Wrapper Line Improvement

Six Sigma Project
Final Tollgate Presentation

Define  Measure  Analyze  Improve  Control

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Problem: The Wrapper Final Assembly Line is experiencing long lead times (Avg = 40 hours) and high variability (SD = 11.5 hours) in delivery over the past three months. This increases the production cost per unit.

Goal: To improve lead times 35%, from 40 hours to ~26 hours, while maintaining final product quality.

Cost savings of $660 per unit
- Current labor cost per unit = $2,128
- Future labor cost per unit = ~$1,450
- Annualized cost savings = ~$165,000 (250 units)

Gate Review Schedule

<table>
<thead>
<tr>
<th>Tollgate</th>
<th>Scheduled</th>
<th>Complete</th>
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<tbody>
<tr>
<td>Define</td>
<td>11/12/2013</td>
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<tr>
<td>Measure</td>
<td>12/13/2013</td>
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<td>Analyze</td>
<td>2/7/2014</td>
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<tr>
<td>Improve</td>
<td>2/19/2014</td>
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<tr>
<td>Control</td>
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Define Phase

1) Average E2E Mfg Lead Time
   - Avg = 40 hours, Std Dev = 11.5 hours
   - Digital method for station and E2E lead time

2) Weekly Defects Per Unit
   - Avg DPU = 1.54
   - Stop gap tick sheet for short-term
   - Digital scanner collection long-term

3) Voice of Customer
   - Used SQDC format to construct CTQC
Measure Phase

**Sigma Level** = 1.07 \[\rightarrow\] 173 of 250 units (69%) do not meet lead time target

**FTE** = 1

**P/T** = 3.1

**C/T** = 3.1

**UTIL** = 11.8%

**T** – Hardware, Raws, FG

**I** – Raw, WIP, FG inventory

**M** – Retrieving tools & parts

**W** – Supplier parts, line balance

**O** – Sub-subs, FA bottleneck

**D** – Orientation, torque, missing

**TOTAL WAIT TIME** 14.25 HRS

**TOTAL PROCESS TIME** 24.95 HRS

**TOTAL LEAD TIME** 39.20 HRS

**Takt-Time** = 26.2

**P/T (HRS)**

- Station A: 3.10
- Station A1: 1.50
- Station B: 3.60
- Station C: 2.10
- Station D: 3.25

**Calibration/ Final Check**

- FTE = 0.5
- P/T = 2.5
- C/T = 5
- UTIL = 19.1%

**Cooler Test**

- P/T = 160
- UTIL = 510.7%

**Measurement Set-Up**

- FTE = 0.45
- P/T = 3
- C/T = 4.4
- UTIL = 17.0%

**Station D**

- FTE = 0.1
- P/T = 1
- C/T = 10
- UTIL = 38.2%

**Work Content SA Bench (hrs)**

**Touch Time by FA Station (hrs)**

**Subassembly**

- Stations significantly unbalanced
- Max = 6.7 hrs, Min = 1.1 hr, Std Dev = 1.6

**Final Assembly**

- Stations significantly unbalanced
- Max = 4.5 hrs, Min = 1 hr, Std Dev = 1.2
Analyze Phase

Defects → Lead Time

- Defects account for 52% of the variability in lead time
- 1 DPU = 10 hrs of Lead Time

Bench & Components → Defects

- Assembly Station and total number of components significant in predicting defects

\[
\text{Defects Per Unit} = 10.092 + 3.073 \times \text{Defects Per Unit}
\]

\[
S = 7.39036 \quad \text{R-Sq} = 51.9% \quad \text{R-Sq(adj)} = 47.1%
\]

Analysis of Variance

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<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
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Scatterplot of Lead Time vs Defects Per Unit
### Improve Phase

#### Tick Sheet
- Failure Mode Effects Analysis
- Poka Yoke Scanning Process
- Subassembly 5s - Sort
- Flipboard

#### LEVEL I
- Digital Defect Tracker
- Finished Goods Stocking Model
- Line Balance
- SQDC Board
- Subassembly 5s - Set In Order
- Improve Subassembly Inspection

#### LEVEL II
- Subassembly 5s - Standardize
- Supplier Quality Audit
- Design for Six Sigma
- Standardized Training Practices

#### LEVEL III

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#### SAFETY STOCK

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#### Work Content by SA Bench (After)
- **MIN**: Before 1.1, After 2.4
- **MAX**: Before 6.7, After 3.4
- **STD DEV**: Before 1.6, After 0.3

#### Touch Time by FA Station (After)
- **MIN**: Before 1.0, After 3.2
- **MAX**: Before 4.5, After 2.5
- **STD DEV**: Before 1.2, After 0.3

#### FIFO LANE FOR FG STOCK

- **SUB ASSY**
  - Before: Min 1.1, Max 6.7, Std Dev 1.6
  - After: Min 2.4, Max 3.4, Std Dev 0.3

- **FINAL ASSY**
  - Before: Min 1.0, Max 4.5, Std Dev 1.2
  - After: Min 3.2, Max 2.5, Std Dev 0.3

### Levels

- **LEVEL I**
  - Digital Defect Tracker
  - Finished Goods Stocking Model
  - Line Balance
  - SQDC Board
  - Subassembly 5s - Set In Order
  - Improve Subassembly Inspection

- **LEVEL II**
  - Subassembly 5s - Standardize
  - Supplier Quality Audit
  - Design for Six Sigma
  - Standardized Training Practices

- **LEVEL III**

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### Safety Stock

- **Service Level**
  - 95%
  - 85%
  - 75%

- **Year**
  - 2011: 21, 18, 16
  - 2012: 24, 20, 18
  - 2013: 41, 30, 24
  - 2014F: 37, 28, 23
  - 3YR: 32, 25, 21
Control Phase

WRAPPER LINE SQDC BOARD

<table>
<thead>
<tr>
<th>SAFETY</th>
<th>DAILY QUALITY</th>
<th>DAILY DELIVERY</th>
<th>DAILY COST</th>
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<table>
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<tr>
<th>FLEXIBILITY MATRIX</th>
<th>QUALITY CIP</th>
<th>DELIVERY CIP</th>
<th>COST CIP</th>
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- Top line tracks information daily and is filled out by operators
- Rolls into YTD data at the end of each month by supervisor/engineer
- CIP is a Rolling Action Item List including tasks, owners and due dates
- Creates a continuous PDCA loop
Summary

Status Update

Final presentation and materials delivered to Mettler Toledo

Lessons Learned

- Soft skills as important as hard skills
- Engage more often with operators on the line
- Clearly explain benefits to all parties before implementing solutions
- Adaptability is paramount

Recommendations

- Data, data, data....
- Do something with that data
- Pull Manufacturing
- Design for Six Sigma
- Supplier Quality Program
- Standardized Training Practices

Lean & Six Sigma Tools Applied

- Control Charting
- SIPOC Diagram
- Voice of Customer
- Critical-To-Quality Tree
- RACI Matrix
- Value Stream Mapping
- Spaghetti Diagram
- Capability Analysis
- Measurement System Analysis
- Cause Mapping
- Regression Analysis
- ANOVA
- FMEA
- Line Balance