

## **6<sup>th</sup> Lean Construction Institute Academic Forum May 10-11, 2010 – Louisville, Colorado, USA**

Forum Minutes

by

Tariq Abdelhamid

### **Forum Attendees:**

Bob Muir (Drexel University), Bolivar Senior (Colorado State University), Brad Haytt (California State University – Fresno), Eric Antillon (University of Colorado), Euysup Shim (Illinois State University), Farook Hamzeh (Colorado State University), Farzad Shahbodaghlu (California State University – East Bay), Francios Jacobs (Colorado State University), Glenn Ballard (University of California – Berkeley), Greg Howell (Lean Construction Institute), Luai M. El-Sabek (University of Toronto), Marcelo Azambuja (Southern Illinois University), Mike Singleton (Colorado State University), Min Liu (North Carolina State University), Richard Livingston (Colorado State University), Sherri (Lean Project Consulting); Susan Miller (Ferris State University), Tariq Abdelhamid (Michigan State University), Yong-Woo Kim (Washington State University).

### **Forum Location:**

Offices of Lean Project Consulting located at 625 Main Street 1-B, Louisville, Colorado 80027

### **Forum Schedule:**

The schedule was as follows (all times in MDT - Mountain Daylight Time):

Monday, 5/10/2010: Workshop from 8am to 5pm

Tuesday, 5/11/20: Symposium from 8am to 3pm

### **Forum Registration/Logistics:**

The registration fee was \$250. Lodging, transportation, meals, and other expenses were the participant responsibility.

### **As-planned Meeting Objectives:**

1. Presentation of Lean Construction classroom instructional simulation models.
  - a. Designed for academics who have research and/or teaching aspirations in Lean Construction.
2. 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 (P2LS, C2P2ai, Edgility, etc )
  - b. Cataloging ongoing research and teaching efforts in Lean Construction
  - c. Research and teaching plans of new LCIAF members.

**As-Realized Meeting:**

The meeting began on Monday May 10, 2010 with a brief overview of the Lean Construction Institute history and mission. The Academic Forum aims and activities were briefly stated as well. The participants then introduced themselves. This was followed by simulation games designed to facilitate the understanding of Lean Construction concepts. The simulations were: The Silent Squares; the Dice Game, and the Airplane Game (modified paper-based version). After each game, a group discussion took place for debriefing and further explanation of the concepts.

The meeting on Tuesday May 11 took the form of group discussions that focused on Lean Construction research and teaching. The session began with collecting inputs on any simulation games that the participants knew about. Following this (30 minute) session the group considered questions and takeaways collected during Monday's workshop. As usual, we had more questions than the time available to address them. Afterwards, presentations were made by each participant regarding the ongoing and planned Lean Construction activities at each university. The group then discussed research questions that represented what we don't know and would like to, and wish someone would work on.

The 7<sup>th</sup> LCI-AF will be held in May 2011, with the exact time to be announced later.

## **Detailed Accounts – Monday May 10, 2010**

### **Silent Squares – Discussion**

1. Who was able to form the pieces right away
2. What happened then?
  - a. Some hesitated to exchange parts....not worried about the others...I won they lost....
  - b. Considered trading but if I broke mine there was no other way because once I broke I couldn't get.
3. Did you think all participants were able to make a square?
  - a. No...I thought it was what it is....
4. Did anyone think about going to the other tables to help or to “spy” on those done?
5. Why did you break the square that you completed?
6. How did the person who didn't get their square done feel?
7. Did you trust the person at the table?
8. How is this game like the real world?
9. If you know the game, then just be an observer. What the observer sees is very different from the participants

### **Discussion:**

- What if there were money or incentives involved? You can do many variations on the game, but it is better to keep it simple so the main concept is demonstrated.
  - o The game is about the moment we are willing to collaborate;
  - o The game is about the moment when you take a cosmic risk to help others;
  - o It's a very good game for those who don't know each other....it shows that breaking boundaries and wanting to move money across these boundaries is a tough thing to accomplish.....The temptation is to draw the boundary around yourself first, and not around the table or around the room.
  - o This game also brings out benefit of co-location.
- People will say that this game is not real because you can ask questions in practice. However, in practice there is sometimes limitation to what you can ask or red-tape. There is also a lag between when you ask a question ( request information) and when the answer is provided ( information provided).
- The ultimate aim of this simulation is not to have 100% collaboration all the time. The importance is on how we collaborate and towards what; we should collaborate but still challenge each other to arrive at better outcomes, and we should collaborate towards maximizing the project and not the pieces. In other words, competition is good to have because it leads to pushing the envelope on innovation.
- How does this simulation relate to Lean Construction? As an instructor, make this question an ongoing question for the class you are teaching - ask students to write their thoughts on this question every time you play a simulation. When you get through more

concepts in Lean Construction, ask the students to revisit their answers, and have them write a new answer. This is a good way to track understanding through the course.

### **Dice Game – Discussion**

- Play out the game on one table as a demo.
- The table for the summary

Dice	Concrete Finished	Paint Finished	Capacity*	Inventory	Max Inventory in a Particular Week
Blue ( 1,2,2,5,5,6)	10	21	301	161	8
Black (123456)	10	20	307	60	9
Red ( 233445)	11	18	286	57	4

\*Compare to the optimal capacity of 245 (35×7)

- Which is the more attractive dice?
- Which is the safer team?
- What crew determined the system throughput?
- What is it that really is affecting the predictability of the assignments? If we can figure that out then we can have better workflow reliability
- If you are a contractor, then would you want a faster or more reliable dice?

### **The Last Planner™ System:**

- F.Hamzeh presented on LPS. Discussions took place about the differences between pull scheduling and current practice.
- Get the phase scheduling process benchmark from Glenn
- Learning from failures (why 5 times) – companies don't do it well.

### **The modified airplane game ( pull/one piece flow):**

The overall objective of the simulation:

- \*All production systems are designed (even if implicitly so)
- \* The way they systems are designed affects their performance

The simulation shows: 1. Consequence of batch size; 2. Issues in work-in-process; 3. Pull vs. push; 4. Quality

- First system was batch
- Second system was pull/one piece flow
  - o Had fewer words languishing in inventory
  - o On station was limiting the performance of the system due to unbalanced workload
  - o Labor utilization higher because of concurrency
  - o Pull makes visible the time you can really use to improve performance ( some stations are still waiting) and that can only happen by reducing your variation

- Third system : Level the stations: this reduces the variation

Improvements suggested to the word-based simulation:

- ½ sheets
- Shorten word strings
- Set production time
- Measure cycle time
- Measure WIP
- Gobbley-gook word strings – then reorganize later ( quality is based on the correct to incorrect words ratio)
- Multiple predecessors
- Multi-skilling
- One station and everyone moves into and out of it
- Expose/discuss the bottleneck
- Takt time

### **The OOPS game - discussion**

- We frequently face moments where have to make decisions among alternatives while we really don't know the payoffs with each alternative. This game demonstrates that.

OOPS and Project Planning:

- project control today is to make sure that we are on sequence and keep all people working...The CPM planning contains hard releases that don't exactly happen in practice.... CPM is ignoring the competition that happens within and the updating burden so we end up trying to enforce contracts.....
- In essence, the superintendent works on a tradeoff of the cost of planning versus the risk of an OOPS...an OOPS is not having work for crews
- In LPS we are trying to avoid the risk of an OOPS ( or at least reduce it). The OOPS in LPS is that the crew will work on things they can't be working on.
- A lot of superintendents think LPS is too much planning, and it is, but this will benefit the whole project

### **LC Introduction – G. Howell**

G. Howell gave an introduction to LC using the three connected opportunities.

### **Takeaways:**

- Balance between competition and collaboration ( based on silent square and OOPS).
- Attacking variation is an efficient strategy to reduce durations.
- Using simulations for teaching
- Moving money across boundaries
- Bottleneck shifting on projects; shows limitations of TOC in construction
- Focus on downstream crews ( think greater good)
- Parade of trades – Workstructuring relevant to construction

- Silent squares teaches thinking outside the box
- Speed versus reliability
- Speed and reliability
- Cost of information to reduce risk ( OOPS game)
- Effect of variation and dependence on performance
- Look ahead planning
- Management of work affects safety

**Questions:**

- Relation between BIM, Lean, and Green?
- What is going on internationally and nationally with Lean Construction?
- Competing vs cooperating – where do we draw the boundary?
- How does safety benefit from Lean Construction?
- How can we distinguish between materials and information flow in TFV versus the practice of loading resources in CPM?
- What is the distinction between flexibility and adaptability?
- What in your early papers are you now unsure about?
- Design liability under IFOA (IPD)?
- What are the boundaries of Lean Construction?
- What is Lean Construction?
- What are the best terms of payment for Lean Construction project delivery?
- In practice, a CM or GC may already out the MEP contractors to talk together and coordinate ( even contractually require it) – is this not the same as Lean Construction?

***End of Detailed Accounts – Monday May 10, 2010***

## **Detailed Accounts – Tuesday May 11, 2010**

### **8:15 am - 8:45: Other Simulations**

The group discussed simulations that were not played on Monday. In general, simulations tend to either replicate reality (take longer) or those that abstract details and focuses on one principle (take less time) - read the book: Games Trainers Play; and Max Bazerman's: Judgment in Managerial Decision Making )

#### **Flow games**

1. Airplane game (Lego-based one) – Visionary Products
2. Airplane game (paper-based one) – [tabdelha@leanconstruction.org](mailto:tabdelha@leanconstruction.org)
3. LeapCon Game – Rafael Sacks ( Technion ) - [cvsacks@technix.technion.ac.il](mailto:cvsacks@technix.technion.ac.il)
4. Helicopter Game (design of experiment) – Luai M. El-Sabek (University of Toronto) ([Luai.Sabek@utoronto.ca](mailto:Luai.Sabek@utoronto.ca))

#### **Lean Design**

5. Delta Design Game - Dr. Louis L. Bucciarelli at [llbjr@mit.edu](mailto:llbjr@mit.edu)
6. Brad's Design World – Brad Haytt – (Fresno State) - [bhyatt@csufresno.edu](mailto:bhyatt@csufresno.edu)

#### **Team Building; collaboration**

7. Win as much as you can – [ghowell@leanconstruction.org](mailto:ghowell@leanconstruction.org)
8. Build as many roads as you can ( Jerry Tally) – [ghowell@leanconstruction.org](mailto:ghowell@leanconstruction.org)
9. Magic Stick game – [ghowell@leanconstruction.org](mailto:ghowell@leanconstruction.org)

#### **Supply Chain**

10. The Beer Game – [ghowell@leanconstruction.org](mailto:ghowell@leanconstruction.org)

### **8:45am - 10:15am: Questions from Monday's discussions:**

1. Why didn't everyone adopt Lean Construction?
  - a. The shift from what we know to new thinking and the need for theory ( Kuhn; Boyd)
  - b. Challenges:
    - i. Convince top senior management
    - ii. Breakthrough development ( culture resistance)
    - iii. Design and planning phases takes longer time compared to existing but longer term will be better
    - iv. Last Planner System ( consulting is needed)
    - v. Contractual agreement
    - vi. FIDC terms
    - vii. Supply chain
    - viii. Extending Lean to subcontractors

- ix. Owners being on board
  - c. You can't talk people into LC.
    - i. LCI's strategy has been: change the vocabulary so we can talk to them; create killer companies (( data does not convince – specifically data showing possible gains doe not convince, rather it is data showing potential for loss); educate owners when you have the opportunity so they request the right thing.
  - d. Business does not use what science knows (Daniel Pink)...financial incentives reduce performance...people are motivated by challenge in their job ...making money will follow.
- 2. BIM, Sustainability and Lean
    - a. See Wikipedia: Lean Construction under FAQ
  - 3. News from around the world (Lean Construction; LCI)

### **10:30 am – noon: Lean Construction Activities**

- Glenn Ballard (Research) –
  - CII RT271: Redesigning the project delivery process from a blank sheet of paper.
  - Skanska: Impact of lean and VDC combined—joint with Stanford's CIFE
  - Learning from Breakdowns
  - Lean in Public Sector Construction Projects
  - Whole Life Target Value Design
  - California Healthcare Facilities Project: Improving the design and permitting of CA hospitals
  - DOE: Reducing energy consumption in buildings
  - Statoil Meeting the challenges of megaprojects
- Greg Howell: Lean expanding: India Lean Construction Institute, network of Skanska in India and make the networks come together. Envisions LCI to be at the intersection of the three big associations; CURT; AIA; and AGC/ABC – but not a part of any one association
  - CURT interested in Lean Construction and has task force
  - AGC has a Lean Construction Forum
  - AIA came out with IPD but with no Lean Construction emphasis because of considering the application of IPD to be in the domain of methods.
- Dr. Cynthia Tsao is full-time LCI; responsible for setting up streamlined procedures for membership, LCI Chapters, web-based community building, and LC knowledge database.
- Greg want to keep the following going:
  - LCI 2-day intro workshop
  - LCI Forums ( design and academic)
  - LCI research meetings (one on safety, one on relational contracting, and one on LC in the public sector)
  - Lean Construction Journal
- Mike Singleton (CSU) – IPD and Lean Construction in DOD construction projects



- Iris Tommelein (Research): adding to Glenn's reporting that she is interested in collaborating on computer simulation of construction processes.
- Farook: Continuing his PhD work on lookahead planning (simulation to include more on critical activities); exploring Lean Construction in Education ( Implementing an open forum teaching method); involved in the LCI Colorado Chapter; started a lean construction chapter at CSU awaiting further input from LCI to finalize the first LCI student chapter in the nation.
- Marcelo: Working on developing a Lean Construction course. Research in Lean Logistics and Materials Management (match supply and demand); IT support for Lean Construction (Video Cameras and RFIDs); Leadership concepts to manage the work of electrical subcontractors; involved in the LCI Saint Louis Chapter.
- Brad:
  - o Design Assist Case Study - Initial research on a \$200M new hospital project that just completed in Merced, California. The project used a design assist method (hiring the Contractor and key Subcontractors for constructability reviews during the final design phase). This was the first "alternate delivery method" hospital (not a medical office building) to be completed in California. It was also one of the first hospitals that used the Incremental Review process for design approval.
  - o Use of BIM in Scheduling Course - Research the use of BIM in an undergraduate CM scheduling course. The goal is to see if this addition allows students to better understand the "means and methods" of the construction process. I have utilized a 4D construction simulation in current scheduling courses to allow students to "see" the process that they are scheduling.
  - o Working on developing a Lean Construction course.
- Bolivar: Developing a BIM-based model for sharing information across stakeholders; will work on a new simulation of the Dice Game.
- Susan Miller: Getting the course on sustainability and Lean Construction off the ground; stay connected with the LC community.
- Bob Muir: Driven by practice ( bridge and highway work); Looking at how Lean Construction can be implemented in highway construction; interests in role that complexity plays in construction environment (adaptive/complexity) since projects are a social construct
- Francois: The Review of Lean Construction Research Literature Themes & Relationship to the TPS. Presented research framework to the group.
- Euysup Shim: Has plans to incorporate Lean Construction into existing classes, as well as offering a full course at some point. Shared with the group that he learned more about Lean Construction and realized it is more than just the Last Planner System or 'pull scheduling'. Studying the problem of overlap between two contractors and the resulting dependency on the method they each follow. As an example, he stated that when contractor A is followed by contractor B in a finish-to-start relation, then the work

method and progression used by A will not impact B's method/progression. In his mind, this was the only situation that allows the use of pull scheduling. He stated that when an overlap between the two contractors occurs, then the work method/progression of the work by contractor A will affect the methods/progression of work by B. Hence, pull scheduling in this case will not work because contractor B (downstream) will have to follow what contractor A is doing (upstream). The group advice was to consider the problem as a batching problem, and work on contrasting this problem under conventional practice vs. Lean Construction.

- Luai: Looking at Six Sigma in construction (only Bechtel using it). Lean in the Public Sector. Also interested in integrating ERP systems in owner organizations.
- Min: Activity variation at the level of production. Two types ( time-based and work-based) of variation. Working on developing a Lean Construction course.
- Farzad ( not presented due to time): Developing Lean Construction course. Collaborate with UC-Berkeley on research.
- Tariq (not presented due to time): AGC LC Development Program; LC: Bahrain and Malaysia; The MSU Way: Better project delivery; Construction Project Performance Benchmarking – Owner; Vendor performance assessment; POE; LC Maturity Assessment/Evaluation. Focus areas: Managing the unexpected during production (production problems and safety problems) ; Work Crew Design ; Last Planner System; Book on LC with Alan Mossman; LCI Michigan Chapter.

**Questions ( what we don't know and hope someone will work on):**

- What do we don't know?
- What limits the adoption of Lean Construction nationally and internationally?
- Why do some view Lean as a flavor of the month?
- When is the tipping point for Lean Construction and how do we know we're there?
- Why aren't we really learning from breakdowns?
- Is there intrinsic uncertainty in a project that would always prevent us from getting to 100% PPC?
- Impact of IFOA/Lean to insurance/surety premiums.
- How do the Lean Construction Pieces connect together?
- Why is a PPC < 100% acceptable?
- What precision of PPC do we look for ( weekly, daily, hourly, minute) ?
- What would a contingency meter look like?
- Does Lean Construction prevent unethical and corrupt practices?

**Action items:**

- Parade of Trade computer simulation - Bolivar
- Collect descriptions of LC activities from participants – Tariq

6th forum Meeting Minutes

- Meeting minutes – Tariq
- Send simulation games instructions to participants – Greg and Tariq
- Create a FAQ about Lean Construction on LCI website – Greg and Tariq

Plus	Δ
Contact w/community	More specificity on teaching Lean Construction
Lots of new smart people	Ran out of time – go to 2 or 2.5 days
16 attendees	No returning faces
Discussions	More instruction on Last Planner™ System
Everyone spoke their mind	Information about expectation from participants
Excellent bottle of wine	Process benchmarks from last year
Good room fit	Invite more grad students
Open format discussion	
Finding collaborators	