Integrating Lean into Design Curriculum at US Universities

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California State University - Fresno

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Benefits Reported by a High Percentage of Lean Practitioners
(By Level of Achievement)


- High Level of Achievement
- Medium Level of Achievement

**Improved Safety**
- 39%
- 38%
- 77%

**Greater Customer Satisfaction**
- 38%
- 42%
- 80%

**Higher Quality Construction**
- 36%
- 48%
- 84%

**Reduced Project Schedule**
- 34%
- 40%
- 74%

**Greater Productivity**
- 33%
- 44%
- 77%

**Greater Profitability/Reduced Costs**
- 30%
- 34%
- 64%

**Better Risk Management**
- 21%
- 50%
- 71%

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*LCI (Ballard and Zabelle), 2000*
Lean Design Supports Innovation
Challenges With a High Degree of Influence on the Decision to Use a Lean Approach (According to Non-Practitioners Familiar With Lean)


- Lack of Industry Support/Understanding of Lean: 39%
- Perception That Lean Will Take Up Too Much Time: 33%
- Lack of Knowledge: 32%

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Why Integrate Lean at US universities?

- **Lean benefits** AEC (Arch., Eng., Const.) projects/industry in many ways
- **Lean integrated design** enhances team collaboration, problem solving, decision-making, and information sharing practices
- Current limitations suggests a **knowledge gap** in the future AEC workforce
- Academia can advance Lean knowledge through **curriculum enhancement**
- **Alignment with accreditation guidelines** can lead to sustainable adoption of Lean at the program level
- For Lean integrated design education, **NAAB accreditation SLOs** can be used for structuring content by student level, i.e., freshmen, sophomore, junior, and senior
- **But where to start?**
Where to start?

1. Create a library of learning resources

1. Review the Bloom’s taxonomy to understand the different learning levels

1. Review the NAAB accreditation criteria

1. Map the Lean learning resources aligned to the various learning levels fulfilling the NAAB criteria

1. Incorporate Lean resources into the design curriculum through teaching

The LCI design community already produces many learning resources in various formats, which can be used to promote learning for university students, who are the future workforce!
LCI Key Learning Offerings

**eLearning**
- Introduction to Lean Project Delivery
- Introduction to Last Planner System®
- Effective Big Room
- Lean in the Design Phase (Pre-con)
- Last Planner System® in Design Phase (Pre-con)
- Target Value Delivery

**Classroom Learning**
- Introduction to Lean Project Delivery
- Introduction to Last Planner System®
- Mindset of an Effective Big Room
- Lean in the Design Phase (Pre-con)
- Last Planner System® in Design Phase (Pre-con)
- Target Value Delivery
- Conducting Gemba Walks
- Business Case for Lean Project Delivery
- Kaizen
- SS in Construction
- Ready, Set, Go Scrum!
- Lean Deployment Guide Workshop
- COAV/LCI Lean for Owners
- Rev Up Your Team: Liberating Structures
- Intermediate Last Planner System®: Practical Application

**Lean Learning Series**
- What is Lean?
- Exploring the 8 Wastes
- Why Lean: The Impact on Project Delivery
- Big Room
- Target Value Delivery
- Last Planner System®
- Conditions of Satisfaction
- A3 Thinking

**Books**
- Transforming Design & Construction: A framework for Change
- Target Value Delivery: Practitioner Guidebook
- Don’t Conform, Transform!: A Guide to Better Project Outcomes

**LCI Short Learning Video Series**
- Available on website

**Recorded Webinar Series**
- Recorded webinars available on demand

**Live Webinar Series**
- Webinar series changes on an annual basis

**Reports/Workbooks/Templates**
- Last Planner System® Workbook
- Last Planner System® Standard Work Guidelines
- Lean Deployment Guide
- Integrated Project Delivery: An Action Guide for Leaders
- Project Valuation Guide
- Lean Learning Health Assessment Tool for Individuals
- Lean IPD Health & Maturity Assessment Tool for Teams
- CMAA Managing Integrated Project Delivery
- Lean Contracting Strategy the P&G Way
- UHS Lean Project Delivery Guide
- Practitioner’s Guide to Essential Lean Research
- Dodge Reports (3)

**Events**
- Annual Congress (Fall)
- Design Forum (Spring)
- Community of Practice (CoP)

**Additional**
- Lean Construction Journal
- LCI Blog
- Newsletter
Bloom’s Taxonomy

- **Remember**
  - Recall facts and basic concepts: define, duplicate, list, memorize, repeat, state
- **Understand**
  - Explain ideas or concepts: classify, describe, discuss, explain, identify, locate, recognize, report, select, translate
- **Apply**
  - Use information in new situations: execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch
- **Analyze**
  - Draw connections among ideas: differentiate, organize, relate, compare, contrast, distinguish, examine, experiment, question, test
- **Evaluate**
  - Justify a stand or decision: appraise, argue, defend, judge, select, support, value, critique, weigh
- **Create**
  - Produce new or original work: design, assemble, construct, conjecture, develop, formulate, author, investigate

2 - Learning Levels of Bloom’s Taxonomy
3 - Review NAAB Guidelines

National Council for Architectural Registration Board
Certification and Licensing

EDUCATION

The typical first step to becoming an architect is finding a school that offers a professional degree in architecture from a program accredited by the National Architectural Accrediting Board (NAAB).

2020 Conditions for Accreditation
3 - Review NAAB Guidelines

Guidelines to the Accreditation Process

2020 Conditions and Procedures

May 16, 2023

Student Criteria (SC): Student Learning Objectives and Outcomes:

SC.1 Health, Safety, and Welfare in the Built Environment
SC.2 Professional Practice
SC.3 Regulatory Context
SC.4 Technical Knowledge
SC.5 Design Synthesis
SC.6 Building Integration
Bachelor of Architecture consists of a minimum of 150 semester credit hours leading to an average of 30 units per year:

- GE courses
- Visual Communication
- Design Studio
- History of Architecture
- Structures
- Materials and Building Construction
- Planning
- Technical Systems Integration
- Building Environmental Systems
- Design Research and Analysis
- Ethics and Professional Practice

*Courtesy: Suggested Academic Plan, Dept. Of Arch, Penn State*
3 - Review NAAB Criteria and Program

01 Heath, Safety, and Welfare in the Built Environment
- Structures
- Design and Design Studio
- Materials and Building Construction
- Building Environmental Systems

02 Professional Practice
- Architectural Professional Practice
- Collaborative Studio

03 Regulatory Context
- Technical Systems Integration
- Design Research and Analysis
- Building Environmental Systems

04 Technical Knowledge
- Materials and Building Construction
- Building Systems Integration
- Building Environmental Systems
- Design and Design Studio

05 Design Synthesis
- Technical Systems Integration
- Design and Design Studio
- Design Research and Analysis

06 Building Integration
- Technical Systems Integration
- Design and Design Studio
- Design Research and Analysis

Student Criteria (SC)

B.Arch. Courses
## 4 - Integration Levels

### Integration Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Scope</th>
<th>Integration Scopes aligned to Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Module CLO, i.e., Syllabus-driven</td>
<td><strong>Potential Lean Topics and Strategies</strong> that can be implemented at this level&lt;br&gt;Assignment Types based on lower to higher order of thinking based on Bloom’s Taxonomy&lt;br&gt;Lists of Associated Learning Resources developed by LCI Instructors, Members, and Partners</td>
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<tr>
<td>2</td>
<td>Course CLO, i.e., Syllabus-driven</td>
<td><strong>Potential Lean Topics and Strategies</strong> that can be implemented at this level&lt;br&gt;Assignment Types based on lower to higher order of thinking based on Bloom’s Taxonomy&lt;br&gt;Lists of Associated Learning Resources developed by LCI Instructors, Members, and Partners</td>
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<tr>
<td>3</td>
<td>Program/ Curriculum SLO, i.e., Accreditation-driven</td>
<td><strong>Potential Lean Topics and Strategies</strong> that can be implemented at this level&lt;br&gt;Assignment Types based on lower to higher order of thinking based on Bloom’s Taxonomy&lt;br&gt;Lists of Associated Learning Resources developed by LCI Instructors, Members, and Partners</td>
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4 - Integration Mapping: Module/Course

<table>
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<tr>
<th>Learning Levels</th>
<th>Lean Topics</th>
<th>Assignments</th>
<th>LCI Learning Resources</th>
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</table>
| Remember        | Basic Lean concepts: Value, Waste, Flow | ● Presentation  
● Q&A: How/where is value generated in design? What types of waste can they see in design (process and product)?  
● Exercise: share their favorite (sport, restaurant, hobby, etc.) and what makes that special? | ● EL: Introduction to Lean Project Delivery  
● CL: Conducting Gemba Walks  
● LLS: Conditions of Satisfaction |
| Understand      | 5S          | Simulations:  
● Numbers Game  
● Puzzle Game (Similar in nature to numbers game)  
● House of Cards Game and discuss what changes in each scenario | ● CL: 5S in Design  
● CL: Kaizen  
● 5S Numbers Game  
● House of Cards Game  
● Puzzle Game |
| Apply           | Continuous Improvement (Kaizen) | ● In each round of the previous games, ask students about changes that could be made in each round to improve the scenario, and document them during a lessons learned review of the round.  
● Next, lead students into writing an A3 to resolve some of the problems identified as the previous games were played. | ● CL: Kaizen  
● LLS: A3 Thinking |

EL = eLearning  
CL = Classroom Learning  
G = Glossary  
LLS = Lean Learning Series  
B = Books  
LCIS = LCI Short Video Series  
RWS = Recorded Webinar Series  
LWS = Live Webinar Series  
RWT = Reports/Workbooks/Templates  
E = Events  
A = Additional
4 - Integration Mapping: Program

Proposed Framework for Integrating Lean Education at the Program-level Aligned to NAAB criteria

Introduce Lean Implementation Areas into the Program Courses

Point of Consideration of Accreditation SCs and Curriculum Guidelines

Point of Consideration for incorporating LCI’s Learning Resources

- First/Second Year: Readings, Discussion forums, Game-based learning
- Third/Fourth Year: Simulation/Lab activities, Reflection papers, Field trips, Exams
- Final Year: Case Studies, Term Projects

Introduce Lean Implementation Areas into the Program Courses
# Lean in Design Education: Proposed

<table>
<thead>
<tr>
<th>Module</th>
<th>Topics</th>
</tr>
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</table>
| **01** Heal, Safety, and Welfare in the Built Environment | - Structures  
- Design and Design Studio  
- Materials and Building Construction  
- Building Environmental Systems |
| **02** Professional Practice | - Architectural Professional Practice  
- Collaborative Studio |
| **03** Regulatory Context | - Technical Systems Integration  
- Design Research and Analysis  
- Building Environmental Systems |
| **04** Technical Knowledge | - Materials and Building Construction  
- Building Systems Integration  
- Building Environmental Systems  
- Design and Design Studio |
| **05** Design Synthesis | - Technical Systems Integration  
- Design and Design Studio  
- Design Research and Analysis |
| **06** Building Integration | - Technical Systems Integration  
- Design and Design Studio  
- Design Research and Analysis |

Please refer provided handout.
In the spirit of continuous improvement, we would like to remind you to complete this session's survey! We look forward to receiving your feedback.

Please take a moment to complete the paper survey - Thank you!

Collaborators: Drs. Sagata Bhawani (CSU-Fresno) and Thais Alves (SDSU)

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