08. Quality Function Deployment
NASA ESMD Capstone Design

Where in the Process?

Phase A: Design Problem Analysis
07. Quality Function Deployment

Project Tools Covered

- Quality Function Deployment
  - A mechanism to ensure that the customer needs drive the entire product design and production process in the company, including market planning, product design and engineering, process development and prototype evaluation, as well as production, sales, and service.

  (Lumsdaine et al., 2006)

Quality Function Deployment

- “Relating the voice of customer to design and manufacturing decisions”
- Quality
  - Satisfies the total needs of the customers
- Measure of quality
  - Difference between what the customers expect and what is provided
- Deployment of quality
  - All phases of a product’s life-cycle
Quality Function Deployment

- Ensures(?) that the needs of the customer are understood
- Philosophy: products are customer driven, future products must offer “exciting quality,” think before you do
- Tool: House of Quality, NOT a magic box

What Is QFD?

- Quality function deployment (QFD) is a continuous improvement tool that brings the voice of the customer into the design process
- It is a very structured team approach to quality control that offers many opportunities for creative thinking and brainstorming to achieve products that do not have any defects
- It is a comprehensive data base for continuous improvement and innovation

(Lumsdaine et al., 2006)
QFD Seeks to Answer …

- What are the qualities the customer desires?
- What functions must the product serve, and what functions must we use to provide the product or service?
- Based on our available resources, how can we best provide what our customer wants?

(Lumsdaine et al., 2006)

History

- Early ‘60’s (Demming) in US
- 1971: Kobe shipyards (Mitsubishi) and Japanese Society of Quality Control
- 1980’s: Toyota - customer values
- Xerox 1980’s and Ford 1984
- Toyota’s famous rust study in 1978 was the result of QFD pointing to rust as a major competitive disadvantage for the company, with many complaints
Benefits of QFD

- Shorter development cycles
- Trade-offs are made in design, rather than in the market
- Lower costs, increased productivity
- Documentation orientation
- Team involvement and commitment at the design stage

(Lumsdaine et al., 2006)

QFD: Key Points

- Design – how do our capabilities match the customers' needs?
- Design – what trade-offs do we make in design?
- Process planning – key processes are identified in the process planning matrix
- Production planning – key process control items are identified in the production planning charts

(Lumsdaine et al., 2006)
QFD Phases

- Translate VOC through product development
- Requirements to metrics to part characteristics to process control to production planning

QFD: The Visual Planning Matrix

- The House of Quality (the first of four QFD matrices) links
  - Customer Requirements
  - Design Requirements
  - Target Values
  - Competitive Performance

(Lamshed et al., 2006)
House of Quality

- Engineering Metrics Interactions
  - Customer Requirements
  - Engineering Metrics
  - Competitors

- Customer Requirements Importance
  - Customer Requirements vs Engineering Metrics
  - Benchmarking

- Engineering Metrics Targets
  - Competitor Benchmarking
  - Engineering Metrics Benchmarking

Phase I Example

- Competitor Coats
  - Very Poor
  - Poor
  - Fair

- Features
  - A
  - B
  - C

- Technical Features
  - A
  - B
  - C

- Raw Scores
  - 1, 2, 3, 4

- Relative Weight
  - 1, 2, 3, 4
**Customer Requirements**

- Customer Requirements
- Customer Requirements Importance
- Customer Requirements vs. Engineering Metrics
- Engineering Metrics
- Engineering Metrics Targets
- Competitors
- Competitor Benchmarking
- Engineering Metrics Benchmarking
- Engineering Metrics Interactions

**The Customers’ Voice**

- From Weighted User Requirements
  - Solicited information
  - Unsolicited information
  - Quantitative information
  - Qualitative information
  - Structured information
  - Random information

*(Lamsdine et al., 2006)*
Requirements Benchmarking

- More customers, more time, more personal, more open-ended (with facilitation) -> more knowledge
- Interviews, process participation (service, sales, design), participant observation

QFD Tools

- Interrelationship diagram
  - Establishes relationships between and among causes
- Tree diagram
  - Classification tree of the ideas in the affinity diagram
- Matrix diagram
  - Maps the voice of the customer against the company capabilities required to meet the customer need

(Lamsdaine et al., 2006)
07. Quality Function Deployment

**Relationships: Requirements versus Metrics**

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Relationships: △ Weak  ○ Medium  ⬤ Strong

(Shah et al., 2006)

**Engineering Metrics Interaction**

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CORRELATION MATRIX

○ Strong Positive  ○ Positive  ✗ Negative  ✗ Strong Negative

(Lumsdaine et al., 2006)
When conflicting requirements for an important product feature cannot be resolved, this presents an opportunity for creative problem solving, the development of new technology, and subsequent innovation in company’s effort to achieve highest quality at the lowest cost.

(Lumsdaine et al., 2006)
Customer wants must be translated into characteristics that are measurable.

These incorporate the design objectives or requirements.

This is a crucial step in QFD, deserving major study and development, so that the voice of the customer is not lost and the design requirements truly reflect the customer wants.
Conduct Technical Competitive Benchmark Studies

- Comparative testing of this type is normally done by a company’s laboratory
- The team should spend preparatory time with the lab personnel who will conduct the study
- They need to be familiar with the company measures the team has established
- It may not be possible to develop data for all measures

(Lumsdaine et al., 2006)

Complete Relationship Matrix of Customer Wants versus Company Measures

- This is a vital step in the QFD process
- Look for the direct relationship of how well the company measure satisfies the customer wants
- The symbols used indicate a strong, medium, or weak relationship
- Most teams find that filling the matrix in a column-wise manner works best

(Lumsdaine et al., 2006)
Establish Preliminary Targets for Company Measures

- Targets are the level of performance which the team believes is required to achieve customer satisfaction
- Traditionally, design specifications reflect the judgment of the engineer and include the capabilities of the manufacturing process

Complete the Correlation Matrix

- Orientation values indicate the direction for optimization
  - Maximize (tensile strength, reliability)
  - Minimize (wear, fade, water leak amount)
  - Target (material stretch, operating effort)
Analysis of Completed QFD Chart

- **Blank rows**
  - No company measures address this customer want
  - If it is important, identify design requirements

- **Blank columns**
  - These may be necessary for the product but do not directly relate to any customer want
  - Remove from QFD matrix but reserve for subsequent use (see Column 12)

(Lumsdaine et al., 2006)

Analysis of Completed QFD Chart

- **Conflicts**
  - If your customer rates your product good, but your engineering competitive assessment does not have a good rating, this could mean that you do not fully understand your customer demand and competitive assessment, or you don’t have a strong relationship

(Lumsdaine et al., 2006)