

## 1. Recognize and Explain the Characteristics of Successful Product Development.

From the perspective of the investors in a for-profit enterprise, successful product development results in products that can be produced and sold profitably, yet profitability is often difficult to assess quickly and directly. Five more specific dimensions, all of which ultimately relate to profit, are commonly used to assess the performance of a product development effort:

- **Product quality:** How good is the product resulting from the development effort? Does it satisfy customer needs? Is it robust and reliable? Product quality is ultimately reflected in market share and the price that customers are willing to pay.
- **Product cost:** What is the manufacturing cost of the product? This cost includes spending on capital equipment and tooling as well as the incremental cost of producing each unit of the product. Product cost determines how much profit accrues to the firm for a particular sales volume and a particular sales price.
- **Development time:** How quickly did the team complete the product development effort? Development time determines how responsive the firm can be to competitive forces and to technological developments, as well as how quickly the firm receives the economic returns from the team's efforts.
- **Development cost:** How much did the firm have to spend to develop the product? Development cost is usually a significant fraction of the investment required to achieve the profits.
- **Development capability:** Are the team and the firm better able to develop future products as a result of their experience with a product development project? Development capability is an asset the firm can use to develop products more effectively and economically in the future.

## **2. Illustrate the composition of product development team for an electromechanical product of modest complexity with the help of a neat block diagram.**

Product development is an interdisciplinary activity requiring contributions from nearly all the functions of a firm; however, three functions are almost always central to a product development project:

- **Marketing:** The marketing function mediates the interactions between the firm and its customers. Marketing often facilitates the identification of product opportunities, the definition of market segments, and the identification of customer needs. Marketing also typically arranges for communication between the firm and its customers, sets target prices, and oversees the launch and promotion of the product.

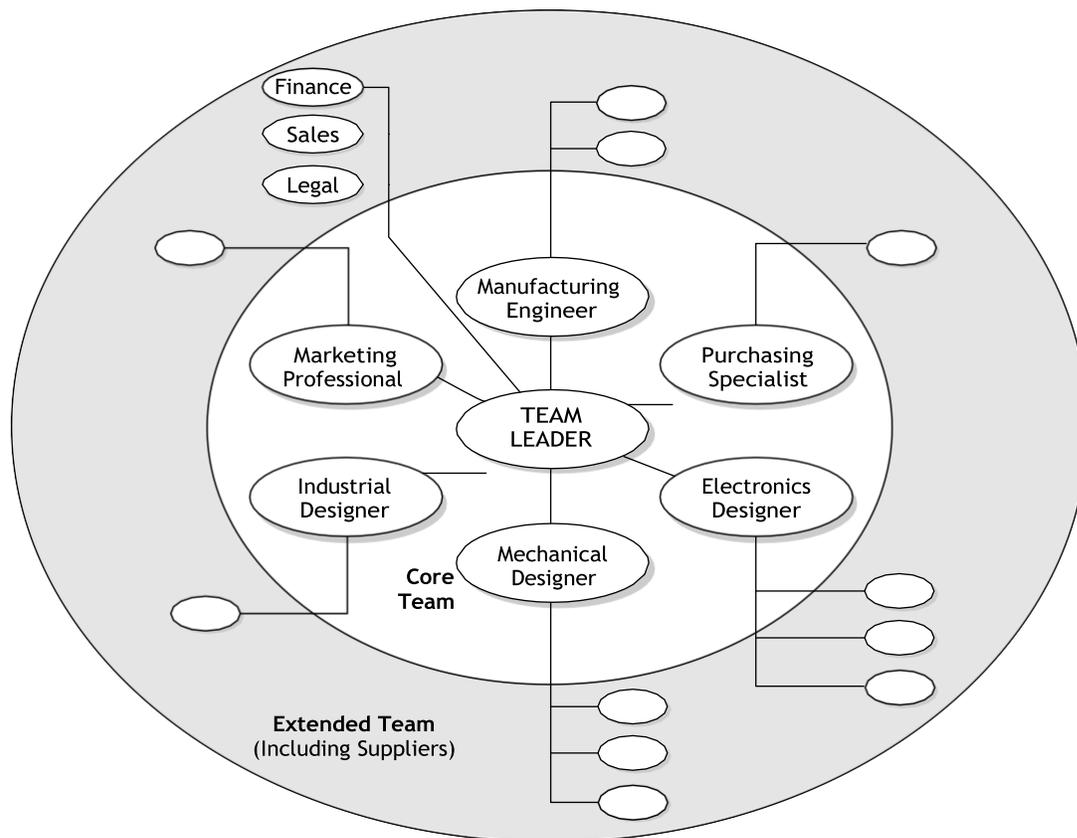
- **Design:** The design function plays the lead role in defining the physical form of the product to best meet customer needs. In this context, the design function includes engineering design (mechanical, electrical, software, etc.) and industrial design (aesthetics, ergonomics, user interfaces).

- **Manufacturing:** The manufacturing function is primarily responsible for designing, operating, and/or coordinating the production system in order to produce the product. Broadly defined, the manufacturing function also often includes purchasing, distribution, and installation. This collection of activities is sometimes called the supply chain.

Different individuals within these functions often have specific disciplinary training in areas such as market research, mechanical engineering, electrical engineering, materials science, or manufacturing operations. Several other functions, including finance and sales, are frequently involved on a part-time basis in the development of a new product. Beyond these broad functional categories, the specific composition of a development team depends on the particular characteristics of the product.

Few products are developed by a single individual. The collection of individuals developing a product forms the project team. This team usually has a single team leader, who could be drawn from any of the functions of the firm. The team can be thought of as consisting of a core team and an extended

team. In order to work together effectively, the core team usually remains small enough to meet in a conference room, while the extended team may consist of dozens, hundreds, or even thousands of other members. (Even though the term team is inappropriate for a group of thousands, the word is often used in this context to emphasize that the group must work toward a common goal.) In most cases, a team within the firm will be supported by individuals or teams at partner companies, suppliers, and consulting firms. Sometimes, as is the case for the development of a new airplane, the number of external team members may be even greater than that of the team within the company whose name will appear on the final product. The composition of a team for the development of an electromechanical product of modest complexity is shown in the below figure.



**FIGURE:** The composition of a product development team for an electromechanical product of modest complexity.

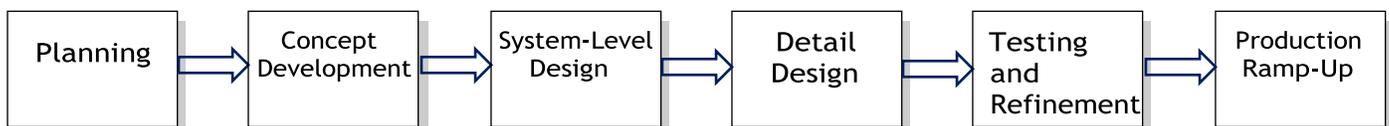
### **3. Identify and Explain the challenges faced during Product Development.**

Developing great products is hard. Few companies are highly successful more than half the time. These odds present a significant challenge for a product development team. Some of the characteristics that make product development challenging are:

- **Trade-offs:** An airplane can be made lighter, but this action will probably increase manufacturing cost. One of the most difficult aspects of product development is recognizing, understanding, and managing such trade-offs in a way that maximizes the success of the product.
- **Dynamics:** Technologies improve, customer preferences evolve, competitors introduce new products, and the macroeconomic environment shifts. Decision making in an environment of constant change is a formidable task.
- **Details:** The choice between using screws or snap-fits on the enclosure of a computer can have economic implications of millions of dollars. Developing a product of even modest complexity may require thousands of such decisions.
- **Time pressure:** Any one of these difficulties would be easily manageable by itself given plenty of time, but product development decisions must usually be made quickly and without complete information.
- **Economics:** Developing, producing, and marketing a new product requires a large investment. To earn a reasonable return on this investment, the resulting product must be both appealing to customers and relatively inexpensive to produce.
- **Creation:** The product development process begins with an idea and ends with the production of a physical artifact. When viewed both in its entirety and at the level of individual activities, the product development process is intensely creative.
- **Satisfaction of societal and individual needs:** All products are aimed at satisfying needs of some kind. Individuals interested in developing new products can almost always find institutional settings in which they can develop products satisfying what they consider to be important needs.

- **Team diversity:** Successful development requires many different skills and talents. As a result, development teams involve people with a wide range of different training, experience, perspectives, and personalities.
- **Team spirit:** Product development teams are often highly motivated, cooperative groups. The team members may be co-located so they can focus their collective energy on creating the product. This situation can result in lasting camaraderie among team members.

#### 4. Demonstrate the different phases of generic product development process.



**Block Diagram:** Different phases of generic product development process.

#### The six phases of the generic development process are:

- **Planning:** The planning activity is often referred to as “phase zero” because it precedes the project approval and launch of the actual product development process. This phase begins with opportunity identification guided by corporate strategy and includes assessment of technology developments and market objectives. The output of the planning phase is the project mission statement, which specifies the target market for the product, business goals, key assumptions, and constraints.
- **Concept development:** In the concept development phase, the needs of the target market are identified, alternative product concepts are generated and evaluated, and one or more concepts are selected for further development and testing. A concept is a description of the form, function, and features of a product and is usually accompanied by a set of specifications, an analysis of competitive products, and an economic justification of the project.
- **System-level design:** The system-level design phase includes the definition of the product architecture, decomposition of the product into subsystems and components, and preliminary design of key components. Initial plans for the production system and final assembly are usually defined during this phase as well. The output of this phase usually includes a geometric layout of the product, a functional specification of each of the product’s subsystems, and a preliminary process flow diagram for the final assembly process.

- **Detail design:** The detail design phase includes the complete specification of the geometry, materials, and tolerances of all of the unique parts in the product and the identification of all of the standard parts to be purchased from suppliers. A process plan is established and tooling is designed for each part to be fabricated within the production system. The output of this phase is the control documentation for the product—the drawings or computer files describing the geometry of each part and its production tooling, the specifications of the purchased parts, and the process plans for the fabrication and assembly of the product. Three critical issues that are best considered throughout the product development process, but are finalized in the detail design phase, are: materials selection, production cost, and robust performance.
- **Testing and refinement:** The testing and refinement phase involves the construction and evaluation of multiple preproduction versions of the product. Early (alpha) prototypes are usually built with production-intent parts—parts with the same geometry and material properties as intended for the production version of the product but not necessarily fabricated with the actual processes to be used in production. Alpha prototypes are tested to determine whether the product will work as designed and whether the product satisfies the key customer needs. Later (beta) prototypes are usually built with parts supplied by the intended production processes but may not be assembled using the intended final assembly process. Beta prototypes are extensively evaluated internally and are also typically tested by customers in their own use environment. The goal for the beta prototypes is usually to answer questions about performance and reliability in order to identify necessary engineering changes for the final product.
- **Production ramp-up:** In the production ramp-up phase, the product is made using the intended production system. The purpose of the ramp-up is to train the workforce and to work out any remaining problems in the production processes. Products produced during production ramp-up are sometimes supplied to preferred customers and are carefully evaluated to identify any remaining flaws. The transition from production ramp-up to ongoing production is usually gradual. At some point in this transition, the product is launched and becomes available for widespread distribution.

## **5. Demonstrate different types of product development organizations with a sketch.**

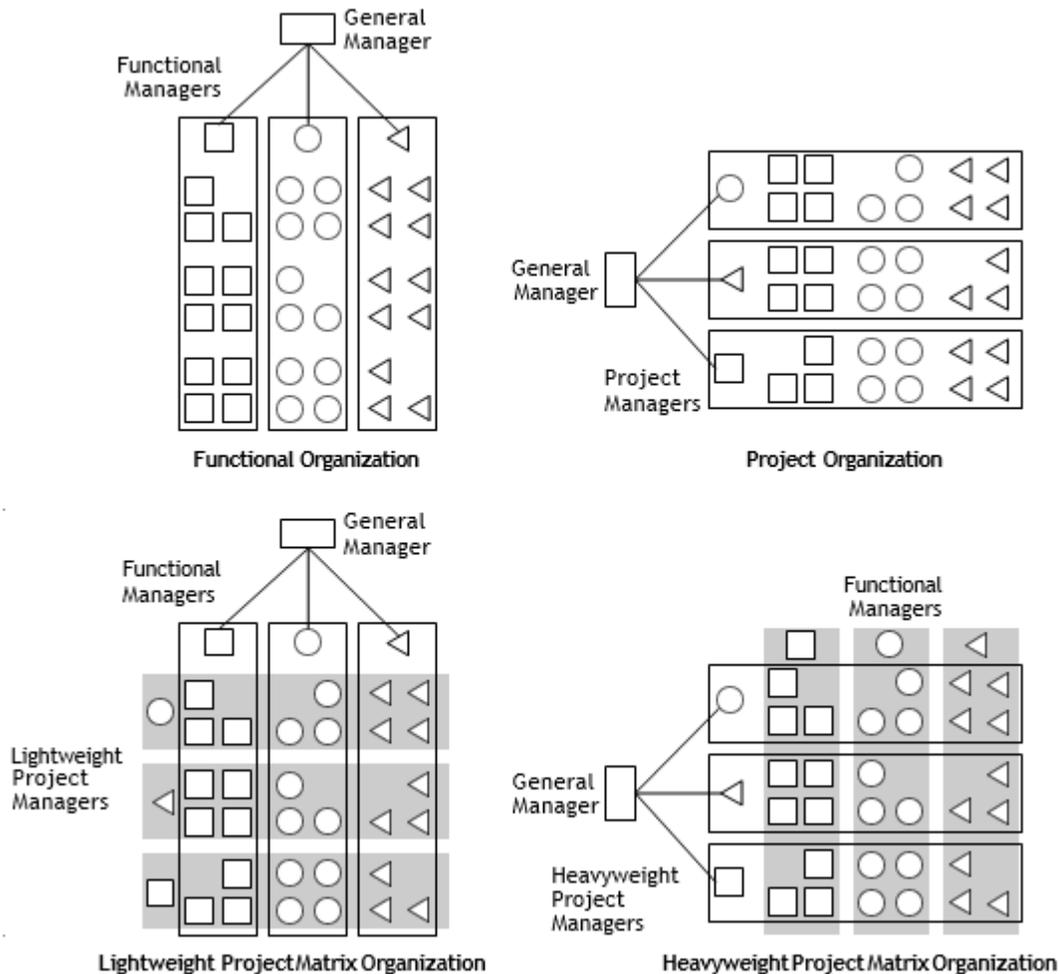
The different types of product development organizations are as follows:

**Functional organization:** A strict functional organization might include a group of marketing professionals, all sharing similar training and expertise. These people would all report to the same manager, who would evaluate them and set their salaries. The group would have its own budget and the people may sit in the same part of a building. This marketing group would be involved in many different projects, but there would be no strong organizational links to the other members of each project team. There would be similarly arranged groups corresponding to design and to manufacturing.

**Project organization:** A strict project organization would be made up of groups of people from several different functions, with each group focused on the development of a specific product (or product line). These groups would each report to an experienced project manager, who might be drawn from any of the functional areas. Performance evaluation would be handled by the project manager, and members of the team would typically be co-located as much as possible so that they all work in the same office or part of a building. New ventures, or “start-ups,” are among the most extreme examples of project organizations: every individual, regardless of function, is linked together by a single project—the growth of the new company and the creation of its product(s). In these settings, the president or CEO can be viewed as the project manager.

**Heavyweight project organization:** A heavyweight project organization contains strong project links. The heavyweight project manager has complete budget authority, is heavily involved in performance evaluation of the team members, and makes most of the major resource allocation decisions. Although each participant in a project also belongs to a functional organization, the functional managers have relatively little authority and control. A heavyweight project team in various industries may be called an integrated product team (IPT), a design-build team (DBT), or simply a product development team (PDT). Each of these terms emphasizes the cross-functional nature of these teams.

**Lightweight project organization:** A lightweight project organization contains weaker project links and relatively stronger functional links. In this scheme, the project manager is more of a coordinator and administrator. The lightweight project manager updates schedules, arranges meetings, and facilitates coordination, but the manager has no real authority and control in the project organization. The functional managers are responsible for budgets, hiring and firing, and performance evaluation.



## **6. Summarize the different activities included in the concept development process.**

The concept development process includes the following activities:

**Identifying customer needs:** The goal of this activity is to understand customer's needs and to effectively communicate them to the development team. The output of this step is a set of carefully constructed customer need statements, organized in a hierarchical list, with importance weightings for many or all of the needs.

**Establishing target specifications:** Specifications provide a precise description of what a product has to do. They are the translation of the customer needs into technical terms. Targets for the specifications are set early in the process and represent the hopes of the development team. Later these specifications are refined to be consistent with the constraints imposed by the team's choice of a product concept. The output of this stage is a list of target specifications. Each specification consists of a metric, and marginal and ideal values for that metric.

**Concept generation:** The goal of concept generation is to thoroughly explore the space of product concepts that may address the customer needs. Concept generation includes a mix of external search, creative problem solving within the team, and systematic exploration of the various solution fragments the team generates. The result of this activity is usually a set of 10 to 20 concepts, each typically represented by a sketch and brief descriptive text.

**Concept selection:** Concept selection is the activity in which various product concepts are analyzed and sequentially eliminated to identify the most promising concept(s). The process usually requires several iterations and may initiate additional concept generation and refinement.

**Concept testing:** One or more concepts are then tested to verify that the customer needs have been met, assess the market potential of the product, and identify any shortcomings that must be remedied during further development. If the customer response is poor, the development project may be terminated or some earlier activities may be repeated as necessary.

**Setting final specifications:** The target specifications set earlier in the process are revisited after a concept has been selected and tested. At this point, the team must commit to specific values of the metrics reflecting the constraints inherent in the product concept, limitations identified through technical modeling, and trade-offs between cost and performance.

**Project planning:** In this final activity of concept development, the team creates a detailed development schedule, devises a strategy to minimize development time, and identifies the resources required to complete the project. The major results of the front-end activities can be usefully captured in a contract book, which contains the mission statement, the customer needs, the details of the selected concept, the product specifications, the economic analysis of the product, the development schedule, the project staffing, and the budget. The contract book serves to document the agreement (contract) between the team and the senior management of the enterprise.

**Economic analysis:** The team, often with the support of a financial analyst, builds an economic model for the new product. This model is used to justify continuation of the overall development program and to resolve specific trade-offs between, for example, development costs and manufacturing costs. Economic analysis is shown as one of the ongoing activities in the concept development phase. An early economic analysis will almost always be performed before the project even begins, and this analysis is updated as more information becomes available.

**Modeling and prototyping:** Every stage of the concept development process involves various forms of models and prototypes. These may include, among others: early “proof-of-concept” models, which help the development team to demonstrate feasibility; “form only” models, which can be shown to customers to evaluate ergonomics and style; spreadsheet models of technical trade-offs; and experimental test models, which can be used to set design parameters for robust performance.