Chapter 1

Introduction

- Product: Something sold by an enterprise to its customers
- Product Development: The set of activities beginning with the perception of a market opportunity and ending in the production, sale, and delivery of a product

1.1 Characteristics of Successful Product Development

- Dimensions to assess performance:
  - Product Quality: The degree to which a product meets customer expectations
  - Product Cost: The total cost incurred in producing and delivering the product
  - Development Time: The time taken from the initial concept to the market launch
  - Development Cost: The total cost incurred in the product development process
  - Development Capability: The ability of the organization to develop products effectively and efficiently

1.2 Participants in Product Development

- Central participants:
  - Marketing: Identifies market opportunities and customer needs
  - Design: Creates the product concept and specifications
  - Manufacturing: Plans and executes the production process
- Project team: The collection of individuals developing a product

  - Core team: A small group of individuals from different functions who work closely together throughout the project
  - Extended team: Includes additional members from other functions who contribute at various stages of the project

1.3 Duration and Cost of Product Development

- Duration: 3 to 5 years for complex products
- Cost: $\propto$ people involved and time taken

1.4 Challenges in Product Development

- Challanges characteristics:
  - Trade-offs: Balancing quality, cost, time, and capability
  - Dynamics: Adapting to changing market conditions and technologies
  - Details: Managing the complexity of product specifications and requirements
  - Time Pressure: Meeting tight deadlines while maintaining quality
  - Economics: Ensuring the product is financially viable
- Intrinsic attributes that make product development attractive:
  - Creation
  - Satisfaction of societal and individual needs
  - Team diversity
  - Team spirit

Chapter 2

Product Development Process and Organization

2.1 Product Development Process

- Product development process: The sequence of steps or activities that an enterprise employs to conceive, design, and commercialize a product
- Advantages of having a well-defined process:
  - Quality assurance: Ensures that the product meets customer expectations
  - Coordination: Facilitates communication and collaboration among team members
  - Planning: Helps in resource allocation and scheduling
  - Management: Provides a framework for monitoring progress and making adjustments
  - Improvement: Enables learning from past projects to enhance future performance
- Six phases of the generic development process:
  0. Planning
  1. Concept Development
  2. System-Level Design
  3. Detail Design
  4. Testing and Refinement
  5. Production Ramp-Up

2.2 Concept Development: The Front-End Process

- Identifying customer needs
- Establishing target specifications
- Concept generation
- Concept selection
- Concept testing
- Setting final specifications
- Project planning
- Economic analysis
- Benchmarking of competitive products
- Modeling and prototyping

Chapter 3

Opportunity Identification

3.1 Opportunity

- Opportunity: An idea for a new product

Types of Opportunities

- Two dimensions:
  - Solution (Technology, Method, Process)
  - Need (Market, Customer, User)

3.2 Tournament Structure of Opportunity Identification

- Goal: To take the opportunity articulated in the mission statement and do everything possible to assure it becomes the best product it can be
- 3 Basic Ways for Effective Opportunity Tournaments:
  - Generate a large number of opportunities
  - Seek high quality of the opportunities generated
  - Create high variance in the quality of opportunities

3.3 Opportunity Identification Process

- 6 steps:
  1. Establish a charter

2. Generate and sense many opportunities
3. Screen opportunities
4. Develop promising opportunities
5. Select exceptional opportunities
6. Reflect on the results and the process

Step 1: Establish a Charter

- Charter: Articulate the goals and establish the boundary conditions for an innovation effort
- Charter $\approx$ Mission statement for a new product
- Requires:
  - Resolving a tension between leaving the innovation problem unconstrained
  - Specifying a direction that is likely to meet the goals of the team and organization
- Recommended:
  - The innovation charter be broad. Benefit is that opportunities that may otherwise have never been considered will challenge the team's assumptions about what kinds of opportunities it should pursue

Step 2: Generate and Sense Many Opportunities

- Opportunities from various sources:
  - Internal sources: Employees, R&D, existing products
  - External sources: Customers, competitors, market trends, technology advancements
- Techniques for Generating Opportunities:
  - Follow a Personal Passion
  - Compile Bug Lists
  - Pull Opportunities from Capabilities (VRIN)
    - Valuable
    - Rare
    - Inimitable
    - Non-substitutable

  - Study Customers (Find latent needs)
  - Consider Implications of Trends
  - Imitate, but Better
    * Media and marketing activities of other firms
    * De-commoditize a commodity
    * Drive an innovation "down market"
    * Import geographically isolated innovations
  - Mine Your Sources (Mainly external sources)
    * Lead users
    * Representation in social networks
    * Universities and government laboratories
    * Online idea submission

Step 3: Screen Opportunities

- Goal: To eliminate opportunities that are highly unlikely to result in the creation of value and to focus attention on the opportunities worthy of further investigation
- **Not** to pick the single best opportunity
- Two methods for screening opportunities:
  - Web-based surveys
    * Fairness: Participants don't know the authors of the opportunities
    * At least 6 independent judgements, Recommended 10
  - Workshops with "multivoting"
    * Each participant presents one or more opportunities
    * Group multivotes on the opportunities
    * About 50 opportunities are good for a workshop. Can use a web-based survey to screen down to 50
    * Also pay attention to those with only a few very enthusiastic supporters

Step 4: Develop Promising Opportunities

- Goal: To resolve the greatest uncertainty surrounding each one at the lowest cost in time and money
- Determine:

  - The major uncertainties regarding the success of each opportunity
  - The tasks you could take to resolve the uncertainties
  - The approximate cost of each task
- Invest modest levels of resources in developing a few of them
- Additional tasks (customer interviews, testing of existing products, etc.)

Step 5: Select Exceptional Opportunities

- Method: RWW (Real, Win, Worth it)
  - Real: Is there a real market and a real product?
  - Win: Can we win? Can our product or service be competitive? Can we succeed as a company?
  - Worth it: Is it worth doing? Is the return adequate and the risk acceptable?

Step 6: Reflect on the Results and the Process

- How many of the opportunities identified came from internal sources versus external sources?
- Did we consider dozens or hundreds of opportunities?
- Was the innovation charter too narrowly focused?
- Were our filtering criteria biased, or largely based on the best possible estimates of eventual product success?
- Are the resulting opportunities exciting to the team?

Chapter 4

Product Planning

- An activity that considers both the current product line and the potential portfolio of projects that an organization might pursue

4.1 Product Planning Process

- Product plan: Identifies the portfolio of products to be developed by the organization and the timing of their introduction to the market
- Inefficiencies (no good product plan):
  - Inadequate coverage of target markets with competitive products
  - Poor timing of market introductions of products
  - Mismatches between aggregate development capacity and the number of projects pursued
  - Poor distribution of resources, with some projects overstaffed and others understaffed
  - Initiation and subsequent cancellation of ill-conceived projects
  - Frequent changes in the directions of projects

4.1.1 Types of Product Plans

- New Product Platforms: A set of products that share a common architecture and components, allowing for economies of scale and scope
- Derivatives of existing product platforms: Products that are based on existing platforms but have modifications or enhancements
- Incremental improvements to existing products: Small enhancements or modifications to existing products to improve performance, quality, or features

- Fundamentally new products: Products that are significantly different from existing offerings and may require new technologies or processes

4.2 Process

1. Identify Opportunities
2. Evaluate and Prioritize Projects
3. Allocate Resources and Plan Timing
4. Complete Pre-Project Planning
5. Reflect on the Results and the Process

4.2.1 Step 1: Identify Opportunities

- Opportunity funnel
- Recommend: each promising opportunity be described in a short, coherent statement and that this information be collected in a database

4.2.2 Step 2: Evaluate and Prioritize Projects

- To select the most promising projects to pursue
- Basic perspectives:
  - Competitive strategy
  - Market segmentation
  - Technological trajectories
  - Project platform

Competitive Strategy

- Defines a basic approach to markets and products with respect to competitors
  - Technology leadership
  - Cost leadership
  - Customer focus
  - Imitate

Market Segmentation

- Allows the firm to consider the actions of competitors and the strength of the firm's existing products with respect to each well-defined group of customers
- Can assess which product opportunities best address weaknesses in its own product line and which exploit weaknesses in the offerings of competitors

Technological Trajectories

- Key: When to adopt a new basic technology in a product line
- Conceptual tool: Technology S-Curve

Project Platform Planning

- The set of assets shared across a set of products
- Effective platform $\xrightarrow[Rapidly]{Easily}$ A variety of derivative products
- Key Strategy: Whether any project will develop a derivative product from an existing platform or develop an entirely new platform
- Technology roadmap:

Evaluating Fundamentally New Product Opportunities

- Market size (units/year×average price)
- Market growth rate (percent per year)
- Competitive intensity (range of competitors and their strengths)
- Depth of the firm's existing knowledge of the market
- Depth of the firm's existing knowledge of the technology
- Fit with the firm's other products
- Fit with the firm's core assets and capabilities
- Potential for patents, trade secrets, or other barriers to competition
- Existence of a product champion within the firm

Balancing the Portfolio

- Two specific dimensions:
  - The extent to which the project involves a change in the product line
  - The extent to which the project involves a change in production processes
- Advantage:
  - Be useful to illuminate imbalances in the portfolio of projects under consideration
  - In assessing the consistency between a portfolio of projects and the competitive strategy

4.2.3 Step 3: Allocate Resources and Plan Timing

Allocate Resources

- Aggregate Planning: Helps an organization make efficient use of its resources by pursuing only those projects that can reasonably be completed with the allocated resources
- Primary resource to be managed: The effort of the development staff (person-hours or person-months)
- Capacity utilization: 80% to 90%

Project Timing

- Timing of product introductions
- Technology readiness
- Market readiness
- Competition

The Product Plan

- The set of projects approved by the planning process, sequenced in time
- May include:
  - A mix of fundamentally new products
  - Platform projects
  - Derivative projects of varying size

4.2.4 Step 4: Complete Pre-Project Planning

- By: Core team
- Product vision statement: A brief description of the product and its intended market

Mission Statement

- Brief (one sentence) description of the product
- Benefit proposition
- Key business goals
- Target market(s) for the product
- Assumptions and constraints that guide the development effort
- Stakeholders

Assumptions and Constraints

- Considers the strategies of several functional areas within the firm
- Consider:
  - Manufacturing
  - Service
  - Environment

4.2.5 Step 5: Reflect on the Results and the Process

- Is the opportunity funnel collecting an exciting and diverse set of product opportunities?
- Does the product plan support the competitive strategy of the firm?
- Does the product plan address the most important current opportunities facing the firm?
- Are the total resources allocated to product development sufficient to pursue the firm's competitive strategy?
- Have creative ways of leveraging finite resources been considered, such as the use of product platforms, joint ventures, and partnerships with suppliers?
- ...

Chapter 5

Identifying Customer Needs

- Concept development:
  - **Identify Customer Needs**
  - Establish Target Specifications
  - Generate Product Concepts
  - Select Product Concepts
  - Test Product Concepts
  - Set Final Specifications
  - Plan Downstream Development
- Goal:
  - Ensure that the product is focused on customer needs
  - Identify latent or hidden needs as well as explicit needs
  - Provide a fact base for justifying the product specifications
  - Create an archival record of the needs activity of the development process
  - Ensure that no critical customer need is missed or forgotten
  - Develop a common understanding of customer needs among members of the development team
- Philosophy: To create a high-quality information channel that runs directly between customers in the target market and the developers of the product

5.1 The Importance of Latent Needs

- Latent needs: Not yet widely recognized by most customers and not yet addressed by existing products

5.2 The Process of Identifying Customer Needs

- 5 steps:
  1. Gather raw data from customers
  2. Interpret the raw data in terms of customer needs
  3. Organize the needs into a hierarchy of primary, secondary, and tertiary needs
  4. Establish the relative importance of the needs
  5. Reflect on the results and the process

5.2.1 Step 1: Gather raw data from customers

- Interview
- Focus group
- Observing the product in use

Choosing Customers to Interview

- 10 to 50 times
- Lead user
- Extreme user

The Art of Eliciting Customer Needs Data

- Effective interaction
  - Go with the flow
  - Use visual stimuli and props
  - Suppress preconceived hypotheses about the product technology
  - Have the customer demonstrate the product and/or typical tasks related to the product
  - Be alert for surprises and the expression of latent needs
  - Watch for nonverbal information
  - Data privacy

Documenting Interactions with Customers

- Audio recording
- Notes
- Video recording
- Still photography

5.2.2 Step 2: Interpret the raw data in terms of customer needs

- Express the need in terms of what the product has to do, not in terms of how it might do it
- Express the need as specifically as the raw data
- Use positive, not negative, phrasing
- Express the need as an attribute of the product
- Avoid the words **must** and **should**

5.2.3 Step 3: Organize the needs into a hierarchy

1. Print or write each needs statement on a separate card or self-stick note
2. Eliminate redundant statements
3. Group the cards according to the similarity of the needs they express
4. For each group, choose a label
5. Consider creating supergroups consisting of two to five groups
6. Review and edit the organized needs statements

5.2.4 Step 4: Establish the relative importance of the needs

- Relying on the consensus of the team members based on their experience with customers
- Basing the importance assessment on further customer surveys

5.2.5 Step 5: Reflect on the results and the process

- Have we interacted with all of the important types of customers in our target market?
- Are we able to see beyond needs related only to existing products to capture the latent needs of our target customers?
- Are there areas of inquiry we should pursue in follow-up interviews or surveys?
- Which of the customers we spoke to would be good participants in our ongoing development efforts?
- What do we know now that we didn't know when we started? Are we surprised by any of the needs?
- Did we involve everyone within our own organization who needs to deeply understand customer needs?
- How might we improve the process in future efforts?

Chapter 6

Product Specifications

6.1 Specifications

- Customer needs → "Language of the customer"
- Specifications → "Language of the engineer"
- Specifications: an unambiguous agreement on what the team will attempt to achieve to satisfy the customer needs
- Include: Metric, Value

6.2 When Are Specifications Established

- Target specifications: Immediately after Identifying Customer Needs
- Final specifications: After concept is determined (tested)

6.3 Establishing Target Specifications

- Target specifications: The goals of the development team, describing a product that the team believes would succeed in the marketplace
- 4 steps:
  - Prepare the list of metrics
  - Collect competitive benchmarking information
  - Set ideal and marginally acceptable target values
  - Reflect on the results and the process

Step 1: Prepare the list of metrics

- Metrics: Reflect as directly as possible the degree to which the product satisfies the customer needs
- Needs-metrics matrix: Represents the relationship between needs and metrics
- QFD (Quality Function Deployment): A tool to help ensure that the metrics are directly related to customer needs
- House of Quality: A matrix that relates customer needs to product specifications, helping to prioritize the metrics based on their importance to the customer
- Considered guidelines:
  - Metrics should be complete
  - Metrics should be dependent, not independent, variables
  - Metrics should be practical
  - Some needs cannot easily be translated into quantifiable metrics
  - The metrics should include the popular criteria for comparison in the marketplace

Step 2: Collect competitive benchmarking information

- Competitive benchmarking chart: A table that lists the metrics and their values for competitive products, allowing the team to understand the current market standards
- 2 kind:
  - Row: the metrics, Column: the competitive products (basic)
  - Row: the customer needs, Column: the competitive products (advanced)

Step 3: Set ideal and marginally acceptable target values

- 2 Target values:
  - Ideal value: The best result the team could hope for
  - Marginally acceptable value: The value of the metric that would just barely make the product commercially viable
- 5 ways to express:
  - At least X
  - At most X

  - Between X and Y
  - Exactly X
  - A set of discrete values

Step 4: Reflect on the results and the process

- Are members of the team "gaming"?
- Should the team consider offering multiple products or at least multiple options for the product to best match the particular needs of more than one market segment, or will one "average" product suffice?
- Are any specifications missing? Do the specifications reflect the characteristics that will dictate commercial success?

6.4 Setting Final Specifications

- Final specifications: Revised target specifications after product concept selection
- 5 steps:
  - Develop technical models of the product
  - Develop a cost model of the product
  - Refine the specifications, making trade-offs where necessary
  - Flow down the specifications as appropriate
  - Reflect on the results and the process

Chapter 7

Concept Generation

7.1 The Activity of Concept Generation

- Concept generation: An approximate description of the technology, working principles, and form of the product
- Form (with a brief textual description):
  - Sketch
  - rough three-dimensional model

7.2 Structured Approaches

- 5 steps:
  1. Clarify the problem
  2. Search externally
  3. Search internally
  4. Explore systematically
  5. Reflect on the results and the process

Chapter 8

Concept Selection

8.1 Concept Selection

- Concept selection: The process of evaluating concepts with respect to customer needs and other criteria, comparing the relative strengths and weaknesses of the concepts, and selecting one or more concepts for further investigation, testing, or development

8.2 Methods of Concept Selection

- External decision
- Product champion
- Intuition
- Multivoting
- Online survey/crowdsourcing
- Pros and cons
- Prototype and test
- Decision matrices

8.3 Advantages

- A customer-focused product
- A competitive design

- Better product-process coordination
- Reduced time to product introduction
- Effective group decision making
- Documentation of the decision process

8.4 Overview

- 2 phases:
  - Concept screening: A quick, rough evaluation of the concepts to eliminate those that are clearly unacceptable
  - Concept scoring: A more detailed evaluation of the remaining concepts to select the best one(s)
- 6 steps for each phase:
  1. Prepare the selection matrix
  2. Rate the concepts
  3. Rank the concepts
  4. Combine and improve the concepts
  5. Select one or more concepts
  6. Reflect on the results and the process

Chapter 9

Concept Testing

- 7 steps:
    1. Define the purpose of the concept test
    2. Choose a survey population
    3. Select a survey format
    4. Communicate the concept
    5. Measure customer response
    6. Interpret the results
    7. Reflect on the results and the process