Quality Tools and Topics
Learning Objectives

At the end of this module, you will be able to:

• Describe how quality is essential to Lean in achieving customer satisfaction

• Use basic quality tools
Why Do We Care About Quality?

*Hidden Costs of Non-Conformance = 2 to 3 Times Measured Costs*

**Direct Measured Costs:**
- Scrap/rework
- Service calls
- Warranties/concessions

**Indirect/Hidden Costs:**
- Excess inventory
- Overtime
- Non-value added steps
- Queues and delays
- Reputation/image

Courtesy of Richard Lewis II. Used with permission.
Problems with Inspection Based Quality Control

- Inspection does not add value to the customer – it simply screens or detects (most of the time) defective products from leaving the factory.
- Inspection is subject to multiple errors
  - Inspector skill and attention
  - Measurement capability
  - Environment (Human Factors)
Inspection Exercise

This exercise will be in two 30 second sessions

Task: Find all of the fs or Fs on a page of text

• Take out the Inspection Exercise from the student folder and turn it face down.

• On “GO”, circle all the fs or Fs you find

• On “STOP”, and turn over your sheet and pass the sheet to the person on your right.

• On “GO”, mark Xs all the other fs or Fs you find

• On “STOP”, count up the number of fs and Fs that are circled and the number with Xs.
Impact of Inspector Efficiency on Escaped Quality

![Graph showing the impact of inspector efficiency on escaped quality. The x-axis represents the number of consecutive inspectors, and the y-axis represents the escaped DPM (Defects Per Million). The graph includes lines for different inspector efficiencies (70%, 80%, 90%, 99%) showing how increasing efficiency decreases the escaped defect rate.]
Total Quality Management (TQM) and Lean are related

- Lean Product Development/Lean Healthcare
- Lean Supply Chain
- 7 Quality Tools
- VSMA

Customer Satisfaction
- Continuous Improvement
- Process Design
- Benchmarking
- Employee Involvement
- Product/Service Design
- Problem-solving Tools
- Purchasing

The Seven Basic Quality Tools

• Flow Charts
• Cause and Effect Diagrams
• Check Sheets
• Histograms
• Pareto Charts
• Scatter Diagrams
• Control Charts

Six Sigma Basics Module

Cause & effect diagram from a factory floor A3 at New Balance.

Photo by Earll Murman
Flow Charts

• Flow Chart examples
  • Process maps
  • S/W program flow
  • Medical algorithms

• Why are Flow Charts a quality tool?
  • Visual description improves comprehension
  • Helps assure process steps are done in the right sequence
  • Ties outputs to inputs
  • Assists with data collection

Photo by Earll Murman

Process map for pre lean treatment of Acute Myocardial Infarction (aka heart attack)
Cause and Effect Diagram
Also called Ishikawa or Fishbone diagram

Measurements  Personnel  Materials

Methods  Environment  Machines

Primary Cause  Primary Cause

Secondary Cause

Effect or problem

Suggested major categories

A root cause analysis tool, often supported by 5 Whys
Example Cause and Effect Diagram

Source: Institute for Healthcare Improvement, Cause and Effect Diagram (IHI Tool).

Courtesy of Institute for Healthcare Improvement. Used with permission.
Check Sheets

A structured tool for collecting data

Instances of Quality Problems in LAI Lean Academy Course

<table>
<thead>
<tr>
<th>Problem</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaker’s voice</td>
<td>II</td>
<td>III</td>
<td>III</td>
<td>14</td>
</tr>
<tr>
<td>Room noise</td>
<td>III</td>
<td>III</td>
<td>III</td>
<td>10</td>
</tr>
<tr>
<td>Typos on slides</td>
<td>IIII</td>
<td>II</td>
<td>I</td>
<td>22</td>
</tr>
<tr>
<td>Fuzzy projection</td>
<td>III</td>
<td>I</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Missing material</td>
<td>III</td>
<td>I</td>
<td>III</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>21</td>
<td>15</td>
<td>67</td>
</tr>
</tbody>
</table>

A purely hypothetical example!
Histograms

Shows

- Frequency of occurrence
- Frequency distribution: normal, random, …

Useful to see

- The spread of a distribution
- Changes over time
- Quantitative inputs/outputs
- Comparison to customer requirements
What product attribute does the Mars Company control variation of to deliver a quality to its customers?

- Open your bag of M&Ms – don’t eat them yet!
- Count the number of M&Ms in your bag by color.
- Fill in your data on the Check Sheet for your table.
- Contribute table data when asked by instructor.
What M&M attribute do you think Mars Company uses quality principles to control variation of?

- **Total M&Ms in a bag?**
- **Color distribution?**
- **Something else**
- **I don’t know**

Hold up the colored 3 x 5 card of your choice.
Pareto Chart of Preventable Causes Leading to ED Admissions

Courtesy of Faten Mitchell, Quality Improvement Advisor, Health Quality Ontario. Used with permission.
Source: Faten Mitchell, Quality Improvement Advisor, Health Quality Ontario.
Pareto Example - Discrepancies During Satellite System Integration & Test

Root Cause of Discrepancies for 229 Satellites tested from 1970-1999

- Operator/Employee: 26%
- Test Equipment: 18%
- No Anomaly: 6%
- Design: 24%
- Software: 12%
- Other: 8%
- Unknown: 3%
- Material: 2%

Scatter Diagrams

- Plots of (x,y) pairs of numerical data
- Can show whether a correlation exists
- Useful starting point for root cause analysis

### Uncorrelated data

**Salary after 5 years vs College GPA**

- $70,000
- $60,000
- $50,000
- $40,000
- $30,000
- $20,000

### Correlated data

**Coordination vs. Performance - Hospitals**

- 0.65
- 0.7
- 0.75
- 0.8
- 0.85

- -0.4
- -0.2
- 0
- 0.2
- 0.4
Summing Up

• Inspection is an ineffective way to produce high quality products and services
• Total Quality Management and Lean Thinking are closely related
• Lean Thinking and TQM both utilized simple, structured, quantitative and qualitative tools to achieve quality
• There are seven basic quality tools
• But remember – capable people are the most important factor in achieving quality
### An Example of Focus on Quality: Floor Beams for Commercial Aircraft

**Table:**

<table>
<thead>
<tr>
<th></th>
<th>747</th>
<th>777</th>
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</thead>
<tbody>
<tr>
<td><strong>Assembly Strategy</strong></td>
<td>Tooling</td>
<td>Toolless</td>
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<tr>
<td>Hard tools</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>Soft tools</td>
<td>2/part #</td>
<td>1/part #</td>
</tr>
<tr>
<td>Major assembly steps</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Assembly hrs</td>
<td>100%</td>
<td>47%</td>
</tr>
<tr>
<td>Process capability</td>
<td>$C_{pk} &lt; 1 \ (3.0\sigma)$</td>
<td>$C_{pk} &gt; 1.5 \ (4.5\sigma)$</td>
</tr>
<tr>
<td>Number of shims</td>
<td>18</td>
<td>0</td>
</tr>
</tbody>
</table>

**References:**


Courtesy of Boeing. Used with permission.
Reading List


Acknowledgements

Contributors
• Dick Lewis – Rolls-Royce (ret.)
• Jose Macedo – Cal Poly, San Luis Obispo
• Hugh McManus – Metis Design
• Earll Murman – MIT
• Steve Shade – Purdue University
• Alexis Stanke – MIT

Collaborators
• Tom Callarman – Arizona State University
• Phil Farrington – University of Alabama in Huntsville
• Al Haggerty – MIT, Boeing (ret.)
• Jan Martinson – Boeing, IDS
• Faten Mitchell – Health Quality Ontario
• Bo Oppenheim – Loyola Marymount University
• Sue Siferd – ASU
• Barrett Thomas – University of Iowa
16.660J / ESD.62J / 16.853 Introduction to Lean Six Sigma Methods
IAP 2012