Operations Management
Managing Quality
Learning Objectives

- Identify or define:
  - Quality
  - Malcolm Baldrige National Quality Awards
  - Demings, Juran, and Crosby
  - Taguchi Technique
Describe or Explain:

- Why quality is important
- Total Quality Management (TQM)
- House of Quality
- Pareto charts
- Process charts
- Quality robust products
- Inspection
To Make the Quality Focus Work

Motorola:

- Aggressively began a worldwide education program to be sure that employees understood quality and statistical process control
- Established goals
- Established extensive employee participation and employee teams
Ways in Which Quality Can Improve Productivity

**Market Gains**
- Improved response
- Economies of Scale
- Improved reputation

**Reduced Costs**
- Increased productivity
- Lower rework and scrap costs
- Lower warranty costs

Improved Quality

Increased Profits
Flow of Activities Necessary to Achieve Total Quality Management

- Organizational Practices
- Quality Principles
- Employee Fulfillment
- Customer Satisfaction
Organizational Practices

- Leadership
- Mission statement
- Effective operating procedure
- Staff support
- Training

_Yields: What is important and what is to be accomplished_
Quality Principles

- Customer focus
- Continuous improvement
- Employee empowerment
- Benchmarking
- Just-in-time
- Tools of TQM

Yields: How to do what is important and to be accomplished
Employment Fulfillment

- Empowerment
- Organizational commitment

Yields: Employees attitudes that can accomplish what is important and to be accomplished
Customer Satisfaction

- Meeting customer needs
- Repeat customers

Yields: An effective organization with a competitive advantage
Definitions of Quality

- **ASQC**: Product characteristics & features that affect customer satisfaction
- **User-Based**: What consumer says it is
- **Manufacturing-Based**: Degree to which a product conforms to *design* specification
- **Product-Based**: Level of measurable product characteristic
Dimensions of Quality for Goods

- Operation
- Reliability & durability
- Conformance
- Serviceability
- Appearance
- Perceived quality
Three Reasons Quality is Important

- Company reputation
- Product liability
- Global implications
Importance of Quality

- Costs & market share
  - Company’s reputation
  - Product liability
  - International implications

Improved Quality

- Market Gains
  - Reputation
  - Volume
  - Price

Increased Profits

- Lower Costs
  - Productivity
  - Rework/Scrap
  - Warranty
International Quality Standards

- Industrial Standard Z8101-1981 (Japan)
  - Specification for TQM
- ISO 9000 series (Europe/EC)
  - Common quality standards for products sold in Europe (even if made in U.S.)
- ISO 14000 series (Europe/EC)
  - Standards for recycling, labeling etc.
- ASQC Q90 series; MILSTD (U.S.)
Malcom Baldridge National Quality Award

- Established in 1988 by the U.S. government
- Designed to promote TQM practices

Some criteria
- Senior executive leadership; strategic planning; management of process quality
- Quality results; customer satisfaction

Recent winners
- Corning Inc.; GTE; AT&T; Eastman Chemical.
Core Elements:

- Environmental management
- Auditing
- Performance evaluation
- Labeling
- Life-cycle assessment
Traditional Quality Process (Manufacturing)

Customer → Marketing → Engineering → Operations

- Customer: Specifies Need
- Marketing: Interprets Need
- Engineering: Designs Product
- Operations: Produces Product

Quality is customer driven!
TQM

Encompasses entire organization, from supplier to customer

Stresses a commitment by management to have a continuing company-wide drive toward excellence in all aspects of products and services that are important to the customer.
Achieving Total Quality Management

Organizational Practices

Quality Principles

Employee Fulfillment

Organizational Practices

Customer Satisfaction

Effective Business

Attitudes (e.g., Commitment)

How to Do

What to Do
Concepts of TQM

- Continuous improvement
- Employee empowerment
- Benchmarking
- Just-in-time (JIT)
- Knowledge of tools
Continuous Improvement

- Represents continual improvement of process & customer satisfaction
- Involves all operations & work units
- Other names
  - Kaizen (Japanese)
  - Zero-defects
  - Six sigma
Employee Empowerment

- Getting employees involved in product & process improvements
  - 85% of quality problems are due to process & material
- Techniques
  - Support workers
  - Let workers make decisions
  - Build teams & quality circles
Quality Circles

- Group of 6-12 employees from same work area
- Meet regularly to solve work-related problems
  - 4 hours/month
- Facilitator trains & helps with meetings
Deming’s Fourteen Points

1. Create consistency of purpose
2. Lead to promote change
3. Build quality into the products
4. Build long term relationships
5. Continuously improve product, quality, and service
6. Start training
7. Emphasize leadership
8. Drive out fear
9. Break down barriers between departments
10. Stop haranguing workers
11. Support, help, improve
12. Remove barriers to pride in work
13. Institute a vigorous program of education and self-improvement
14. Put everybody in the company to work on the transformation
Benchmarking

Selecting best practices to use as a standard for performance

- Determine what to benchmark
- Form a benchmark team
- Identify benchmarking partners
- Collect and analyze benchmarking information
- Take action to match or exceed the benchmark
Resolving Customer Complaints

- Make it easy for clients to complain
- Respond quickly to complaints
- Resolve complaints on the first contact
- Use computers to manage complaints
- Recruit the best for customer service jobs
Relationship to quality:

- JIT cuts cost of quality
- JIT improves quality
- Better quality means less inventory and better, easier-to-employ JIT system
Just-in-Time (JIT)

- ‘Pull’ system of production/purchasing
  - Customer starts production with an order
- Involves ‘vendor partnership programs’ to improve quality of purchased items
- Reduces all inventory levels
  - Inventory hides process & material problems
- Improves process & product quality
Just-In-Time (JIT) Example

Unreliable Vendors
Scrap
Capacity Imbalances

Work in process inventory level (hides problems)
Reducing inventory reveals problems so they can be solved.
Tools for TQM

1. Quality Function Deployment
   House of Quality
2. Taguchi technique
3. Quality loss function
4. Pareto charts
5. Process charts
6. Cause-and-effect diagrams
7. Statistical process control
Quality Function Deployment (QFD)

- Determines what will satisfy the customer
- Translates those customer desires into the target design
Quality Function Deployment

- Product design process using cross-functional teams
  - Marketing, engineering, manufacturing
- Translates customer preferences into specific product characteristics
- Involves creating 4 tabular ‘Matrices’ or ‘Houses’
  - Breakdown product design into increasing levels of detail
To Build House of Quality

- Identify customer *wants*
- Identify *how* the good/service will satisfy customer wants.
- Relate the customer’s *wants* to the product’s *hows*.
- Identify relationships between the firm’s *hows*.
- Develop importance ratings
- Evaluate competing products
House of Quality Sequence

Customer Requirements

Design Characteristics

House 1

Design Characteristics

Specific Components

House 2

Specific Components

House 3

Production Process

House 4

Quality Plan

Production Process
Taguchi Techniques

- Experimental design methods to improve product & process design
  - Identify key component & process variables affecting product variation

- Taguchi Concepts
  - Quality robustness
  - Quality loss function
  - Target specifications
Quality Robustness

- Ability to produce products uniformly regardless of manufacturing conditions
- Put robustness in House of Quality matrices besides functionality
Quality Loss Function

- Shows social cost ($) of deviation from target value

- Assumptions
  - Most measurable quality characteristics (e.g., length, weight) have a target value
  - Deviations from target value are undesirable

- Equation: \( L = D^2 \cdot C \)
  - \( L = \text{Loss} ($) \); \( D = \text{Deviation} \); \( C = \text{Cost} \)
Loss = (Actual X - Target)^2 • (Cost of Deviation)
The specifications for the diameter of a gear are $25.00 \pm 0.25 \text{ mm}$. If the diameter is out of specification, the gear must be scrapped at a cost of $4.00. What is the loss function?
Quality Loss Function Solution

\[ L = D^2 \cdot C = (X - \text{Target})^2 \cdot C \]

\[ L = \text{Loss ($)}; \ D = \text{Deviation}; \ C = \text{Cost} \]

\[ 4.00 = (25.25 - 25.00)^2 \cdot C \]

Item scrapped if greater than 25.25 (USL = 25.00 + 0.25) with a cost of $4.00

\[ C = \frac{4.00}{(25.25 - 25.00)^2} = 64 \]

\[ L = D^2 \cdot 64 = (X - 25.00)^2 \cdot 64 \]

Enter various X values to obtain L & plot
A study found U.S. consumers preferred Sony TV’s made in Japan to those made in the U.S. Both factories used the same designs & specifications. The difference in quality goals made the difference in consumer preferences.
Pareto Analysis of Wine Glass Defects

Causes, by percent of total defects:

- Scratches: 72% (54)
- Porosity: 16% (12)
- Nicks: 5% (5)
- Contamination: 4% (4)
- Misc: 3% (2)
Process Chart

- Shows sequence of events in process
- Depicts activity relationships
- Has many uses
  - Identify data collection points
  - Find problem sources
  - Identify places for improvement
  - Identify where travel distances can be reduced
**Process Chart Example**

**SUBJECT: Request tool purchase**

<table>
<thead>
<tr>
<th>Dist (ft)</th>
<th>Time (min)</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>●↔ □ D ▼</td>
<td>Write order</td>
</tr>
<tr>
<td></td>
<td></td>
<td>○↔ □ ⬇</td>
<td>On desk</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>○↔ □ D ▼</td>
<td>To buyer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>○↔ □ D ▼</td>
<td>Examine</td>
</tr>
</tbody>
</table>

:i = Operation; ĩ = Transport; o = Inspect; D = Delay; Ŧ = Storage
Cause and Effect Diagram

- Used to find problem sources/solutions

- Other names
  - Fish-bone diagram, Ishikawa diagram

- Steps
  - Identify problem to correct
  - Draw main causes for problem as ‘bones’
  - Ask ‘What could have caused problems in these areas?’ Repeat for each sub-area.
Cause and Effect Diagram
Example

Problem

Too many defects
Cause and Effect Diagram Example

- Method
- Manpower
- Material
- Machinery

Main Cause: Too many defects
Cause and Effect Diagram Example

Method

Drill

Over Time

Manpower

Too many defects

Material

Steel

Wood

Machinery

Lathe

Sub-Cause
Cause and Effect Diagram

Example

Method

Manpower

Material

Machinery

Drill

Over Time

Tired

Too many defects

Slow

Wood

Steel

Old

Lathe
Statistical Process Control (SPC)

- Uses statistics & control charts to tell when to adjust process
- Developed by Shewhart in 1920’s
- Involves
  - Creating standards (upper & lower limits)
  - Measuring sample output (e.g. mean wgt.)
  - Taking corrective action (if necessary)
- Done while product is being produced
Start

Produce Good Provide Service

Take Sample

Inspect Sample

Create Control Chart

Assign. Causes?

No

Yes

Stop Process

Find Out Why
Control Chart Example

X

UCL

LCL

Time

1 3 5 1 9 11
Inspection

- Involves examining items to see if an item is good or defective
- Detect a defective product
  - Does not correct deficiencies in process or product
- Issues
  - When to inspect
  - Where in process to inspect
When and Where to Inspect

- At the supplier’s plant while the supplier is producing
- At your plant upon receipt of goods from the supplier
- Before costly or irreversible processes
- During the step-by-step production processes
- When production is complete
- Before shipment from your plant
- At the point of customer contact
# When and Where to Inspect in Services

<table>
<thead>
<tr>
<th>Business</th>
<th>Where</th>
<th>Variable</th>
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<tbody>
<tr>
<td>Bank</td>
<td>Teller station</td>
<td>Speed, courtesy</td>
</tr>
<tr>
<td></td>
<td>Checking</td>
<td>Accuracy</td>
</tr>
<tr>
<td>Store</td>
<td>Stockrooms</td>
<td>Stock rotation</td>
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<tr>
<td></td>
<td>Display areas</td>
<td>Attractiveness</td>
</tr>
<tr>
<td></td>
<td>Counters</td>
<td>Courtesy, knowledge</td>
</tr>
</tbody>
</table>
Service quality is more difficult to measure than for goods.

Service quality perceptions depend on:
- Expectations vs. reality
- Process & outcome

Types of service quality:
- Normal: Routine service delivery
- Exceptional: How problems are handled
Service Quality Attributes

- Reliability
- Tangibles
- Understanding
- Security
- Credibility
- Communication
- Responsiveness
- Competence
- Access
- Courtesy