did
Will
Can
Should

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Last Planner® System

When you do it

Learning
Weekly Work Planning
Make Ready Planning
Pull Planning
Milestone Schedule

Daily
Weekly
Weekly
As Needed
Pre-Set

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Planning Quotes

“The purpose of any plan is to establish the conceptual basis for action. The plan provides a reasonably accurate forecast of execution. However, it remains a starting point, not the centerpiece of the operation.”

- U.S. Army Field Manual
“In preparing for battle, I have always found that plans are useless, but planning is indispensable.”  – Dwight Eisenhower

**Last Planner® System**

- **Learning**: Daily
- **Weekly Work Planning**: Weekly
- **Make Ready Planning**: Weekly
- **Pull Planning**: As Needed
- **Milestone Schedule**: Pre-Set
Master Planning

- High level view of project with limited detail
- Fewer activities—50 to 100 compared to thousands
- Confirms feasibility of the project
- Highlights long-lead items
- Identifies phases

Last Planner® System

- Milestone Schedule: Pre-Set
- Pull Planning: As Needed
- Make Ready Planning: Weekly
- Weekly Work Planning: Weekly
- Learning: Daily
Pull Planning Process

- Includes all trades involved in delivering a milestone
- Starts with anticipated milestone completion and works backwards
- Fosters conversations around conditions for handoffs
- Results in a phase plan
How We Do It

<table>
<thead>
<tr>
<th>Task</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>Crew</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flooring</th>
<th>L2 Area B</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 days</td>
<td>3</td>
</tr>
</tbody>
</table>

| Paint Complete |

**Task**
- **Flooring**
  - **Floor, Zone B**
  - **4 days**
  - **Need lights & Drywall mud off floors**
  - **Paint complete**

**Duration**
- 3 days

**Trigger**
- **Flooring**
  - 3 days

**Area**
- Area B

**Beginning of phase**
- Rebar
  - Area A
  - 3 days
- Vapor Barrier
  - 1 day
- Embeds
  - Area A
  - 2 days
- Rebar at Perimeter
  - Milestone completion

**SOG**
- Area A
  - Pour
    - 1 day
  - Rebar Inspection
    - 8
  - Inspect
    - 1 day

**Add post-its to wall from right to left**

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Pull Planning Outcome

• Better understanding by all of how project milestones will be completed
• Reduce Uncertainty
• Reduce Variability (Reliable Workflow)
• Eliminate Waste
• Improve milestone delivery
Last Planner® System

- Learning: Daily
- Weekly Work Planning: Weekly
- Make Ready Planning: Weekly
- Pull Planning: As Needed
- Milestone Schedule: Pre-Set

“Pinging the water” for Icebergs

Constraint

Make Ready Planning

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Weekly Planning and Execution Cycle

Plan
- Make-Ready
- Weekly Work Plan

Check
- Daily Production
- Huddles & PPC

Adjust
- Learning from plan failures

Do

6-Week Look-Ahead Schedule
Constraint Log
What, When, Who?

Last Planner® System

Learning
Weekly Work Planning
Make Ready Planning
Pull Planning
Milestone Schedule

Daily
Weekly
Weekly
As Needed
Pre-Set
Weekly Work Planning

The Workflow Loop

1. Request "Will You?"
2. COMMIT "I Promise I WILL"
3. Declare Complete "I'm Done"
4. Declare Satisfaction "Thank you"

CUSTOMER

Provider

Conditions of Satisfaction & Completion Date

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Percent Plan Complete

- PPC means **Percent Plan Complete**
- No partial credit – Either 100% or not
- PPC = \( \frac{\text{# of tasks completed as scheduled}}{\text{# of tasks planned for completion}} \)

It’s not the score that matters…it’s what was learned and what countermeasures were installed to prevent the problem from happening again…
Daily Stand-up Meeting

Last Planner® System

- Learning [Daily]
- Weekly Work Planning [Weekly]
- Make Ready Planning [Weekly]
- Pull Planning [As Needed]
- Milestone Schedule [Pre-Set]

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Construction Institute
Goals of Lean Design & Construction

• Achieve optimal project duration by creating and maintaining reliable workflow
• Produce the appropriate level of quality the first time, eliminating defects and rework
• Eliminate all wastes including accidents and injuries, thereby increasing value to the customer while reducing costs

We strive to reach the goal through ...
• Continuous improvement
• Respect for people
Domains of Project Delivery

Traditional Domains of Project Delivery

- Organization
- Commercial Terms
- Operating System

- Org: Cmd & Ctrl
- Terms: Transactional
- OS: CPM Scheduling

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Construction Institute
Traditional Hospital Project

Architect
- Civil
- Structural
- Mechanical
- Electrical
- Plumbing
- Landscape
- Elevators
- Interior
- Parking

Owner
- Geotech
- Traffic
- Food Service
- Materials
- Medical Equip
- Operations
- Surgery
- Pharmacy
- Admin
- Birthing
- ER
- Diagnostics

CM/GC
- Site
- Concrete
- Mechanical
- Electrical
- Plumbing
- Landscape
- Framing
- Floor Cover
- Painting
Traditional Level of Common Understanding

Pre-Construction Services

Owner

Architect Hired

Engineers Hired

CM/GC Hired

Construction

≤100%

Major Trades Hired

SD

DD

CD

Time

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Lean (IPD)

Domains of Project Delivery

Lean Project Delivery

Terms: Relational

Org. Collaboration

OS: Lean (Eliminate Waste)
Traditional Level of Common Understanding

- Pre-Construction Services
- Construction

- Owner
- Architect Hired
- Engineers Hired
- CM/GC Hired
- Major Trades Hired

Organization

- Pre-Construction Services
- Construction

- Owner
- Architect Hired
- CM/GC Hired
- Engineers Hired
- Major Trades Hired

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Multi-Trade Prefab

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Sharing of Risk

Negligence (Insurance $$)

or

Owner

Losses or Cost Overruns

IPD $$ (Profit Pool)

Owner $$ (IPD Cont.)
**Fundamental Principles**

- The commercial system must be aligned with the other domains
- Lean calls for management by process, not by results
- Encourage Prudent Risk Taking
- Eliminate Hidden Contingency
  - Greg Howell’s “new” waste
“Buildings Leak at the Intersection of Contracts”

Roofing
Wall stud
Caulking
Window
Masonry
Waterproofing
Concrete
Structural steel
Foundation
Excavation

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Todd Zabelle

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Lesson One: Prototyping Matters

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Prototype → Refine

Lesson Two: Diverse Skills Matter
Target Value Design (TVD)
Foundational Practices
Engage Deeply with the Client to Establish the Target Value

Express the client value as a collection of “conditions of satisfaction”

- How will the project generate true customer value?
- How will the project enhance the owner’s ability to achieve more of the organization’s goal?
- What must be “true” when the project is done?

Lead the Design Effort for Learning and Innovation

- What do we want to learn?
- What do we need to learn?
- How are we going to ensure we continue to learn?
Design to a Detailed Estimate

• Start with a detailed estimate
• Estimate continuously, rather than in batches
• As costs are identified, update remaining unknown values

Design and Detail in the Sequence of the “Customer” who will use it

• Pull plan design phases like construction phases.
• Plan the work so the work flows
Work in Small and Diverse Groups

Work in a “Big Room”
Conduct Retrospectives Throughout the Process

- PDCA governs all practices
- Lessons Learned and Plus/Deltas are regularly scheduled team activities

Engage the Client as a Key Performer
Design in Small Batches

Use One-piece flow in design
- It helps keep the design coordinated while minimizing rework
- It makes estimating easier

Task-switching undermines productivity
- Create work packages that can be accomplished in <5 days
- Start work that can be finished and then finish it

Model the Space-in-Use prior to Design

- Use light-weight design tools for space planning and to establish the process-at-a-glance
- Mock-up before design
- Investigate use causes and scenarios
- Always include people who will be using the space
- PDCA throughout
Use A3 Learning and Set-Based Concurrent Design

Create | Analyze | Converge | Decide

A3 Learning

- A3s tell a story of how a group came to their decision and course of action
- Structure and process of PDCA
- A3s are works-in-process thru follow-up
Adopt Choosing by Advantages Decision-making

- Considers all stakeholders
- Builds consensus around the decision (Buy-in)
- Results in a transparent artifact that documents the decision

TVD in Practice

- **Easy**
  - Co-locate
  - Retrospectives
  - Work in a Big Room

- **Hard**
  - Real-time Estimating
  - Consensus Decision-making
  - Engaging the Client
Choosing By Advantages

A decision-making system for yielding sound, reliable, grounded choices

from

The Choosing by Advantages Decision Making System by Jim Suhr

CBA - Purpose & description

• A method of decisionmaking considering all factors, especially non-monetary & subjective items

• Methods → Decisions → Actions → Outcomes
  • If outcomes matter, then methods matter.

• CBA uses a specific vocabulary which helps to structure discussions consistently
CBA - Principles

• Decisions must be anchored to the relevant facts
• Stakeholders contribute relevant subjective data
  • Decisions must be based upon stakeholder values
• Decisions must be based on the importance of advantages

CBA Vocabulary

• Alternative – Two or more people, things, or plans from which one is to be chosen
  • e.g., Chevy Cruze, Toyota Camry, Honda Accord
• Factor – Element for comparison of Alternatives
  • e.g., MPG, Passangers, # of airbags
  • Usually many factors to consider, chosen by Stakeholders
  • Cannot compare or rank factors – unrelated to each other, no anchoring
  • Cost is not treated as a factor, but will be addressed in the last step in the CBA process.
CBA – Buying a new car
Alternatives & evaluation factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>New Car Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A – Chevy Cruze</td>
</tr>
<tr>
<td></td>
<td>B – Toyota Camary</td>
</tr>
<tr>
<td></td>
<td>C – Honda Accord</td>
</tr>
<tr>
<td>1. Passengers</td>
<td></td>
</tr>
<tr>
<td>2. Interior</td>
<td></td>
</tr>
<tr>
<td>3. Hwy MPG</td>
<td>SUBJECTIVE:</td>
</tr>
<tr>
<td></td>
<td>Chosen by Stakeholders</td>
</tr>
<tr>
<td>4. Airbags</td>
<td></td>
</tr>
</tbody>
</table>

CBA Vocabulary

- **Advantage** – Difference between Attributes of two Alternatives OR benefit, gain, improvement, or betterment
  - e.g., Most appealing, 5 More MPG
  - If Advantages are equal, they are not a basis for a decision.
- An Advantage = a disadvantage
  - Advantage of one Attribute is disadvantage of another
  - Double counting creates error, unsound choices
- Advantages → positive process
- Disadvantages → negative process

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## CBA – Buying a new car

### Paramount Advantage Importance (subjective)

<table>
<thead>
<tr>
<th>Factors</th>
<th>New Car Alternatives</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Passengers</td>
<td>Attributes: 4 passengers</td>
<td>5 passengers</td>
<td>7 passengers</td>
<td></td>
</tr>
<tr>
<td>Advantage:</td>
<td>+1 passenger</td>
<td>30</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>2. Interior</td>
<td>Attributes: Leather seats, wood trim</td>
<td>Leather seats, vinyl trim</td>
<td>Vinyl seats &amp; trim</td>
<td></td>
</tr>
<tr>
<td>Advantage:</td>
<td>More appealing</td>
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<td>30</td>
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</tr>
<tr>
<td>3. Hwy MPG</td>
<td>Attributes: 32 mpg</td>
<td>26 mpg</td>
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<td></td>
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<tr>
<td>Advantage:</td>
<td>+6 mpg</td>
<td>70</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>4. Airbags</td>
<td>Attributes: 4 airbags</td>
<td>6 airbags</td>
<td>4 airbags</td>
<td></td>
</tr>
<tr>
<td>Advantage:</td>
<td>+2 airbags</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Criteria:
1. Want min. 4 passenger capacity
2. Want fancy interior
3. Must have min. 26 MPG
4. Must have min. 4 airbags

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## CBA – Buying a new car

### Importance of Advantages (subjective)

<table>
<thead>
<tr>
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<td></td>
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</tbody>
</table>

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Construction Institute
### CBA – Buying a new car
#### Total Importance (objective)

<table>
<thead>
<tr>
<th>Factors</th>
<th>New Car Alternatives</th>
<th>A</th>
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<tr>
<td>Total Importance</td>
<td></td>
<td>110</td>
<td>160</td>
<td>90</td>
</tr>
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</table>

### CBA – Buying a new car
#### Cost data

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<tr>
<td>Total Importance</td>
<td></td>
<td>110</td>
<td>160</td>
<td>90</td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td>$20,000</td>
<td>$25,000</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

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Actions to Take

- Implement the Last Planner System
- Organize and manage the project as a Collective Enterprise
- Use Target Value Design from concept to completion to focus on value
- Adopt a commercial structure that supports the organization and operating system
- Institutionalize Rapid Learning as part of the project culture

Anticipated Results

- Higher Value to Owner
  - Better fit between need & solution
- Lower cost
- Greater financial return on human capital
- Improved safety
- Improved quality
- Greater stakeholder satisfaction
Plus/Delta

- Helps establish practice of continuous improvement
- Close each meeting with a + / ∆
- Plus: “What added value by being in this meeting?” (I LIKE....)
- Delta: “What could we change so that you would receive more value next time? (I WISH.....)
- Assign a champion to fix the deltas

Lean Project Delivery System

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Lean & Last Planner® System

THANK YOU!
Questions?

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This concludes The American Institute of Architects Continuing Education Systems Course

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