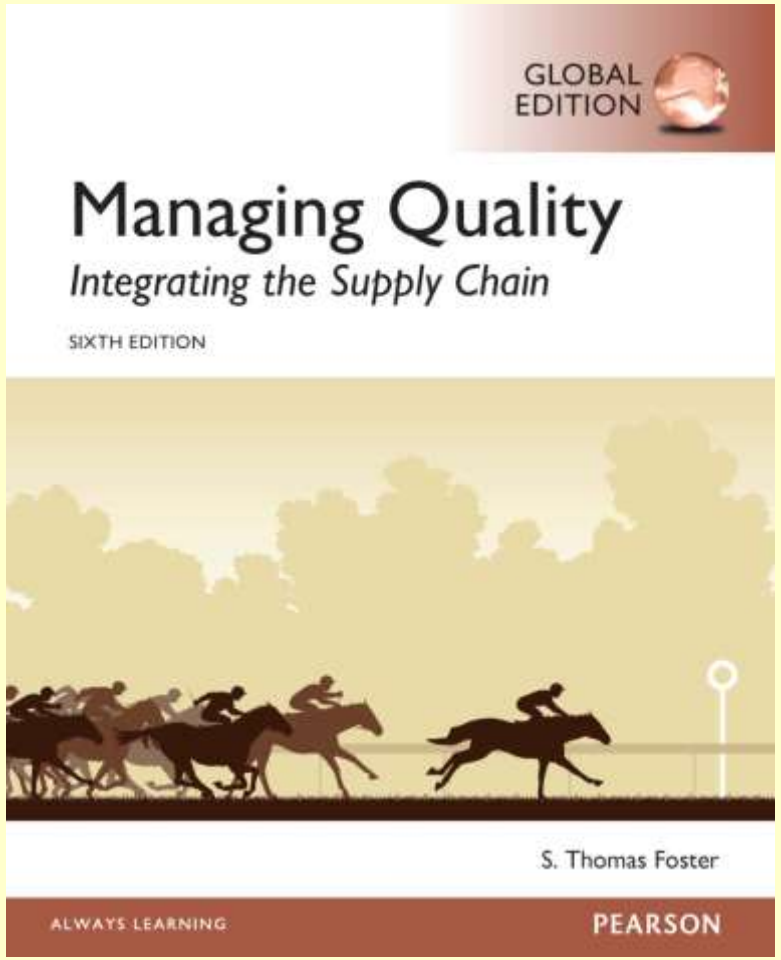

Chapter 7

Quality and Innovation in Product and Process Design

Chapter Objectives

1. Discuss the processes firms use to design products.
2. Perform “house of quality” quality function deployment (QFD) analysis.
3. Defend design concerns such as design for manufacture, maintainability, and reliability.
4. Perform rudimentary failure modes and effects analysis.
5. Discuss green design.

Designing Products for Quality

- What are the functions the customer wants?
- What are the capabilities of current products?
- What are the limitations of the materials we have selected for the product?
- Are there better materials available?
- How much will the product cost to make?
- How much must the product cost to make it successful in the marketplace?

The Design Process

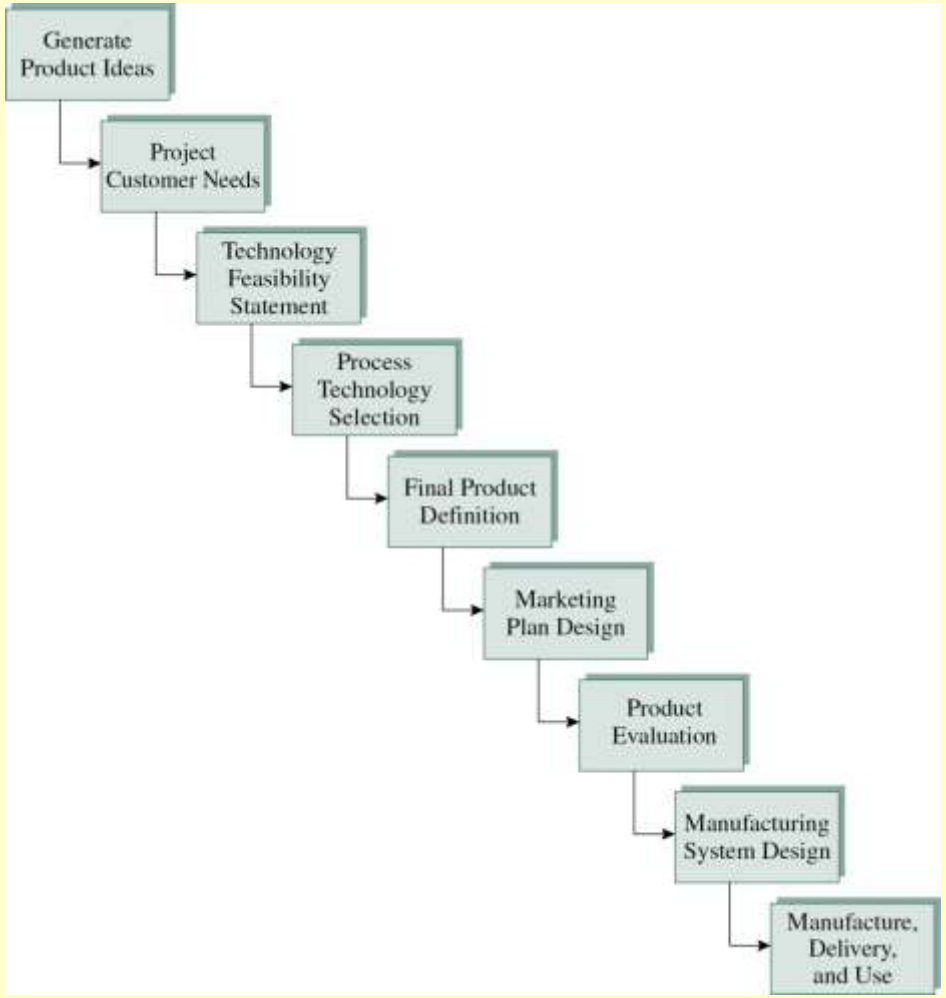

Figure 7-2

The Design Process

Step 1: Product idea generation

- External sources
  - The customer, industry experts, consultants, competitors, suppliers, inventors
- Internal sources
  - Marketing, management, research and development (R&D), employee suggestions

The Design Process (cont'd)

Step 2: Customer future needs projection

- Using data to predict future customer needs

Step 3: Technology selection for product development

- Designers choose the materials and technologies that will provide the best performance for the customer at an acceptable cost.

- Technology feasibility statement

The Design Process (cont'd)

Step 4: Technology development for process selection

Step 5: Final product definition

Step 6: Product marketing and supply chain preparation

Step 7: Product design and evaluation

Step 8: Manufacturing system design

Step 9: Product manufacture, delivery, and use

Quality Function Deployment (QFD)

- A method for translating customer requirements into functional design
- The process of translation is also called the voice of the customer.

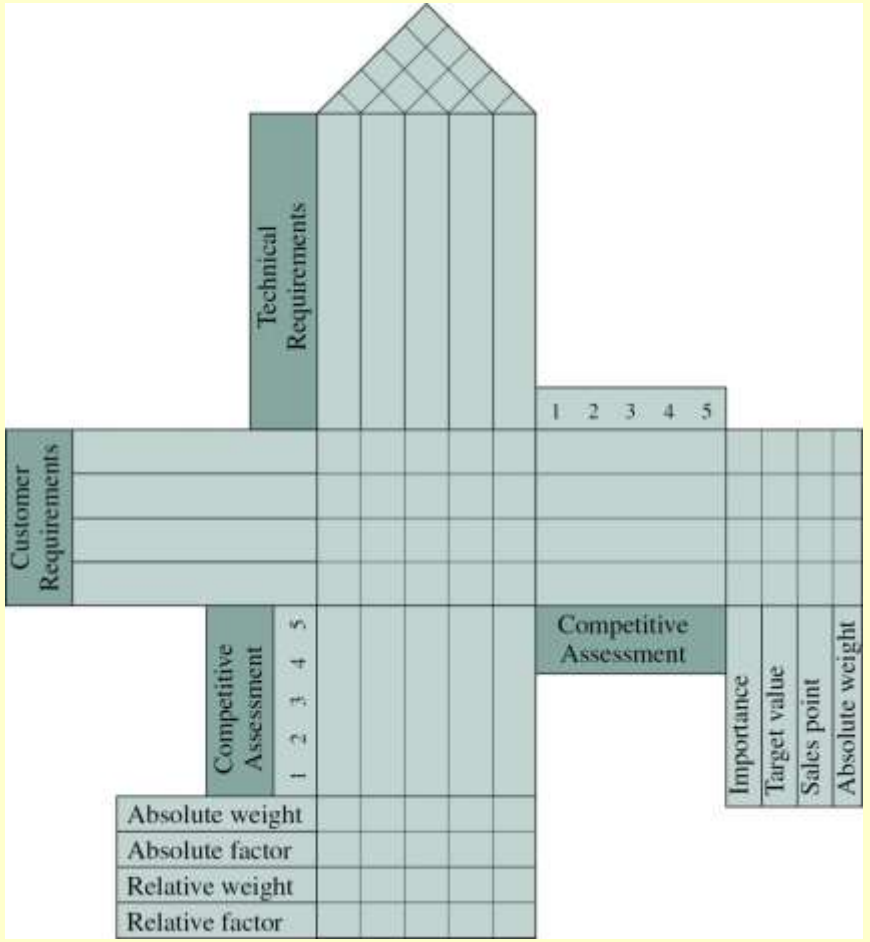

Figure 7-3

Quality Function Deployment

Step 1 – Develop a list of customer requirements.

Customer Requirements
Clean facilities
Comfortable seating
Delicious food
Responsive servers

Figure 7-4

Quality Function Deployment (cont'd)

Step 2 – Develop a list of technical design elements along the roof of the house.

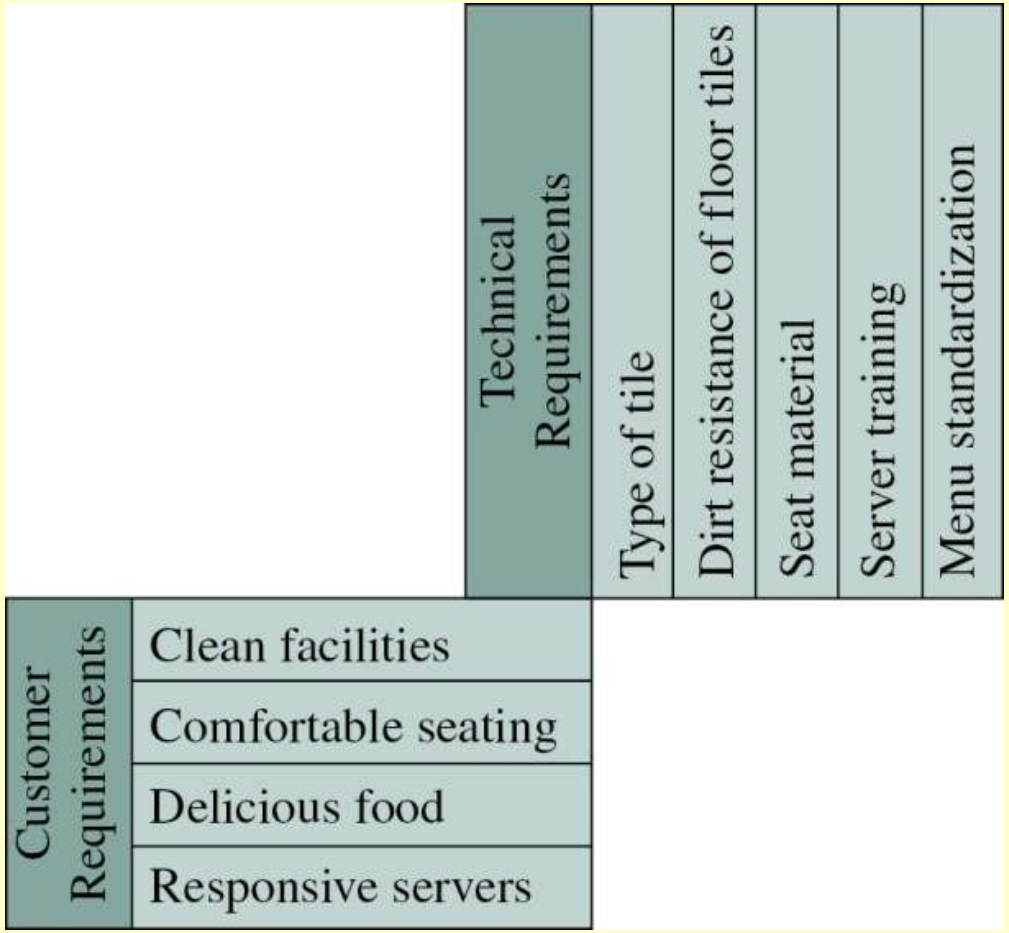

Figure 7-5

Quality Function Deployment (cont'd)

Step 3 – Demonstrate the relationships between the customer requirements and technical design elements.

		Technical Requirements: Type of tile	Dirt resistance of floor tiles	Seat material	Server training	Menu standardization
Customer Requirements	Clean facilities	●	●	○	△	
	Comfortable seating			●		
	Delicious food				△	●
	Responsive servers				●	○

Symbols
- ● = 9 (Strong association)
- ○ = 3 (Somewhat associated)
- △ = 1 (Weak association)

Figure 7-6

Quality Function Deployment (cont'd)

Step 4 – Identify the correlations between design elements in the roof of the house.

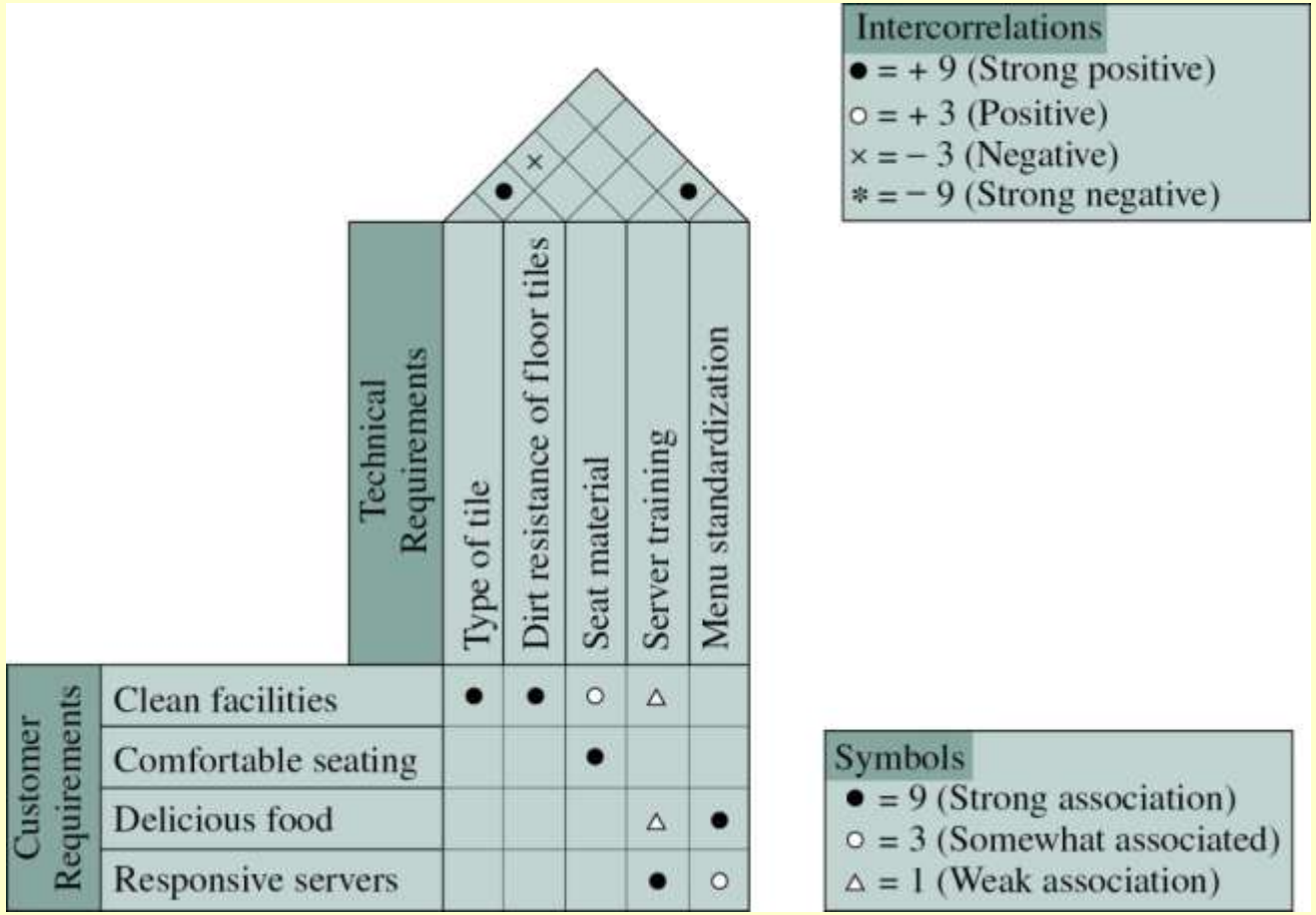

Figure 7-7

Quality Function Deployment (cont'd)

Step 5 – Perform a competitive assessment of the customer requirements.

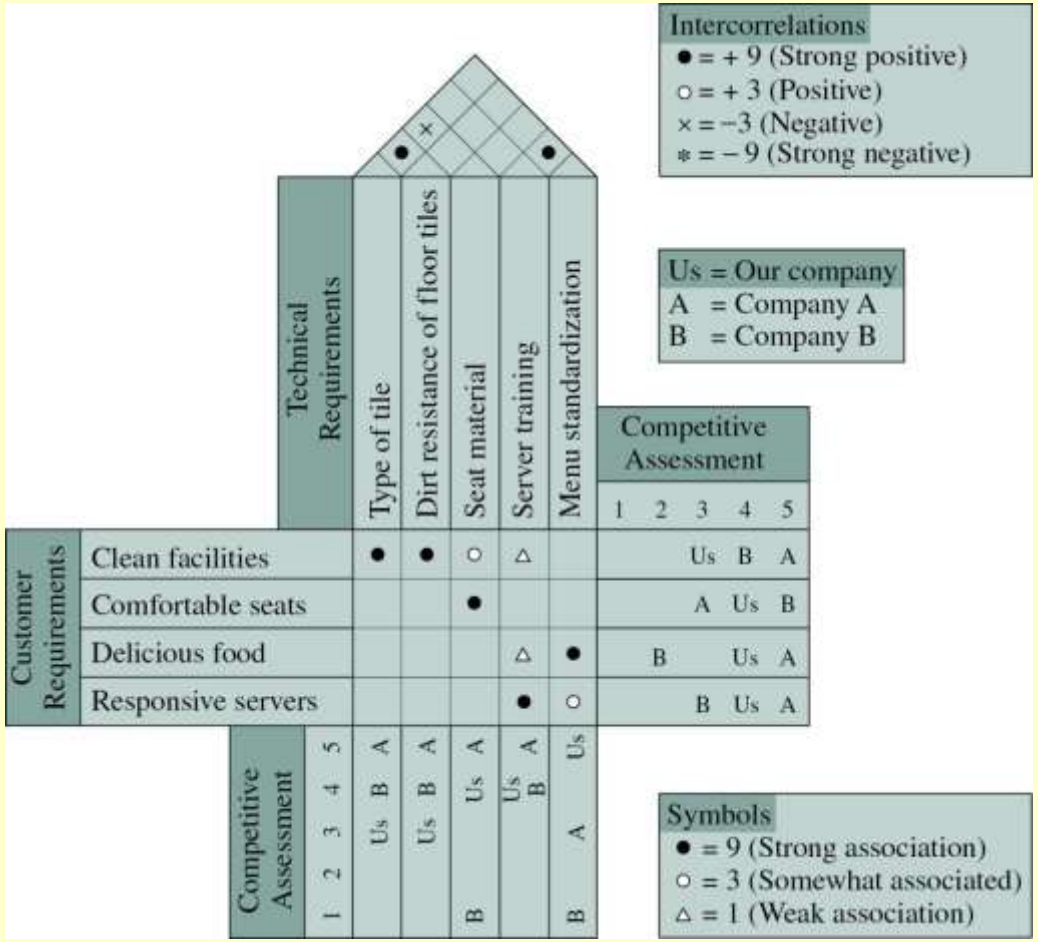

Figure 7-8

Quality Function Deployment (cont'd)

Step 6 – Prioritize customer requirements.

Importance: A rating that shows how important each customer requirement (VOC) is relative to the others.

Scale 1–10 (10 = most important).

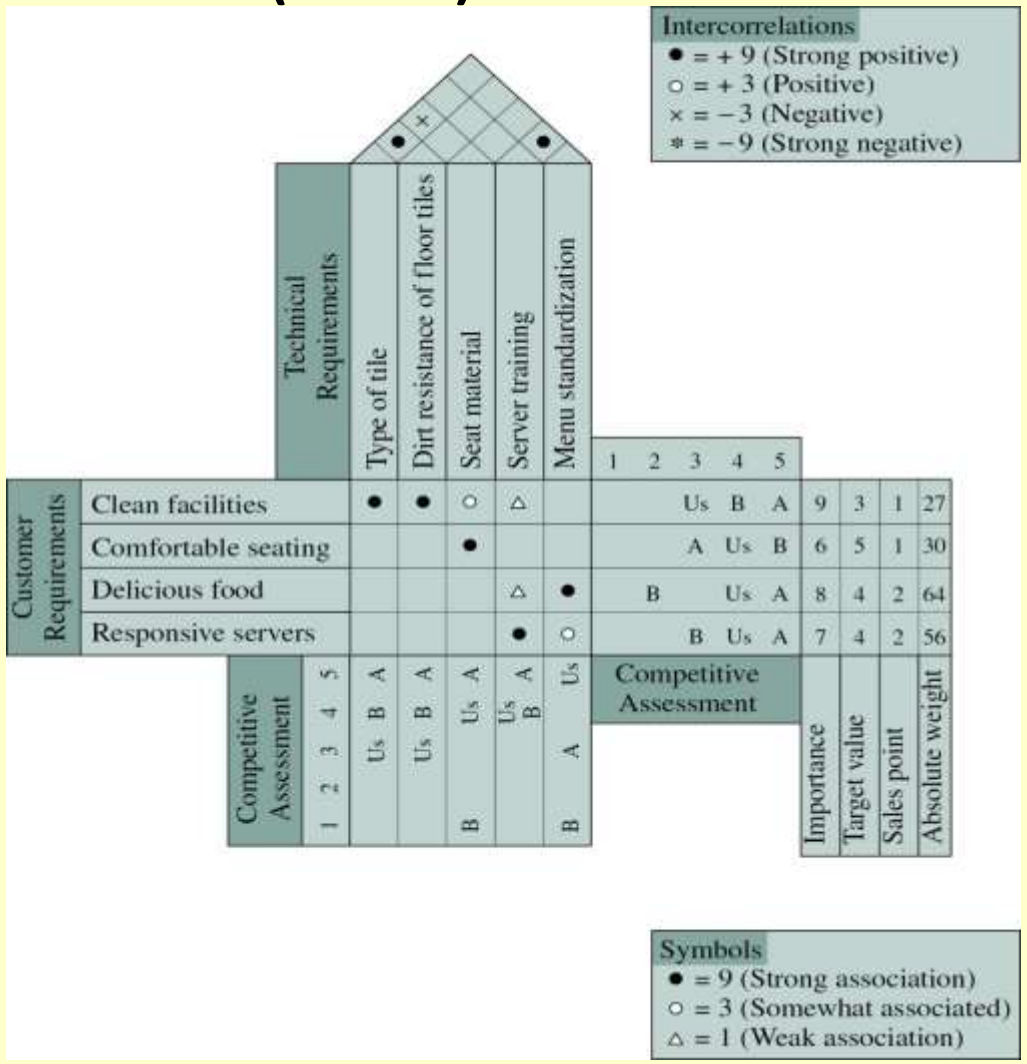

Figure 7-9

Step 06: Target Value

They are rating targets on a 1–5 competitive scale for each customer requirement. E.g.,

- A target value of 5 means: "We aim to be rated 5/5 by customers on this requirement in the future."
- A target of 3 or 4 means: "For this requirement, our design goal is to reach level 3 or 4 on the same 1–5 scale."
- So, those 3, 5, 4, 4 are desired future performance ratings (how customers should score you vs competitors).

Step 06: Sales point

- **Sales Point:**
- 1 = low/no sales point. The requirement is important, but it does not strongly help you sell or differentiate (e.g., “clean facilities” – expected by everyone).

- 2=high sales point. The requirement is a strong selling feature that can be highlighted in marketing and really attracts customers (e.g., “delicious food”, “responsive servers”).

Quality Function Deployment (cont'd)

Step 7 – Prioritize technical requirements.

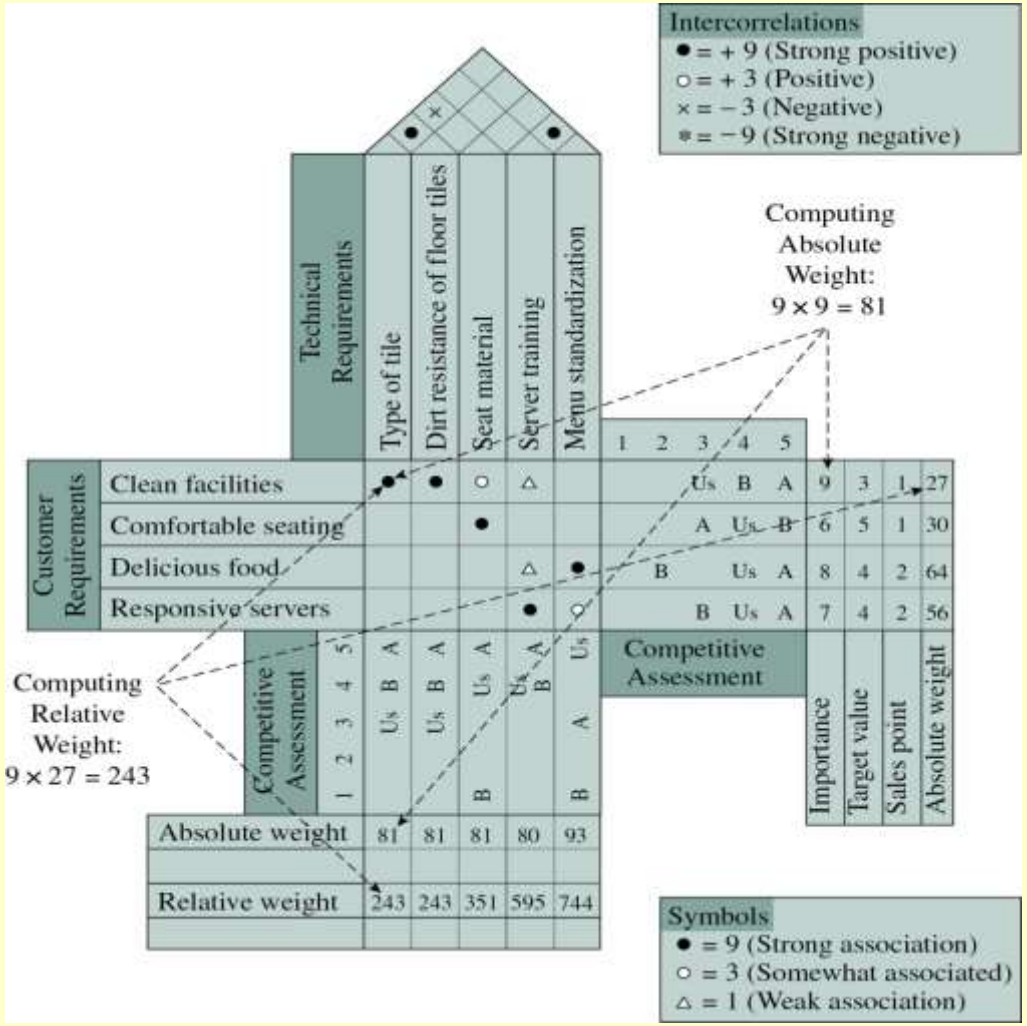

Figure 7-10

Quality Function Deployment (cont'd)

Step 8 – Perform a final evaluation.

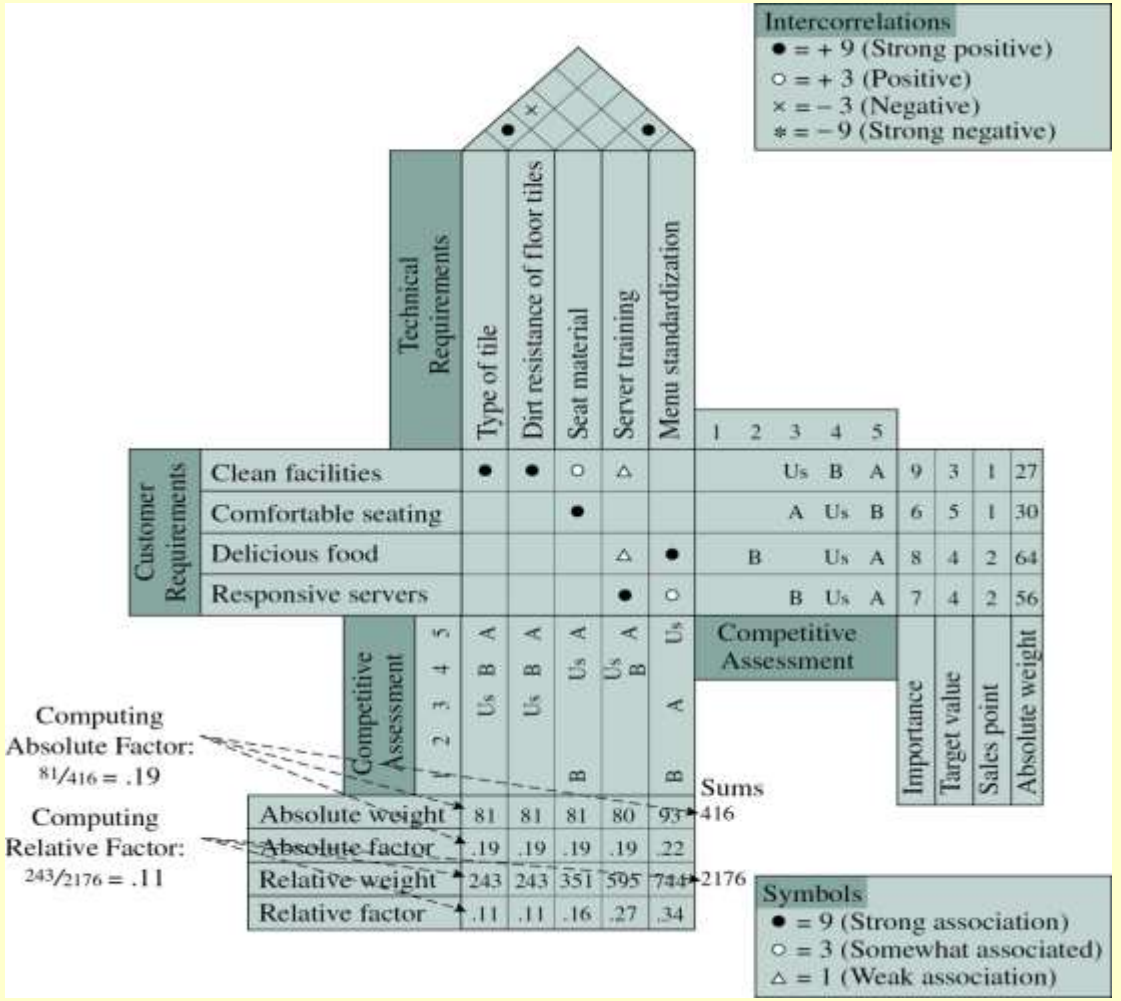

Figure 7-11

Technology in Design

- **Computer-aided design system (CAD)**
  - Systems with tools that can greatly improve the ability of designers to generate new and varied designs by simplifying the design process

- **Multiuser CAD systems**
  - Multiple designers in locations worldwide can work on a design simultaneously

Technology in Design

CAD systems are used in the following processes:

- Geometric modeling
- Engineering analysis
- Design review and interference checking
- Automated drafting

CAD/CAM

CAD/CAM systems are often tied together in a closed-loop system with:

- Computer-aided inspection (CAI)
- Computer-aided testing (CAT)

Other Design Methodologies

- **Design for the manufacture (DFM)**
  - Designing products so they are cost-effective and simple to build
    - Over-the-wall syndrome
    - Enterprise resource planning (ERP) systems
    - Product data management (PDM) tool

Other Design Methodologies

- **Design for maintainability**
  - Customers should be provided with the necessary information and ease of access to the product that allow for simple or preventative maintenance.

- **Design for maintainability concepts include:**
  - Components that are easily replaced
  - Components that are easily removed with standard tools
  - Adequate space to perform the maintenance function
  - Nondestructive disassembly
  - Safe maintenance
  - Available adequate owners' manuals and documentation

Designing for Reliability

- **Reliability**
  - Results from the interaction of multiple components in a system

- **Reliability dimensions**
  - Component reliability
  - System reliability

Reliability Analysis Tools

- **Failure modes and effects analysis (FMEA)**
  - A process that systematically considers each component of a system – identifying, analyzing, and documenting the possible failure modes within that system and the effects of each failure on the system

- **Benefits of FMEA:**
  - Improvement of the safety, quality, and reliability of products
  - Improvement of a company's image and its competitiveness
  - Increased satisfaction from a user standpoint
  - Reduction in product development cost
  - Record of actions taken to reduce a product risk

Reliability Analysis Tools

Five basic areas in which FMEA can be applied:

- Concept
- Process
- Design
- Service
- Equipment

How FMEA Works

1. Give each component in the system a unique qualifier.
2. List all the functions each part of the system performs.
3. List one or two failure modes for each function from the second step.
4. Describe what effects each failure mode of the component will have.
5. Determine whether the failure will result in a potential hazard to personnel or the system.

How FMEA Works (cont'd)

6. Estimate the relative likelihood of occurrence for each failure on a 10-point scale.
7. Estimate the ease with which the failure may be detected.
8. Use the estimates from steps 5, 6, and 7 to identify the highest risks related to the system.
9. Decide what action will be taken to eliminate or reduce the highest risks in the system.

More Reliability Analysis Tools

- **Fault-tree analysis**
  - An analytical tool that graphically reduces the combinations of faults that lead to system failure

- **Failure modes, effects, and criticality analysis (FMECA)**
  - An extensive but simple method for identifying ways in which an engineered system could fail

Product Traceability and Recall Procedures

- Product traceability
- Recall procedures
- Consumer Product Safety Commission (CPSC)

Environmental Considerations in Design

Green manufacturing:

- Design for reuse
- Design for disassembly
- Design for remanufacture

Environmental Considerations in Design

Green design concerns:

- Use nonhazardous materials if possible.
- Avoid waste.
- Product components should operate efficiently.
- Accept costs associated with reuse, recycling, and disposal.
- Make products durable.
- Design products so they can be used, recycled, and reused.
- Use reusable energy when possible.