Lean Enterprise Value Simulation Game

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Metis Design and MIT
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The Game

- A simulation of a complex aerospace enterprise
- Philosophy draws heavily on LAI research and the recent book *Lean Enterprise Value*
- Content and cases based on LAI member experience
- Integrated with lecture material to provide intellectual basis, tools, and experiential learning
Game Architecture

• Tables of 4-6 people represent major silos
  • Manufacturing
  • Supplier Network
  • Product Development
  • Each table can be a stand-alone game

• Each person has their own facility, or “Mat”
  • Manufacturing plant
  • Individual 1st or 2nd tier supplier
  • Product Development function

• Game Goals:
  • Build Lego™ aircraft efficiently, make “money”
  • Adapt to changes in supply base and customer need
Manufacturing Table

Plant A Wings \rightarrow 2 \rightarrow Final Assembly

Manufacturing Table

Plant B Tail \rightarrow 1 \rightarrow Plant C Fuselage
Manufacturing Mat

Process Time

<table>
<thead>
<tr>
<th>Part Count</th>
<th>Hourglass Sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3</td>
<td>30</td>
</tr>
<tr>
<td>4-7</td>
<td>60</td>
</tr>
<tr>
<td>8-13</td>
<td>120</td>
</tr>
<tr>
<td>14-21</td>
<td>180</td>
</tr>
</tbody>
</table>

Costs

<p>| | |</p>
<table>
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<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Carry (per round)</td>
<td>60</td>
</tr>
<tr>
<td>Build</td>
<td>240</td>
</tr>
<tr>
<td>Upgrade</td>
<td>240</td>
</tr>
<tr>
<td>Move</td>
<td>90</td>
</tr>
<tr>
<td>Demolish</td>
<td>60</td>
</tr>
</tbody>
</table>

Legacy Manufacturing

Work Process:
Build Assembly:
1) Receive all necessary parts/assemblies from ATTACHED facilities or suppliers to complete ONE assembly
2) Flip process hourglass and build ONE assembly according to build-to specifications
3) Deliver assembly to downstream customer’s receiving when hourglass runs out or part is complete (whichever is longer)

Rework Assembly:
1) Flip process hourglass and do rework to meet specifications
2) Deliver assembly to downstream customer’s receiving when hourglass runs out or part is complete (whichever is later)
Manufacturing Mat

- Explicit work instructions
  - Reinforces process thinking
- System capability represented by hourglass
  - Prevents “racing”
  - Reinforces process thinking
- Costs part of simple economic system

Process Time

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Costs

- Carry (per round): 60
- Build: 240
- Upgrade: 240
- Move: 90
- Demolish: 60

Rework Assembly:
1) Flip process hourglass and do rework to meet specifications
2) Deliver assembly to downstream customer’s receiving when hourglass runs out or part is complete (whichever is later)
Supply Chain

Supplier 5

Supplier 3

Supplier 4

Supplier 1

Plant A
Wings

Final
Assembly

Plant B
Tail

Plant C
Fuselage

Supply Chain
Table
Designed for minimum complexity given advanced lean lessons

- **Manufacturing table**
  - Balancing load distributions, establishing and reducing Takt time
  - Targeted capability improvements at bottlenecks
  - Links to Supply Chain and PD

- **Supplier Network table**
  - Supply chain architecture
  - Transactions (orders management and accounting) burdens
  - Role of visibility across the supply chain

- **Product Development table**
  - Visualizing Process
  - Uncertainty and Iterations
  - Mixed model line with conflicting priorities

- **Enterprise Integration and Adaptability Issues**
  - Relationship development and information system design
  - Learning curve and enterprise change dynamics
  - Multi-stakeholder value proposition creation
The Game as a Teaching Tool

• Game “Scenarios” designed to support learning objective
  • Which modules to use
  • Start point - chaos to almost lean
  • Level of mentoring - free play to dictated improvements
  • Many other variables

• Integration with lecture material and other tools
  • Most effective when interspersed with lean lessons
  • Serves multiple learning styles

• The game provides tactile and experiential lessons in lean
  • “I like how the day was broken up -- lecture/simulation alternating. It made for a more interesting day and less boring. Thanks.”
Example: Lean Enterprise Value Seminar

• A three-day integrated learning experience for advanced students - Summer 2002
• Learning objectives
  • Necessity (and difficulty) of full enterprise lean
  • Big payoffs in cross-functional cooperation
  • Living with change and disruption
• Scenario
  • Entire game (participants “staff” manufacturing, suppliers, and PD)
  • Legacy (very unlean starting position) to Lean transition
  • Active mentoring on game mechanics, but players made their own decisions
  • Early improvements made at individual tables
  • Later improvements made cooperatively across tables
  • Instabilities in supply chain and changing customer needs
Scenes from LEV game

Supplier Network Table

Manufacturing and PD

web.mit.edu/lean
Integrated Learning

Lecture

Peer Learning

Lean Production

web.mit.edu/lean

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Game Simulates Lean Enterprise: Supplier Profits

Local Lean

Enterprise Lean Integration

Profit (per round)

Round

Supplier 1
Supplier 2
Supplier 3
Supplier 4
Supplier 5
Total
Example: Lean Engineering Training

• One day course in basic lean concepts for engineers
• Lecture, film, game
• Learning objectives - understanding how lean applies
  • Understanding and visualizing engineering processes
  • Effect of uncertainties and iterations
  • Effect of “mixed model” production (hard and easy jobs)
• Scenario
  • PD table as stand-alone game
  • Situations modeled on CMMI levels 1, 3, 5 (unlean and unmeasured process to lean, measured, managed process)
  • Active mentoring on game mechanics and improvements
  • “Customer” provides lots of work, demands cycle time improvement
Visualizing Engineering Processes

Design
Design InBox

Analysis
Analysis InBox

Engineering
Sys Eng InBox
Verification InBox
System Engineering
Verification
Understanding the Value Stream

Design InBox
Wait Time:
Cycle Time:
Utilization:
Pass Rate:

Analysis InBox
Wait Time:
Cycle Time:
Utilization:
Pass Rate:

Verification InBox
Wait Time:
Cycle Time:
Utilization:
Pass Rate:
Understanding causes and metrics

Cost

- (G) Capital Improvements: 20%
- (F) Carrying Costs: 49%
- (E) Dots in Inventory: 3%
- (D) Dots on completed jobs: 28%

Time

- Design work: 14%
- Design wait: 19%
- Analysis work: 12%
- Analysis Wait: 30%
- Verification work: 14%
- Verification wait: 11%
Lessons Learned

- Game effective
- Game scenario needs to be adapted to learning objectives
- Time needed to learn mechanics and absorb lessons
- Active mentoring (helping players learn) and mastering (adapting scenario real-time) vital

- Response enthusiastic - game is fun
- Students quickly come up with improvements
- Students map game situations onto real problems

- Good solutions difficult (esp. enterprise integration)
- Communication and collaboration key to success
An Emerging LAI Product

- **LAI-administered workshops**
  - Summer 2002 Lean Enterprise Value 3-day workshop
  - Future workshops depend on demand

- **Training at your site**
  - Lean Enterprise Value training material and scenarios
  - Custom training possible

- **Collaborative relationships**
  - Use the game and other materials in your training
  - Scenario design, train-the-trainer mentoring possible
  - IP policy emerging

- **Please ask us about possibilities**