



# 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)**



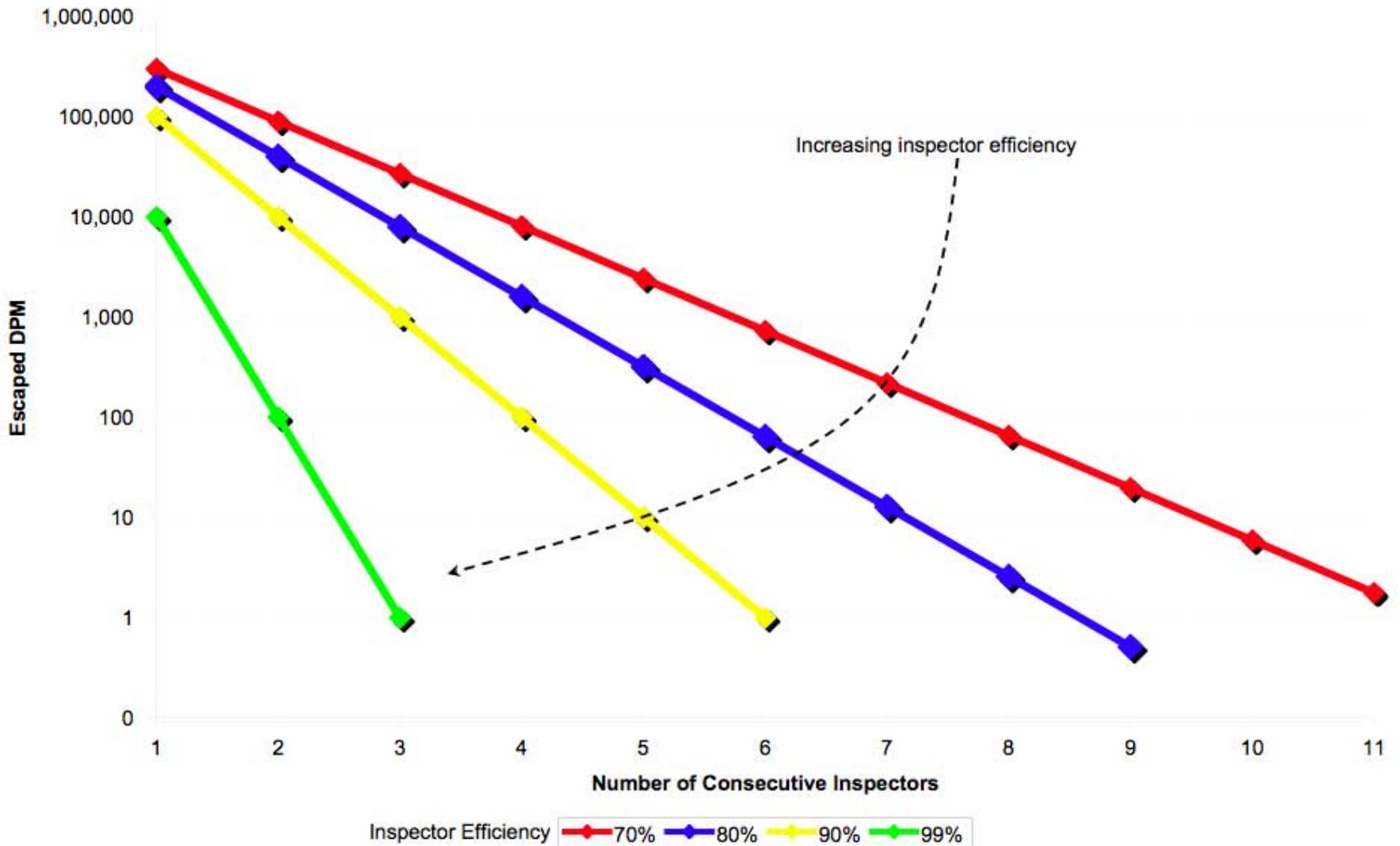
# Inspection Exercise

**This exercise will be in two 30 second sessions**

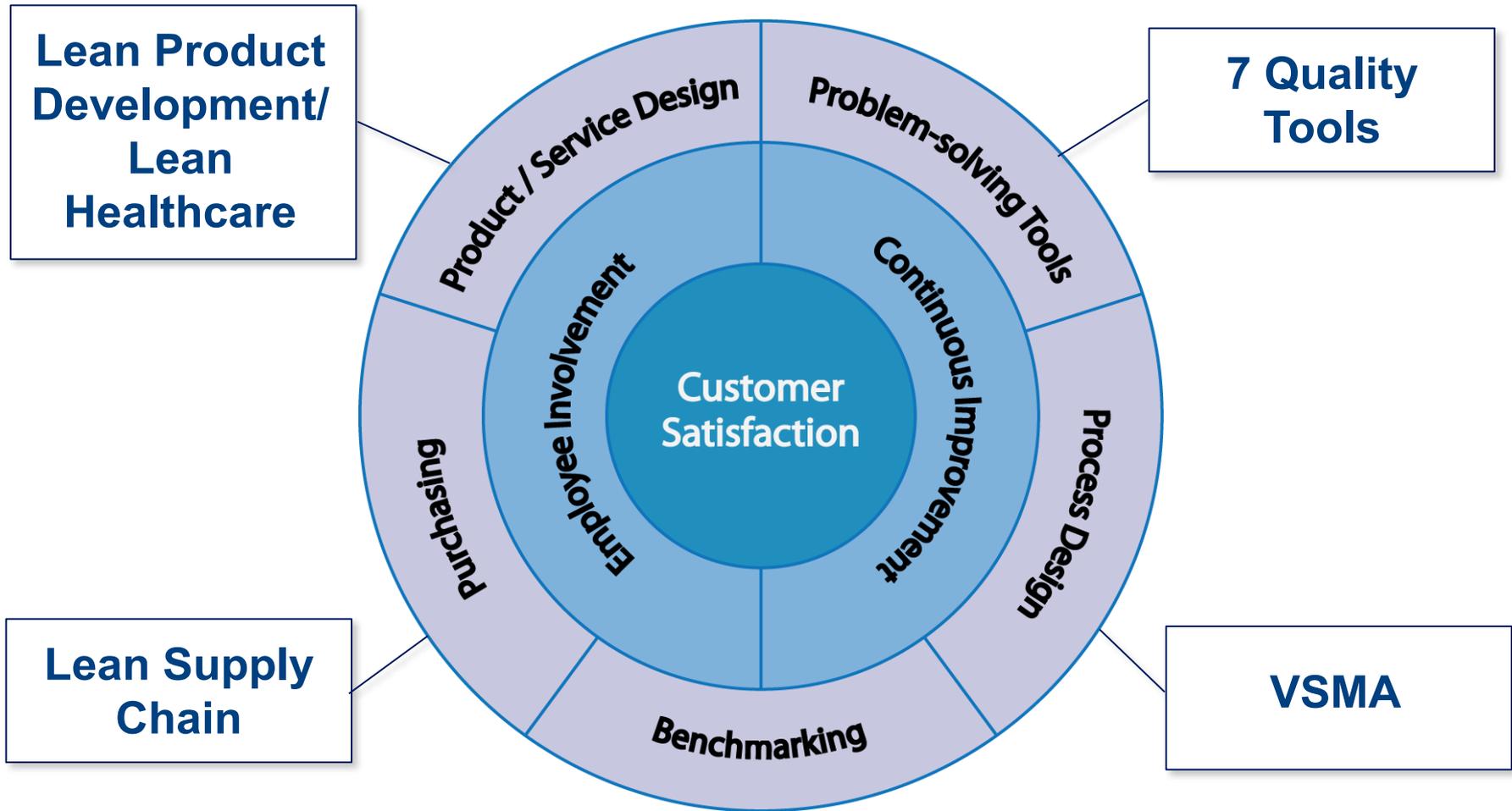
**Task: Find all of the **f**s or **F**s on a page of text**

- **Take out the Inspection Exercise from the student folder and turn it face down.**
- **On “GO”, **circle** all the **f**s or **F**s 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 **f**s or **F**s you find**
- **On “STOP”, count up the number of **f**s and **F**s that are circled and the number with Xs.**

# Impact of Inspector Efficiency on Escaped Quality



# Total Quality Management



## Total Quality Management (TQM) and Lean are related

# The Seven Basic Quality Tools

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

Six Sigma Basics Module

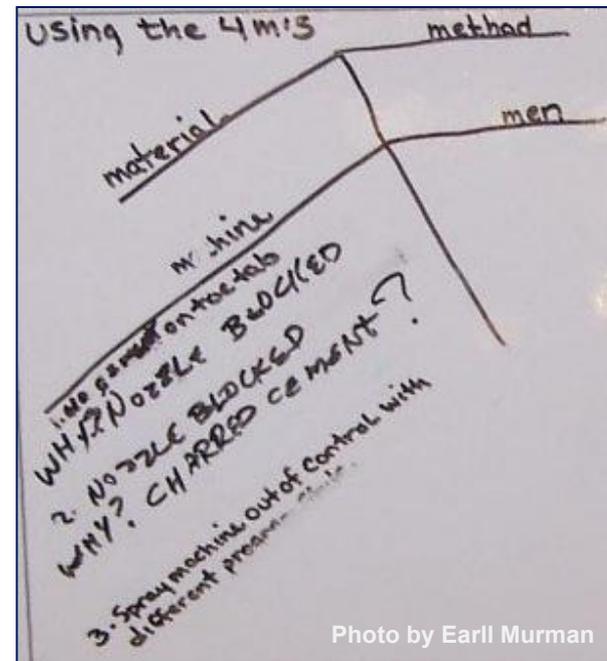


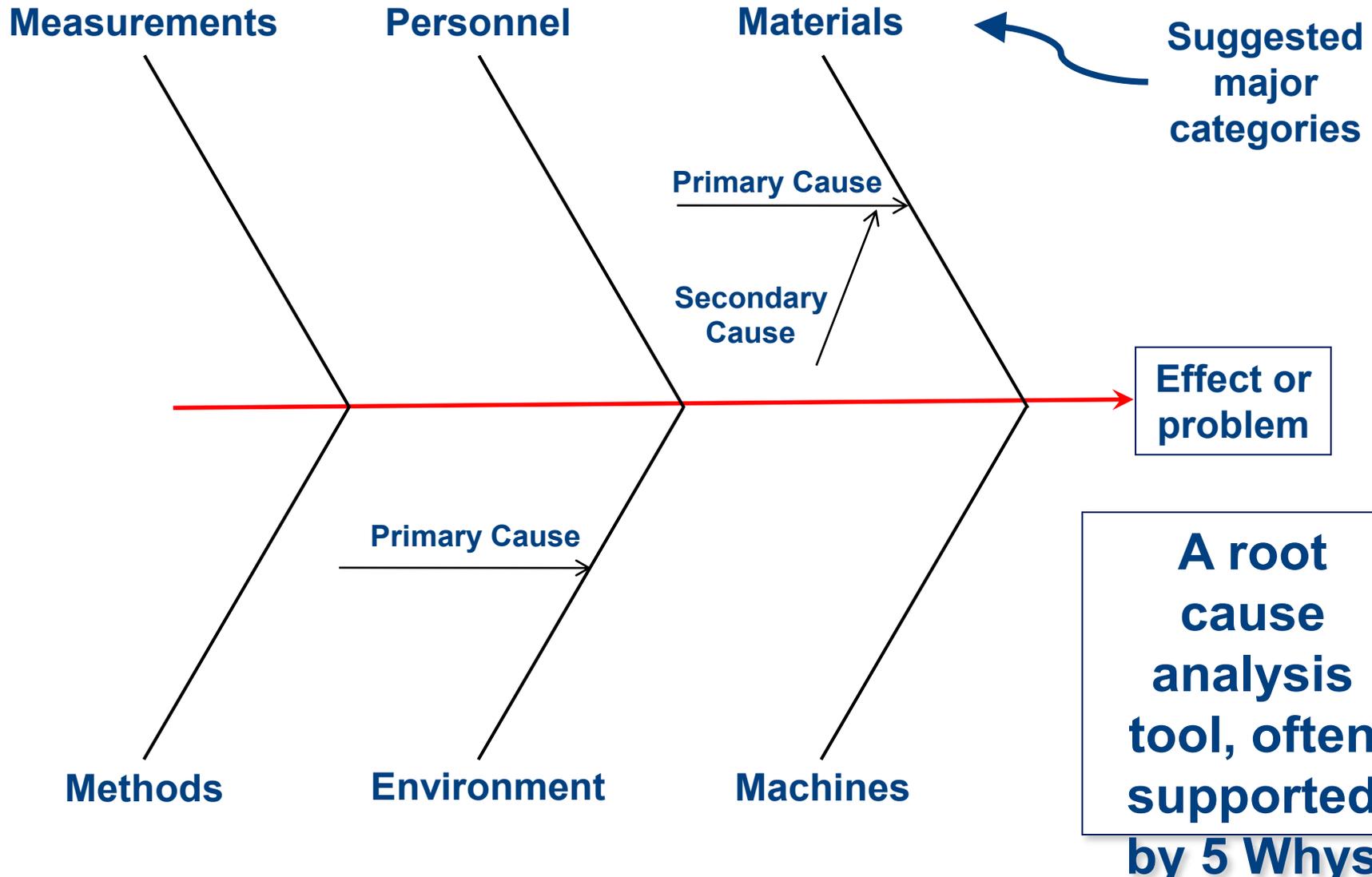
Photo by Earl Murman

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

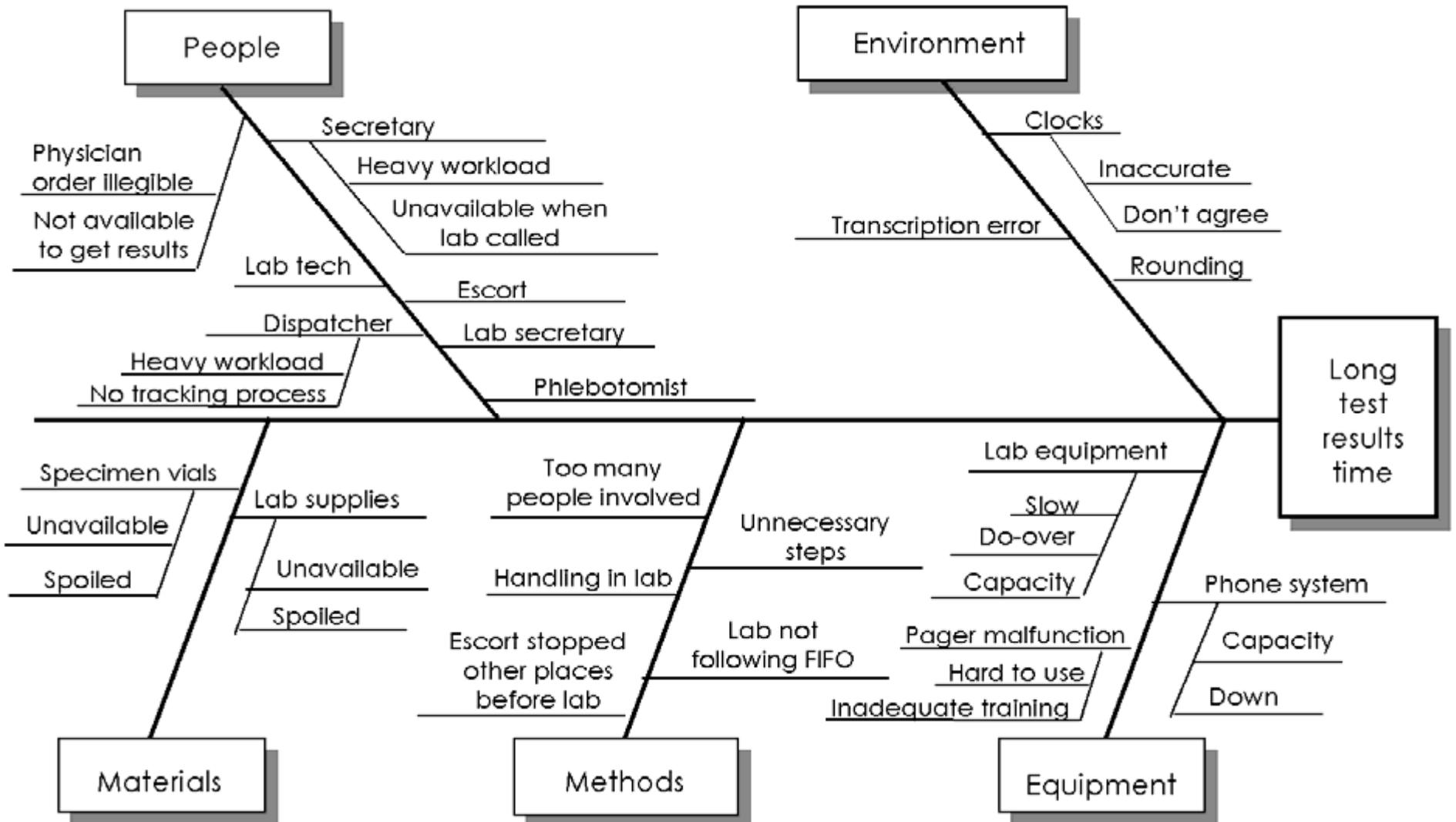


# Cause and Effect Diagram

Also called Ishikawa or Fishbone diagram



# Example Cause and Effect Diagram



# Check Sheets

## A structured tool for collecting data

Instances of Quality Problems in LAI Lean Academy Course

Problem	Monday	Tuesday	Wednesday	Total
Speaker's voice	<del>    </del> II	IIII	III	14
Room noise	IIII	III	III	10
Typos on slides	<del>    </del> IIII	<del>    </del> II	<del>    </del> I	22
Fuzzy projection	III	I		4
Missing material	<del>    </del> III	<del>    </del> I	III	17
Total	31	21	15	67

*A purely hypothetical example!*

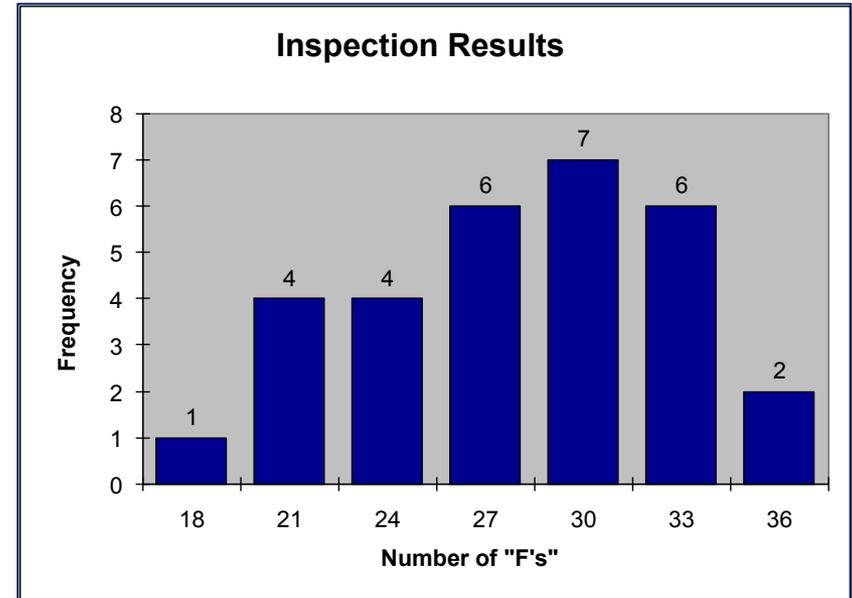
# Histograms

## 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



# M&M Exercise

***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.**

M & M Exercise Check Sheet						
Record the number of M&Ms by color for each team member, then the sum for each team member and for each color.						
M&M color	Team Member Name					Sum by color
Brown						
Orange						
Blue						
Green						
Yellow						
Red						
Sum by name						

Table Name/Number

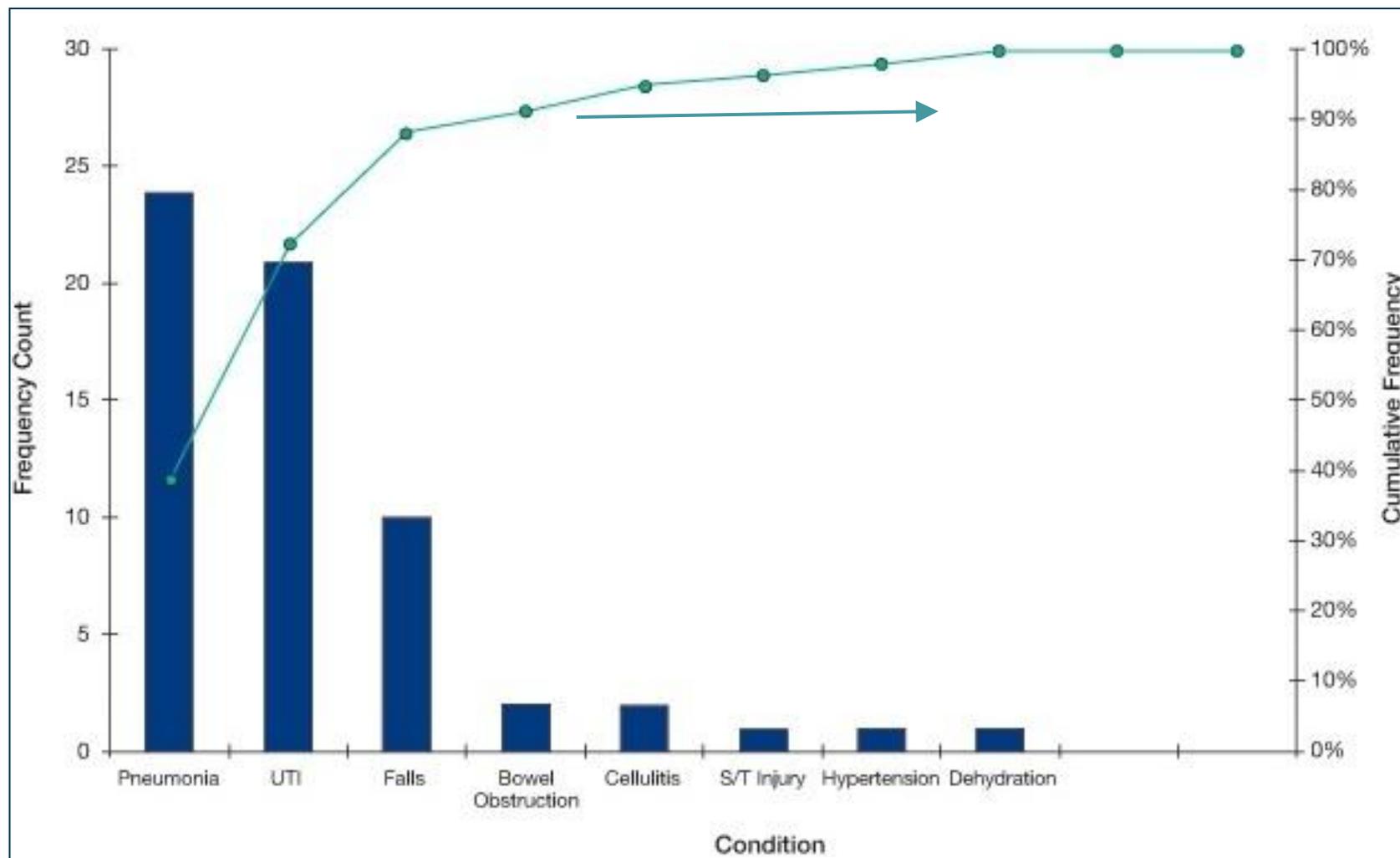


What M&M attribute to you think Mars Company uses quality principles to control variation of?

- **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**

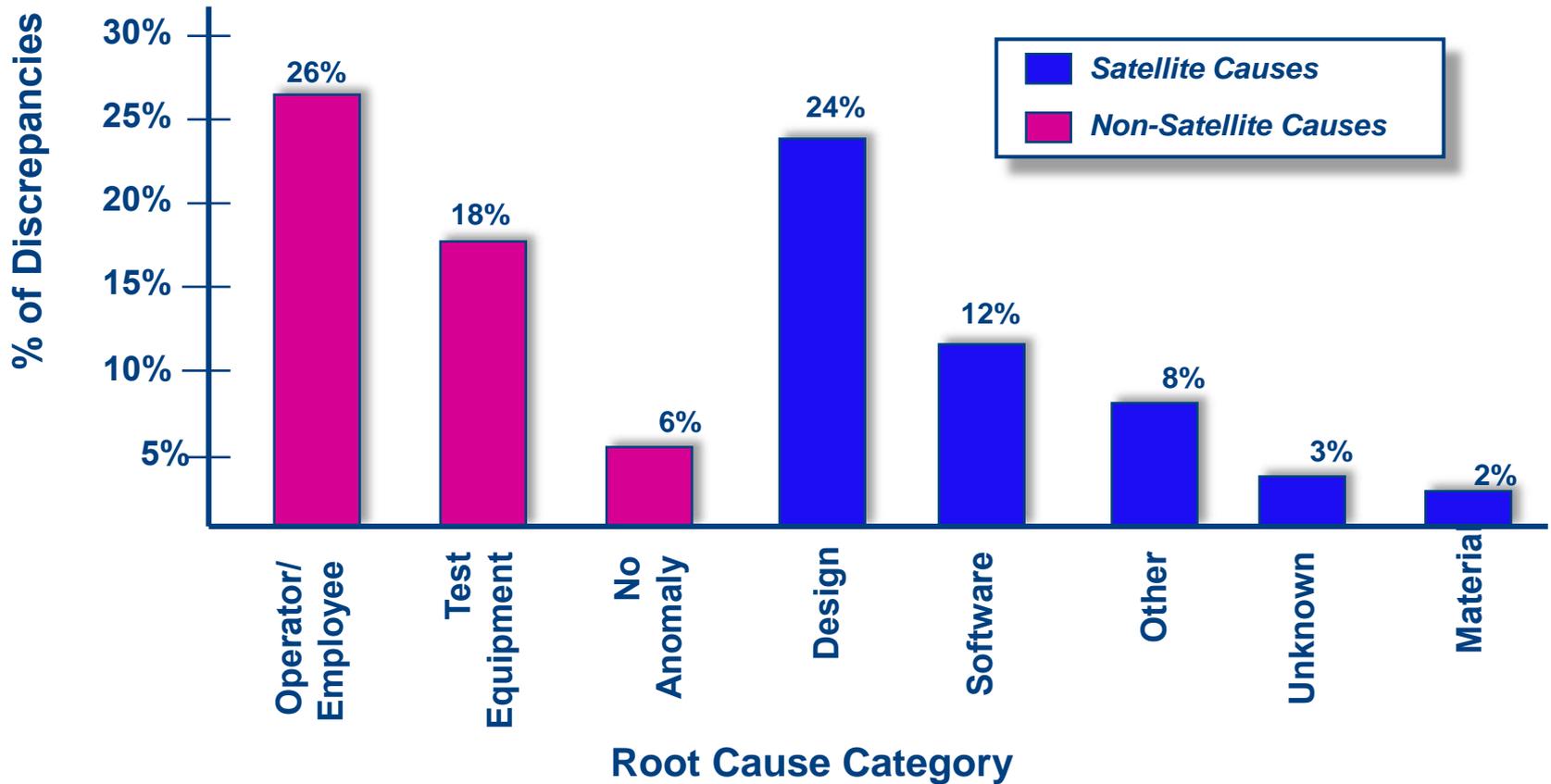
# Pareto Chart of Preventable Causes Leading to ED Admissions



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

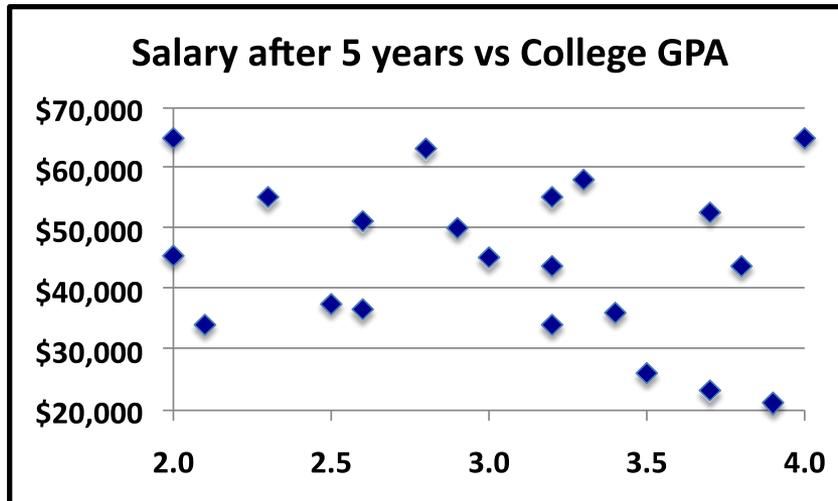


Source: Weigel A. and Warmkessel, J., "Seeing The Spacecraft Testing Value Stream", LAI Executive Board Briefing, June 2000

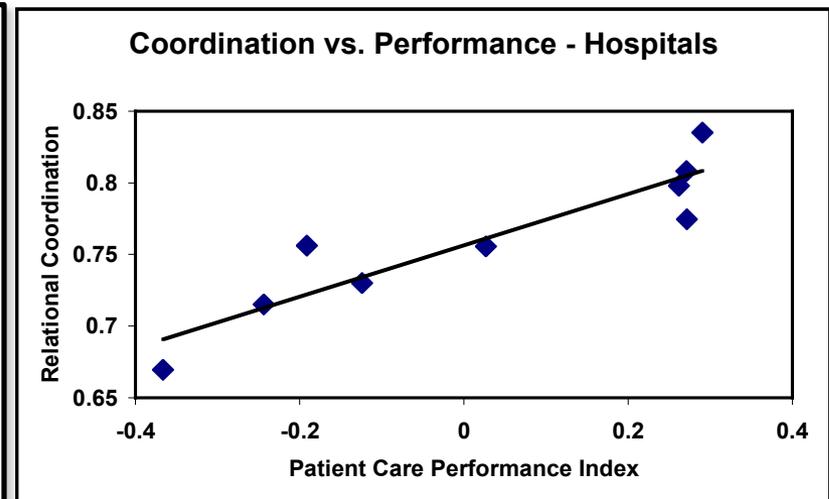
Ref: Weigel, A., "Spacecraft System Level Test Discrepancies: Characterizing Distributions and Costs", MIT SM Thesis, May 2000

# 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**



**Correlated data**

# 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



Courtesy of Boeing. Used with permission.

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

# Reading List

**Deming, E., *Out of Crisis*, The MIT Press, Cambridge, MA, 2000**

**Hopp, W.J. and Spearman, M.L., *Factory Physics, 3<sup>rd</sup> Edition*, McGraw-Hill/Irwin, 2007**

**Juran, J.M., *Juran on Quality by Design*, The Free Press, New York, 1992**

**Nelson, E.C., Batalden, P.B., Godfrey, M. M., *Quality By Design: A Clinical Micosystems Approach*, John Wiley and Sons, New York, 2007**

**Ritzman, L.P. and Krajewski, L.J., *Foundations of Operations Management*, Prentice Hall, Upper Saddle Brook NJ, 2003**

**Tague, N.R., *The Quality Tool Box*, Second Edition, ASQ Quality Press, 2004**

# Acknowledgements

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