# CHAPTER III

# PRODUCT AND SERVICE DESIGN

## Introduction

- The essence of any organization is the products or services it offers. There is an obvious link between the design of those products or services and the success of the organization: organizations that have well-designed products or services are more likely to realize their goals than those with poorly designed products or services.
    - Hence, organizations have a vital stake in achieving good product and service design.
- Product and service design plays a strategic role in the degree to which an organization is able to achieve its goals. It is a major factor in customer satisfaction, product and service quality and production costs.
    - The customer connection is obvious: The product or service is the main concern of the customer, and becomes the ultimate basis for judging the organization.
    - The quality connection is twofold. Quality is obviously affected by design. But also during production, by the degree to which production conforms to the intent of design. A key factor there is *manufacturability*, which refers to the case with which design features can be achieved by production.
    - Similarly, design affects cost, both, the cost of materials specified by design and the cost required to achieve the intent of design (e.g. labor and equipment costs).

### Objectives of Product and Service Design

- The objectives of product and service design are:
    1. To bring new or revised products or services to the market as quickly as possible.
    2. To design products and/or services those have customer appeal.
    3. To increase the level of customer satisfaction.
    4. To increase quality.
    5. To reduce costs.
- In a competitive environment, getting new or improved products or services to the market a head of competitors gives an organization a competitive advantage that can lead to increased

profits as well as increased market share, and can create an image of the organization as a leader.

## 2.1. The Design Process

- The design process begins with the *motivation* for design. For a new business or a new product, the motivation may be obvious: to achieve the goals of the organization.
    - For an existing business. In addition to that general motivation, there are more specific factors to consider, such as government regulations, the appearance of new technologies that have product or process applications, competitive pressures, and customer needs.
    - Ultimately, the *customer* is the driving force for product and service design.
        - Failure to satisfy customers can result in customer complaints, returns, warranty claims, and so on.
        - Loss of market share becomes a potential problem if customer satisfaction is not achieved.
- In order for the design process to occur, there must be *ideas* for new or improved designs. These can come from a variety of sources, most obviously the customer.
    - "*marketing* can tap this source of ideas is a number of ways, such as the use of focus groups, surveys, and the analyses of buying patterns".
    - Some organizations have *research and development departments* that also generate ideas for new improved products and services.
    - *Competitors* are another important source of ideas. By studying competitor's products or services, and how it operates (e.g. pricing policies, return policies, warranties, and so on), an organization can learn a great deal that can help to achieve design improvements.
        - Beyond that, some companies buy a competitor's newly designed product the moment it appears on the market.
        - Using a procedure called **reverse engineering;** they then carefully dismantle and inspect the product.
        - This may uncover product improvement that can be incorporated in their own product.

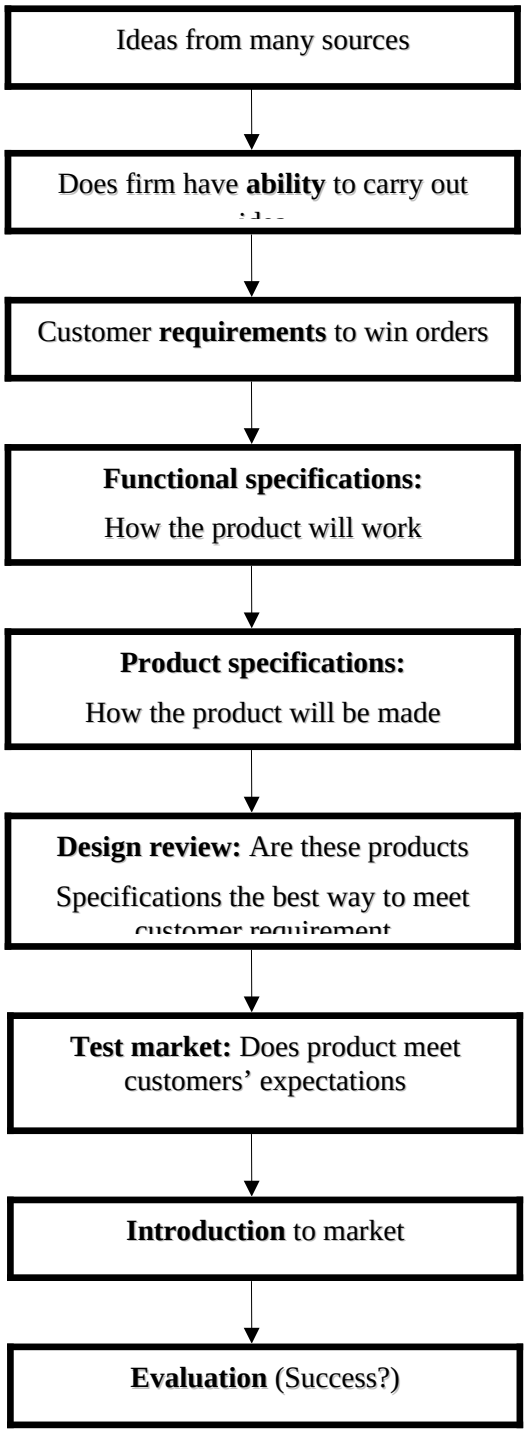
- Sometimes reverse engineering can lead to a product that is *superior* to the one begin examined; that is designers are able to conceive and improved design, enabling them to "leap frog" the competition by introducing an improved version of a competitor's product within a short time.
- This may deny the competitor some of the rewards that usually result from being the first to introduce a new product, or one with new features.

## 2.2. Product Development

### Product Development System

- An effective product strategy links product decisions with cash flow, market dynamics, product life cycle, and the organization's capabilities.
    - A firm must have the cash for product development, understand the changes constantly taking place in the marketplace, and have the necessary talents and resources available.
- The product development system may well determine not only product success but also the firm's future.

- The following figure shows the stages of product development.



Product Development Stages: product concepts are developed from a variety of sources, both external and internal to the firms. Concepts that survive the product idea state progress through various stages, with nearly constant review in a highly participative environment to minimize failure.

- In the above system, product options go through a series of steps, starting with ideas that may come from either internal or external sources and ending with the evaluation of new products.
- Two tools that are particularly helpful in the early stages of product development are (1) creativity and (2) identifying customer wants.
    - We can address the former via creative, open organizations and *brainstorming* and the second with *quality function deployment.*
    - **Brainstorming** is a technique in which a diverse group of people share, without criticism, ideas on a particular topic. The goal in this application is to generate an open discussion that will yield creative ideas about possible products and product improvements.

## Quality Function Deployment (QFD)

- Quality function development (QFD) refers to both (1) determining what will satisfy the customer and (2) translating those customer desires into the target design.
    - The idea is to capture a rich understanding of customer wants and to identify alternative process solutions.
    - This information is then integrated into the evolving product design.
    - QFG is used early in the design process to help determine *what will satisfy the customer* and *where to deploy quality efforts.*
    - One of the tools of QFD is house of quality. **The house of quality** is a graphic technique for defining the relationship between customer desires and product (or service).
        - Only by defining the relationship in rigorous way can operations managers build products and processes with features desired by customers.
        - Defining this relationship is the first step in building a world-class production system.

## Organizing for product Development

- The traditional approach to product development is an organization with distinct departments. These departments are: first, a research and development department to do the necessary research: then a manufacturing engineering department to design a product that can be produced: and finally, a production department that produces the product.
    - The distinct advantage of this approach is that fixed duties and responsibilities exist.
    - The distinct disadvantage is lack of forward thinking: How will downstream departments in the process deal with the concepts, ideas, and designs presented to them, -- ultimately what will the customer think of the product?
- Another approach to product development is the use of teams. Such teams are known variously as *product development teams, design for manufacturability teams, and value engineering teams.*
- **Product development teams** are charged with the responsibility of moving from market requirements for a product to achieving a product success.
    - Such teams often include representatives from marketing, manufacturing, purchasing, quality assurance, and field service personnel.
    - Regardless of the formal nature of the product development effort, research suggests that success is more likely in an open, highly participate environment where those with potential contributions are allowed to make them.
    - The objective of a product development team is to make the good or service a success. This includes marketability manufacturability, and serviceability.
    - Use of such teams is also called **concurrent engineering** and implies a team representing all affected area (known as a *cross-functional* team).
    - To achieve a smoother transition from product design to production, and to decrease product development time, many companies are using *simultaneous development,* or concurrent engineering.
    - Concurrent engineering implies speedier product development through simultaneous performance of various aspects of product development.

## 2.3. Issues for Product Design

- In addition to developing an effective system and organization structure for product development. Several *techniques* are important to the design of a product. We will now review five of these: (1) robust design, (2) modular design, (3) computer-aided design, (4) value analysis, and (5) environmentally friendly designs.

## Robust Design

- Some products will perform as designed only within a narrow range of conditions, while other products will perform as designed over a much broader range of conditions.
    - The latter have *robust design.* The more robust a product is the less likely that it will fall due to a change in the environment in which it is used.
    - Hence, the extent to which designers can build robustness into the product, the better it should hold up, and the higher the level of customer satisfaction.

## Modular Design

- Modular design is a form of standardization in which components parts are subdivided into modules that are easily replaced or interchanged.
- Modular design makes it possible to have relatively high product variety and low component variety at the same time.
    - The basic idea is to develop a series of basic product components, or modules, that can be assembled into a large number of different products. To the customer, it appears there are a great number of different products. To operations, there are only a limited number of basic components and processes.
- Modular design offers a fundamental way to change product design thinking, instead of designing each product separately, the company designs product around standard component modules and standard processes.
    - Common modules should be developed that can serve more than one product line, and unnecessary product frills should be eliminated.
    - This approach will still allow for a great deal of product varieties but the number of unnecessary product variations will be reduced.

## Computer-Aided Design (CAD)

- Computers are increasingly used for product design. Particularly for manufacturing. **Computer-aided design (CAD)** uses computer graphics for product design.
    - The designer can modify an existing design or create a new one by means of a light pen, a keyboard, a joystick, or a similar device.
    - Once the design is entered into the computer, the designer can maneuver it on the screen: it can be rotated to provide the designer with different perspectives, it can be split a part to give the designer a view of the inside, and a portion of it can be enlarged for closer examination.
    - When the design has been completed, the designer can obtain a printed version.
    - In addition, the design can be filed electronically, making it accessible to manufacturing personnel and others in the firm who has need for this information (e.g., marketing).
- A major benefit of CAD is the increased productivity of designers. No longer is it necessary to laboriously prepare mechanical drawings of products or parts and revise them repeatedly to correct errors or incorporate revisions.
    - A rough estimate is that CAD increases the productivity of designers from 3 to 10 times.
    - A second major benefit of CAD is the creation of a data base for manufacturing that can supply needed information on product geometry and dimensions, tolerances, material specifications, and so on.

### Value Analysis

- Value analysis is a method for improving the usefulness of a product without increasing its cost or reducing the cost without reducing the usefulness of the product.
    - It can result in great cost savings or a better product for the customer, or both.
    - Value analysis seeks improvements that lead to either a better product or a product made more economically.
    - Value analysis is like a zero base budgeting in that each product function is carefully examined for possible elimination.

## Environmentally Friendly Designs

- One of the operation manager's most environmentally sound activities is to enhance productivity.
    - Environmental Teams-with employees from different functional areas working together, a wider range of environmental issues can be addressed.
        - These teams should consider two issues. First, they should view the impact of product design from a "systems" perspective, that is, view the product in terms of its impact on the entire economy. Second, the terms should consider the life cycle of the product, from raw material, to installation, to use, to disposal. The goal is to reduce the environmental impact of a product throughout its life. The benefits of such a strategy include:
            1. Developing safe and more environmentally sound products.
            2. Minimizing waste of raw materials and energy.
            3. Differentiating products from the competition.
            4. Increasing cost-effectiveness of complying with environmental regulations.
            5. Being recognized as a good corporate citizen.

Green manufacturing – The concept of **green manufacturing** that is, making environmentally sound products through efficient processes can be good business.

Companies can show their sensitivity to green manufacturing in product and process design in several ways:

1. Make product recyclable.
2. Use recycled products
3. Use less harmful ingredients
4. Use lighter components
5. Use less energy
6. Use less material.

- Green manufacturing is appreciated by the public, and it can save money, material, and the environment we live in. These are the kind of win situations that operations managers seek.

## 2.4. Service Design

- Service industries include banking, finance, insurance, transportation, and communications.

- Designing services is challenging because they often have unique characteristics.
  - One reason productivity improvements in services are so low is because both the design and delivery of service products include customer interaction.
  - When the customer participates in the design process, the service supplier may have a menu of services from which the customer selects options.
- Because of the differences between services and products, the design of services must take into account different elements than the design of products.

## Consider these differences:

1. Products are generally tangible; services are generally intangible. Consequently, service design often focuses more on intangible factors than product design does.
2. Services are often produced and received at the same time (e.g. a haircut, a car wash). Because of this, there is less latitude in finding and correcting errors before the customer has a chance to discover them. Consequently, training, process design, and customer relations are particularly important.
3. Services cannot be inventoried. This poses restrictions on flexibility, and makes capacity design very important.
4. Some services have low barriers to entry and exit. This places additional burden on service design to continually be aware of what competitors are offering.
5. Location is often important in service design, with convenience as a major factor. Hence, design of services and choice of location are often closely linked.

## Application of Decision Trees to Product Design

Decision trees can be used for new product decisions as well as for a wide variety of other management problems. They are particularly helpful when there are series of decisions and various outcomes that lead to *subsequent* decisions followed by other outcomes. To form a decision tree, we use the following procedure:

1. Be sure that all possible alternatives and states of nature are included in the tree. This includes an alternative of “doing nothing.”

2. Pay offs are entered at the end of the appropriate branch. This is the place to develop the payoff of achieving this branch.
3. The objective is to determine the expected value of each course action. We accomplish this by starting at the end of the tree (the right-hand side) and working toward the beginning of the tree (the left), calculating values at each step and "pruning" alternatives that are not as good as others from the same node.

**Example 1:-** shows the use of a decision tree applied to product design.

Silicon, Inc, a semiconductor manufacturer, is investigating the possibility of producing and marketing a microprocessor. Undertaking this project will require either purchasing a sophisticated CAD system or hiring and training several additional engineers. The market for the product could be either favorable or unfavorable, silicon, inc., of course, has the option of not developing the new product at all.

With favorable acceptance by the market, sales would be 25,000 processors selling for $100 each. With unfavorable acceptance sales would be only 8,000 processors selling for each. The cost of CAD equipment is $500,000, but that of hiring and training three new engineers is only $375,000. However, manufacturing costs should drop from $50 each when manufacturing without CAD to $40 each when manufacturing with CAD.

The probability of favorable acceptance of the new microprocessor is 40; the probability of unfavorable acceptance is 60.sec Figure 2.1 below

The expected monetary value (EMVs) has been circled at each step of the decision tree. For the top branch:

EMV (purchase CAD system) = (.4) ($1,000,000) + (.6)(-$20,000)

= $388,000

This figure represents the results that will occur if Silicon, Inc. purchases CAD.



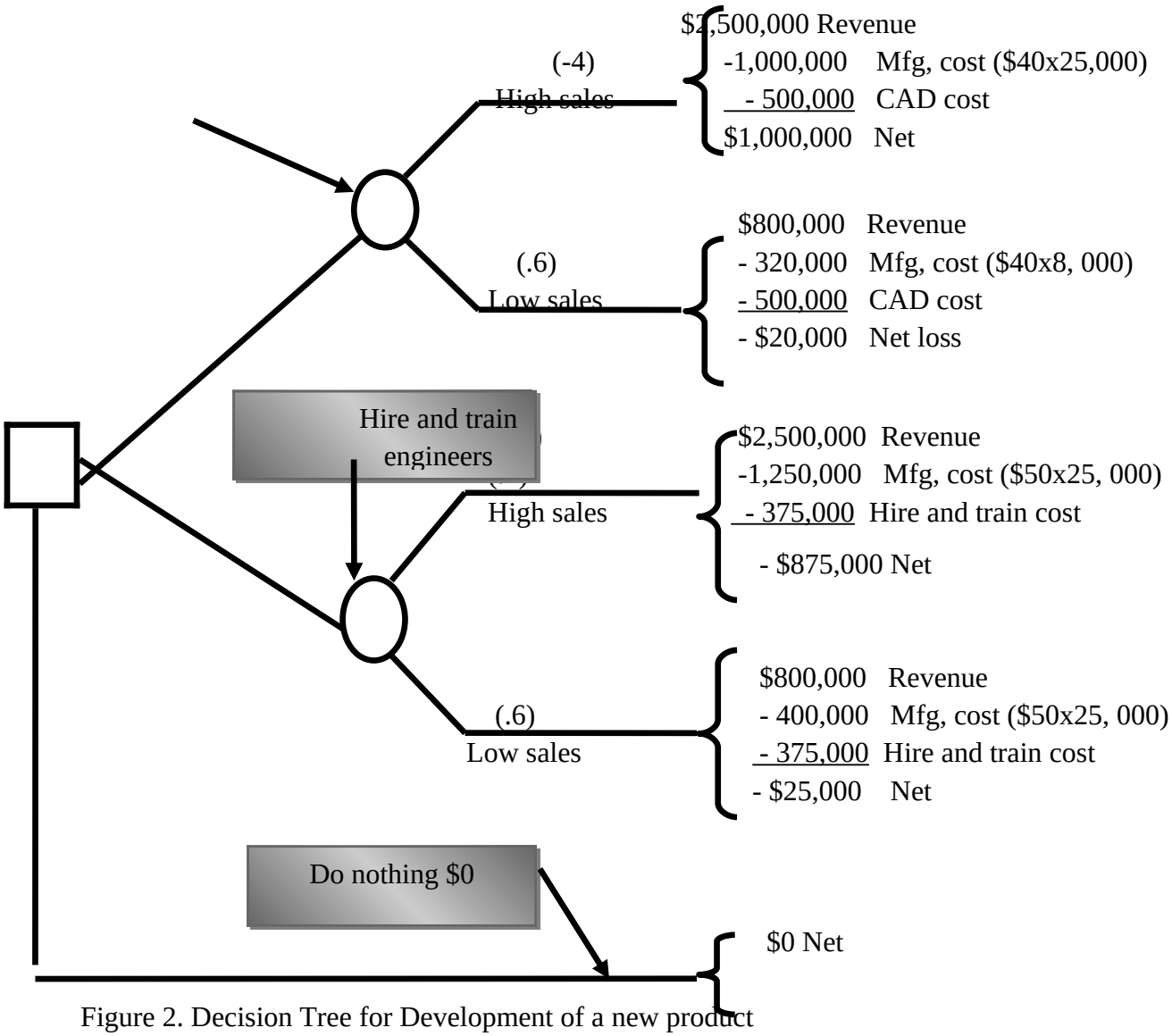



Figure 2. Decision Tree for Development of a new product

The expected value of hiring and training engineers is the second series of branches:

EMV /hire/ train engineers) = (4) (8875,000 + (.6)($25,000)

= $365,000

The EMV of doing nothing is $0.

Because the top branch has the highest expected monetary value (an EMV of $388,000 Vs $365,000 Vs, $0) it represents the best decision. Management should purchase the CAD system.