Learning Objectives

- Origin of ideas for new products/services
- Components of new products/services design
- Role of reliability
- Differences in design
Module 3

Quality Management

Strategic Decisions (some)

- Design of Products and Services
- Process Selection and Design
- Capacity and Facility Decisions

Forecasting

Project Management

Tactical & Operational Decisions
The first rule of business:

“You have to have products that sell”

Product Design is a Business Issue
Why Firms Develop New Products

1. Competitive Advantage
2. Market Share Gain
3. Higher Profitability
4. Enhancement of Brand
5. Faster Competitive Response
6. Improved Operating Cost & Resource Utilization
Firms innovate and develop new products for unique opportunities for competitive advantages.

Example: The iPod was instrumental in the survival and emergence of a stronger and more competitive Apple Inc., resulting in market share gain and higher profitability.
New products introduced in the marketplace provide additional “first mover advantages” to the company.

By developing new products, a company can quickly capture a big share of the market before competitive products are introduced.

Example: Toyota’s successful introduction of the Prius hybrid car prior to its competitors’ development of such a car has allowed the company to establish a dominant position in the emerging market segment of fuel-efficient and environmentally friendly automobiles.

Who else is in this ‘green’ automotive marketplace?
Higher Profitability

- During the early stages, a new product faces less competition than a product in a mature market; therefore, its profitability tends to be higher.

- As the market becomes saturated with several competitive products, prices start falling, and profit margins decrease.
Enhancement of Corporate Image and Brand Name

- The developments of innovative and creative new products is a very powerful source of goodwill and creates a positive corporate image.

- Brand equity measures used in marketing show that firms with more successful new product development efforts command higher respect from customers and profitability.

  - **brand equity**: the monetary or relative value of a brand perceived in the marketplace by its customers.
Having a systematic process for new product development in place can introduce new products quickly after a competitor’s product is launched.

Sony’s Playstation, Microsoft’s X-Box, and Nintendo’s Wii compete fiercely in the video game industry. Each company tries to quickly introduce new products to compete with others.
The product development effort is often closely linked with process development.

New products provide the opportunity for enhanced sales as the demand for older products decreases over time.
Product Development Tradeoffs

- Development Cost
- Development Speed
- Product Performance
- Product Cost

Questions:
- How fast can we get it to market?
- Does it meet the customer’s needs?
- How much will it cost the customer?
- How much will it cost us?
Multiple Product Life Cycles

- Total sales
- Sales for individual products

Time
Single Item (Industry) Product Life Cycle

<table>
<thead>
<tr>
<th>Sales</th>
<th>Introduction</th>
<th>Growth</th>
<th>Maturity</th>
<th>Decline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internet-based phones (VOIP)</td>
<td>Mobile phone/PDA/MP3 player</td>
<td>Mobile phones</td>
<td>Landline phones</td>
</tr>
</tbody>
</table>

Time
Radical and Disruptive Innovation

- **Radical Innovation**: a new product, generally containing new technologies, that significantly changes behaviors and consumption patterns in the marketplace.

- **Disruptive Innovation**: a new product that is initially introduced at a lower quality level along some established criteria but a much superior quality level along a new dimension.
# Examples of Disruptive New Products

<table>
<thead>
<tr>
<th>Industry</th>
<th>Existing Product</th>
<th>Disruptive Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>Horse-driven carriages</td>
<td>Automobiles based on gasoline-powered engines</td>
</tr>
<tr>
<td>Transportation</td>
<td>Automobiles based on gasoline-powered engines</td>
<td>Automobiles based on hybrid (gasoline + electric battery) engines</td>
</tr>
<tr>
<td>Computers</td>
<td>Mainframe computers</td>
<td>Laptop computers</td>
</tr>
<tr>
<td>Computers</td>
<td>Laptop computers</td>
<td>Palm-top computers</td>
</tr>
<tr>
<td>Retailing</td>
<td>Shopping center</td>
<td>Internet retailer</td>
</tr>
<tr>
<td>Hotels</td>
<td>Large convention and standard hotels</td>
<td>Boutique hotels</td>
</tr>
<tr>
<td>Restaurants</td>
<td>Traditional quick-service (or fast-food) establishments</td>
<td>Gourmet, organic, and health food-based restaurants</td>
</tr>
<tr>
<td>Communication</td>
<td>Landline phones</td>
<td>Mobile phones</td>
</tr>
<tr>
<td>Communication</td>
<td>Mobile phones</td>
<td>Internet-based phones (VoIP)</td>
</tr>
<tr>
<td>Photography</td>
<td>Camera using film</td>
<td>Digital cameras</td>
</tr>
<tr>
<td>Music</td>
<td>Audio cassettes</td>
<td>Compact disk players</td>
</tr>
<tr>
<td>Music</td>
<td>Compact disk players</td>
<td>MP3 players</td>
</tr>
</tbody>
</table>
Product/Service Design

- Major Business Functions Involved
Historically…

Functional “Silos”

- Operations
- Engineering
- Marketing
Historically...

As the customer wanted it.

As Operations made it.

As Marketing interpreted it.

As Engineering designed it.
House of quality
- Helps the cross functional team to focus on building a product that satisfies customers
- Graphical technique to relate customer needs (WHATs) to product design characteristics (HOWs)
Process Choice

- Selection of inputs, operations, workflows, and methods for producing goods and services
Process Example 1: How to Make a Car
Process Example 2:
How to Make a Burger
Elements of Product Design: Design Simplification

(a) The original design

Assembly using common fasteners

Figure 3.3
Design Simplification

(a) The original design
Assembly using common fasteners

(b) Revised design
One-piece base & elimination of fasteners
Design Simplification

(a) The original design
Assembly using common fasteners

(b) Revised design
One-piece base & elimination of fasteners

(c) Final design
Design for push-and-snap assembly
Standardizing parts among different products at Ford

<table>
<thead>
<tr>
<th>Product</th>
<th># before</th>
<th># after</th>
<th>Savings/veh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air filters</td>
<td>18</td>
<td>5</td>
<td>$0.45</td>
</tr>
<tr>
<td>Carpet</td>
<td>9</td>
<td>3</td>
<td>$1.25</td>
</tr>
<tr>
<td>Trunk carpet</td>
<td>7</td>
<td>1</td>
<td>$1.16</td>
</tr>
</tbody>
</table>

Annual savings = $3M + $9M + $5M
= $17M
Process Types

- Project
- Batch Production (job shop)
- Mass Production (assembly line)
- Continuous Production
**Process Types**

- **Project**
  - HI variety of products, low volume, flow not unique

- **Batch Production (job shop)**
  - Wide variety of products, med volume, jumbled flow

- **Mass Production (assembly line)**
  - Low variety of products, High volume, dominant flow

- **Continuous Production**
  - Commodity product, HIGHEST volume,
# Process Type - Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Project /Batch</th>
<th>Assembly /Continuous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume/Variety:</strong></td>
<td>Low/high</td>
<td>High/low</td>
</tr>
<tr>
<td><strong>Capacity Measured:</strong></td>
<td>Inputs</td>
<td>Outputs</td>
</tr>
<tr>
<td><strong>Competition:</strong></td>
<td>Non-cost</td>
<td>Cost</td>
</tr>
<tr>
<td><strong>Process Stages:</strong></td>
<td>Separate</td>
<td>Linked</td>
</tr>
<tr>
<td><strong>Equipment:</strong></td>
<td>General</td>
<td>Specialized</td>
</tr>
<tr>
<td><strong>Work In Process:</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Size:</strong></td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td><strong>Flexibility:</strong></td>
<td>Very</td>
<td>Not at all</td>
</tr>
<tr>
<td><strong>Labor Content:</strong></td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>
The Product-Process Matrix

I. Project
   - Making a movie
   - German restaurant

II. Batch
   - Hospital visit
   - Coffee Shop

III. Assembly Line
   - Automobile assembly
   - Burger King

IV. Continuous Flow
   - Sugar refinery

Make to order vs. Make to stock vs. Assemble to order

Process Focus vs. Product Focus

Make to Order - Low Volume - One of a Kind
Assemble to Order - Low Volume - Multiple Products
Make to Stock - Higher Volume - Few Products
Hi Volume - High Standardization

Flexibility? - High
Unit Cost? - High

Flexibility? (Low)
Unit Cost? (Low)
Where Do New Product Ideas Come From?

Traditional sources:

- customer surveys
- analyzing warranty claims, customer complaints
- surveys of suppliers, distributors, and salespersons
Modern Sources – New Products

- Benchmarking
  - comparing product/service against best-in-class
- Reverse engineering
  - dismantling competitor’s product to improve your own product
- Early Supplier Involvement (ESI)
Analysis Tools for New Product Development

- Customer Choice Analysis
- Product Reliability Analysis
- Product-Complexity Index
- Quality Function Deployment
Customer Choice Analysis

- **Customer choice analysis**: an experimental approach to identify the relative importance of various product features for customer choices

- **Willingness to pay**: define

- **Desirability**: define
Product Reliability Analysis

An approach for assessing the overall integrity of a product based on the configuration of its components
Product Reliability Analysis

- **Redundancy**: the use of backup components and systems to enhance the reliability of a product

- **Robust design**: a design approach that ensures that small variations in the production process do not adversely affect the quality of the product
Quantifying Reliability

- State Reliability in Terms of Probability
  - Ex: A Product that is 90% Reliable Has a Failure Probability of $1 - 0.9 = 0.1$ (10%)

- What If a Product Has Multiple Components That Can Fail?
  - Component A: 90% Reliability
  - Component B: 80% Reliability
  - Under What Conditions Does the Product Fail?
  - If One or Both Components Fail → Product Fails
Quantifying Reliability

- In Other Words → Both Components Must NOT Fail

- Probability of Both Being Reliable is:
  - \((0.9)(0.8) = 0.72\) (72% Chance of Being Reliable)
  - \(1 - 0.72 = 0.28\) (28% Chance of Failure)

- Calculate System Reliability By Multiplying Reliabilities of Components
Quantifying Reliability

What Is the Reliability of the Product Below? (Component Reliabilities Shown)

A (0.9)  B (0.95)  C (0.9)

Reliability = (0.9)(0.95)(0.9) = 0.77 (77%)
Quantifying Reliability

How to Improve Reliability?
- Add Redundancy!

Ex: Add a Backup Component to Component A

Under What Conditions Does This Product Fail?
Quantifying Reliability

Under What Conditions Does This Product Fail??
A & It’s Backup Fail OR B Fails OR C Fails

What Is Probability that BOTH A & Backup Fail?
(0.1)(0.2) = (0.02) (2%) (98% Reliable)

Reliability of Product? (0.98)(0.95)(0.9) = 0.84
Quality Function Deployment

A structured approach for systematically integrating customer requirements and quality standards into every aspect of product development from planning to the production floor.
Quality Function Deployment

- Integrates voice of the customer into product design
- Involves cross-functional teams

Market Research

- Needs
- Expectations
- Importance ratings
Quality Function Deployment

- House of quality
  - Helps the cross functional teams to focus on building a product that satisfies customers
# The Quality Function Deployment (QFD) Process

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Identification of customer needs and preferences</td>
</tr>
<tr>
<td>Step 2</td>
<td>Relationship between customer needs and engineering design characteristics</td>
</tr>
<tr>
<td>Step 3</td>
<td>Interrelationships among the engineering design characteristics</td>
</tr>
<tr>
<td>Step 4</td>
<td>Competitive evaluation of competing products and targets for design attributes</td>
</tr>
<tr>
<td>Step 5</td>
<td>Linking engineering design characteristics and component characteristics</td>
</tr>
<tr>
<td>Step 6</td>
<td>Linking component characteristics and the process operations</td>
</tr>
<tr>
<td>Step 7</td>
<td>Linking the process operations and control parameters</td>
</tr>
<tr>
<td>Step 8</td>
<td>Implementation and continuous improvement</td>
</tr>
</tbody>
</table>
The QFD Process

- The first QFD matrix, called the *House of Quality* links the voice of the customer to the product design attributes (*voice of the engineer*).
House of Quality Layout
### The House of Quality

<table>
<thead>
<tr>
<th>Customer Requirements</th>
<th>Importance</th>
<th>Wire size</th>
<th>Number of turns</th>
<th>Lamination stack</th>
<th>Varnished method</th>
<th>Insulation type</th>
<th>Design for manufacturing</th>
<th>Competitive Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low cost (with required regulation)</td>
<td>8</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td>X A B</td>
</tr>
<tr>
<td>Reliability</td>
<td>8</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td></td>
<td>B A X</td>
</tr>
<tr>
<td>Temperature rise</td>
<td>7</td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td>⭐️</td>
<td></td>
<td>A B X</td>
<td></td>
</tr>
<tr>
<td>Delivery</td>
<td>7</td>
<td>⭐️</td>
<td></td>
<td></td>
<td></td>
<td>⭐️</td>
<td>BA X</td>
<td></td>
</tr>
<tr>
<td>Meets UL/CSA/VDE/CE or other</td>
<td>6</td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td></td>
<td></td>
<td>AB X</td>
<td></td>
</tr>
<tr>
<td>Noise level</td>
<td>6</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td>⭐️</td>
<td>B A X</td>
<td></td>
</tr>
<tr>
<td>Physical size</td>
<td>5</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td></td>
<td>AB X</td>
<td></td>
</tr>
<tr>
<td>High efficiency</td>
<td>5</td>
<td>⭐️</td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td></td>
<td>X A B</td>
<td></td>
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<tr>
<td>Aesthetics</td>
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<td></td>
<td>⭐️</td>
<td>⭐️</td>
<td></td>
<td>X AB</td>
<td></td>
</tr>
</tbody>
</table>

X = HighTrans Inc.  A B = Competitors of HighTrans Inc.
Summary

- Why is it important to develop new products?
- Radical versus disruptive innovation?
- What are the various process types and where is each best?
- What are sources of new products?
- Who do you quantify reliability?
- Quality deployment function?