



Lean Construction Institute
Building Knowledge in Design and Construction

**8th Lean Construction
Institute Academic Forum
May 14-16, 2010 – Boulder,
Colorado, USA**

Forum Notes
by

Tariq Abdelhamid

Forum Attendees:
(see table at end of notes)

Forum Location:
Millennium Harvest House - Boulder

Forum Schedule:
The schedule was as follows (all times in MDT - Mountain Daylight Time):
Monday, 5/14/12: Workshop from 8am to 5pm
Tuesday, 5/15/12: Symposium from 8am to 5pm
Wednesday, 5/16/12: Symposium from 8am to noon

- Forum Objectives:**
- Presentation of Lean Construction instructional simulation models.
 - a. Designed for academics and practitioners interested in teaching Lean Construction.
 - Lean Construction research and teaching symposium, dedicated to:
 - a. Accounts of Lean Construction research and teaching taking place at LCI, and at LCI affiliated research centers

- Day 1 Meeting Highlights:**
1. Brief history of LCI and Academic Forum
 2. Overview of Lean Construction
 3. Simulations
 - a. Variation in Production Systems: Dice Game
 - b. The Ball Game
 - c. The Number Racket
 - d. Variation in Production Systems: Parade of Trades™
 - e. Pull in Production Systems: The Dot Card Simulation
 - f. Silent Squares

Simulation discussion points: Audience; Time; Lessons; Did We Reach Audience?

Day One Simulation Results

Dice Game:

6/4 (team predicted it will take them 58 total rolls)

Position	1	2	3	4	5	Total
Number of rolls to pass 50 chips	<i>10</i>	<i>11</i>	<i>11</i>	<i>11</i>	<i>12</i>	<i>55</i>
Average production (50/Number of rolls)	<i>5</i>	<i>4.55</i>	<i>4.55</i>	<i>4.55</i>	<i>4.16</i>	<u><i>4.55</i></u>
System throughput						<i>4.16</i>

9/1 die (team predicted it will take them 69 total rolls)

Position	1	2	3	4	5	Total
Number of rolls to pass 50 chips	<i>17</i>	<i>18</i>	<i>21</i>	<i>22</i>	<i>24</i>	<i>102</i>
Average production (50/Number of rolls)	<i>2.94</i>	<i>2.78</i>	<i>2.38</i>	<i>2.27</i>	<i>2.08</i>	<u><i>2.45</i></u>
System throughput						<i>2.08</i>

Parade of Trades (results):

Table # (die color)	Capacity Bid	Weeks Bid	Actual Capacity	Weeks Done	Week Concrete Done	Total Inventory.	Highest Inventory in one week.
1	325	21	282	19	8	86	6
2	315	20	328	20	10	68	7
3	275	18	344	22	12	76	5
4	285	21	336	22	10	163	10
5	290	23	402	25	14	70	5
6	285	30	344	21	6	174	19

Red : 2, 3, 3, 4, 4, 5 Blue: 1, 2, 2, 5, 5, 6 Black: 1, 2, 3, 4, 5, 6

Make A Card (results):
Round 1

	Good Cards	Time to first Card	Rework	WIP	
Table	Bid Actual	Bid Actual	Bid Actual	Bid Actual	Cash Position (\$)
1	20 7	0:45 4:57	5 3	6 15	2,500
2	5 2	5:00 5:52	1 3	20 14	-1,500
3	5 0	3:00 6:00	1 0	15 10	2,500
4	5 5	4:59 4:33	2 5	20 10	2,500
5	5 2	4:00 6:00	0 0	15 7	-1,250

What would you change in this production system to get better performance?

- Stamp 1st	-Paper clip at end	-Do we need clip?	-redistribute/reorder work	-eliminate diagonal lines
-go to batch of ONE	-Fold don't line	-share RED load	-ALLOW communication	-Inspect at every station
-Better Specs	-Sample @ each station	-Eliminate Star	-Inspector as worker	-Inspectors meet together
-Wine at tables	-Outsource			

Round 2 (only changes as prescribed by instructions in simulation)

	Good Cards	Time to first Card	Rework	WIP	
Table	Bid	Bid	Bid	Bid	Cash
	Actual	Actual	Actual	Actual	Position(\$)
1	35	0:20	5	7	17,000
	19	1:07	3	3	
2	20	0:50	0	5	25,250
	27	0:30	2	5	
3	10	1:30	3	6	19,000
	20	0:50	2	2	
4	20	1:00	15	4	27,750
	30	0:26	9	0	
5	5	2:00	0	5	28,250
	29	0:42	1	2	

The group discussed the changes and the impact on performance. Observations solicited from group members on qualitative changes. See debrief guide in the simulation instructions.

Round 3 (only changes as prescribed by instructions in simulation)

	Good Cards	Time to first Card	Rework	WIP	
Table	Bid	Bid	Bid	Bid	Cash
	Actual	Actual	Actual	Actual	Position(\$)
1	20	1:00	3	3	31,250
	33	0:38	4	3	
2	50	0:20	3	0	58,000
	58	0:29	0	0	
3	35	0:30	4	3	47,750
	48	0:28	1	0	
4	50	0:18	4	0	62,000
	62	0:18	0	0	
5	40	1:00	0	2	51,500
	52	0:25	1	1	

Day one: Plus /Delta

Plus	Δ
Lower variation = more predictable performance	Better setup for room (projector location)
No value to overall project in doing more than was planned	Thicker markers to see from back of room
Learning that system throughput is at last workstation in the line	Discuss commonly held beliefs before simulation
Validated observations	Use Dice Game as an ice breaker
Variation bad / Predictability good	Videos on how to run game
Participatory	Batch size gets lost in Make A Card simulations
Games order and selection	
Tips about setting up, running, and debriefing simulations	
Learning our names	
High Passion	
Real life examples	

Day 2 Meeting Highlights:

- Pull in Production Systems: Lighting Fixture Simulation
- Last Planner® System: Pull Plan and Make Ready Planning Video
- The status of Lean Construction Teaching and Research: Who’s doing what?
- Presentations

Day 2 Simulation Results

a. Pull in Production Systems: Lighting Fixture Simulation

8-piece Batch

	QTY	Time to 1 st Light Fixture	WIP	Green Fixture	
Table	Bid	Bid	Bid	Bid	Cash
	Actual	Actual	Actual	Actual	Position(\$)
1	16	6:00	16	1	-2000
	0	5:30	40	0	
2	16	4:20	32	2	-800
	8	5:30	40	0	
3	24	2:15	16	2	0
	8	5:50	24	0	

4-piece Batch

	QTY	Time to 1 st Light Fixture	WIP	Green Fixture	
Table	Bid	Bid	Bid	Bid	Cash
	Actual	Actual	Actual	Actual	Position(\$)
1	8	4:00	20	1	-1,400
	0	3:00	28	0	
2	12	2:15	16	3	3,600
	36	2:05	36	1	
3	24	2:30	24	3	3,400
	28	2:35	16	2	

Pull System with 1-piece

	QTY	Time to 1 st Light Fixture	WIP	Green Fixture	
Table	Bid	Bid	Bid	Bid	Cash
	Actual	Actual	Actual	Actual	Position(\$)
1	30	0:20	3	3	5,250
	36	0:33	3	3	
2	50	0:20	3	3	7,600
	52	0:23	4	3	
3	60	0:19	3	3	7,200
	49	0:27	3	3	

Day 2 Summary: Who's doing what?

Raymond Couzens:

- Keep up on continuing education – read on Lean Construction (Empire State Building Notebook).
- Recently presented at AGC event on prefabrication.

Lincoln Forbes:

- Interested in doing research related to Lean Construction.
- Raising the profile of Lean Construction in the IIE construction track (solution track and research track).
- Involved in the annual contest on student best paper at IIE conference (\$2500).
- Seeking input from faculty using his book on improvements, exams, and questions.
- Very interested in commissioning and its relation to the Lean Project Delivery

Emily Shackles:

- Works in the Mission Critical Group Center of Excellence
- First conference to attend with LCI
- Learning about Lean Construction as it relates to her work

Christian Blomdahl:

- Changing business model to Lean Construction
- Started with hiring LPC
- Focused on field to run Last Planner ®System (Skanska Finland requires use of LPS on every job)
- First conference to attend with LCI

Heip Tran Dinh:

- Applied LPS® on a major industrial project when it was behind schedule. He learned that LPS® needs good understanding of the capacity of the crew. The relation between the supplier and the sub-contractors is also critical.
- Studying English and preparing for GRE to get into a Construction Management masters program.

Mohamed Hassan:

- PhD on Lean Construction at George Mason University.
- Teaches at DeVry university
- Working with LCI DC on the Lean Construction Congress preparation

Charles Rountree:

- Works as an owner representative. Always looking for opportunities to implement Lean Construction.
- Having a challenge on a project that is running behind schedule and wants to bring LPS® approaches to bring it under control.
- Safety research with Dr. Bolivar Senior (CSU) on Resilience Engineering.
- Co-chair of LCI Colorado, which started in 2009

Bolivar Senior:

- Feels the next research frontier will be related to psychological aspects.
- Working on Theory of Decision Making as it relates to adoption of Lean Construction
- Teaches Lean Construction as a part of a course in Productivity Improvement

Zophia Rybkowski:

- o Teaches Lean Construction in an Undergraduate and Graduate class
- o Finds it interesting that Lean is labeled by some as a fad, and directs students to primary sources and readings on Lean to better understand the evolution of Lean.
- o Involved with LCI – Houston

Ed Beck:

- o Involved in construction for 40 years – 15 years in Lean Construction
- o Provides Lean Collaborative Construction Management services:
 - Working with a contractor in Atlanta
 - Minneapolis developer
 - Auburn University rebuilding an area that was demolished in Katrina
 - Working with non-profits (pro-bono)
- o Working to form a Steering Committee to start the LCI Atlanta COP
- o Planning on teaching Lean Construction in the AGC program in Mobile, Alabama
- o Very interested in getting architects, engineers, and owners involved in Lean Construction

Ashley Colburn:

- In the Birmingham, Alabama area, there is a concentration of health care organizations. This influenced the adoption of Lean Construction. He works with his company on Lean Construction implementations..
- Teaches Last Planner® and Lean Construction on projects
- Concerned Lean Construction could wane after the economy picks up
- Finds little recognition in his area about Last Planner® and Lean Construction in general. Strangely, he does know of a local contractor, Golden Constructors, practicing Lean Construction without calling it that but they are very successful in implementing 5S and solicitation of continuous improvement ideas.
- Would like to see more focus on TWI (Training-Within-Industry), with its three modules.

Robert Warcup:

- Former Centex manager – went through an ACE training process (ACE = Achieving Competitive Excellence) that emphasized Lean Thinking practices. The ACE training was one his best times in the industry. Did a Value Stream Map on cabinet installation and other systems.
- Finished externship with SunRock Building materials, part of the Clyde companies – focused on civil construction
- Teaching Lean Construction as part of a class – and hoping to develop a course - Utah Valley University
- Completing his PhD from Utah State University.

Wenda Nofera:

- Learned about Lean Construction in University of Birmingham in 2004 (Same university where Glenn Ballard finished his dissertation).
- PhD student at Michigan State University. Working with T.Abdelhamid on lean crew design.
- Would like to take Lean Construction back to Indonesia. The challenge will be that DBB is the main procurement model. Projects usually have four parties: owner, contractor, architect, and a supervising consultant. All the work is performed by one contractor so the problems of handoffs are hidden within the company, rather than across multiple companies.

Ali Lahouti:

- Introduced to Lean Construction at Michigan State University. Working with T.Abdelhamid on PhD looking at the impact of explicit versus implicit instructions on performance of construction crews.
- Working as project manager assistant at MSU's Physical Plant. Implementing Last Planner® System. The champion is very important in any change.

Rich Seiler:

- Entered into Lean Construction by mistake – learning about it in 2004 when working at the Austin company (he had his company also building high-end residential homes; and worked as a specialty electrical contractor).
- Co-founder of LCI Chicago
- Teaching as an adjunct
- Interested in consulting in Lean Construction.

Tariq Abdelhamid

- Teaching Lean Construction at the graduate level since 2001
- LCI Michigan; AGC Lean Construction Forum; LCI Journal; LCI Academic Forum
- Lean/IPD Coach on MSU Project.
- AGC Lean Construction Education Program (with Enovio Consulting)
- Lean Thinking in Campus Operations and Service
- LEED credit for Lean Steel Fabricators/Erectors
- Michigan Construction Best Practice Initiative
- Research with Learning Partners (aka graduate students)

Day 2: Summary: Presentations

a. *Zophia Rybkowski:*

Asked the group to complete the “Lean on a Napkin” challenge. Discussed her graphical representation and solicited inputs from the group. CB suggested making the graphic representation unique to lean thinking. LF and WN suggested incorporation of the waste/value reciprocal relation. CR pointed to the paper: *“Creating Value: A Sufficient Way To Eliminate Waste In Lean Design And Lean Production.”* A. Mossman (2009) – Lean Construction Journal.

b. *Christian Blomdahl and Emily Shackles:*

Shared with the group developments at Mission Critical Group working on Data Centers. Skanska began from first principles; where is the value for owners of data centers? This approach resulted in rethinking how Skanska engages Data Center clients.

Day two: Plus /Delta

Plus	Δ
Light Fixture Simulation	Less noisy A/C
Last Planner® Session	Increase volume on video
Room size	Add PPC discussion o Last Planner®
Interactions amongst participants	Keep instructors to day two and three
Mindfulness of participants needs	Stay longer (full third day)
	Hold closer to Denver
	Hold in university
	Hold in Las Vegas

Day 3 Meeting Highlights:

Reflections on day two:

- Liked the LPS® modeling and discussion
- Enjoyed talking with other lean enthusiasts
- Realizing that there is no one way to do things in lean – achieving the aim is the key
- Interactions at tables and across the room
- Experiencing portable version of the airplane game
- Presentations of who's doing what with lean, and formal ones
- Sharing of ideas
- Validating one's understanding
- Fantastic Food (lunch outdoors and choices)
- The Light Fixture Simulation
- Personal Stories
- Small size of the group

Presentations Summary (Day 3):

a. Robert Warcup:

Presented a VSM approach in residential construction. Used 'Budgeted Waste' instead of 'Contingency'. Showed us a specific example regarding cabinets requiring multiple measurements due to variations in framing (3 punch trips; field measurements). Before eliminating the measurement step, they asked themselves why measurement is done using a 5-Why approach. Measurement by the cabinet installer was eliminated when the framing was tightened. The homebuilder guaranteed the measurements to the cabinet installer. Other waste elimination efforts resulted in a combined 12% reduction in a cost of a single house (from 110K to 98.6K; \$13,400 over 1200 houses giving the homebuilder a \$16 million saving).

b. Mohamed Hassan:

Presented his PhD topic to the group. Focus is on creating a Lean Project Rating System, to define project success factors in the different project phases (Conceptual, Design and Construction). Suggestions from the group included: checking the CII reports on project success factors and on alignments matrix, consider adding satisfaction to project criteria.

c. Hiep Tran Dinh:

Presented an application of LPS® from Vietnam. The Dinh Vu Polyester Plant Project is the first polyester fiber factory in Vietnam with the purpose of using feed from refinery to produce polyester fiber. This is a \$M 255, 25 month duration. The project is of massive size and data collection and tracking required dedicated staff. Areas of improvement cited by Hiep include: Engage Design, Suppliers and Owner's Team at Site (Planning,

Observe, etc); Modify standard contracts with subcontractor, suppliers; Manage meeting with key person (Daily toolbox and Weekly); Review corrective action together every week.

d. Bolivar Senior:

Presented an excel spreadsheet that simulated the Dice Game. The uses that Bolivar envisioned include: conducting what-if scenarios; using the simulation spreadsheet to save time during a workshop. He would like feedback on the spreadsheet form the group.

e. Wenda Nofera:

Presented motivation and problem statement of her PhD research. The focus is on investigating whether work performed by construction crews can be choreographed to minimize waste involved in traditional operations. This is not operation design; rather it is focused on how the crew can organize itself to accomplish the work at hand. She will be using Agent Based Modeling to study different lean-driven principles of crew design. BV suggested she look at the military research on troop task design.

f. Ali Lahouti:

Presented his PhD work by citing a study of 180 job sites that found that the most frequent factor impacting site productivity is how comprehensive the instructions received were. Workers indicated that they only receive complete information on what to do 70% of the time. He is using Agent Based Modeling to understand the cost of explicit versus implicit information received by the crew. ES suggested he look at how crowd behavior is modeled in subways.

g. Charles Rountree:

Discussed safety concerns in the industry. Shared research he is working on with Bolivar Senior that utilizes Resilience Engineering as a backbone for approaching safety. Using an interactive session with the participants, Charles went through the following: *What is the current problem in Construction Safety? Why do we have this problem? What is Resilience Engineering? How can Resilience Engineering help?* He tried to show the group the following videos, but the internet didn't cooperate with us:

- i. <http://www.youtube.com/watch?v=kHfX5ia74qY&feature=related>
- ii. <http://www.youtube.com/watch?v=mVt9nIf9VJw>
- iii. http://www.youtube.com/watch?v=xFhn_GUahGU

h. Raymond Couzens

Presented to the group his perspective of “Collaborative Construction” using BIM. Started with the following poignant reminder: **(Proverbs 20:18) . . .By counsel plans themselves are firmly established. . .**” We were reminded that

THE GOAL OF COLLABORATION

The goal of collaborating is to get more work accomplished correctly in a shorter period of time. It also allows a group to take advantage of skill sets possessed by other people. One employee

Concluding the first presentation, he stated that “Collaboration requires effective communication. Effective communication requires a common language.”

In his second presentation, titled “3D MEP COORDINATION-THE DIFFICULT BIT”, practical applications were presented of challenging situations in the plenum space and how it is addressed using BIM.

Raymond recommended the two books “ The Gold Mind” and “ The Lean Manager” to the group.

Day three: Plus /Delta

Plus	Δ
Participation in the 3 days with academics and practitioners	Put research first day or alternate with educational simulations
Room 2 nd and 3 rd day is cozy and nice	Better Internet
Discussions	Spread games over the three days
Longer event allows interactions and rich discussions and reflection	Weekend event, preferably in Las Vegas
Facilitation	More practitioners should stay because academics have interesting things going on and we can partner with them
Tireless energy of facilitator	
Seeking input from all	
Not cutting off discussions	
Motivating environment to learn the ‘how’ to behind simulations	

Academic Forum adjourned with a round of applause at 12:10pm on 5/16/2012!!