Techniques and Tools
TQM Operationalized

- Find out what the customer wants
- Design a product or service that meets or exceeds customer wants
- Design processes that facilitates doing the job right the first time
- Keep track of results
- Extend these concepts to suppliers
Continuous Improvement

- Philosophy that seeks to make never-ending improvements to the process of converting inputs into outputs
- **Kaizen**: Japanese word for continuous improvement
- Start Continuous Improvement any time with customer complaints
Quality at the source

The philosophy: **Make each worker responsible** for the quality of his or her work.

“Do it right. **If isn't right, fix it.**”

- Workers understand that they are to
  (a) provide goods or services that meet specifications and
  (b) find and correct mistakes that occur.
- Each worker becomes a quality inspector for his or her work. Each worker certifies that the product meets the quality standards.
Problem Solving

- Problem solving is one of the basic procedures of TQM
- To be effective, problem-solving efforts should follow a standard, systematic approach
- A key aspect of problem solving in TQM is eliminating the cause so that the problem does not reoccur
- TQM users think of problems as opportunities for improvement
- Use statistical methods wherever possible
Process Improvement and Tools

• Process improvement--a systematic approach to improving performance
  – Process mapping
  – Analyze the process
  – Redesign the process

• Tools
  – Tools aid in data collection and interpretation, and provide the basis for decision making
Basic Quality Tools

• Flowcharts
• Check sheets
• Histograms
• Pareto Charts
• Scatter diagrams
• Control charts
• Cause-and-effect diagrams
• Run charts
7 Basic quality improvement tools

- **Run Chart** - Tracking Trends
  Show changes in data over time | Measure one variable over time | Collect data sequentially

- **Histogram** - Process Centering, Spread and Shape
  Organize data | Evaluate process performance | Monitor process performance before and after a change

- **Control Chart** - Recognizing Sources of Variation
  Monitor the performance of a process over time | Recognize and control variation in a process | Methods to minimize variation and defects

- **Pareto Chart** - Focus on Key Problems
  Approach problems systematically | Discover the sources that may cause the majority of problems | Using different measurement scales break down problems into smaller ones

- **Flowchart** - Picturing the Process
  See how an entire process works | Identify critical points in a process for data collection | Locate bottlenecks | Event, people and material flow

- **Scatter Diagram** - Measuring Relationships Between Variables
  Statistically test a theory about a possible cause and effect connection between two factors | Test and confirm a hypothesis using quantitative data | Data analysis

- **Cause & Effect Diagram** - Find and Cure Causes, Not Symptoms
  Study a problem condition or improvement opportunity to find its 'root' causes | Blend creative thinking with data analysis in the problem-solving process
Check Sheet

Billing Errors
- Wrong Account
- Wrong Amount

A/R Errors
- Wrong Account
- Wrong Amount

Monday
Pareto Analysis

80% of the problems may be attributed to 20% of the causes

Number of defects

Off center  Smeread print  Mising label  Loose  Other
Control Chart

![Control Chart Image]

- UCL (Upper Control Limit)
- LCL (Lower Control Limit)

Samples

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Cause-and-Effect Diagram

- Environment
  - Methods
  - Materials
  - People
  - Equipment

Effect

- Cause
- Cause
- Cause
- Cause
- Cause
- Cause
- Cause
- Cause
- Cause
- Cause
- Cause
Fishbone Chart - Truck Delivery Failures

- **Shipping Documents**
  - Invoice missing
  - Packing list incorrect

- **Trucking**
  - Latest traffic and road conditions not updated
  - Leave at wrong time
  - Driver does not know route
  - Poor truck maintenance

- **Container Labeling**
  - Wrong information
  - Label stuck on poorly

- **Packing**
  - Wrong label location
  - No protective packing
  - Wrong container
  - Quality in container incorrect

- **Truck Delivery Failure**
Ishikawa Cause-Effect Diagram
Run Chart

Diameter

Time (Hours)

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Flowchart: Original Travel Authorization Process

Traveler informs secretary
To approving manager

OK?

Secretary arranges for tickets

Secretary types travel authorization (TA)
To manager

Manager inspects TA
Wait for signature

Travel writes tickets
Wait

Traveler fetches tickets, check, TA

Secretary gets tickets & check

Disbursing writes check
Wait

Completes TA

Secretary completes TA

Disbursing completes TA

Manager completes TA

To Travel & Disbursing departments

Signs

Travels

Traveler completes TA

Secretary completes TA

Disbursing completes TA

Manager completes TA
## Flow Chart Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Activity</th>
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<tbody>
<tr>
<td>✄️</td>
<td>Operation: Activity that adds value to a workpiece or provides a <em>value-adding</em> service to a customer; usually requires a setup.</td>
</tr>
<tr>
<td>➡️</td>
<td>Transportation: Movement of object from one work station to another; movement of customer from one operation to another.</td>
</tr>
<tr>
<td>□</td>
<td>Inspection: Work is checked for some characteristic of quality; may call for 100-percent inspection or inspection by sampling.</td>
</tr>
<tr>
<td>▼</td>
<td>Storage: Applies to materials or documents; may be temporary or permanent.</td>
</tr>
<tr>
<td>□️</td>
<td>Delay: Time person, materials, or documents wait for next operation; in lot delay, wait is for other items in the lot to be processed; in process delay, entire lot waits for workstation or other bottleneck to clear.</td>
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</table>
Flowchart: Revised Travel Authorization Process

Improved authorization process -- with *E-mail*

Traveler types and sends *E-mail* memo to manager

Some delay before manager responds

If yes, notifies traveler, Disbursing, Travel dept.

Disbursing writes check

To traveler

Travel prints tickets

No

To traveler

Travels
Tracking Improvements

Process not centered and not stable

Process centered and stable

Additional improvements made to the process
Methods for Generating Ideas

- Brainstorming
- Quality circles
- Interviewing
- Benchmarking
- 5W2H
Methods For Generating Solutions

**Brainstorming**: Technique for generating a free flow of ideas to solve a problem

**Quality Circles**:
- Groups of workers who voluntarily meet to discuss ways of improving products or process.
- The circle comprises a number of workers who get together periodically to discuss ways of improving products and processes.
- Quality circles are usually less structured and more informal than taskforces entrusted with a project.
Benchmarking

- Involves identifying companies or other organizations that are best at something and studying how they do it, to learn how to improve your operation.
- The other organizations *need not be* in the same line of business as yours.
- Xerox used a mail-order company, L L Bean, to benchmark order filling.

1. **American Express** is well-known for its ability to get customers to pay up quickly.
2. **Disney World** : for its employees commitment.
3. **Federal Express** : for its speed.
4. **McDonald's** : for its consistency.
5. **Xerox** : for its benchmarking techniques.
Suppliers can give ideas

- Suppliers are partners in the process, and long-term relationship should be encouraged.
- Partnership gives suppliers a vital stake in providing quality goods and services.
- Suppliers can provide quality at the source, thereby reducing or eliminating the need to inspect deliveries (ISO 9000/QS 9000).
- Suppliers can participate in new product development.
Six Sigma Tools & Modules

- **Fundamental Quality Tools**
  - Pareto Analysis
  - Process Mapping
  - Brainstorming
  - Cause-and-Effect
- **Process Characterization**
  - Defectives
  - Defects
  - Variables Data
- **Capability Analysis**
- **Measurement System**
  - Evaluation
- **Design of Experiments**

- **Statistical Process Control (SPC)**
- **Hypothesis Testing**
  - t Test
  - Analysis of Variance (ANOVA)
  - Homogeneity of Variance (HOV)
  - Chi Squared ($\chi^2$)
- **Linear Regression**
- **Failure Mode and Effects Analysis** (FMEA)
- **Short and Long Term Analysis**
- **Power & Sample Size**
Research & Development

• R&D: A Predictor of Success
  – Definitions
    • Research: pushes bounds of knowledge
      – Basic (knowledge oriented)
      – Applied (problem oriented)
    • Development: translates into tools/outputs
  – Appropriate amounts vary by industry

• Traditional R&D Weaknesses
  – Slow process
    • First-to-market concept (*time-based competition*)
  – Neglect of process design
QFD: A Model for the Design Process

- Provides Structure for Integrating Product and Process Design
- Multiple Matrix Representation (*House of Quality*)
  - Walls: customer requirements (*what’s*); competitive evaluation
  - Ceiling: operating requirements (*how’s*)
  - Interior: correlation between what’s and how’s
  - Roof: correlation among how’s
  - Basement: target values for how’s
  - Foundation: competitive evaluation of hows
### "House of Quality" for Dry Cleaners Shop

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<tr>
<th>Importance weighting</th>
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<td>1</td>
<td>2</td>
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<tr>
<td>Completely clean</td>
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<td>Perfect press</td>
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<td>No delays at counter</td>
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<td>Quick turn-around</td>
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<td>Good equip</td>
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<td>Firm press pads</td>
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<td>2-wk OJT</td>
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**Competitive evaluation**

- X: Us
- A: Comp A
- B: Comp B

**Correlation**

- Strong positive
- Positive
- Negative
- Strong negative

**Relationships**

- Strong = 9
- Medium = 3
- Small = 1

**Montly, plus as needed**

- Visual daily
- Visual monthly
- Clean monthly
- Change monthly

**Target values**

- 5
- 4
- 3
- 2
- 1
Quality Function Deployment

• QFD Facilitates
  – Comparisons to competitors
  – Setting target values for operating requirements
QFD Phases

Customer requirements → Design requirements → Part/item characteristics → Process operations → Operations requirements

Product planning → Product design → Process planning → Process control
Evolution of QA Methods...


SPC

Inspection

DOE

Taguchi

TQM, Quality Mgmt Systems

Six Sigma...

Agile mfg.

OPRE 6364
Gage R&R
Quality Circles
Useful links

http://deming.eng.clemson.edu/pub/tutorials/qctools/homepg.htm
7 Tools tutorial