Introducing Lean Construction
- Reforming Project Management

Gregory A. Howell, P.E.
Executive Director
Lean Construction Institute
What has changed Manufacturing, and sharply pushed up productivity, are new concepts. Information and automation are less important than new theories of manufacturing, which are an advance comparable to the arrival of mass production 80 years ago. Indeed, some of these theories, such as Toyota’s “lean manufacturing”, do away with robots, computers and automation.

Results in words

- Workers hourly salaries are going up
- Job satisfaction is improved
  - Participation → Motivation
  - Higher degree of self justice
- Less claims
- Shorter construction time
- Less errors and omissions
- Lower construction costs
- Improved competitive capacity
Results in numbers

5 test projects (PPB-programme):
- Reduced construction time by up to 20%
- Reduced construction costs by up to 10%
- Up to 35% higher hourly salaries
- 0-errors on several projects
Waste reduction in a design office

<table>
<thead>
<tr>
<th>PRODUCT UNIT ERRORS</th>
<th>% OF WAITING TIME IN PROCESS</th>
<th>% NON VALUE ADDING ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Before</td>
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44% Decrease  
53% Reduction  
31% Decrease  

PRODUCTIVITY INCREASE OF 31%
Evolution of PPC

![Graph showing the evolution of PPC over 20 weeks with changes indicated at week 12.](image-url)
Productivity Evolution

![Graph showing productivity changes over 8 months with a 65% increase from month 5 to 6 and an 86% increase from month 6 to 7.]

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Causes of no Completion

62%

- Internal Causes
- External Causes
- Others
The results show that we are on the right path...

- Budget profit: $6,200,000
- Actual profit: $9,200,000

Institute, 2001
Generic Taxiway Construction

- Pre Framework Benchmark: £123
- Year 1 Framework Rates: £113
- STAL Juliet Ph. 1: £96
- STAL Juliet Ph. 2&3: £93
- HAL N. Taxiway: £93
- Target: £86

Year 2000
Who else is exploring application?

Owners: Intel, Ford, Solutia, Rice University, BAA
Designers: IDC, Neenan, Burt Hill Kosar Rittelmann,
Constructors: Boldt, Kinetics, Southland Industries, EMCOR, Neenan, Linbeck, DPR, EMCOR, Fluor/Ames/Kramer, Walbridge Aldinger, GyM, Westbrook AC, Simpson Mechanical
Range of Projects & LCI

Stodgy  Understand the “Physics” of the Task  Dynamic

Design Systems to Support Lean Ideal

Conform Organization and Contracts
Objectives of LCI

- To develop theory and tools for understanding and managing the way work is done throughout the project delivery process, and
- To support implementation and dissemination.
What is this thing called “LEAN”?  

• Not mass, not craft. A third form of production system design.  
• The Lean Ideal  
  – Meet requirements of a unique customer  
  – Deliver it instantly  
  – Maintain no inventory  

• “Give customers what they want, deliver it instantly, with no waste.”
Business Objectives of Project-Based Producers

Minimize Waste
- Reduce defective products
  - Improve supplier quality & on-time delivery
  - Improve the quality of intermediate products
  - Reduce the no. of suppliers & engage in lean
  - Actively learn with suppliers from project to project
  - Require evidence of product compliance from suppliers
  - Reduce the no. of suppliers & engage in lean
  - Improve design constructability
  - Use in-process inspection
  - Pay after inspection /QA
  - Use commissioning
  - Minimize negative iteration in design

Make materials & information flow/ reduce cycle times
- Structure work for flow
  - Reduce inspection time
  - Reduce rework time
  - Improve supplier quality & on-time delivery
  - Use last planner

Control work for flow
- Control work for flow
  - Reduce inventories
  - Reduce time mits & info spend being moved and not processed
  - Reduce the cost of using mits & info
  - Reduce variability
  - Reduce transfer batch sizes
  - Reduce setup times
  - Reduce no. of moves
  - Pull mits & info when possible

Deliver the Project
- Get more from less
  - Increase system control (ability to realize purposes)
  - Increase system transparency
  - Use Last Planner
  - Reduce variability

Maximize Value
- Deliver products that enable customers to better accomplish their purposes
  - Increase transaction costs
  - Increase resource utilization
  - Increase resource product- vity
  - Increase system control on the complete system

- Deliver products on time/Reduce cycle time
  - Reduce transaction costs
  - Reduce purchase prices
  - Reduce transaction costs
  - Reduce purchase prices
  - Align stakeholder interests
  - Use a collaborative project definition
  - Use a set based strategy in design
  - Design for all life cycle stages
  - Inspect against purposes

- Increase system control
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  - Increase system control

- Reduce variability
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- Minimize production disruptions
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- Respond rapidly to production disruptions
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- Increase positive iteration
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- Design for all life cycle stages
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- Inspect against purposes
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- Increase system control
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How do we manage projects now?

• Determine client requirements and design to meet them. Align design to quality, schedule and budget limits.
• Manage the project by breaking it into pieces, estimating duration and resource requirements for each piece, then put the pieces in a logical order with CPM.
• Assign or contract for each piece, give start notice and monitor each piece to assure it meets safety, quality, schedule and cost standards. Take action on negative variance from standards.
• Coordinate using the master schedule and weekly meetings.
• Cost may reduced by productivity improvement. Duration by speeding each piece or changing logic. Quality and safety get better with inspection and enforcement.
Essential Features of Current Practice

- **Activity** centered - Batch and Queue that **trades** efficiency for apparent security.
- **Inflexible** to changes in business case and owner requirements after concept design.
- **Control** begins with **Tracking** cost and schedule.
- Improving local productivity/speed leads to **Unreliable Work Flow** further reducing project performance.
- Protecting activities leads to **adversarial** relations.
- Planning system cannot **Coordinate** the work between crews.
More Physics: Variability, Lead Time, & Capacity Utilization

![Graph showing Capacity Utilization vs. 100%]

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The Impact of Variability

![Graph showing the impact of variability on wait time and capacity utilization. The graph indicates that as capacity utilization increases, wait time also increases, with different curves for PPC=50%, PPC=70%, and PPC=90%.]
PPC and Capacity Utilization

Wait Time vs. Capacity Utilization

Target values for PPC:
- PPC = 50%
- PPC = 70%
- PPC = 90%

Wait times increase as PPC increases from 50% to 90%.
The Opportunity

Change the way projects are managed!

– Current practice
  • Takes too long, costs too much, kills too many
  • Rests on incomplete understanding of work and its improvement
  • Deficient concept of control
    – Increases risk and uncertainty
    – Causes sub-optimal performance
  • Confuses scheduling with a production management, and commercial contracting with making and keeping commitments at the operating level
Designing Project Based Production Systems

- Understand the physics of production (making - dependence and variation, and design - wicked problems).
- Assure design, planning and logistic systems all support reliable and speedy workflow.
- Provide organizations to support these systems.
- Draft contracts that create these organizations.
Business Objectives of Project-Based Producers

Minimize Waste
- Reduce defective products
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  - Actively learn with suppliers from project to project
  - Require evidence of product compliance from suppliers
  - Minimize negative iteration in design
- Improve the quality of intermediate products
  - Improve design constructability
  - Use in-process inspection
  - Use commissioning
  - Pay after inspection/QA
  - Use continuous flow processes where possible
  - Layout for flow
- Reduce the number of suppliers & engage in lean
  - Simplify site work to final assembly & testing
- Reduce inspection time
  - Make inspection unnecessary or automatic
  - Incorporate inspection into processing time
- Reduce rework time
  - Use Last Planner
- Reduce process times
  - Make inspection unnecessary or automatic
  - Incorporate inspection into processing time

Deliver the Project
- Make materials & information flow/reduce cycle times
  - Control work for flow
  - Reduce work for flow
  - Reduce inventory
  - Reduce control for flow
  - Reduce process times
  - Do in-process inspection
  - ID & act on causes of defective work
- Get more from less
  - Increase resource productivity
  - Reduce the cost of acquiring resources, mtlcs, & info
  - Reduce material scrap
  - Reduce unneeded work space

Maximize Value
- Deliver products that enable customers to better accomplish their purposes
  - Structure work for value generation
  - Understand, critique, & expand customer purposes
  - Increase system control (ability to realize purposes)
  - Increase positive iteration
  - Inspect against purposes
  - Design for all life cycle stages
- Deliver products on time/Reduce cycle time
  - Use a collaborative project definition
  - Use a set based strategy in design
  - Use Last Planner
  - Use Last Planner
  - Use Last Planner

USE Last Planner
- Use Last Planner
  - Increase system control
  - Reduce variability
  - Use Last Planner
  - Design for all life cycle stages
  - Inspect against purposes
  - Reduce variability
  - Reduce 'emissions'
The Last Planner System of Production Control

• Planning at the assignment level releases work to the next crew.

• The Last Planner System (LPS) is the key to coordination, workflow reliability, quality and safety and their continuous improvement.

• LPS is a decentralized system that narrows uncertainty as the time for work approaches & builds judgment through rapid learning.

• Planning and coordination is a process of making and keeping commitments to others.
Project control in the *Last Planner System* is principally the practice of securing reliable promises and declarations of completion of those activities that releases work to others. This allows the project work to stay in the desired sequence.  

Hal Macomber, Good2Great
Project and Production Controls

- Project Objectives
- Work Structuring
- Master or Phase Schedule
- Lookahead Planning
- SHOULD
- Make Ready Process
- Can
- Last Planning Process
- WILL
- Production
- PPC
- DID

On Budget & Schedule?
What We Know for Sure about Last Planner Production Management

First - It Works!!!!!!
What is happening now.

• Lean Project-based production systems are coming into construction.
• Specialty contractors make the most money sooner. Construction Users get better projects sooner.
• Leading edge of significant change in the industry flying under the radar of current thinking.
• Need to develop and extend theory & technique.
# Current Practice vs Lean

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<tr>
<th></th>
<th>Current</th>
<th>Lean</th>
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<tr>
<td>Planning</td>
<td>Knowing</td>
<td>Learning</td>
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<tr>
<td>Uncertainty</td>
<td>External</td>
<td>Internal</td>
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<tr>
<td>Control</td>
<td>Tracking</td>
<td>Steering</td>
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<tr>
<td>Coordination</td>
<td>Following Orders</td>
<td>Making and Keeping Commitments</td>
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<tr>
<td>The Goal of Supervision</td>
<td>Point Speed</td>
<td>Reduce Variation</td>
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<tr>
<td>Commercial Contracts</td>
<td>Trades Production System Efficiency for Apparent Security</td>
<td>Aligns Production System Objectives with Interests</td>
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<tr>
<td>Date</td>
<td>Event</td>
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<tr>
<td>Jan 16/17/0</td>
<td>Introduction to Lean Construction - Dallas</td>
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<td>Jan 18/02</td>
<td>Owner Forum</td>
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<td>March 14/115</td>
<td>Production Control Research Meeting - Chicago</td>
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<td>March 27/28</td>
<td>LCI Academic Forum - Michigan State</td>
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<td>Aug 2</td>
<td>4th Annual Lean Congress - Berkeley</td>
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<td>Aug 5/9</td>
<td>10th Annual IGLC Meeting - Brazil</td>
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*Member/CLIENT Only Meetings*
Questions?