Quality Management

Heidi Maier Sagstad
Six Sigma tools can be effectively used in a Quality management program by helping to identify CTQ’s, measure the project Y, and identify Key X’s:

**Project Management**
- Lean/Six Sigma
- DMAIC

**Plan Quality**
- Project Y = Identify Quality Measures

**Quality Tools**
- Cause and Effect Matrix
- Pareto
- Scatter Plot
Introductions

- Name
- Company
- Experience with
  - Project Management / Quality Management
  - Lean / Six Sigma
- Expectations of today’s session
Project Management

Quality Management,

Lean / Six Sigma

DMAIC
What is project quality management?

«Project Quality Management works to ensure that the project requirements, including product requirements, are met and validated.»

Minimize variation and deliver results that meet defined requirements.
Project Quality Management

Plan Quality Management
• Identify Quality Requirements

Perform Quality Assurance
• Auditing the quality requirements

Control Quality
• Monitoring and recording results to assess performance and make changes
Lean Six Sigma

- Total Quality Management System
- Total Employee involvement
- Project Rigor
- Continuous Improvement
- Customer Focus
- Deliver products to the customer:
  - Time
  - Cost
  - Quality
Lean Six Sigma - Philosophy

**Six Sigma:**
Do it Right the First Time
Understand the problem
Fix the right problem
Sustain Results

**Lean:**
Just In Time
GO SEE
Fix It NOW
Faster, Cheaper, Better
Lean Six Sigma - Method

**Six Sigma:**
- DMAIC
- DIDOV
- DFSS

**Lean:**
- DMAIC
- KAIZEN
- Lean Start Up

**Philosophy**

**Method**

**Tools**
Lean Six Sigma - Tools

**Six Sigma:**
- Accuracy and Precision
- Reduce variation
- Identify critical X

**Lean:**
- Improve flow
- Reduce Cycle time
- Identify Waste
Project manager structure

- Champion
- Master Black Belt
- Black Belt
- Green Belt
- Yellow Belt
Lean

Lean Tools are used to:

• Eliminate Waste
• Improve Flow
• Reduce Cycle Time

You may use lean tools to address a quality issue!
Lean – 7 types of waste

Motion
Overproduction
Waiting
Transport
Inventory
Unnecessary Processing
Defects

(Under-utilized people)
Lean - Improve Flow
Lean - Reduce Cycle Time

Reduction in cycle time is achieved by making improvements which ultimately improve overall quality performance.
You may use Six Sigma tools to measure and/or identify a quality issue!
Lean/Six Sigma Improvement Strategy

A

Off-Center

Target

Centered

B

Unpredictable

Center Process

Reduce spread

Remember... customers experience our variation, not our averages

The shortest distance between You and Improved
Six Sigma

<table>
<thead>
<tr>
<th>Sigma level</th>
<th>DPMO</th>
<th>Yield (%)</th>
</tr>
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<tbody>
<tr>
<td>1σ</td>
<td>692,462</td>
<td>30.7538</td>
</tr>
<tr>
<td>2σ</td>
<td>308,538</td>
<td>69.1462</td>
</tr>
<tr>
<td>3σ</td>
<td>66,807</td>
<td>93.3193</td>
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<tr>
<td>4σ</td>
<td>6,210</td>
<td>99.3790</td>
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<tr>
<td>5σ</td>
<td>233</td>
<td>99.9767</td>
</tr>
<tr>
<td>6σ</td>
<td>3.4</td>
<td>99.9997</td>
</tr>
</tbody>
</table>

Figure 1. Six Sigma limits and defects per million opportunities (DPMO).

## Six Sigma 99.9% perfect

<table>
<thead>
<tr>
<th></th>
<th>1σ</th>
<th>3σ</th>
<th>6σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost your mail</td>
<td>1106</td>
<td>107</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Your office coffee pot empty</td>
<td>470</td>
<td>45</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Dropped your phone call</td>
<td>4839</td>
<td>467</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Lost your mail
Your office coffee pot empty
Dropped your phone call
99.9% Perfect is not good enough

- 1 hour of unsafe drinking water every month
- 2 unsafe plane landings per day in Chicago
- 16,000 pieces of lost US mail every HOUR
- 20,000 incorrect drug prescriptions every year
- 500 incorrect operations each week
- 50 babies dropped at birth every day
- 22,000 bills drawn from the wrong bank account every HOUR
## DMAIC

a problem solving approach

<table>
<thead>
<tr>
<th>Letter</th>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Define</td>
<td>Clearly define the problem and form your team</td>
</tr>
<tr>
<td>M</td>
<td>Measure</td>
<td>Measure what is key to the customer and confirm that your data is reliable</td>
</tr>
<tr>
<td>A</td>
<td>Analyze</td>
<td>Search for the root causes and identify the most significant factors</td>
</tr>
<tr>
<td>I</td>
<td>Improve</td>
<td>Establish methods to improve the root causes and significant factors</td>
</tr>
<tr>
<td>C</td>
<td>Control</td>
<td>Make sure the problem doesn’t come back</td>
</tr>
</tbody>
</table>
PDCA - Roots of the DMAIC Process

**Plan the Improvement**
- Identify process to improve
- Develop the test plan

**Conduct the Test**
- Identify potential causes
- Compare causes to facts

**Check the Results**
- Identify the likely root causes
- Determine how to improve

**Change the Process**
- Adopt the change or abandon it
- Standardize the change
- Gather additional data

**Plan**

**Check**

**Act**

**Do**
The DMAIC Roadmap

**Phase Define**
- SIPOC Process Map
- Bar Chart
- Cause & Effect Matrix
- Pareto Chart
- RACI Matrix

**Activities/Tools**
- SIPOC Process Map
- Bar Chart
- Cause & Effect Matrix
- Pareto Chart
- RACI Matrix

**Phase Measure**
- Swim-Lane Diagram
- Value Stream Mapping
- Pareto Charts
- Fishbone Diagram
- Concentration Diagrams
- FMEA
- Measurement System Analysis/Gage R&R
- Process Control Charts
- Capability Studies

**Activities/Tools**
- Swim-Lane Diagram
- Value Stream Mapping
- Pareto Charts
- Fishbone Diagram
- Concentration Diagrams
- FMEA
- Measurement System Analysis/Gage R&R
- Process Control Charts
- Capability Studies

**Phase Analyze**
- Brainstorming
- Fishbone Diagram
- Change Point Analysis
- Multi-Vari Charts
- Scatter Diagrams
- Hypothesis Testing
- ANOVA
- Correlation & Regression Analysis
- 7MP tools

**Activities/Tools**
- Brainstorming
- Fishbone Diagram
- Change Point Analysis
- Multi-Vari Charts
- Scatter Diagrams
- Hypothesis Testing
- ANOVA
- Correlation & Regression Analysis
- 7MP tools

**Phase Improve**
- Process Flowcharting
- Value Stream Mapping
- Mistake Proofing
- 5S/Kaizen
- FMEA
- Process Tolerancing

**Activities/Tools**
- Process Flowcharting
- Value Stream Mapping
- Mistake Proofing
- 5S/Kaizen
- FMEA
- Process Tolerancing

**Phase Control**
- Risk Assessment of Changes-FMEA
- Control/Action Plan
- Standard Operating Procedures
- Project Commissioning
- Process Validation
- Process Control Charts
- Capability Studies
- Visual Controls

**Activities/Tools**
- Risk Assessment of Changes-FMEA
- Control/Action Plan
- Standard Operating Procedures
- Project Commissioning
- Process Validation
- Process Control Charts
- Capability Studies
- Visual Controls
Problem Solving Storyboard

1. Describe the Problem
   - Goal Statement:
     1. Achieve a defect level less than 500 dpm.
     2. Improve throughput by 30%.
   - Effect Diagram (5M)

2. Identify Potential Causes
   - Cause & Effect Diagram
   - Distinctions 
     & Changes
   - Failure Modes & Effects Analysis

3. Collect & Organize Existing Data
   - CUSUM Chart of Defect Level
   - Pareto Analysis
   - Control Chart

4. Compare Causes to the Facts
   - Scatter Diagram
   - Checksheet
   - Multi-Vari Chart
   - Contradiction Matrix

5. Collect Additional Data to Identify Root Cause(s)
   - Screening Experiment
   - ANOVA
   - Contingency Tables
   - Pair t-Test
   - F-test
   - Other Statistical Tests
   - Component Swapping Study

6. Determine Best Solution(s)
   - Response Surfaces
   - Robust Tolerance Analysis or VTA
   - Elimination
   - Facilitation
   - Mitigation
   - Flagging
   - Mistake Proofing

7. Verify, Implement, Standardize Procedures
   - Implementation Plan
   - Control Chart
   - Capability Study
   - Sampling Plan

---

<table>
<thead>
<tr>
<th>TASK</th>
<th>SCHEDULE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Inputs → Outputs

Goal: p=0.1%

Process Adjusted: p=8.6%

Equipment Change: 4/99

Process or Usage Flow

Is / Is Not Diagram

WHAT
WHEN
WHERE
EXTENT

START → END → START

Is / Is Not Diagram

Failure Modes & Effects Analysis

Distinct Change

END

START

1. Describe the Problem
   - IS
   - IS NOT
   - WHAT
   - WHEN
   - WHERE
   - EXTENT

2. Identify Potential Causes
   - People
   - Material
   - Machine
   - Environment
   - Method
   - Measurement

3. Collect & Organize Existing Data
   - CUSUM Chart of Defect Level
   - Pareto Analysis
   - Control Chart

4. Compare Causes to the Facts
   - Scatter Diagram
   - Checksheet
   - Multi-Vari Chart

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   - Flagging
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7. Verify, Implement, Standardize Procedures
   - Implementation Plan
   - Control Chart
   - Capability Study
   - Sampling Plan
**Project Definition**

**Goal:** Improve yield by 10%

**Est Completion Date for Measure:** April 13, 2008
Attach a map of your current process (i.e. Current VSM, Swim-lane, top-down chart).
## Measurement System Analysis

**How do you trust your data?**

### Cycle Count Analysis

<table>
<thead>
<tr>
<th>CYCLE COUNT</th>
<th>ACTUAL INVENTORY</th>
<th>LOGGED INVENTORY</th>
<th>DELTA INVENTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$75,491.83</td>
<td>$75,512.20</td>
<td>$20.37</td>
</tr>
<tr>
<td>2</td>
<td>$93,804.34</td>
<td>$98,686.00</td>
<td>$4,881.66</td>
</tr>
<tr>
<td>3</td>
<td>$49,105.00</td>
<td>$81,592.00</td>
<td>$32,487.00</td>
</tr>
<tr>
<td>4</td>
<td>$83,856.74</td>
<td>$83,810.61</td>
<td>$(46.13)</td>
</tr>
<tr>
<td>5</td>
<td>$121,657.00</td>
<td>$127,100.00</td>
<td>$5,443.00</td>
</tr>
<tr>
<td>6</td>
<td>$164,750.00</td>
<td>$187,314.00</td>
<td>$22,564.00</td>
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<tr>
<td>7</td>
<td>$111,968.10</td>
<td>$111,931.30</td>
<td>$(36.80)</td>
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<tr>
<td>8</td>
<td>$123,943.50</td>
<td>$122,800.40</td>
<td>$(1,143.10)</td>
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<tr>
<td>9</td>
<td>$255,238.40</td>
<td>$247,571.30</td>
<td>$(7,667.10)</td>
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<tr>
<td>10</td>
<td>$42,468.67</td>
<td>$42,468.67</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>$54,409.91</td>
<td>$54,409.91</td>
<td>-</td>
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<tr>
<td>12</td>
<td>$224,343.00</td>
<td>$225,277.00</td>
<td>$934.00</td>
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<td>13</td>
<td>$101,199.40</td>
<td>$101,199.10</td>
<td>$(0.30)</td>
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<td>14</td>
<td>$99,348.83</td>
<td>$96,632.61</td>
<td>$(2,716.22)</td>
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<tr>
<td>15</td>
<td>$84,420.45</td>
<td>$85,984.91</td>
<td>$1,564.46</td>
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<td>16</td>
<td>$123,372.00</td>
<td>$123,973.10</td>
<td>$601.10</td>
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<td>17</td>
<td>$114,937.90</td>
<td>$114,938.20</td>
<td>$0.30</td>
</tr>
<tr>
<td>18</td>
<td>$87,678.17</td>
<td>$89,656.06</td>
<td>$1,977.89</td>
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<tr>
<td>19</td>
<td>$83,531.17</td>
<td>$83,610.20</td>
<td>$79.03</td>
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<tr>
<td>20</td>
<td>$136,368.30</td>
<td>$133,259.30</td>
<td>$(3,109.00)</td>
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<tr>
<td>21</td>
<td>$80,436.30</td>
<td>$77,335.59</td>
<td>$(3,100.71)</td>
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<tr>
<td>22</td>
<td>$100,647.30</td>
<td>$100,647.00</td>
<td>-</td>
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<tr>
<td>23</td>
<td>$91,068.44</td>
<td>$91,068.44</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>$49,007.76</td>
<td>$53,499.08</td>
<td>$4,491.32</td>
</tr>
</tbody>
</table>

**Standard Deviation:** $50,503.24 $8,330.35

**Variance:** $2,550,577,534.45 $69,394,668.73

**Error of Transaction:** 2.72%

### Gage R&R

**Source**

- **VarComp:** (of VarComp)

**Total Gage R&R:** 332.21

**Repeatability:** 154.55

**Reproducibility:** 177.66

**Part-To-Part:** 3269.44

**Total Variation:** 1601.65

### Study Var

- **StdDev (SD):** 18.2267
- **(5.15 * SD):** 93.867
- **(%SV):** 45.54

**Total Gage R&R:** 18.2267

**Repeatability:** 12.4318

**Reproducibility:** 13.3290

**Part-To-Part:** 35.6292

**Total Variation:** 40.0206

**Number of Distinct Categories:** 2

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Attach Measurement System Analysis for your Y. Use Transactional MSA, Gage R&R, etc as applicable to your data.
Baseline Data - Normality

Normal or non-normal? Use “Graphical Summary”.

Summary for Reading at 405

Anderson-Darling Normality Test
A-Squared 4.67
P-Value < 0.005

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Mean</td>
<td>0.20541</td>
</tr>
<tr>
<td>StDev</td>
<td>0.10428</td>
</tr>
<tr>
<td>Variance</td>
<td>0.01088</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.874044</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.563682</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.04700</td>
</tr>
<tr>
<td>1st Quartile</td>
<td>0.11600</td>
</tr>
<tr>
<td>Median</td>
<td>0.17750</td>
</tr>
<tr>
<td>3rd Quartile</td>
<td>0.28725</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.63800</td>
</tr>
</tbody>
</table>

95% Confidence Interval for Mean
0.19033 0.22050

95% Confidence Interval for Median
0.16215 0.19709

95% Confidence Interval for StDev
0.09465 0.11611

P < 0.05
Not Normal
Baseline Data - Stability

Stable or unstable? Use appropriate Control Charts. Explain out-of-control points.

I-MR Chart of Reading at 405

Shut-down, new equipment, etc

Individual Value

Observation

Moving Range

Observation

UCL=0.3771

UCL=0.2109

LCL=0.0337

LCL=0

X=0.2054

MR=0.0646

Measure

Baseline Data - Stability
Baseline Data - Capability

Capable or incapable?

Process Capability of Reading at 405
Calculations Based on Weibull Distribution Model

Process Data
- LSL: *
- Target: *
- USL: 0.40000
- Sample Mean: 0.20541
- Sample N: 186
- Shape: 2.11863
- Scale: 0.23311

Overall Capability
- Pp: *
- PPL: *
- PPU: 0.55
- Ppk: 0.55

Expected Overall Performance
- PPM < LSL: *
- PPM > USL: 43316.5
- PPM Total: 43316.5

Observed Performance
- PPM < LSL: *
- PPM > USL: 37634.4
- PPM Total: 37634.4

SPC Wizard's Sigma Calculator
- Defects: 13317
- Units Inspected: 1000000
- Opportunities per Unit: 1
- DPMO: 43317
- Process Sigma: 3.2

For more info go to: www.spcwizard.com
Identifying Significant Xs

Supporting data and/or charts that explain what led you to your significant Xs. What impact do they have on your Y?

Possible tools: Pareto, VSM, Fishbone, CE matrix, ANOVA, Moods Median, Box&Whisker charts, regression, etc. (Use only the tools that are appropriate.) See your coach for help.
Short Term Process Capability

Process Capability of delta t 2
Calculations Based on Weibull Distribution Model

Baseline SQL to Improve SQL: 1.1 to 1.8
New Process Capability

Baseline SQL to Control SQL: 1.1 to 1.8

Process Capability of \( \delta t \) 2
Calculations Based on Weibull Distribution Model

**Process Data**
- LSL: *
- Target: *
- USL: 3
- Sample Mean: 4.34462
- Sample N: 13
- Shape: 0.648483
- Scale: 3.05148

**Observed Performance**
- PPM < LSL: *
- PPM > USL: 307692
- PPM Total: 307692

**Overall Capability**
- \( P_p \): *
- \( P_{pl} \): *
- \( P_{pu} \): 0.02
- \( P_{pk} \): 0.02

**Exp. Overall Performance**
- PPM < LSL: *
- PPM > USL: 371939
- PPM Total: 371939

**Process Sigma = 1.8**

For more info go to: [www.spcwizard.com](http://www.spcwizard.com)

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**Baseline SQL to Control SQL:** 1.1 to 1.8
Two-Sample T-Test and CI: Before, After

Two-sample T for Before vs After

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>16</td>
<td>27.8</td>
<td>17.3</td>
<td>4.3</td>
</tr>
<tr>
<td>After</td>
<td>17</td>
<td>5.00</td>
<td>3.41</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Difference = mu (Before) - mu (After)
Estimate for difference: 22.8125
95% CI for difference: (13.4767, 32.1483)

T-Test of difference = 0 (vs not =): T-Value = 5.18  P-Value = 0.000  DF = 16

If the P value is less than 0.05 then Ho has to go; i.e. there is a statistical difference.

P value: 0.00

Is P value less than 0.05? yes

There is a statistical difference.
Results
Break time...

I HAVEN'T HAD MY COFFEE YET

DON'T MAKE ME KILL YOU
Identify Quality Measures
Cost of Quality

The 1-10-100 Rule!

The cost effect of defects when they are:

- **Discovered in the process**: 1X
- **Discovered internally (after process completion)**: 10X
- **Discovered by customer**: 100X

Prevention → Detection → Field Defect
What is Quality?

The degree of conformance to the customer requirements
Who are the Customers?

- **Internal Customer** - Anyone **inside** the company who receives the output of a process or the results of our work.

- **External Customer** - Anyone **outside** the company who receives the output of a process or the results of our work.

- **Process Owner** - Anyone **inside** the company who controls the inputs of a process and is responsible for the outputs.

- **Project Sponsor** - Anyone **inside** the company who requests the project, and receives direct benefit from the project results.
What are their Requirements?

• Requirements are related to measurable characteristics in the outputs of our processes.

• These characteristics can be expressed in either **quantitative** or **qualitative** ways.

• Internal requirements should be connected to one or more customer **CTQs**.
How do we know what to measure?

All processes have inputs

Inputs

X1
X2
X3
X4

Process

Step 1
Dec 1
Step 2A

Step 2B
Dec 2
Step 3A

Step 3B

Outputs

Y1
Y2

All processes have outputs
Example of a CTQ Tree

Customer Says: “I want a coffee that is good.”

- Taste
  - Not acidic
  - Rich
  - Aromatic
  - Temperature
    - >60 C
    - 70 C
    - <80 C
  - Cost
    - < 20 kr
    - Loyalty Stamp

General ↔ Specific

Hard to measure ↔ Easy to measure
The VOC Flow Down Logic

**Term**
- Voice of the Customer
- Critical To Quality
- Key Output Variable
- Specification Limits

**Abbreviation**
- VOC
- CTQ
- Y
- USL, LSL

**Explanation**
- Customer concerns or needs
- Customer needs translated into the process language
- Specific measure that reflects the CTQ
- Acceptance limits for the measure collected
How do we define quality?

**VOC:** “I want my product as I agreed to when I want it.”

**CTQ:** “Product released in full, on time and at the potency demanded.”

**Y:** fulfillment = percentage of orders completed and shipped on time

**Specification Limits:** 98% shipped within 21 days after issuance of the order
Specifications for CTQs

• In manufacturing, specification limits often come from technical or mechanical requirements.

• Otherwise, base specification limits on data about customer needs.

• Set specifications at the places where customer satisfaction starts to fall off appreciably.
## Other Examples

<table>
<thead>
<tr>
<th>Customer Concern or Need (VOC)</th>
<th>Customer CTQ</th>
<th>Key Process Y</th>
<th>Specification Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Our fill volumes are not homogenous across the lots, some exceeding spec limits.”</td>
<td>fill volume</td>
<td>fill volume</td>
<td>50 ml as USL</td>
</tr>
<tr>
<td>“We need to find a way to release our products sooner.”</td>
<td>release processing time</td>
<td>release processing cycle time, which is the difference between end of production and final issuance of approval sheet</td>
<td>28 days as USL</td>
</tr>
<tr>
<td>“We need to get as much saleable product from each manufactured batch as possible.”</td>
<td>process yield</td>
<td>Yield = ratio of ((weight/density<em>potency)_\text{in} ) [ \text{Yield} = \frac{(weight/density</em>potency)<em>\text{in}}{(flow*time)*potency}</em>\text{out} ]</td>
<td>Yield greater than 85% (LSL(\geq)85)</td>
</tr>
</tbody>
</table>
The List of Terms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DMAIC</strong></td>
<td>Define-Measure-Analyze-Improve-Control</td>
</tr>
<tr>
<td><strong>Process Y</strong></td>
<td>Output of a process</td>
</tr>
<tr>
<td><strong>Process X</strong></td>
<td>Input of a process</td>
</tr>
<tr>
<td><strong>VOC</strong></td>
<td>Voice of the Customer</td>
</tr>
<tr>
<td><strong>VOB</strong></td>
<td>Voice of the Business</td>
</tr>
<tr>
<td><strong>CTQ</strong></td>
<td>Critical to Quality</td>
</tr>
<tr>
<td><strong>Project Y</strong></td>
<td>Process Output Used by the Six Sigma Project</td>
</tr>
<tr>
<td><strong>USL, LSL</strong></td>
<td>Upper and Lower Specification Limits</td>
</tr>
</tbody>
</table>
Data Collection Plans

• Select a project Y
  – Can you measure it?
  – How readily available are the data?
  – Who will collect it?
  – How often will it be collected? Sample size?
  – Where will the data be stored?
Data Collection Plan Features

Data Collection Plan

What questions do you want to answer?

Being clear about your question will help you make sure you collect the right data.

<table>
<thead>
<tr>
<th>Data</th>
<th>Operational Definition and Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>What</td>
<td>Measure type/ Data type</td>
</tr>
<tr>
<td></td>
<td>How measured 1</td>
</tr>
<tr>
<td></td>
<td>Related conditions to record 2</td>
</tr>
<tr>
<td></td>
<td>Sampling notes</td>
</tr>
<tr>
<td></td>
<td>How/where recorded (attach form)</td>
</tr>
</tbody>
</table>

An operational definition defines exactly how you will go about collecting and recording the data.

Recording what data you are going to collect reminds you what you want to accomplish. Noting the type of data helps you decide how you should analyze the data.

NOTES
1) Be sure to test and monitor any measurement procedures/instruments.
2) “Related factors” are stratification factors or potential causes you want to monitor as you collect data.
### Data Collection Plan Features, cont.

<table>
<thead>
<tr>
<th>How will you insure consistency and stability?</th>
<th>What is your plan for starting data collection? (Attach details if necessary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What will you do to make sure the data collected at one point in time is comparable to data collected at other times? That is, that no biases have been introduced in the way the data is collected?</td>
<td>Just how will you go about collecting the data?</td>
</tr>
<tr>
<td>How will the data be displayed? (Sketch below)</td>
<td>Thinking about how you will display the data will help you make sure you’re getting the right kind of data to answer the question you have in mind.</td>
</tr>
</tbody>
</table>
Quality Tools

Fishbone

Cause and Effect matrix

Pareto

Scatter Plot
I DON’T ALWAYS ASK “WHY?”

BUT WHEN I DO, I ASK IT 5 TIMES

www.leanblog.org
Refines brainstormed ideas, and helps to identify likely causes of an observed problem.

Provides a discussion context that assists in determining likely root causes.

Sorts the factors that may affect a process when little quantifiable data are available.

To graphically displays the team's level of problem understanding.
Cause & Effect Diagram

Problem or Effect

Methods

Cause #2

Why?

Why?

Cause #1

Why?

Why?

Materials

Cause #2

Why?

Why?

Cause #1

Why?

Why?

Man

Cause #2

Why?

Why?

Cause #1

Why?

Why?

Environment

Cause #1

Why?

Why?

Measures

Cause #2

Why?

Why?

Cause #1

Why?

Why?

Machine

Cause #2

Why?

Why?

Cause #1

Why?

Why?

Also known as “Fish Bone Diagrams”
Cause & Effect Diagram

People
- Construction
- Acid rain

Material
- Pesticides
- Fertilizer
- Pruning

Machine
- Crushed roots

Environment

Method

Measurement

Trees are Dying
## Cause and Effect Matrix

<table>
<thead>
<tr>
<th>Process Step</th>
<th>Customer Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Availability</td>
</tr>
<tr>
<td>STEP 1</td>
<td>3</td>
</tr>
<tr>
<td>STEP 2</td>
<td>1</td>
</tr>
<tr>
<td>STEP 3</td>
<td>3</td>
</tr>
<tr>
<td>STEP 4</td>
<td>9</td>
</tr>
</tbody>
</table>

---

### Brainstorming

### Fishbone Diagram

**Process Performance or Effect**

**Step 1**

**Step 2**

**Step 3**

**Step 4**
Pareto Charts

• **Definition**
  – A Pareto chart is a graphical tool used to rank items.
  – It is a bar chart used to prioritize items in a process and to identify the area where to focus the attention.
  – 80% of the problem is related to 20% of the process

• **Examples**
  – A process engineer wants to know which visual defects are detected most frequently in order to improve yield.
  – A quality control administrator wants to identify the analytical tests which contribute most to excessive lead time.
Pareto
Pareto Charts

- Pareto charts help us to prioritize observed causes of problems so we can focus limited resources on areas where we can get the biggest results.

- It can help us separate the “vital few” opportunities from the “trivial many” observations.

- Often we use the “80/20 rule”, sometimes called Pareto's rule, when we want to identify the small fraction of the causes producing most of the defects or problems.
Fitted Line Plot (scatter plot)

- Determine correlation between an X and a Y
- How strong is the relationship
- Method to further evaluate vital X’s.
Fitted Line Plot (scatter plot)

The higher the R-sq value, the stronger the relationship, but that does not necessarily mean it is the cause.

Happiness vs. Income: is it the income that makes people happier, or that they are better educated, work in better conditions, fields they enjoy?
Summary

Six Sigma tools can be effectively used in a Quality management program.

• Identify CTQ’s
• Measure the project Y
• Identify Key X’s
Dogbert the time management expert.

NEVER PUT TIME INTO AN ACTIVITY THAT HAS NO POTENTIAL BENEFIT.

For example, why bother putting on makeup if you’re going to wear that hideous outfit?

That’s like knitting a sweater for a dead squirrel.