Lean Enterprise Value Simulation Game

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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**
- **Plant B Tail**
- **Plant C Fuselage**

Diagram: Plant A Wings → 2 → Manufacturing Table → Final Assembly → 1 → Plant B Tail → 1 → Plant C Fuselage
**Manufacturing Mat**

<table>
<thead>
<tr>
<th>Process Time</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Count</td>
<td>Carry (per round)</td>
</tr>
<tr>
<td>Hourglass</td>
<td>Build</td>
</tr>
<tr>
<td>Sec</td>
<td>Upgrade</td>
</tr>
<tr>
<td></td>
<td>Move</td>
</tr>
<tr>
<td></td>
<td>Demolish</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

**Process Time**

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

**Costs**

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

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

**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)

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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
Integrated Learning

Lecture

Peer Learning

Lean Production
Game Simulates Lean Enterprise: Supplier Profits

**Diagram Description:**
- **Title:** Game Simulates Lean Enterprise: Supplier Profits
- **X-Axis:** Round
- **Y-Axis:** Profit (per round)
- **Legend:**
  - Total
  - Supplier 1
  - Supplier 2
  - Supplier 3
  - Supplier 4
  - Supplier 5

**Graph Analysis:**
- The graph shows the profit per round for different suppliers and the total profit.
- Supplier 1 and Supplier 2 have similar profit trends, with Supplier 1 slightly higher.
- Supplier 3 and Supplier 4 have more fluctuating profit trends.
- Supplier 5 has a distinct profit trend, starting lower and increasing sharply in the later rounds.
- The overall total profit shows a pattern of fluctuations.

**Conclusion:**
- The game simulates lean enterprise by highlighting the profit trends of different suppliers and the total enterprise profit integration.
- The enterprise lean aspect is indicated by the sharp increase in profit for Supplier 5 in the later rounds.
- Local lean is shown by the fluctuating profit trends for Suppliers 3 and 4.

**Additional Information:**
- The graph is sourced from the Lean Aeronautics Initiative (LAI) at MIT.
- The website link is provided: web.mit.edu/lean
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

Analysis

Verification

InBox

InBox

InBox

InBox
Understanding the Value Stream
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**

- Verification work 14%
- Design work 14%
- Design wait 19%
- Analysis work 12%
- Verification wait 11%
- Analysis Wait 30%
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 member sites
  • One day Lean Engineering training in v1.0 state at member site
  • Game experience as part of 10 day lean training in development

• 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