Lean Ergonomics: Successful Implementation Within a Kaizen Event

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Lean Manufacturing

- Definition – producing only what is needed, when it is needed

- Values:
  - Flexibility
  - Quality
  - Productivity
Three Principles of Lean

1. Let the customer say what is of value to them
2. Reduce waste (non-value added activities) causing process speed to increase
3. Improved process positively relates to:
   - Less waste
   - Less cost
   - Less work in progress
   - Less complexity
   - Higher quality
   - Satisfied customers

(Tischler, 2006)
Lean and Toyota Production System
14 Fundamental Concepts:

- Genchi Genbutsu
- Shugi
- Visual Management
- Normal or Abnormal
- Total Productive Maintenance
- Kaizen
- Find Problems
- Leadership
- 5S
- Safety
- Cross-train
- Self-education
- Teams
- Communication
- Quality

(Mika, 2006)
Expected Outcomes of Lean

- Improved process
- Improved work conditions
- Meeting the organizations needs and purpose

(Tischler, 2006)
Lean and Ergonomics

- Safety and ergonomics should be one of the core values of the lean process

- Seven Factors of Integration:
  - Identify work process to improve
  - CTD risk assessment
  - Stakeholder involvement
  - Ergonomics training
  - Ergonomic design
  - Quantifying the impact of ergonomic changes
  - Creating shared belief for the benefit of ergonomics

(Wilson, 2005)
Implementation of Lean may be done through use of a Kaizen Event
Identify and Eliminate Waste

“Waste Not Only Occurs in the Plant, It Occurs in Your Body!”

- Waste of motion that does not add value
  - Can lead to muscle fatigue
- Waste of manual effort
  - Can lead to muscle fatigue
- Waste of movements to transport material
  - Can lead to muscle fatigue and strains
- Waste of time to rework, repair, or scrap
  - May be related to fatigue, strains or sprains
    - Focus on self and not on job
Case Study

HARLEY-DAVIDSON

CONCORDIA UNIVERSITY WISCONSIN

HAYES BRAKE
WMSD Problems at HBI

- Neck Strain
- Shoulder Strains
- Elbow tendonitis
- Low back strain, disc problems
- Carpal tunnel syndrome
- Knee pain
- Ankle sprains
Industry Standards


- Private industry averages 28.8 per 10,000 FTE’s
- Motorcycle and Bicycle parts average 221.8 per 10,000 FTE’s

- 10X greater incidence rate
Kaizen Event Description

- 5 Day Event
- Two distinct phases made up the kaizen event:
  - Education of participants in ergonomics and kaizen process
  - And process implementation
Kaizen Event Description

- Kaizen co-leaders directed assignment of individuals to one of three teams.
  - Forecasting, Time Observation, or Layout.
  - Machining and assembly cell employees were represented on all teams.
  - Other individuals were assigned to teams based on expertise.
Pre Kaizen Ergonomics

- Ergonomics team evaluated production using the **OSHA risk factor checklist** (OSHA, 1995).
  - Workers video recorded on-site (at least 10 production cycles)

- **Risk Factor Scoring**
  - Individual raters scored each risk factor
  - Final score for each risk factor based on rater consensus.
  - Risk factor scores summed within checklists
  - A total score of more than 5 points indicated a "problem job" and employer needed to "control the job" (OSHA Draft Proposal, 1995).

- Identified specific risk factors in “problem jobs” and developed list of potential interventions.
<table>
<thead>
<tr>
<th>Risk Factor Category</th>
<th>Risk Factors</th>
<th>2-4 hrs</th>
<th>4+ to 8 hrs</th>
<th>8+ hrs</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetition</td>
<td>Identical or Similar motions performed every few seconds (reps every 15 secs or &lt;)</td>
<td>1</td>
<td>3</td>
<td></td>
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</tr>
<tr>
<td>Hand Force</td>
<td>Grip more than 10 lb. load (power grip)</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
<td>Hand Force</td>
<td>Pinch more than 2 pounds (pinch grip)</td>
<td>2</td>
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<tr>
<td>Awkward Postures</td>
<td>Neck: Twist/bend (&gt;20 degrees for fwd, side to side; &gt;5 degrees back)</td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>Contact Stress</td>
<td>Hard/Sharp Objects press into the skin</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Vibration</td>
<td>Sitting/standing on vibrating surface (without dampening)</td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>Environment</td>
<td>Cold temperature (sedentary &lt;60 deg.; light &lt;40 deg.; mod/heavy &lt;20 deg; cold blowing on hands)</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Control over workspace</td>
<td>No control over workspace (machine-paced, piece rate, constant)</td>
<td>1 (one control)</td>
<td>2 (two or more controls)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total score:</td>
<td></td>
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</tbody>
</table>
Group Tasks

- Forecasting
- Time Observation
- Layout
Forecasting

- Determine takt times
  - Available work / consumer demand
- Packaging issues (size and quantity)
  - incoming
  - in-process (WIP)
  - finished (outgoing) goods
- First In - First Out (FIFO) materials flow
Time Observation

- **Production cycle times (build & finish)**
  - (2nd and 4th days of the Kaizen)
  - Average production cycle time for 20 pieces
  - Cycle time used with production estimates from Forecasting team

- **Worker movement patterns measured**
  - Followed movement of workers on the floor during machining and assembly
  - (measuring wheel)
Layout

- Utilized scale models of the operation footprint, machines, and stock to draft a new layout

- Goals
  - Optimize one piece flow, FIFO, point of use for incoming materials, access to aisles (materials and assemblers), and incorporate ergonomics principles
<table>
<thead>
<tr>
<th>Team</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecasting</td>
<td>Orientation</td>
<td>Production</td>
<td>Production</td>
<td>Sort area</td>
<td>Presented</td>
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<tr>
<td>Time</td>
<td>Orientation</td>
<td>MTM</td>
<td>Run</td>
<td>Timed</td>
<td>Presented</td>
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<td>Observation</td>
<td>Measure</td>
<td>REDesigned</td>
<td>trials of</td>
<td>new cell</td>
<td>Findings</td>
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<td>travel</td>
<td>line</td>
<td>distance</td>
<td>Measure</td>
<td>travel</td>
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<tr>
<td>Layout</td>
<td>Orientation</td>
<td>Redesign</td>
<td>Modify</td>
<td>Modify</td>
<td>Presented</td>
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<td>cell</td>
<td>design</td>
<td>design</td>
<td>Findings</td>
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<td>Set-up cell</td>
<td>Re-set cell</td>
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<td>Ergo Team</td>
<td>Presented</td>
<td>With</td>
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<td>Presented</td>
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<td>line. CUW 2007</td>
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</table>
Prototype trays allowing vertical instead of horizontal handle orientation/presentation to worker.

- Significantly decreased horizontal reach
Forecast – Ergonomic Results

Recommended replacing wire parts baskets (capacity 300 parts), used with WIP, with plastic trays (capacity 15 parts) and roller bases.

- Allowed the integration of a parts washer decreasing material handling.
  Also facilitated future implementation of roller trays for part presentation at assembly.
Pre-Kaizen
Post-Kaizen
Layout – Ergonomic Results

Modifications made regarding parts presentation to the workers:

- orientation of parts trays was changed from horizontal to approximately 30 degrees angled toward the worker,
Post-Kaizen
Post-Kaizen
Post-Kaizen
Results

- Time Observation
  - cycle time capable of meeting the estimated takt time provided by the Forecasting group
<table>
<thead>
<tr>
<th>Shift</th>
<th>Pre-Kaizen</th>
<th>Post-Kaizen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>4 Operators</td>
<td>3 Operators</td>
</tr>
<tr>
<td>2nd</td>
<td>3½ Operators</td>
<td>3 Operators</td>
</tr>
<tr>
<td>3rd</td>
<td>1 Operator</td>
<td>0 Operators</td>
</tr>
</tbody>
</table>

- Eliminated the requirement of three shifts of production to meet takt time.
- Reduced the number of operators to meet takt time.
- Savings of $83,329.00/yr.
  - 1896 hours available
  - $17.58 Labor rate
  - 2.5 operators
  - = savings of $83,329.00/yr
Results

- **Layout**
  - Changes in machine layouts and storage resulted in $353^2$ ft reduction of assembly area footprint.
LAYOUT BEFORE KAIZEN USED AN AREA OF 965 SQUARE FEET FOR ASSEMBLY.

AFTER THE KAIZEN THE ASSEMBLY AREA USES AN AREA OF 612 SQUARE FEET.
Post-Kaizen
Results

- **Layout**
  - Reduced travel distance for machining, build, and final.
  - Machine layout incorporated sub-assemblies into the line and made worker movement patterns more consistent during build and final assembly.
Travel Totals

- **Pre-kaizen**
  - Machining: 3006 ft/day
  - Build: 7324 ft/day
  - Final: 7176 ft/day
  - Sub-assembly: 851 ft/day
  - Total: 18357 ft/day

- **Post-kaizen**
  - Machining: 1806 ft/day
  - Build: 5732 ft/day
  - Final: 3850 ft/day
  - Water spider: 2103 ft/day
  - Total: 13491 ft/day

Savings = 1 Mile per day
Pre-Kaizen (Spaghetti)
Post-Kaizen (Spaghetti)
Pre-Kaizen
Post-Kaizen
Layout – Ergonomic Results

Modifications made regarding parts presentation to the workers:

- parts trays were attached to the machines between elbow and shoulder height,
- sub assembled parts were moved closer to point of use
Post-Kaizen
Pre-Kaizen
Post-Kaizen
Post-Kaizen
Ergonomic Team Results

- Ergonomic modifications facilitated through involvement in the layout and time observation teams resulted in significant changes in the OSHA checklist risk factor scores.

- On average **84% reduction in checklist scores**.
  - The most dramatic reduction in scores occurred in the piston assembly/insertion components of the manufacturing process.
# OSHA Checklist Scores

## Tasks

<table>
<thead>
<tr>
<th>Tasks</th>
<th>OSHA UE scores</th>
<th>OSHA LE scores</th>
<th>OSHA MMH scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pistons Assembly/Insertion</td>
<td>Before 29, After 5</td>
<td>Before 17, After 0</td>
<td>Before 18, After 2</td>
</tr>
<tr>
<td>Final Assembly</td>
<td>Before 11, After 3</td>
<td>Before 8, After 0</td>
<td>Before 12, After 4</td>
</tr>
</tbody>
</table>

Average decrease - 15.5 points (range 24-7)
Ergonomic Improvements

- Improved work postures
  - Incline tabletop of work surfaces
  - Reorientation of part bins
  - Pallet pal – adjustable height
- Reduced manual materials handling
  - Reduced tray size
  - Eliminated need to carry water
Ergonomic Improvements

- Reduced reaches
  - Changed packaging
  - Reorientation of workstations
  - FIFO storage
  - Tombstone modification
- Improved work/rest cycles
- Outsourcing/Incorporation of subassemblies
Summary

- Participatory ergonomics model was used where the ergonomics team acted to facilitate, support, and advise the teams they were working with.

- Interaction between ergonomics team and other teams, allowed for integration of ergonomic principles within the lean implementation process.
Summary

- Ergonomics and forecasting teams interactions facilitated changes in packaging and material flow quantities resulting in:
  - reduced ergonomic risk factors for MMH.
  - reduced upper extremity scores (reducing reach requirements 2nd to smaller WIP quantities.)
Ergonomics and time observation team interactions resulted in reduced travel distances and MMH requirements (implementation of a parts washer in the machining process).

Ergonomics and layout teams interactions resulted in reduced upper extremity risk factor scores within Build and Final Assembly (changes in parts presentation and materials delivery to assembly).
Lean and Ergonomics

- Both require participation at all levels
- Both modify the work environment
- Both are processes involving change
- Both modify worker interface with the work environment
- Both benefit worker and employer
- Both are ongoing processes
Lean and Ergonomic Benefits

- Improved efficiency
- Improved productivity
- Improved profitability
- Improved safety
- Reduce waste

(Kincaid, 2004)
Questions?