Application of New Ergonomic Tools and Methods to Lean, Ergonomics and Six Sigma (LESS)

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Objective & Agenda of Workshop

• Present some new tools and methods specifically designed to integrate ergonomics into Lean Six Sigma systems
  • Tools and methods to quantify risk, measure human performance, determine the impact of solutions, and demonstrate return-on-investment.

• Operational Human Excellence
  • Lean Manufacturing, Six Sigma, Risk Management, & How Ergonomics fits into it all
Evolution of Ergonomics

- Ramazinni
- Industrial Revolution
  - Agricultural Vs. Mfg based society
    - Frederick Taylor, Henry Ford, F. & J. Gilberth
  - Human Factors Engineering / Applied Research
  - OSHA & Injuries
- What about internal Productivity?
  - Doing the same or more amount of work with less effort and within the confines of the human musculoskeletal, physiological and psychological systems.
Internal Productivity

80% reduction in lifting capacity as horizontal distance increases
Company Goals:
- Improve efficiency of operations
- Reduce defects related to the quality of products
- Introduction of new products/services quicker to market
- Basically – how to do what we do better, faster and cheaper

Problem – What do employees want?
Future State of Ergonomics

• Facts and data must drive the process

• Align with board room objectives and demonstrate impact ergonomics has on company goals:
  • Better, Faster, Cheaper and Safer

• Calculate the actual “Value to Operational Human Excellence” to create “pull” not “push
Lean

Eliminating “waste or wasteful activities”

- Transportation
- Inventory
- Motion
- Underutilization
- Waiting
- Defects
- Over-processing
- Over-production

Eight Wastes

Waste of Motion impacts external & internal productivity

How do you find “Waste” related to hidden human performance issues?
Six Sigma

Uses a robust process known as DMAIC:

- **Define**: Identify problems
- **Measure**: Describe condition
- **Analyze**: Determine root cause(s)
- **Improve**: Propose solutions, prepare action plans, implement improvements
- **Control**: Verify results, control, document, communicate and identify additional opportunities

Long Term Implementation
Where Do People Fit Into LSS?

- People are biggest source of quality, productivity, variation and cost.

- Minimizing NVA waste/overburden related to people, and creating consistent/repeatable processes we can improve production, quality, reduce costs and improve health & safety.

Are You Really World Class in Ergonomics & Human Performance?
Lean Ergonomic Six Sigma Tools

Control, Sustain, & Scale Solutions
- Best Practices – FORM
- Training & Standard Work Instructions
- Design Guidelines
- Ergo DFM/DFA/DFLSS
- Control Plan & Charts

Define The Issues
- Current Injury Data (injuries, costs, rates)
- Employee Comments/Feedback
- Production & Quality Issues

Improve Process & Verify Results
- Solution Impact Chart
- Action Plan
- Rapid Prototyping
- Test & Evaluation

Analyze Solutions
- Ergo Fishbone
- Brainstorm/Opportunity List
- Impact Analysis – PICK Chart, REBAR, PIPE
- Solution Matrices

Measure The Problem (Baseline)
- Pareto Analysis of Injuries
- B&W of Cycle Time Variation
- Ergo Value Stream Map (Risk Map)
- Task Analysis – VA, NVA
- Link Analysis/Spaghetti Diagram
- Ergo Risk Assessment – REBAR
- Process Capability

Best Practices
- FORM
- Training & Standard Work Instructions
- Design Guidelines
- Ergo DFM/DFA/DFLSS
- Control Plan & Charts

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Define & Measure Problem

Define

Measure

REBAR Scores

<table>
<thead>
<tr>
<th>P10 Preservation Technicians / Painters</th>
<th>Left Wrist</th>
<th>Right Wrist</th>
<th>Left Elbow</th>
<th>Right Elbow</th>
<th>Left Shoulder</th>
<th>Right Shoulder</th>
<th>Back</th>
<th>Neck</th>
<th>Legs</th>
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<tr>
<td>AB AL False Decking</td>
<td>43</td>
<td>43</td>
<td>40</td>
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<td>43</td>
<td>43</td>
<td>20</td>
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<tr>
<td>Lube Oil Tank Prep</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>57</td>
<td>57</td>
<td>20</td>
<td>47</td>
<td>27</td>
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<tr>
<td>Tanks 5-78 2F &amp; 1F – Grinding</td>
<td>53</td>
<td>53</td>
<td>53</td>
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<td>57</td>
<td>57</td>
<td>28</td>
<td>53</td>
<td>40</td>
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<tr>
<td>Engine Room 1 – Prep for Paint</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>50</td>
<td>50</td>
<td>36</td>
<td>47</td>
<td>40</td>
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<tr>
<td>Engine Room 1 – Hot Work Rapid Response</td>
<td>30</td>
<td>30</td>
<td>23</td>
<td>27</td>
<td>20</td>
<td>33</td>
<td>22</td>
<td>40</td>
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</tr>
</tbody>
</table>
Measure – Task Analysis VA vs. NVA

- Graphs showing time distribution for different tasks.
- Pie chart illustrating the percentage of NVA, BNVA, and Value-Add time.

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Analysis - Fishbone Diagram

Equipment
- Old Tools – High Vibration
- Match Consumable To Tool
- Poor Tool Maintenance

Materials
- Wrong Consumable
- Metal Quality
- Upstream Processes
  - Welding, Bending, Forming

Method / Process
- Standard Process
  - finish
  - blend vs. whole
- NVA steps
  - wrong abrasive = scratches
  - Over processing = polish apple
  - Upstream processes
    - Grind sick @ table
    - Grind sink prior to dresser

People
- Training
  - Feeds, Speeds, Pressure
- Tool Variation / Right Tool
  - too many options
- Preventative Tool Maintenance
  - daily oiling
  - return tools to Tool Crib

Equipment & Materials
- REBAR
  - High Risk
  - Body Part
    - Hand- Wrist
    - Elbow
  - Ergo Risk Factor
    - Vibration

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Analysis - Impact Prioritization

Solutions prioritized based on lean metrics, ergo impact, cost, resources, operational efficiency

<table>
<thead>
<tr>
<th>Improvements Impact on Lean Metrics</th>
<th>40%</th>
<th>20%</th>
<th>25%</th>
<th>50%</th>
<th>Ergonomic Risk</th>
<th>Motion impact (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quick Connectors, Future based Sliding Barbie</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>0.96</td>
</tr>
<tr>
<td>2. Have suspension operators pull未来 into future</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>0.72</td>
</tr>
<tr>
<td>3. In-cell with Future to assist operation</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>1.0</td>
</tr>
<tr>
<td>4. Move say stack controller to be within 90° of Future on the left side</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>0.72</td>
</tr>
<tr>
<td>5. Maintain air gap and timet for pallet to activate</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>3.72</td>
</tr>
</tbody>
</table>

Definitions:

- **COST**:
  - Low cost ≤ $500
  - Moderate cost $500 - $2,000
  - High cost ≥ $2,000

- **DIFFICULTY TO IMPLEMENT**:
  - Easy to implement – Quick out of the shelf
  - Moderate – Lean process
  - Difficult – VIP process validation

### Solutions

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Impact Ranking</th>
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</thead>
<tbody>
<tr>
<td>Mechanized Grinding</td>
<td>3.1</td>
</tr>
<tr>
<td>Grinding Carts/Tool Ext</td>
<td>2.85</td>
</tr>
<tr>
<td>Tool Maintenance - PM</td>
<td>2.75</td>
</tr>
<tr>
<td>Double Grinding</td>
<td>2.7</td>
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<tr>
<td>Daily Tool Maintenance</td>
<td>2.5</td>
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<tr>
<td>Grind To Spec</td>
<td>2.5</td>
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<tr>
<td>DFA/DFM, Lean Six Sigma</td>
<td>2.45</td>
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<tr>
<td>Grinding Reduction Team</td>
<td>2.45</td>
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<tr>
<td>Upstream Processes</td>
<td>2.45</td>
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<tr>
<td>Tool Monopod</td>
<td>2.4</td>
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<tr>
<td>Behavior Based Training</td>
<td>2.35</td>
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<tr>
<td>Right Tool Right Job</td>
<td>2.35</td>
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<tr>
<td>Tool Training</td>
<td>2.35</td>
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<tr>
<td>Task Rotation</td>
<td>2.2</td>
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<td>Ergo Tools</td>
<td>2.15</td>
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<tr>
<td>Swivel / quick disconnects</td>
<td>2.05</td>
</tr>
<tr>
<td>Foot Pedal for Man Lift</td>
<td>2</td>
</tr>
<tr>
<td>Anti-vibratory Gloves</td>
<td>1.9</td>
</tr>
<tr>
<td>Grip Gloves</td>
<td>1.9</td>
</tr>
<tr>
<td>Tool Balancers</td>
<td>1.75</td>
</tr>
</tbody>
</table>
Improve

Cell View

Workstation View
Verify & Control

Initial
82% high risk tasks
38% high risk body parts

Follow Up
35% high risk tasks
13% high risk body parts

65% Reduction in Risk
40-60% Time Savings
Summary

- Understanding root cause of ergonomic issues is key in creating the long-term vision
- Linking ergonomic risk reduction to board room goals will ensure a long-term “pull”
- Integrating ergo into LSS is truly moving towards “Operational Human Excellence”
- Take time & effort - results are so worth it