Lean Manufacturing

Overview and Perspectives on Lean Methods and Tools
Lean Building Blocks

Continuous Improvement

Teams  Pull/Kanban  Cellular/Flow

Changeover Reduction  Batch Reduction

Visual Control  Supermarkets  Quality

5S  Standard Work  Plant Layout

October, 2010
5 “S” – The 5 Pillars of the Visual Workplace

- **Sort** – Organization by placing red tag on all unneeded items and moving them to a temporary area to be disposed, sold, or given away. “When in doubt, through it out”

- **Set in Order** - Orderliness to the remaining items. “A place for everything and everything in its place”.

- **Shine** - Cleanliness inside and out. Dirt, grime, and oil are the first indicators of problems --- make it easy to see when things get dirty.

- **Standardize** – Create rules and audits for maintaining the first 3 S’s. Use visual controls.

- **Sustain** - Discipline to adhere to rules and audits. “It takes 21 days to break an old habit”.

October, 2010
Place for everything
Clean as a Hospital!
Lean Building Blocks

Continuous Improvement

- Teams
- Pull/Kanban
- Cellular/Flow
- Changeover Reduction
- Batch Reduction
- Visual Control
- Supermarkets
- Quality
- 5S
- Standard Work
- Plant Layout

October, 2010
Standard Work

- Operations safely carried out with all tasks organized in the best known sequence, using the most effective combination of:
  - People
  - Materials
  - Methods
  - Machines
<table>
<thead>
<tr>
<th>No.</th>
<th>Work Elements</th>
<th>KEY POINTS</th>
<th>Time Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Icon Safety, Quality, Technique, Cost</td>
<td>Auto Manual</td>
</tr>
<tr>
<td>1</td>
<td>Pull veneer on to table</td>
<td>◆ Check for moisture and buckle</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moisture content is to be not greater than 14%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>If MC is greater than 14% set aside for return</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>to vendor</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cut to length</td>
<td>◆ Use both safety buttons to operate head clipper</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cut to length to optimize yield and quality (Refer to cutting guidelines)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Inspect and stack down</td>
<td>◆ Inspect cuts and re-cut if necessary</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>◆ Use proper lifting techniques</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>◆ Stack off-fall onto carts</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>◆ Sign first name to Kanban</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Return to number 1</td>
<td>◆ Place scrap in proper area</td>
<td>7</td>
</tr>
</tbody>
</table>
Lean Building Blocks

Continuous Improvement

- Teams
- Pull/Kanban
- Cellular/Flow

- Changeover Reduction
- Batch Reduction

- Visual Control
- Supermarkets
- Quality

- 5S
- Standard Work
- Plant Layout

Value Stream Mapping

October, 2010
Plant Layout
Spaghetti Diagram
Lean Building Blocks

Continuous Improvement

- Teams
- Pull/Kanban
- Cellular/Flow
- Changeover Reduction
- Batch Reduction
- Visual Control
- Supermarkets
- Quality
- 5S
- Standard Work
- Plant Layout

Value Stream Mapping
Visual Control
## Panel Saw Cutting Visual

<table>
<thead>
<tr>
<th>9 3/4</th>
<th>9 3/4</th>
<th>36 13/16</th>
<th>36 13/16</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 3/4</td>
<td>9 3/4</td>
<td>9 3/4</td>
<td>9 3/4</td>
</tr>
<tr>
<td>21 3/4</td>
<td>21 3/4</td>
<td>24 13/16</td>
<td>24 13/16</td>
</tr>
<tr>
<td>18 1/4</td>
<td>24 3/4</td>
<td>24 3/4</td>
<td>24 3/4</td>
</tr>
<tr>
<td>18 1/4</td>
<td>18 1/4</td>
<td>18 1/4</td>
<td>18 1/4</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>36 3/4</td>
<td>36 3/4</td>
</tr>
<tr>
<td>18 1/4</td>
<td>36 3/4</td>
<td>36 3/4</td>
<td></td>
</tr>
<tr>
<td>18 1/4</td>
<td>18 1/4</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>24 3/4</td>
<td>24 3/4</td>
<td>36 3/4</td>
<td></td>
</tr>
<tr>
<td>24 3/4</td>
<td>30 3/4</td>
<td>36 3/4</td>
<td></td>
</tr>
<tr>
<td>30 3/4</td>
<td>30 3/4</td>
<td>30 3/4</td>
<td></td>
</tr>
</tbody>
</table>

Lean Manufacturing for the Wood Products Industry  
Wood Education and Resource Center --- Princeton, WV  

October, 2010
Visually controlled WIP off-fall
Supermarkets

- Visual control --- Like shelves in a supermarket, stock is replenished based on demand (customers go there to “shop”)
- Communication between links in value stream (suppliers-customers) w/o a written production schedule
- “Supermarket” has limited capacity to minimize WIP and/or finished goods inventory
- “Kanbans” can be used to signal supplier process to produce more
Parts Supermarket
Lean Building Blocks

Continuous Improvement

- Teams
- Pull/Kanban
- Cellular/Flow
- Changeover Reduction
- Batch Reduction
- Visual Control
- Supermarkets
- Quality
- 5S
- Standard Work
- Plant Layout

Value Stream Mapping

October, 2010
Quality at the Source

- **Source Inspection:** Operators are certain that product they pass to the next workstation is of acceptable quality
- Operators must be given the tools to perform inspection
- Goof proof wherever possible!
- Samples or established standards can be used as visible tools
- Documentation defining quality inspection standards may need to be developed
Goof Proofing

Before

After
Mineral Streak – May be used in natural finished products (Summerhill) for face or back material.
<table>
<thead>
<tr>
<th>No.</th>
<th>Work Elements</th>
<th>KEY POINTS</th>
<th>Time Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspect machine</td>
<td>Keep hands clear of moving parts, pinch points and sawblades</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check machine to ensure Gang Rip is operational</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Set daily program</td>
<td>Set machine to rip sizes needed for days</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Individual Spacers fabricated for each select cut</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Deal boards from Planner</td>
<td>Deal boards using foot control under terminal</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use keypad to operate lasers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Place bowed wood in staging area properly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trim as little as possible off board to ensure high yield and efficiency</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Deal single boards into Gang Rip staging</td>
<td>Watch for splinters</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Be careful not to mash fingers</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Determine cut of board using lasers and</td>
<td>Use keypad to operate lasers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>keyboard</td>
<td>Place bowed wood in staging area properly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trim as little as possible off board to ensure high yield and efficiency</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Deal board into Gang Rip</td>
<td>Keep hands clear of all moving parts and pinch points</td>
<td>8.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deal boards using keypad</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check periodically to maintain steady flow of material to Moulder and Dept. 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Buffer zone should be utilized to keep steady flow of material through Gang Rip</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Return to step 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**
- **SAFETY/ERGO**
- **IN-PROCESS STOCK**
- **QUALITY CHECK**
- **POKA YOKE**
- **Work Element Walking**
- **Return to start**

**Totals:** 24.5
Lean Building Blocks

Continuous Improvement

Teams | Pull/Kanban | Cellular/Flow
Changeover Reduction | Batch Reduction
Visual Control | Supermarkets | Quality
5S | Standard Work | Plant Layout

October, 2010
Changeover Reduction

- Definition: The time between the last good piece off the current run and the first good piece off the next run

- Before Shigeo Shingo’s “Single Minute Exchange of Die” (SMED), typical setup tasks and time breakdowns:
Lean Building Blocks

Continuous Improvement

Teams  Pull/Kanban  Cellular/Flow
Changeover Reduction  Batch Reduction
Visual Control  Supermarkets  Quality
5S  Standard Work  Plant Layout

October, 2010
Fake Flow

- Extra material, space, people, lead time
- Processes moved closer together in a “module,” but no true continuous flow
- Stations operate independently as “isolated islands”
- Inventory accumulates between processes
- Operators process batches
Impact of Batch Size Reduction

Continuous Flow Processing
Batch & Push Processing

Process A: 10 minutes

Process B: 10 minutes

Process C: 10 minutes

Lead Time: 30++ minutes for total order, First part: 21 minutes

Continuous Flow “make one, move one”
Lean Building Blocks

Continuous Improvement

- Teams
- Pull/Kanban
- Cellular/Flow
- Changeover Reduction
- Batch Reduction
- Visual Control
- Supermarkets
- Quality
- 5S
- Standard Work
- Plant Layout
- Value
- Stream
- Mapping

October, 2010
Cellular Manufacturing

- Cells are “mini factories” within the system
  - Typically u-shaped
  - Cross-trained workers
  - Continuous or one-piece flow (i.e., no WIP)
  - Unique standard work and performance metrics
  - Built-in flexibility
1-piece flow through Cell operations
Cellular Manufacturing

Key:
- Solid line: Product flow
- Dashed line: Worker route
Takt Time

- The production pace needed to meet demand
- The “heart beat” of the system
- Unique to each value stream/product family
- A method of smoothing production by synchronizing production with the rate of demand
Example

- Available work time/day = 460 min.
- Demand/day = 920 parts/day
  - Takt time = Available Time/Demand
  - Takt time = 460/920 = 0.5 min/part
  - Takt time = 30 seconds per part

- Interpretation:
  - Customer is buying a part every 30 s
  - Target rate of production should be a part every 30 s
Staffing the Cell and Balancing the Work

Current Operator Balance

- **takt time**: 30 s
- **A**: 5s
- **B**: 10s
- **C**: 15s
Staffing the Cell and Balancing the Work

After a cellular redesign...

takt time
30 s

Cell lead time = 30 s
Value added time = 30 s

October, 2010
Design and Construct Cell

- **Goals**
  - Flexibility, make one-move one, visual controls, standard work, Point-of-Use-Storage
  - Simplify flow, materials flow one way
  - Minimize material handling (eliminate NVA)
  - Make use of people 100 percent
    - A machine can wait on a person but a person should never wait on a machine
Lean Building Blocks

Continuous Improvement

- Teams
- Pull/Kanban
- Cellular/Flow
- Changeover Reduction
- Batch Reduction
- Visual Control
- Supermarkets
- Quality
- 5S
- Standard Work
- Plant Layout

October, 2010
Push vs. Pull Systems

- Push System
  ✓ Resources are provided to the consumer based on forecasts or set schedules

- Pull System
  ✓ A method of controlling the flow of resources by replacing only what has been consumed
Pull Systems

- Flexible and simple method of controlling and balancing the flow of materials and information
  - Eliminates/reduces the 7 forms of waste

- Characteristics of pull systems:
  - Production based on actual consumption
  - Small batches
  - Low inventories
  - Visual controls
  - Better and simpler communication
Pull System Illustration

Supplier

Process A

Process B

Process C

Customer

Material Flow

Information Flow
Kanban Pull System Example – line balancing
Lean Building Blocks

Continuous Improvement

Teams  Pull/Kanban  Cellular/Flow
Changeover Reduction  Batch Reduction
Visual Control  Supermarkets  Quality
5S  Standard Work  Plant Layout

October, 2010
Teams ---
Lean Workforce Practices

- Rotation of highly specified jobs
- Cross-trained and multi-skilled employees
- Embrace and live the continuous improvement (lean) philosophy
- Process quality, not inspection
- Participation and empowerment
Leadership Development Through Teams

Front Row
- Viral Shah
- Sarah Moore
- Dee Dee Mullins
- Dennis Armstrong

Back Row
- Leon Powers – Facilitator
- Greg Akers
- Earl Kline
- Dave Prater - Team Leader
Lean Building Blocks

Continuous Improvement

Teams  Pull/Kanban  Cellular/Flow
Changeover Reduction  Batch Reduction
Visual Control  Supermarkets  Quality
5S  Standard Work  Plant Layout

Value
Stream
Mapping
The Challenge

“Change is never easy... particularly when things are going well”

“By re-inventing ourselves...and our companies...regularly...we will better serve our customers...prosper...and preserve our planet for future generations.”

Fujio Cho
Past President
Toyota Motor Corporation
Additional Resources

- Rother and Harris. 2001. Creating Continuous Flow. Version 1.0. Lean Enterprise Institute, Brookline MA.
- Better Thinking, Better Results. Bob Emiliani. 2007. The Center for Lean Business Management, LLC.
Web Resources

- Lean Enterprise Institute: www.lean.org
- Shingo Prize: www.shingoprize.org
- American Society for Quality: www.asq.org
- National Performance Review: govinfo.library.unt.edu/npr/index.htm
Virginia Tech Resources

**LEAN Club**

is a platform for **lean practitioners** to cultivate knowledge and experience regarding lean transformations.

**LEAN**

is a **student-driven**, faculty-supported initiative to help organizations become more efficient and more competitive.

➡️ Contact us at www.vtlean.org
How do you get started?

- Create a sense of urgency
- Get the right people on the bus and in the right seats
- Value Stream Mapping (VSM)
- Kaizen Events
  - 5S
  - Setup time reduction
- Create a learning environment for sustainable change

source: Lean@Virginia Tech
## Conclusions

**Lean Thinking**

- ✓ How do we deliver value the customer wants?
- ✓ Quality is free
- ✓ Reducing environmental impact is free
- ✓ Workers are experts
- ✓ Mistakes are studied to guide improvement
- ✓ Inventory is waste
- ✓ Do it right the first time

**Traditional**

- ✓ How do we sell our products to customers?
- ✓ Quality costs
- ✓ Reducing environmental impact costs
- ✓ Managers are experts
- ✓ Mistakes are accepted as part of the business
- ✓ Inventory is value
- ✓ It’s close enough
THANK YOU!

“The significant problems we face cannot be solved by the same level of thinking that created them”

Albert Einstein