Chapter 5: product Design and Quality Function Deployment

(QFD)

Learning Outcomes

After successful studying this chapter You should be able to
- Define what is QFD?
- Discuss the benefits of QFD
- Explain the QFD methodology
- Describe the four phases
  - Product Planning
  - Design Deployment
  - Manufacturing Process Planning
  - Production Planning
History...

• 1972
• Japan
• Mitsubishi
• Total Quality Management
• Valuable tool
• Underused
• Fundamental to success

Introduction

• Yoji Akao is widely regarded as the father of QFD and his work led to its first implementation at the Mitsubishi Heavy Industries Kobe Shipyard in 1972.
• The interest in QFD in the West was stimulated by reports of the achievements made by Toyota through its application between 1977 and 1984.
• These included a reduction in product development costs by 61%, a decrease in the development cycle by one third and the virtual elimination of rust related warranty problems
QFD - Defined

- A quality assurance tool for profit and non-profit organizations aimed at locating customer needs and transcending those needs into product/service production stages, ensuring that customer needs are delivered in the end.

Quality Function Deployment

- Identify customer wants
- Identify how the good/service will satisfy customer wants
- Relate customer wants to product hows
- Identify relationships between the firm’s hows
- Develop importance ratings
- Evaluate competing products
- Compare performance to desirable technical attributes
QFD – Purpose…

- Translate consumer’s voice into technical design requirements
- Determine & prioritize customer needs
- Translate customer needs to product design parameters
- Coordinate efforts and skills of an organization from a project’s inception to its completion
- Ensure customer expectations
- Avoid manufacturing catastrophe

QFD can be used to:

- Reduce product development time by 50%
- Cut start-up & engineering costs by 30%
- Reduce time to market
- Reduce # of design changes
- Lower rework
- Reduce facility’s maintenance/operation costs
- Improve quality
Where does QFD fit?

QFD
- Planning Tool
- Customer Driven
- Proactive
- Cross Functional Teams

Pugh Concept Selection: Invented by Stuart Pugh the decision-matrix method is a quantitative technique used to rank the multi-dimensional options of an option set.

The Overall Goal

- Increase customer satisfaction
- Increase business success
Competitive Advantages

- Fewer and Earlier Changes
- Shorter Development Time
- Fewer Start-up Problems
- Lower Start-up Cost
- Warranty Reduction
- Knowledge Transfer
- Customer Satisfaction

The bottom line of QFD is higher quality, lower cost, shorter timing and a substantial marketing advantage.

Common Pitfalls

- Complex house of quality
- Too much “chart focus”
- Handling trade-offs
- Too much internal focus
- “Fixed on tradition”
- “Hurry up and get done”
- Failure to integrate QFD
- QFD on everything
- Inadequate priorities
- Lack of teamwork
  - Wrong participants
  - Turf (duty) issues
  - Lack of team skills
  - Lack of support
  - Lack of support
House of Quality

- QFD’s primary tool
- Arranges facts
- Forms relationships
- Measures success

The What's & How's

- What side
  - Customer requirements/needs

- How side
  - How to meet those needs
The House of Quality

Building the House of Quality Nuts & Bolts...

- Step 1: Prepare customer requirements list
- Step 2: Prioritize customer requirements list
- Step 3: Translate Requirements to quantifiable measures
- Step 4: Determine “How” Measurement
- Step 5: Prepare correlation matrix
- Step 6: Determine What and How relationships
- Step 7: Determine design characteristics importance
- Step 8: Evaluate current competitors
- Step 9: Identify benchmarks
- Step 10: Determine target values
- Step 11: New design evaluation
The House of Quality

• QFD goes back to the principles of marketing; i.e. discovering consumers needs and delivering those needs to them
House of Quality Example

Your team has been charged with designing a new camera for Great Cameras, Inc. The first action is to construct a House of Quality

<table>
<thead>
<tr>
<th>Customer wants</th>
<th>Importance rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight</td>
<td>3</td>
</tr>
<tr>
<td>Easy to use</td>
<td>4</td>
</tr>
<tr>
<td>Reliable</td>
<td>5</td>
</tr>
<tr>
<td>Easy to hold steady</td>
<td>2</td>
</tr>
<tr>
<td>Color correction</td>
<td>1</td>
</tr>
</tbody>
</table>

Customer importance rating (5 = highest)
House of Quality Example

<table>
<thead>
<tr>
<th>Low electricity requirements</th>
<th>Aluminum components</th>
<th>Auto focus</th>
<th>Auto exposure</th>
<th>Paint pallet</th>
<th>Ergonomic design</th>
</tr>
</thead>
</table>

**How to Satisfy Customer Wants**

- High relationship
- Medium relationship
- Low relationship

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Relationship matrix
**House of Quality Example**

- **What the Customer Wants**
  - Relationship Matrix
- **Technical Attributes and Evaluation**
- **Interrelationships**
- **Analysis of Competitor**
- **How to Satisfy Customer Wants**

**Relationships between the things we can do**

- Low electricity requirements
- Aluminum components
- Auto focus
- Auto exposure
- Paint pallet
- Ergonomic design

**House of Quality Example**

<table>
<thead>
<tr>
<th>Lightweight</th>
<th>3</th>
<th>●</th>
<th></th>
<th>●</th>
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<tr>
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<td></td>
<td></td>
<td></td>
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</table>

**Our importance ratings**

|             | 22 | 9 | 27 | 27 | 32 | 25 |

**Weighted rating**
House of Quality Example

How well do competing products meet customer wants

- **Lightweight**: 3  ●  ●  G  P
- **Easy to use**: 4  ●  ●  G  P
- **Reliable**: 5  ●  ●  F  G
- **Easy to hold steady**: 2  ●  ●  G  P
- **Color corrections**: 1  ●  ●  P  P

Our importance ratings: 22  S

House of Quality Example

Target values (Technical attributes)

- **Panel ranking**
- **Failure 1 per 10,000 circuits**
- **2 circuits**
- **2 to ∞**

Technical evaluation

<table>
<thead>
<tr>
<th>Product</th>
<th>Target Values</th>
<th>Technical Attributes</th>
<th>Failure per 10,000</th>
<th>Panel ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>0.7 60%</td>
<td>yes</td>
<td>1</td>
<td>ok G</td>
</tr>
<tr>
<td>Company B</td>
<td>0.6 50%</td>
<td>yes</td>
<td>2</td>
<td>ok F</td>
</tr>
<tr>
<td>Us</td>
<td>0.5 75%</td>
<td>yes</td>
<td>2</td>
<td>ok G</td>
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</tbody>
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Target values (Technical attributes)

- **Panel ranking**
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<td>2</td>
<td>ok G</td>
</tr>
</tbody>
</table>
House of Quality Example

Completed House of Quality

<table>
<thead>
<tr>
<th>House of Quality Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight 3</td>
</tr>
<tr>
<td>Easy to use 4</td>
</tr>
<tr>
<td>Reliable 5</td>
</tr>
<tr>
<td>Easy to hold steady 2</td>
</tr>
<tr>
<td>Color correction 1</td>
</tr>
</tbody>
</table>

Our importance ratings

<table>
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<tr>
<th>Target values (Technical attributes)</th>
</tr>
</thead>
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<tr>
<td>Company A</td>
</tr>
<tr>
<td>Company B</td>
</tr>
<tr>
<td>Us</td>
</tr>
</tbody>
</table>

Family ranking

<table>
<thead>
<tr>
<th>Failure 1 per 10,000 circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

Panel ranking

| 22  | 9  | 27  | 27  | 32  | 25  |

House of Quality Sequence

Deploying resources through the organization in response to customer requirements

Figure 5.1
Conclusion

- QFD is a method. It is not a solution.
- QFD is an effective tool for improving the inventory system.
- It matches customer requirements with technical requirements.
- The use of QFD provides a better understanding of the planning process.

Some “Right Questions”

- How was the voice of the customer determined?
- How were the design requirements (etc) determined? Challenge the usual in-house standards.
- How do we compare to our competition?
- What opportunities can we identify to gain a competitive edge?
- What further information do we need? How can we get it?
- How can we proceed with what we have?
- What trade-off decisions are needed?
- What can I do to help?

Points to remember

- The process may look simple, but requires effort.
- Many of the entries look obvious - after they are written down.
- If there aren’t some “tough spots” the first time, it probably isn’t being done right!
- Focus on the end-user customer.
- Charts are not the objective.
- Charts are the means of achieving the objective.
- Find reasons to succeed, not excuses for failure.
END

Department of Industrial Engineering

Failure Modes & Effects Analysis (FMEA)
Failure Modes & Effects Analysis (FMEA)

- Many organizations use FMEA as a “reliability” analysis tool separate from safety
- A safety version of FMEA is:
  - FMECA – Failure Modes & Effects Criticality Analysis
- FMEA is used in DoD, NASA, DoE, Private Industry
- See “Form” on next slide
- See handout on FMEA from Stephans
**FMEA – Failure Modes, Effects Analysis**

- Manual analysis to determine the consequences of component, module or subsystem failures
- Bottom-up analysis
- Consists of a spreadsheet where each failure mode, possible causes, probability of occurrence, consequences, and proposed safeguards are noted.

**FMEA – Failure Mode Keywords**

<table>
<thead>
<tr>
<th>Rupture</th>
<th>Spurious start</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack</td>
<td>Loss of function</td>
</tr>
<tr>
<td>Leak</td>
<td>High pressure</td>
</tr>
<tr>
<td>Plugged</td>
<td>Low pressure</td>
</tr>
<tr>
<td>Failure to open</td>
<td>High temperature</td>
</tr>
<tr>
<td>Failure to close</td>
<td>Low temperature</td>
</tr>
<tr>
<td>Failure to stop</td>
<td>Overfilling</td>
</tr>
<tr>
<td>Failure to start</td>
<td>Hose bypass</td>
</tr>
<tr>
<td>Failure to continue</td>
<td>Instrument bypassed</td>
</tr>
<tr>
<td>Spurious stop</td>
<td></td>
</tr>
</tbody>
</table>
FMEA on a Heat Exchanger

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Causes of Failure</th>
<th>Symptoms</th>
<th>Predicted Frequency</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube rupture</td>
<td>Corrosion from fluids (shell side)</td>
<td>H/C at higher pressure than cooling water</td>
<td>Frequent – has happened 2x in 10 yrs</td>
<td>Critical – could cause a major fire</td>
</tr>
</tbody>
</table>

1. Rank items by risk (frequency x impact)
2. Identify safeguards for high risk items

FMEA – Failure Modes, Effects Analysis

- FMEA is a very structured and reliable method for evaluating hardware and systems.
- Easy to learn and apply and approach makes evaluating even complex systems easy to do.
- Can be very time-consuming (and expensive) and does not readily identify areas of multiple fault that could occur.
- Not easily lent to procedural review as it may not identify areas of human error in the process.

