INNOVATION

"This really is an innovative approach, but I'm afraid we can't consider it. It's never been done before."

Table of Contents

Chapter One

The importance of technological innovation

Technological innovation: The act of introducing a new device, method, or material for application to commercial or practical objectives.

- Increasing importance due in part to globalization of markets
- Computer-aided design and manufacturing have made shorter production runs economics and reduced the importance of production economies of scale
- Firms further reduce production costs by using common components in many of the models
- Product life cycles have become as short as 4-12 months for software, 12-24 months for hardware, and 18-36 months for home appliances
- A firm that doesn't innovate quickly finds its margins diminishing as its products become obsolete

The impact of technological innovation on society

Gross domestic product (GDP): The total annual output of an economy as measured by its final purchase price.

Externalities: Costs, or benefits, that are borne, or reaped, by individuals other than those responsible for creating them.

Technology is, in its purest essence, knowledge.

Innovation by industry

The innovation funnel

- Most innovative ideas do not become successful new products.
- The innovation process is often conceived as a funnel with many ideas going in the wide end, and few making it out the other.

The strategic management of technological innovation

- A firm's innovation projects should align with its resources and objectives, leveraging its core competencies and helping it achieve its strategic intent
- A firm's organizational structure and control system should encourage the generation of innovative ideas while ensuring efficient implementation
- A firm's new product development process should maximize the likelihood of projects being both technically and commercially successful
- To achieve these things a firm needs:
    - An in-depth understanding of the dynamics of innovation
    - A well-crafted innovation strategy
    - Well-designed process for implementing the innovation strategy

Chapter Two

Innovation, the practical implementation of an idea into a new device or process, can arise from many different sources. Innovation can:

- Originate with individuals
- Come from the research efforts of universities, governments, or private organizations

One primary engine of innovation is firms.

- Firms typically have greater resources that individuals
- Firms have strong incentives to develop differentiating products and services

Networks of innovators that leverage knowledge and other resources from multiple sources are one of the most powerful agents of technological advance.

Creativity

Innovation begins with the generation of new ideas. An **idea** is something imagined or pictured in the mind. The ability to generate new and useful ideas is termed creativity. **Creativity** is the ability to produce novel and useful work.

The degree to which a product is novel is a function both of how different it is from prior work and the audience's prior experiences.

Individual creativity

An individual's creative ability is a function of their intellectual abilities, knowledge, style of thinking, personality, motivation, and environment.

- An individual with only a moderate degree of knowledge of a field might be able to produce more creative solutions than an individual with extensive knowledge in that field.
- Personalities deemed most important for creativity include:
    - Self-efficacy
    - Tolerance for ambiguity
    - Willingness to overcome obstacles and take reasonable risks
    - Intrinsic motivation

To fully unleash an individual's creative potential often requires an environment that provides support and rewards for creative ideas.

Organizational creativity

- The creativity of the organization is a function of creativity of the individuals within it and a variety of social processes and contextual factors that shape the way those individuals interact and behave
- Employees can access the company's idea repository through the company's intranet. **Intranet** is a private network, accessible only to authorized individuals
- Sometimes monetary rewards undermine creativity by encouraging employees to focus on extrinsic rather than intrinsic motivation

Translating creativity into innovation

Innovation is more than the generation of creative ideas; it is the implementation of those ideas into some new device or process

The inventor

Most successful inventors possess the following traits:

- They have mastered the basic tools and operations of the field in which they wish to invent
- They are curious and more interested in problems than solutions
- They question the assumptions made in previous work in the field
- They often have the sense that all knowledge is unified

Innovation by users

Innovation often originates with those who create solutions for their own needs. User innovations can also blossom into new industries.

Research and development by firms

Research can refer to both basic and applied research.

- **Basic research** is effort directed at increasing understanding of a topic or field without a specific immediate commercial application in mind
- **Applied research** is directed at increasing understanding of a topic to meet a specific need
- **Development** refers to activities that apply knowledge to produce useful devices, materials, or processes

Science-push approach:

- Originated during the 1950's and 60's
- Assumed that innovation proceeded linearly from scientific discovery, to invention, to engineering, to manufacturing activities, and finally marketing.

Demand-pull model:

- Originated in the mid-60's
- Argued that innovation was driven by the perceived demand of potential users

Current research suggests that firms that are successful innovators utilize multiple sources of information and ideas, including:

- In house R&D
- Linkages to customers
- Linkages to an external network of firms
- Linkages to other external sources of scientific and technical information

Firm linkages with customers, suppliers, competitors, and complementors

Firms often form alliances with customers, suppliers, complementors, and even competitors to jointly work on an innovation project or to exchange information and other resources.

The most frequent collaborations are between firms and their customers, suppliers, and local universities.

Complementors are organizations or individuals of complementary goods or services.

Absorptive capacity: the ability of an organization to recognize, assimilate, and utilize new knowledge.

- Doing in-house R&D helps to build the firm's absorptive capacity

Universities and government-funded research

Universities

Technology transfer offices: Offices designed to facilitate the transfer of technology developed in a research environment to an environment where it can be commercially applied.

Government-funded research

Science parks: Regional districts, typically set up by government, to foster R&D collaboration between government, universities, and private firms.

Incubators: Institutions designed to nurture the development of new businesses that might otherwise lack access to adequate funding or advice.

Innovation in collaborative networks

As firms forge collaborative relationships, they weave a network of paths between them that can act as conduits for information and other resources.

Technology clusters: Regional clusters of firms that have a connection to a common technology, and may engage in buyer, supplier, and complementor relationships, as well as research collaboration.

Proximity and interaction can directly influence firms' ability and willingness to exchange knowledge.

- Knowledge that is complex or tactic may require frequent and close interaction
    - **Complex knowledge**: knowledge that has many underlying components, or many interdependencies between those components, or both.
    - **Tactic knowledge**: knowledge that cannot be readily codified
- Closeness and frequency of interaction can influence a firm's willingness to exchange knowledge

Agglomeration economies: the benefits firms reap by locating in close geographical proximity to each other.

Downsides to geographical clustering:

- Proximity can lead to competition that reduces pricing power with both buyers and suppliers

- Increases likelihood of competitor's gaining access to proprietary knowledge
- Can lead to traffic congestion, inordinately high housing costs, and higher concentrations of pollution

Knowledge brokers: Individuals or organizations that transfer information from one domain to another in which it can be usefully applied.

The degree to which innovative activities are geographically clustered depends on:

- The nature of the technology
- Industry characteristics
- Cultural context of the technology

Technological spillovers: A positive externality from R&D resulting from the spread of knowledge across organizational or regional boundaries

The likelihood of spillovers is also a function of the nature of the underlying knowledge base and the mobility of the labor pool.

Chapter Three

Technology trajectory: The path a technology takes through its lifetime. This path may refer to its rate of performance improvement, its rate of diffusion, or other change of interest.

Four of the dimensions most commonly used to categorize innovations:

Product vs. process innovation

- Product innovations are embodied in the outputs, that is goods or services.
- Process innovations are innovations in the way an organization conducts its business. Often orientated toward improving the effectiveness or efficiency of production.
- Both often occur in tandem.
  - New processes may enable the production of new products
  - New products may enable the development of new processes
  - A product innovation for one firm may simultaneously be a process innovation for another

Radical vs. incremental innovation

- **Radical innovation**: An innovation that is very new and different from prior solutions
  - Radicalness might be conceived as a combination of newness and the degree of differentness
  - The radicalness of innovation is also sometimes defined in terms of risk
  - The radicalness of an innovation is relative and may change over time or with respect to different observers
- **Incremental innovation**: An innovation that makes a relatively minor change from existing practices

Competence enhancing vs. competence destroying

- **Competence enhancing (destroying) innovation**: An innovation that builds on existing knowledge and skills
- Whether an innovation is competence enhancing or competence destroying depends on whose perspective is being taken.

Architectural vs. component innovation

- **Component (modular) innovation**: An innovation to one or more components that doesn't significantly affect the overall configuration of the system
- **Architectural innovation**: An innovation that changes the overall design of a system or the way its components interact with each other
  - Often have far-reaching and complex influences on industry competitors and technology users

Technology S-Curves

Both the rate of a technology's performance improvement and the rate at which the technology is adopted in the marketplace repeatedly have been shown to conform to an s-shape curve.

S-Curves in technological improvement

When a technology's performance is plotted against the amount of effort and money invested in the technology, it typically shows slow initial improvement, then accelerated improvement, then diminishing improvement.

- Often plotted with performance against time
    - If the effort invested is not constant over time, the s-curve can obscure the true relationship
    - If the effort is relatively constant over time, it will result in the same characteristic curve as plotting performance against effort
    - If the amount of effort invested decreases or increases over time, the resulting curve could appear to flatten much more quickly, or not flatten at all

Discontinuous technology: A technology that fulfills a similar market need by building on an entirely new knowledge base.

S-Curves in technology diffusion

Technology diffusion: The spread of a technology through a population.

- Obtained by plotting the cumulative number of adopters against time
- Some of the knowledge about the technology might be tactic and require transmission from person to person though extensive contact
    - Many potential adopters will not adopt until such knowledge is available to them
- Many technologies become valuable to a wide range of users only after a set of complementary resources are developed for them.
- As technologies are better developed, they become more certain and useful to users, facilitating their adoption

S-Curves as a prescriptive tool

S-curves can be used as a model to predict when a technology will reach its limits.

Limitations of S-Curve model as a prescriptive tool

- Rare that the true limits of a technology are known in advance
- The shape of a technology's s-curve is not set in stone
- Firms can influence the shape of the s-curve through their development activities
- Whether switching to a new technology will benefit a firm depends on a number of factors:
    - The advantages offered by the new technology
    - The new tech's fit with the firm's current abilities
    - The new tech's fit with the firm's position in complementary resources
    - The expected rate of diffusion of the new tech

Technology cycles

*Creative destruction**:*** The emergence of new technological discontinuity which can overturn the existing competitive structure of an industry.

Dominant design: A product design that is adopted by the majority of producers, typically creating a stable architecture on which the industry can focus its efforts.

- Each technological discontinuity inaugurates a period of turbulence and uncertainty (*era of ferment*). While the new tech displaces the old (*substitution*) there is considerable design competition
- Dominant design was never in the same form as the original discontinuity, but it was also never on the leading edge of the tech
- The dominant design tended to bundle together a combination of features that best fulfilled the demands of the majority of the market
- The rise of a dominant design signals the transition from the era of ferment to the era *of incremental change*. In this era, firms must focus on efficiency and market penetration
    - This period may account for the bulk of the technological progress in an industry, and continues until the next technological discontinuity
- Most competition revolves around improving components rather than altering the architecture
- In some industries, heterogeneity of products and production processes are a primary determinant of value, and thus a dominant design is undesirable

Chapter Four

The more a technology is adopted, the more valuable it becomes. Complex technologies often exhibit increasing returns to adoption.

Learning effects

The more a technology is used, the more it is developed, and the more effective and efficient it becomes.

- The standard form of the learning cure: $y = ax^{-b}$
  - Y is the number of direct labor hours required to produce the *x*th unit
  - A is the number of direct labor hours required to produce the first unit
  - X is the cumulative number of units produced
  - B is the learning rate
- Learning curves have also been identified by using a variety of performance measures, including productivity, total cost per unit, accidents per unit, and waste per unit

Prior learning and absorptive capacity

Absorptive capacity: the ability of an organization to recognize, assimilate, and utilize new knowledge.

- The effects of absorptive capacity suggest that firms that develop new technologies ahead of others may have an advantage in staying ahead
- At the aggregate level, the more firms that are using a given technology and refining it, the more absorptive capacity that is being generated related to that technology, making development of that technology more effective and efficient
- As firms develop complementary technologies to improve the productivity or ease of utilization of the core technology, the technology becomes more attractive to other firms

Network externalities

Network externalities: Also termed *positive consumption externalities*, is when the value of a good to a user increases with the number of other users of the same or similar good.

- Network externalities can also arise in markets that do not have physical networks
- **Installed base**: the number of users of a particular good
- **Complementary goods**: additional goods and services that enable or enhance the value of another good.
  - Network externalities also arise when complementary goods are important
- Firms can also attempt to influence the selection of a dominant design by building coalitions around a preferred technology

Government regulation

In some industries, the consumer welfare benefits of having compatibility among technologies have prompted government regulation, and thus a legally induced adherence to a dominant design. Examples of this are utilities, telecommunications, and television industries.

The result: winner-take-all markets

All these forces can encourage the market toward natural monopolies.

- **Path dependency**: when end results depend greatly on the events that took place leading up to the outcome. Often impossible to reproduce the results that occur in such a situation
- The influence of a dominant design can also extend beyond its own technology cycle
- **Increasing returns**: when the rate of return from a product or process increases with the size of its installed base

Stand-alone value

The buyer utility map argues that it's important to consider 6 different utility levers, as well as 6 stages of the buyer experience cycle, to understand a new technology's utility to a buyer.

- These stages are:
  - Purchase
  - Delivery
  - Use
  - Supplements
  - Maintenance
  - Disposal
- The utility levers are:
  - Customer productivity
  - Simplicity
  - Convenience
  - Risk
  - Fun and image
  - Environmental friendliness
- A new tech might offer a change in value in a single cell or in a combination
- Designed with an emphasis on consumer products, but their mapping principle can be easily adapted to emphasize industrial products or different aspects of buyer utility
- The new benefits have to be considered with respect ot the cost to the customer of obtaining or using the tech, it's the ratio of benefits to cost that determine value

The Buyer Utility Map with Honda Insight Example

	Purchase	Delivery	Use	Supplements	Maintenance	Disposal
Customer productivity	Price of Insight slightly higher than comparable nonhybrid models		Offers speed and power comparable to nonhybrid models	Can stop less often for gas, saving money and time		
Simplicity	Buyer may feel less able to assess value of vehicle		Operates like a regular combus-tion engine vehicle	Refuels like a regular combustion engine vehicle		Hybrids have larger batteries that would have to be recycled and disposed of at end of life
Convenience		Will be sold through traditional dealer channels	Does not have to be plugged into electrical outlet	Can purchase fuel at regular gas stations	Maintenance is similar to regular combustion engine vehicle	
Risk			Buyer might face a higher risk of product failure because it embodies a new technology		Buyer might have difficulty finding replacement parts because of new technology	Insight might be more difficult to resell or have lower resell value
Fun and image		Connotes image of environmental responsibility				
Environmental friendliness	Buyers feel they are helping support the development of more environ-mentally friendly cars		Emits lower levels of pollutants	Requires less use of fossil fuels		

Network externality value

In industries characterized by network externalities, the value of a technological innovation to users will be a function not only of its stand-alone benefits and cost, but also of the value created by the size of its installed base and the availability of complementary goods.

- For the new tech to compete on its stand-alone utility alone, that utility must be so great that it eclipses the combined value of an existing techs stand-alone utility, its installed base, and its complementary goods
- When users are comparing the value of a new tech to existing tech, they are weighing a combination of objective information, subjective information, and expectation for the future
- *Vaporware*: products that aren't actually on the market and may not even exist but are advertised
- By building the impression among customers that a product is ubiquitous, firms can prompt rapid adoption of the product when it actually is available

Competing for design dominance in markets with network externalities

- Beyond some threshold level, the network externality returns begin to increase rapidly, until at some point, most of the benefits have been obtained and the rate of return decreases
- When 2 technologies compete for dominance, customers will compare the overall value yielded
- If both technologies earn similar network externality returns to market share, but one tech offers greater stand-alone utility, the indifference point will be shifted in its favor

Are winner-take-all markets good for consumers?

- Monopoly costs refer to the costs users bear as a larger portion of the market adopts the same good
- Monopoly costs to market share are often considered to be exponentially increasing
- The steepness of the monopoly cost curve is largely a function of the firm's discretionary behavior

Chapter Five

First movers: The first entrants to sell in a new product or service category.
Early followers: Entrants that are early to the market, but not first.
Late entrants: Entrants that do not enter the market until the time the product begins to penetrate the mass market or later.

First-mover advantages

- **Brand loyalty and technological leadership**
  - If aspects that customers have come to expect in a technology are difficult for competitors to imitate, being the technology leader can yield sustained **monopoly rents**. Also an opportunity to build brand loyalty
    - **Monopoly rents**: The additional returns a firm can make from being a monopolist
- **Preemption of scarce assets**
  - Firms that enter the market early can preemptively capture scarce resources such as key locations, government permits, access to distribution channels, and relationships with suppliers
- **Exploiting buyer switching costs**
  - Once buyers have adopted a good, they often face costs to switch to another good
- **Reaping increasing returns advantages**
  - The timing of a firm's investment in new tech development may be particularly critical to its likelihood of success

First-mover disadvantages

- Market pioneers have a higher failure rate, about 47%
- First movers can earn greater revenues, but they face higher costs
  - First movers bear the bulk of the R&D expenses
  - They must pay to develop suppliers and distribution channels, plus consumer awareness
  - **Incumbent inertia**: The tendency for incumbents to be slow to respond to changes in the industry environment due to their large size, established routines, or prior strategic commitments to existing suppliers and customers
- **Research and development expenses**
- **Undeveloped supply and distribution channels**
- **Immature enabling technologies and complements**
  - **Enabling technologies**: component technologies that are necessary for the performance or desirability of a given innovation
- **Uncertainty of customer requirements**

Factors influencing optimal timing of entry

- How certain are customer preferences?
- How much improvement does the innovation provide over previous solutions?

- Does the innovation require enabling technologies, and are these technologies sufficiently mature?
- Do complementary goods influence the value of the innovation, and are they sufficiently available?
- How high is the threat of competitive entry?
- Is the industry likely to experience increasing returns to adoption?
- Can the firm withstand early losses?
- Does the firm have resources to accelerate market acceptance?
- Is the firm's reputation likely to reduce the uncertainty of customers, suppliers, and distributors?

Strategies to improve timing options

If the firm intends to refine an earlier entrant's technology and beat the earlier entrant to market with a new version of this tech, it must have *fast-cycle development processes*.

- A firm with very fast development deployment processes should be able to take advantage of both first- and second-mover advantages
- A new product development cycle time indicates that development time can be greatly shortened by using strategic alliances, cross-functional new product development teams, and parallel development processes
    - **Parallel development process**: when multiple stages of the new product development process occur simultaneously

Chapter Six

Assessing the firm's current position

External analysis

- **Porter's five-force model**: the attractiveness of an industry and a firm's opportunities and threats are identified by analyzing 5 forces:
    - **The degree of existing rivalry**
        - The number and relative size of competitors will shape the nature of the rivalry
        - **Oligopolistic industries**: highly consolidated industries with a few large competitors, which can be fiercely competitive if firms choose to engage in price wars
        - **Exit barriers**: costs or other commitments that make it difficult for firms to abandon an industry. In declining industries, high exit barriers can intensify rivalry
    - **Threat of potential entrants**
        - Influenced by both the degree to which the industry is likely to attract new entrants and the height of entry barriers.
            - **Entry barriers**: conditions that make it difficult or expensive for new firms to enter an industry.
    - **Bargaining power of suppliers**
        - The degree to which the firm relies on one or a few suppliers will influence its ability to negotiate good terms
        - **Switching costs**: factors that make it difficult or expensive to change suppliers or buyers
        - **Vertical integration**: getting into the business of one's suppliers (backwards vertical integration) or one's buyers (forward vertical integration).
    - **Bargaining power of buyers**
        - Many of the same factors that influence the bargaining power of suppliers have an analogous role with the bargaining power of buyers. The degree to which the firm is reliant on a few customers will increase the customer's bargaining power, and vice versa.
        - Highly differentiated products typically experience less bargaining power
        - If buyers face switching costs, it will lower bargaining power
        - If a firm faces switching costs to work with other buyers it will increase the buyer's bargaining power
        - If the buyers can threaten to backward vertically integration, it will increase their bargaining power
        - If the firm can threaten to forward vertically integrate, it will lower customer bargaining power
    - **Threat of substitutes**

Complements: products or services that enhance the usefulness or desirability of another products

Stakeholder analysis

Stakeholder (any entity that has an interest in the organization) models are often used for both strategic and normative purposes.

- A strategic *stakeholder analysis* emphasizes the stakeholder management issues that are likely to impact the firm's financial performance
- A *normative stakeholder analysis* emphasizes the stakeholder management issues the firm ought to attend to due to their ethical or moral implications

Internal analysis

Begins with identifying the firm's strengths and weaknesses.

Primary activities include:

- *Inbound logistics*
- *Operations*
- *Outbound logistics*
- *Marketing and sales*
- *Service*

Support activities include:

- *Procurement*
- *Human resource management*
- *Technology development*
- *Infrastructure*

To be a source of sustainable competitive advantage, resources must be

- *Rare*
- *Valuable*
- *Durable*
- *Inimitable*

If valuable resources are **tactic**, path dependent, **socially complex**, or **casually ambiguous**, they will be extremely difficult to imitate. *Talent* is typically considered to be a tactic and causally ambiguous resource.

- **Tactic resources**: resources of an intangible nature that cannot be readily codified.
- **Socially complex resources**: resources or activities that emerge through the interaction of multiple individuals.
- **Casual ambiguity**: the relationship between a resource and the outcome it produces is poorly understood.

Identifying core competencies and capabilities

Core competency (capability): A set of integrated and harmonized abilities that distinguish the firm in the marketplace.

- Typically considered to be those that differentiate a company strategically
- More than just a core technology

- Arises from a firm's ability to combine and harmonize multiple primary abilities in which the firm excels into a few key building block of specialized expertise
- Often combine different kinds of abilities
- Several core competencies may underlie an individual business unit, and several business units may draw upon the same core competency

The risk of core rigidities

Sometimes the very things that a firm excels at can enslave it, making the firm rigid and overly committed to inappropriate skills and resources.

Dynamic capabilities: a set of abilities that make a firm more agile and responsive to change.

- In fast-changing markets, it can be extremely useful for a firm to develop a core competency in responding to change
- Also possible for a firm to develop core competencies that aren't specific to any set of technologies or products, but rather to a set of abilities that enable it to quickly reconfigure its organization structure and routines in response to new opportunities

Strategic intent

A firm's purpose is to create value. This means, besides improving operations or cutting costs, leveraging corporate resources to create more performance for customers, more well-being for employees, and more returns for shareholders.

- Focusing on the firm's existing markets results in the development of products and services that meet current market requirements, rather than future market requirements.

Chapter Seven

Capital rationing: the allocation of a finite quantity of resources over different possible users.

The development budget

Under capital rationing, the firm sets a fixed R&D budget, and then uses a rank ordering of possible projects to determine which will be funded.

R&D intensity: the ratio of R&D expenditures to sales.

The rank ordering used in capital rationing may be established by any number of methods, including:

- Quantitative methods
- Qualitative methods
- A combination of multiple methods

Quantitative methods for choosing projects

- Usually entail converting projects into some estimate of future cash returns from a project
- Enable managers to use rigorous mathematical and statistical comparisons of projects

Discounted cash flow methods: quantitative methods for assessing whether the anticipated future benefits are large enough to justify expenditure, given the risks.

- They take into account the payback period, risk, and TVM
- **NPV**: the discounted cash inflows of a project minus the discounted cash outflows
- **IRR**: the rate of return yielded by a project, normally calculated as the discount rate that makes the NPV of an investment equal zero

Net Present Value

- *NPV = Present value of cash inflow – Present value of cash outflows*
  - If this value is greater than 0, then the project generates wealth
- If the cash inflows from the development project were expected to be the same each year, we can use the formula for calculating the present value of an annuity instead of discounting each of the cash inflows individually
  - $Annuity\ present\ value = C \times \frac{1-\{1/(1+r)^1\}}{r}$
  - $Perpetuity\ present\ value = C \times \frac{1}{r}$
- **Discounted payback period**: the time required to break even on a project using discounted cash flows

Internal Rate of Return

The IRR of a project is the discount rate that makes the NPV of the investment zero. Managers can compare this rate of return to their required return to decide if the investment should be made.

Real options: the application of stock option valuation methods to investments in nonfinancial assets.

- Development projects can create valuable future opportunities for the firm that would otherwise be unavailable
- With respect to R&D:
  - The cost of the R&D program can be considered the price of a call option
  - The cost of future investment required to capitalize on the R&D program can be considered the exercise price
  - The returns to the R&D investment are analogous to the value of a stock purchased with a call option
- Options are valuable when there is uncertainty, and because technology trajectories are uncertain, an options approach may be useful

Qualitative methods for choosing projects

Most new product development projects require the evaluation of a significant amount of qualitative information.

Screening questions

A management team is likely to discuss the potential costs and benefits of a project, and the team may create a list of screening questions that are used to structure this discussion.

The aggregate project planning framework

Many companies find it valuable to map their R&D portfolio according to levels of risk, resource commitment, and timing of cash flows. Four types of development projects commonly appear on this map:

- Advanced R&D
- Breakthrough
  - Involve development of products that incorporate revolutionary new product and process technologies
- Platform
  - Offer fundamental improvements in the cost, quality, and performance of a technology over preceding generations
  - Designed to serve a core group of consumers
- Derivative projects
  - Involve incremental changes in products and/or processes
  - Represent modifications of the basic platform design to appeal to different niches within that core group

Companies that use the project map categorize all their existing projects and those under consideration by the resources they require and by how they contribute to the company's product line. Mapping the company's R&D portfolio encourages the firm

to consider both short-term cash flow needs and long-term strategic momentum in its budgeting and planning.

Q-Sort is a simple method for ranking objects or ideas on a number of different dimensions.

- Individuals in a group are each given a stack of cards with an object or idea on each card
- Each card could identify a potential project
- Then a series of project selection criteria are presented and for each criterion, the individuals sort their cards in rank order or in categories

Combining quantitative and qualitative information

Conjoint analysis is a family of techniques used to estimate the specific value individuals place on some attribute of choice. These techniques include:

- Discrete choice
- Choice modeling
- Hierarchical choice
- Trade-off matrices
- Pairwise comparisons

Conjoint analysis enables a subjective assessment of a complex decision to be decomposed into quantitative scores of the relative importance of different criteria.

Data envelopment analysis is a method of assessing a potential project using multiple criteria that may have different kinds of measurement units.

- Uses linear programming to combine these different measures from the projects to create a hypothetical efficiency frontier that represents the best performance on each measure
    - **Efficiency frontier**: the range of hypothetical configurations that optimize a combination of features
- It can also consider which measures are inputs vs. outputs. It then measures the distance of each project from this frontier to give it an efficiency value.
- These values can then be used to rank-order the projects or identify projects that clearly dominate others.

Chapter Eight

Reasons for going solo

A firm might choose to engage in solo development of a project for a number of reasons:

- The first may perceive no need to collaborate with other organizations
- The firm may prefer to obtain complementary skills or resources from a partner
- A firm might choose to develop a project as a solo venture if it's concerned that collaborating would put its proprietary technologies at risk or if it seeks to have full control over the project's development and returns
- It might give it more opportunities to build and renew its capabilities
- **Availability of capabilities**
- **Protecting proprietary technologies**
- **Controlling technology development and use**
    - **Alliance**: a general term that can refer to any type of relationship between firms. May be short or long-term
- **Building and renewing capabilities**
    - Collaborating on development projects can offer a firm a number of advantages:
        - Can enable a firm to obtain necessary skills or resources more quickly than developing them in-house
        - Obtaining some of the necessary capabilities or resources from a partner rather than building them in-house can help a firm reduce its asset commitment and enhance its flexibility
        - Collaboration with partners can be an important source of learning for the firms. Close contact with other firms can facilitate both the transfer of knowledge between firms and the creation of new knowledge that individual firms couldn't have created alone
        - One primary reason firms collaborate on a development project is to share the costs and risks of the project
        - Firms may also collaborate on a development project when such collaboration would facilitate the creation of a shared standard. Collaboration at the development stage can be an important way of ensuring cooperation in the commercialization stage of a technology
    - **Joint venture**: a partnership between two or more firms involving a significant equity stake by the partners and often resulting in the creation of a new business entity

Type of collaborative arrangements

Collaboration can include partnering with suppliers, customers, competitors, complementors, organizations that offer similar products in different markets, organizations that offer different products in similar markets, nonprofit organizations, government organizations, universities, etc.

Collaboration can also be used for many different purposes, including manufacturing, services, marketing, or technology-based objectives.

Collaboration arrangements can also take many forms, from very informal alliances to highly structured joint ventured or technology exchange agreements (**licensing**). Licensing is a contractual arrangement whereby one organization or individual obtains the rights to use the proprietary technology of another organization or individual.

Strategic alliance

- Firms may use strategic alliances to access a critical capability that is not posses in-house
- Might for alliances to pool their resources
- Share the risk of a venture or to speed up market development and penetration
- Can enhance a firm's overall level of flexibility
- Used to enable partners to learn from each other and develop new competencies
- Useful to categorize a firm's alliance strategy along two dimensions
    - First dimension is the degree to which alliances practice capability complementation vs. capability transfer
        - **Capability complementation**: combining the capabilities and other resources of partner firms, but not necessarily transferring those resources between the partners
        - **Capability transfer**: exchange of capabilities across firms in such a manner that partners can internalize the capabilities and use them independently of the particular development project
    - Second dimension is whether the firm manages each alliance individually or manages a collective network of alliances
- In building an alliance portfolio, managers should think carefully about competitive, complementing, and network structure effects
    - If multiple alliances are serving the same strategic needs, there is a risk of redundant resources investment, or competitive conflict between partners
    - Complementary alliances can be super addictive if carefully managed
    - Managers should consider how their portfolio of alliances positions them in the web of relationships that connects their firm, partners, and partners' partners

Joint ventures

- A particular type of strategic alliance that entails significant structure and commitment
- Involves a significant equity investment from each partner and often results in establishment of a new separate entity

Licensing

- A contractual arrangement whereby one organization or individual obtains the rights to use the proprietary technology of another organization or individual

- For the licensor, licensing can enable the firm's tech to penetrate a wider range of markets than it could on its own
- Licensing a tech from another firm is typically less expensive than developing a new tech in house
- Licensing agreements typically impose many restrictions on the licensee, enabling the licensor to retain control over how the tech is used
- Sometimes firms license their techs to preempt their competitors from developing their own competing tech

Outsourcing

Firms that develop new technological innovations don't always possess the competencies, facilities, or scale to perform all the value-chain activities for the new innovation effectively or efficiently. Such firms might outsource activities to other firms.

- One common form of outsourcing is the use of contract manufactures
    - **Contract manufacturing**: when a firm hires another firm to manufacture its products
    - Allows firms to meet the scale of market demand without committing to long-term capital investments or an increase in labor force
    - Enables firms to specialize in those activities central to their competitive advantage
- Other activities, such as product design, process design, marketing, information technology, or distribution can also be outsourced
- Outsourcing can have downsides:
    - Reliance on outsourcing may cause the firm to forfeit important learning opportunities
    - By not investing in development of in-house capabilities, a firm might not develop many of the skills and resources related to its products that enable the development of future product platforms
    - Can impose significant transaction costs for the firm

Collective research organizations

May take a number of forms, including trade associations, university-based centers, or private research corporations.

Choosing a mode of collaboration

- Solo internal development is, on average, a relatively slow and expensive way of developing a technology
    - A firm that engages in solo internal development retains total control over how the tech is developed and used
    - Solo internal development might make sense for a firm that has strong competencies related to the new tech, has access to capital, and is not under time pressure
- Some strategic alliances may enable a firm to relatively quickly and cheaply gain access to another firm's tech, but give the firm a low level of control over that tech

    - Other strategic alliances might be aimed at utilizing the firm's own tech in a broader range of markets, which can be fast and cost-effective, and still enable the firm to retain a considerable amount of control
- A joint venture is much more structured
    - It involves developing a new tech and can take almost as long as solo internal development
    - It may be slightly faster due to the combination of the capabilities of multiple firms

Choosing and monitoring partners

Partner selection

- The success of collaborations will depend in large part on the partners chosen
- *Resource fit* refers to the degree to which potential partners have resources that can be effectively integrated into a strategy that creates value
- *Strategic fit* refers to the degree to which partners have compatible objectives and styles

Partner monitoring and governance

- Successful collaboration agreements typically have clear, yet flexible, monitoring and governance mechanisms
    - **Governance**: the act or process of exerting authority and/or control
- These are 3 main types of governance mechanisms organizations use to manage their collaborative relationships:
    - **Alliance contracts** are legally binding contractual arrangement to ensure that partners
        - Are fully aware of their rights and obligations
        - Have legal remedies available if a partner should violate the agreement.
        - Such contracts typically include:
            - What each partner is obligated to contribute to the collaboration, including money, services, equipment, ip, etc.
            - How much control each partner has in the arrangement
            - When and how proceeds of the collaboration will be distributed
            - Often also include mechanisms for monitoring each partner's adherence to the agreement
            - Many agreements also include provisions for terminating the relationship if the need for the alliance ends
    - **Equity ownership**: when each partner contributes capital and owns a specified right to a percentage of the proceeds from the alliance
    - **Relational governance**: self-enforcing norms based on goodwill, trust, and reputation of the partners. These typically emerge over time through repeated experiences of working together

Chapter Nine

Appropriability

Appropriability: the degree this which a firm is able to capture the rents from its innovation

- Determined by how easily or quickly competitors can imitate the innovation
    - This ease is a function of both the nature of the tech and the strength of the mechanisms used to protect the innovation
- **Tactic knowledge**: knowledge that cannot be readily codified or transferred in written form
- **Socially complex knowledge**: knowledge that arises from the interaction of multiple individuals

Patents, trademarks, and copyrights

- Patent: a property right protecting a process, machine, manufactured item, or variety of plant
    - Often categorized into different types
        - A *utility* patent may be granted to an inventor who creates or discovers a new and useful process, machine, manufactured item, or combination of materials
        - A *design* patent may be granted to the inventor of an original ornamental design for a manufactured item
        - A *plant* patent may be granted to an inventor who invents or discovers and asexually reproduces any distinct and new variety of plant
        - An invention must pass 3 tests to be patentable:
            - It must be *useful*
            - It must be *novel*
            - It must *not be obvious*
        - The following are not typically patentable:
            - Substituting one material for another
            - Merely changing the size of an already existing device
            - Making something more portable
            - Substituting an element for an equivalent element
            - Altering an item's shape
    - To apply for a patent, the inventor must explain how to make and use the invention, and make claims about what it does that makes it a new invention. Drawings are often required
    - The entire process from application to granting of the patent can take between 2 and 5 years
    - Utility patents are typically granted more protection than other types of patents
    - Almost every country assigns a protection term of 20 years to utility patents
    - A patent granted in one country doesn't provide protection in other countries

        - US patent laws is one of the most unusual (with the publicizing of the patents)
        - Many countries require that the invention be manufactured in the country in which a patent was granted within a certain time frame, often 3 years, from the time the patent was granted. This is called the working requirement and it effectively prevents inventors from patenting inventions in countries in which they have no intention of setting up production
    - Several international treaties seek to harmonize the patent laws around the world:
        - **Paris Convention for the Protection of Industrial Property and the Patent Cooperation Treaty**
            - An international intellectual property treaty adhered to by 174 countries as of December 2011
            - A citizen of any member country may patent an invention in any of the member countries and enjoy the same benefits of patent protection as if the inventor were a citizen of those countries
            - It eliminates any differential patent rights afforded to citizens of the country vs. foreign nationals
            - Once an inventor has applied for patent protection in one of the member countries, the inventor may apply for protection in all the other member countries within 12 months for utility patents and 6 months for design patents and trademarks
                - The applications to those later countries will be treated as if they were made on the same date as the first application
        - **Patent cooperation treaty (PCT)**
            - PCT facilitates the application for a patent in multiple countries
            - An inventor can apply for a patent to a single PCT governmental receiving office
                - That application reserves the inventor's right to file for patent protection in more than 100 countries for up to 2½ years
            - Once the inventor has filed the application, a PCT governmental searching office will perform the patent search for the application
            - Advantages:
                - Applying for the PCT patent buys the inventor the option to apply to multiple nations later without committing the inventor to the expense of those multiple applications
                - With a PCT application, the inventor can establish a date of application in multiple countries, while paying only the single PCT application fee
                - It helps make the results of patent applications more uniform

        - There are 144 member states of the PCT
- Trademark an indicator used to distinguish the source of a good
    - A word, phrase, symbol, design, or other indicator that is used to distinguish the source of goods from one party from the goods of others
    - A service mark is basically the same as a trademark, but distinguishes the provider of a service rather than a product
    - *Trademark* is often used to refer to both trademarks and service marks
    - Most marks are embodied in visual indicators, but can also use other senses such as sound or smells
    - Trademark rights may be used to prevent others from using a mark that is similar enough to be confusing, but they may not be used to prevent others from producing or selling the same goods or services under a clearly different mark
    - A trademark doesn't require registration, but registration provides advantages:
        - Registering the mark provides public notice of the registrant's claim of ownership over the mark
        - Marks must be registered before a suit can be brought in federal court against an infringement of the mark
        - Registration can be used to establish international rights over the trademark
    - Trademark protection can last as long as the trademark is in use, but the registration requires periodic renewal
    - The World Intellectual Property Organization administers a System of International Registration of Marks governed by two treaties: The Madrid Agreement Concerning the International Registration of Marks and the Madrid Protocol
- Copyright a property right protecting works of authorship
    - A form of protection granted to works of authorship
    - Authors of original literary, dramatic, musical, artistic, and certain other intellectual works can obtain copyright protection
    - The rights of copyright protection are established by legitimate use of the work
    - This protection is available whether or not the work is published and prevents others from producing or distributing that work
    - The owner of the copyright has the exclusive right to:
        - Reproduce the work
        - Prepare derivative works based upon the work
        - Distribute copies of the work to the public by sale or other transfer of ownership
        - Perform the work publicly
        - Display the copyrighted work publicly
        - Perform the work publicly
    - Limitation to these rights:
        - The doctrine of fair use stipulates that in most circumstances it's not a violation of copyright for others to use copyrighted material for purposes such as criticism, comment, news reporting, teaching, scholarship, or research

    - Some type of work can't be copyrighted:
        - Titles
        - Names
        - Short phrases
        - Slogans
        - Familiar symbols
        - Lists of ingredients
    - Copyright protection is secured automatically when an eligible work is created and fixed in a copy for the first time. No publication or registration with the Copyright Office is necessary to establish this copyright
    - Registering the copyright is advantageous in that it establishes a public record of the copyright claim and is required before filing an infringement suit
    - Berne Union for the Protection of Literary and Artistic Property specifies a minimum level of copyright protection for all member countries, and it requires member countries to offer the same protection to both its own citizens and foreign nationals

Trade secrets

Trade secret: information that belongs to a business that is held private.

- Trade secrets needn't meet many of the stringent requirements of patent law, enabling a broader class of assets and activities to be protectable
- Information is typically considered to be a trade secret only if:
    - Offers a distinctive advantage to the company in the form of economic rents
    - Remains valuable only as long as the information remains private
- For information to qualify as a trade secret under the Uniform Trade Secret Act it must meet the following criteria:
    - The information must not be generally known or readily ascertainable through legitimate means
    - The information must have economic importance that is contingent upon its secrecy
    - The trade secret holder must exercise reasonable measures to protect the secrecy of the information
- The act states that no individual or group can copy, use, or otherwise benefit from a trade secret without the owner's authorization if they meet any of the following conditions:
    - They are bound by a duty of confidentiality
    - They have signed a nondisclosure agreement
    - They acquire the secret through improper means such as theft or bribery
    - They acquire the information from someone who didn't have the right to disclose it
    - They learn about the secret by mistake but have a reason to know that the information was a protected trade secret

The effectiveness and use of protection mechanisms

The methods used to protect innovation, and their effectiveness, vary significantly both within and across industries.

- It's notoriously difficult to enforce patents protecting industrial processes such as manufacturing techniques
- Patents provide little protection, the firm may rely more heavily on trade secrets
- For some competitive situations, protecting a tech may not be as desirable as liberally diffusing it
- The more a tech is adopted, the more valuable it becomes
- Firms may liberally diffuse their tech (example **open source software** or liberal licensing arrangements) to accelerate the techs proliferation and thereby jump-start the self-reinforcing feedback effect that can lead to the techs dominance
- Liberal diffusion of the tech can result in the fragmentation of the tech platform

Wholly proprietary systems vs. wholly open systems

Wholly proprietary systems are those based on tech that is company-owner and protected through patents, copyrights, secrecy, or other mechanisms.

- Often not compatible with the products offered by other manufacturers
- Proprietary systems typically provide their developers with the opportunity to appropriate rents from the tech

Wholly open systems, the tech used in a product or process is not protected by secrecy patents; it may be based on available standards or it may be new tech that is openly diffused to other producers.

- Quickly commoditized and provide little Appropriability of rents to their developers
- **Original equipment manufacturers (OEM)**: firms that assemble goods using components made by other manufacturers, also called value-added resellers (VAR)

Advantages of protection

If a single firm is the primary beneficiary of its techs success, it has much greater incentive to invest in further developing the tech.

- Protecting the tech gives the developing firm architectural control over the tech
- **Architectural control**: the ability of a firm to determine the structure, operation, compatibility, and development of a tech

Advantages of diffusion

- Open technologies may accrue more rapid adoption
- Competition among producers may drive the price of the tech down
- A liberal diffusion strategy can stimulate the growth of the installed base and availability of complementary goods
- External development poses some costs and risks:

    - External development efforts typically lack the coordination of internal development
    - Whether and how these improvements get incorporated into the tech and disseminated to other users of the tech can prove very problematic
- A firm must carefully consider the following factors in deciding whether, and to what degree, it should protect its innovation

Production, capabilities, marketing capabilities, and capital

If the firm is unable to produce the tech at sufficient volume or quality levels, then protecting the tech so that the firm is its sole provider may significantly hinder its adoption.

If complementary goods influence the value of the tech to users, then the firm must:

- Be able to produce the complements in sufficient range and quantity
- Sponsor their production by other firms
- Encourage collective production of the complements through a more open tech strategy

Resources for internal development

If a firm doesn't have significant resources to invest in the techs functionality, it may have difficulty producing a tech that has an initial performance level, and rate of improvement, that the market finds attractive.

Control of fragmentation

For technologies in which standardization and compatibility are important, maintaining the integrity of the core product is absolutely essential, and external development can put it at risk.

Incentives for architectural control

Architectural control over the evolution of a tech is always valuable; however, it becomes particularly valuable if a firm is a significant producer of complements to the tech in question.

Architectural control can also enable the firm to direct the development efforts put into the tech so that it exploits the firm's core competencies.

Chapter Ten

Size and structural dimensions of the firm

In the 1940's Schumpeter pointed out that:

- Capital markets are imperfect, and large firms are better able to obtain financing for R&D projects
- Firms with larger sales volume over which to spread the fixed costs of R&D would experience higher returns than firms with lower sales volume
- If large firms spend more on R&D in an absolute sense, they might also reap economies of scale and learning curve advantages in R&D
- As a large firm gains experience in choosing and developing innovation projects, it may learn to make better selections of projects that fit the firm's capabilities and have a higher likelihood of success
- Large firms are also in a better position to take on large or risky innovation projects than smaller firms
- On the other hand, as a firm grows, its R&D efficiency might decrease because of a loss of managerial control
- Large firms may also be less innovative because their size can make them less nimble and responsive to change
- Small firms are often considered more flexible and entrepreneurial than large firms
    - They are unencumbered by multiple layers of administration, large fixed-asset bases, or strategic commitments to large numbers of employees, customers, and suppliers
    - May also find it much simpler to monitor employees and reward them for their effort or success at innovation
- **Disaggregated**: when something is separated into its constituent parts

Structural dimensions of the firm

Formalization: the degree to which the firm utilizes rules, procedures, and written documentation to structure the behavior of individuals or groups within the organization.

- Can facilitate the standardization of firm activities and help to regulate employee behavior by providing clear expectations of behavior and decision-making criteria

Standardization: the degree to which activities are performed in a uniform manner.

Centralization: the degree to which decision making authority is kept at top levels of management, it is the degree to which decision making authority is pushed down to lower levels of the firm

- If the firm centralizes R&D in a single department, it may maximize economies of scale in R&D, enabling greater division of labor among the R&D specialists and maximizing the potential for learning-curve effect through the development of multiple projects
    - Also enables the central R&D department to manage the deployment of new technologies throughout the firm, improving the coherence of the

firm's new product development efforts and avoiding the possibility that valuable new techs are underutilized throughout the organization

Mechanistic vs. organic structures

Mechanistic: an organization structure characterized by a high degree of formalization and standardization, causing operations to be almost automatic or mechanical.

- Often associated with greater operational efficiency, particularly in large-volume production settings

Organic: an organization structure characterized by a low degree of formalization and standardization. Employees may not have well-defined job responsibilities and operations may be characterized by a high degree of variation.

- Often considered better for innovation and dynamic environments

The ambidextrous organization

Ambidextrous organization: the ability of an organization to behave almost as two different kinds of companies at once. Different divisions of the firm may have different structures and control systems, enabling them to have different cultures and patterns of operations.

- Can achieve both short-term efficiency and long-term innovation
- When multiple teams interact closely, there is a risk that a solution that appears to have an advantage will be too rapidly adopted by other teams
- **Skunk works**: a term that originated with a division of Lockheed Martin that was formed in June of 1943 to quickly develop a jet fighter for the USAA. It has evolved as skunk works to refer more generally to new product development teams that operate nearly autonomously from the parent organization, with considerable decentralization of authority and little bureaucracy
    - Has indicated that there can be significant gains from isolating new product development teams from the mainstream organization
- Firms that have multiple product divisions might find that one or more divisions need a more organic structure to encourage creativity and fluid responses to environmental change, while other divisions benefit from a more structured and standardized approach

Modularity and loosely coupled organization

Another method firms use to strike a balance between efficiency and flexibility is to adopt standardized manufacturing platforms or components that can then be mixed and matched in a modular production system.

Modular products

Modularity refers to the degree to which a system's components may be separated and recombined.

- Modular products become more valuable when customers have heterogeneous demands and there are diverse options for meeting them
- When products are made more modular, it enables the entire production system to be made more modular

Loosely coupled organizational structures

Organizations can also be made modular through the adoption of structures that enable loose coupling. In a loosely coupled structure, development and production activities are not tightly integrated but rather achieve coordination through their adherence to shared objectives and common standards

- Advances in IT have also enabled loosely coupled organizational structures to become more common
- Less need for integration frees firms to pursue more flexible R&D and production configurations
- By focusing on those activities in which the firm has a competitive advantage, the firm can improve its chance of developing a product that has a price-to-value ratio that attracts customers while reducing the overhead and administrative complexity of maintaining a wide scope of activities
- Disadvantages of loose coupling:
    - Many activities reap significant synergies by being integrated
    - If ongoing intensive coordination is required, the development activities might be better carried out through close integration of all parties
    - An integrated firm also has mechanisms for resolving conflict that may be more effective or less expensive than those available in the market

Managing innovation across borders

The **center-for-global strategy** entails conducting all innovation at a centralized hub. The centralization of innovation activities enables management to:

- Tightly coordinate all R&D activities
- Achieve greater specialization and economies of scale in R&D activities while avoiding duplication of activities in multiple divisions
- Develop and protect core competencies
- Ensure that innovations are standardized and implemented throughout the company

Managers choose a center-for-global approach to innovation when:

- They have a strong desire to control the evolution of a tech
- They have strong concerns about the protection of proprietary techs
- Development activities require close coordination
- There is a need to respond quickly to technological change and dispersed efforts are likely to create inefficiencies.

A **local-for-local strategy** is the opposite of the center-for-global strategy.

- Each national subsidiary uses its own resources to create innovations that respond to the needs of its local market
- Customizes innovation for the needs and tastes of the local market
- Several downsides:
    - Significant redundancy
    - Each division may suffer from a lack of scale in R&D activities
    - Risk that valuable innovations will not be diffused across the firm

Locally leveraged strategy: when each division or subsidiary of the firm conducts its own R&D activities, but the firm attempts to leverage resulting innovations throughout the company.

Globally linked strategy: innovation activities are decentralized, but also centrally coordinated for the global needs of the corporation

In both the locally leverages and globally linked strategies, R&D divisions are decentralized and linked to each other.

Chapter Eleven

Objectives of the new product development process

For new product development to be successful, it must simultaneously achieve 3 sometimes conflicting goals:

- Maximizing the product's fit with customer requirements
    - For a new product to be successful in the marketplace, it must offer more compelling features, greater quality, or more attractive pricing than competing products
        - The firm may not have a clear sense of which features customers value the most
        - Firms may overestimate the customer's willingness to pay for particular features
        - Firms may have difficulty resolving heterogeneity in customer demands
- Minimizing the development cycle time
    - Products can fail if they take too long to bring to market
    - **Development cycle time**: the time elapsed from project initiation to product launch, usually measured in months or years
    - A company that is slow to market with a particular generation of technology is unlikely to be able to fully amortize the fixed costs of development before that generation becomes obsolete
    - A company with a short development cycle can quickly revise or upgrade its offering as design flaws are revealed or technology advances
- Controlling development costs

Sequential vs. partly parallel development processes

Partly parallel development process: a development process in which some, or all, of the development activities at least partially overlap.

- Product design is initiated before concept development is complete, and process design is begun long before product design is finalized, enabling much closer coordination between the different stages and minimizing the chance that R&D will design products that are difficult or costly manufacture

Project champions

Assign a senior member of the company to champion a new product development project. Senior executives have the power and authority to support and fight for a project. They can facilitate the allocation of human and capital resources to the development effort, ensuring that cycle time is not extended by resource constraints, and help ensure that the project can sustain the necessary momentum to surmount the hurdles that inevitably will arise.

Risks of championing

Vigorous project championing has it risks. A manager's role as champion may cloud judgment about the true value of the project.

Involving customers and suppliers in the development process

Involving customers

The customer is often the one most able to identify the maximum performance capabilities and minimum service requirements of a new product.

- *Beta testing*
- **Lead users** are those who face the same needs of the general marketplace but face them months or years earlier than the bulk of the market, and expect to benefit significantly from a solution to those needs

Involving suppliers

By tapping into the knowledge base of its suppliers, a firm expands its information resources.

Crowdsourcing

Firms can also open up an innovation task to the public through crowdsourcing. **Crowdsourcing** is a distributed problem-solving model whereby a design problem or production task is presented to a group of people who voluntarily contribute their ideas and effort in exchange for compensation.

Tools for improving the new product development process

Some of the most prominent tools used to improve the development process include:

- Stage-gate processes
    - Escalating commitment can lead managers to support projects long after their expected value has turned negative
    - To help avoid this, implement tough **go/skill decision points** in the product development process
        - Gates established in the development process where managers must evaluate whether or not to kill the project or allow it to proceed
    - At each stage, a cross-functional team of people undertakes parallel activities designed to drive down the risk of a development project
        - The team is required to gather viral technical, market, and financial information to use in the decision to move the project forward, abandon the project, hold, or recycle the project
        - Stage 1: the team does a quick investigation and conceptualization of the project
        - Stage 2: the team builds a business case that includes a defined product, its business justification, and a detailed plan of action for the next stages
        - Stage 3: the team begins the actual design and development of the product, including mapping out the manufacturing process, the market launch, and operating plans. The team also defines the test plans utilized in the next stage
        - Stage 4: the team conducts the verification and validation process for the proposed new product

        - Stage 5: the product is ready for launch
        - Preceding each stage is a go/kill gate
        - Each gate has 3 components:
            - *Deliverables*
            - *Criteria*
            - *Outputs*
- Quality function deployment (QFD)
    - QFD was developed in Japan as a comprehensive process for improving the communication and coordination among engineering, marketing, and manufacturing personnel
    - This matrix is completed in a series of steps:
        - The team must first identify customer requirements
        - The team weights the customer requirements in terms of their relative importance from a customer's perspective
        - The team identifies the engineering attributes that drive the performance of the product
        - The team enters the correlations between the different engineering attributes to assess the degree to which one characteristic may positively or negatively affect another
        - The team fills in the bod of the central matrix
        - The team multiplies the customer importance rating of a feature by its relationship to an engineering attribute
        - The team evaluates the competition
        - Using the relative importance ratings established for each engineering attribute and the scores for competing products, the team determines target values for each of the design requirements
        - A product design is then created based on the design targets from step 8. The team then evaluates the new design that was created
    - The great strength of the house of quality is that it provides a common language and framework within which the members of a project team may interact
- Design for manufacturing
    - Another method of facilitating integration between engineering and manufacturing, and of bringing issues of manufacturability in the design process as early as possible, is the use of design for manufacturing methods (DFM)
    - DFM is simply a way of structuring the NPD process
        - Often this involves articulating a series of design rules
    - The purpose of such design rules is typically to reduce costs and boost product quality by ensuring that product designs are easy to manufacture
    - Considering manufacturing at an early stage of the design process can shorten development cycle time
    - By lowering costs and increasing product quality, DFM can increase the product's fit with customer requirements
- Failure models and effects analysis

    - Failure modes and effects analysis (FMEA) is a method by which firms identify potential failures in a system, classify them according to their severity, and put a plan into place to prevent the failures from happening
        - Potential failure modes are identified
        - Potential failure modes are then evaluated on three criteria of the risk they pose:
            - Severity
            - Likelihood of occurrence
            - Inability of controls to detect it
        - Each criterion is given a score and then a composite risk priority number is created for each failure mode by multiplying its score together
- Computer-aided design/computer-aided manufacturing
    - Computer-aided design (CAD) is the use of computers to build and test product designs
    - Construct a 3 dimensional working image of a product or subassembly
    - Computer-aided manufacturing (CAM) is the implementation of machine-controlled processes in manufacturing
    - CAM is fasted and more flexible than traditional manufacturing
    - **Three-dimensional printing**: a method whereby a design developed in a computer aided design program is printed in 3 dimensions by laying down thin strips of material until the model is complete

Tools for measuring new product development performance

In addition to providing feedback about a particular new product, such performance assessments help the company improve its innovation strategy and development processes.

Measures of the success of the NPD process can help management to:

- Identify which projects met their goals and why
- Benchmark the organization's performance compared to that of competitors or to the organization's own prior performance
- Improve resource allocation and employee compensation
- Refine future innovation strategies

Multiple measures are important because any measure used singly may not give a fair representation of the effectiveness of the firm's development process or its overall innovation performance. The firm's development strategy, industry, and other environmental circumstances must be considered when formulating measures and interpreting results.

To use such methods, it's important to first define a finite period in which the measure is to be applied.

Chapter Twelve

Constructing NPD teams

Team size

By combining the efforts and expertise of multiple individuals, groups can often outperform individuals on many problem-solving tasks, implying that the size of the development team might be related to its potential for success.

- Large teams can create more administrative costs and communication problem.
- The larger the team, the harder it can be to foster a shared sense of identity among team members
- **Social loafing**: when an individual in a team doesn't exert the expected amount of effort and relies instead on the work of other team members
- Social loafing occurs when, as the size of the team increases, individuals perceive that they will not receive full credit for their contribution to the group effort and so their effort and commitment decrease

Team composition

- A lack of communication among the marketing, R&D, and manufacturing functions of a company can be extremely detrimental to NPD.
- A lack of cross-functional communication between functions can lead to longer cycle times as a product iterates back and forth between different stages in the process
- **Cross-functional teams** include members drawn from more than one functional area, such as engineering, manufacturing, or marketing
- A greater variety of specialists provides a broader knowledge base and increases the cross-fertilization of ideas
- Individuals who enter the organization at different times are likely to have different contacts outside of the team, enabling the team to draw from a wider mix of resources
- **Homophily**: the tendency for individuals to like other people whom they perceive as being similar to themselves
- Heterogeneous teams should possess more information than homogeneous groups
- The personality characteristics that enhanced the success of a NPD team where high extroversion, high agreeableness, and low neuroticism

The structure of NPD teams

Functional teams

- Members remain in their functional departments and report to their regular functional manager
- They may meet periodically to discuss the project
- Usually temporary, individuals may spend less than 10% of their time working on team-related activities

- Don’t have a project manager or dedicated liaison personnel
- This structure provides little opportunity for cross-functional coordination
- Team members have little commitment to the development project
- Appropriate for derivative projects that primarily affect only a single function of the firm

Lightweight teams

- Members still reside in their functional departments, and functional supervisors retain authority over evaluation and rewards
- Typically temporary, members spend the majority of their time on their normal functional responsibilities
- Lightweight teams have a project manager and dedicated liaison personnel who facilitate communication
- Managers of lightweight teams are normally junior or middle management employees
- Not able to exert significant influence
- Small improvement in team coordination and likelihood of success over functional teams
- Appropriate for derivate projects where high levels of coordination and communication aren’t required

Heavyweight teams

- Members are removed from their functional departments so that they may be *collocated* with the project manager
- Project managers of heavyweight teams are typically senior managers who outrank functional managers and have significant authority to command resources and evaluate and reward team members
- Dedicated full-time to the project
- Strong cross-functional coordination and communication
- Team members are significantly committed to the development project
- Still often temporary
- Offers a significant improvement in communication and coordination over functional teams, and it’s typically considered appropriate for platform projects

Autonomous teams

- Members are removed from their functional departments and dedicated full-time (often permanently) to the development team
- Collocated with the project manager, who is a very senior person in the org
- The project manager of an autonomous team is given full control over resources contributed from different functional departments, and the project manager has exclusive authority over the evaluation and reward of team members
- Teams don’t conform to the operating procedures of the rest of the organization
- Held fully accountable for the success of the project
- Typically excel at rapid and efficient NPD

- Typically considered to be appropriate for break-through projects and some major platform projects
- Independence of the autonomous teams can cause them to underutilize the resources of the parent org
- Autonomous teams are often hard to fold back into the org if the project is completed or terminated
- Many autonomous teams go on to become separate divisions of the firm, or may even be spun off of the firm as a subsidiary

The management of NPD teams

Team leadership

The team leader is responsible for:

- Directing the team's activities
- Maintaining the team's alignment with project goals
- Serving as a communicator between the team and senior management

In heavyweight and autonomous teams, the team leader may also be the person who is primarily responsible for the evaluation, compensation, and promotion of individual team members

Team administration

- The *project charter* encapsulates the project's mission and articulates exact and measurable goals for the project
- Establishing an explicit set of goals for the project helps ensure that the team members have a common understanding of the project's overall purpose and priorities
- The *contract book* defines in detail the basic plan to achieve the goal laid out in the project charter

Managing virtual teams

Virtual teams are teams in which members may be a great distance from each other, but are still able to collaborate intensively via advanced information technologies.

- Virtual teams pose a distinct set of management challenges
- Must often rely on communication channels that are much less rich than face-to-face contact
- Face significant hurdles in establishing norms and dialects
- It's important to select personnel who are both comfortable with the tech being used and who have strong interpersonal skills
- Team members must be able to work independently and have a strong work ethic
- Virtual teams also face challenged in developing trust, resolving conflict, and exchanging tactic knowledge

Chapter thirteen

Launch timing

Strategic launch timing
Firms try to decrease their development cycles in order to decrease their costs and increase their timing of entry options.

- A firm can strategically use launch timing to take advantage of business cycle or seasonal effects

Optimizing cash flow vs. embracing cannibalization
For firms introducing a next generation tech into a market in which they already compete, entry timing can become a decision about whether and to what degree to embrace cannibalization.

- **Cannibalization**: when a firm's sales of one product diminish its sales of another of its products
- In industries driven by technological innovation, delaying the introduction of a next generation product can enable competitors to achieve a significant technological gap
- If the firm invests in continuous innovation and willingly cannibalizes its existing products with more advanced products, the firm can make it very difficult for other firms to achieve a technological lead large enough to prove persuasive to customers

Licensing and compatibility
If a firm completely open its tech, other producers may drive the price of the tech down to a point at which the firm is unable to recoup its development expense.

- Opening a tech completely may cause its underlying platform to become fragmented as different producers alter it to their needs, resulting in loss of compatibility across producers and the possible erosion of product quality
- If the firm wishes to avoid giving away its own installed base or complementary goods advantages to others, it may protect them by ensuring its products are incompatible with those of future entrants
- **Backward compatible**: when products of a technological generation can work with products of a previous generation
- A firm that both innovates to prevent a competitor from creating a technological gap and utilizes backward compatibility so that its new platform or models are compatible with previous generations of complementary goods can leverage the existing value yielded by a large range of complementary goods to its new platform

Pricing
Price simultaneously influences the product's positioning in the marketplace, its rate of adoption, and the firm's cash flow. Before a firm can determine its pricing strategy, it must determine the objectives it has for its pricing model.

- A *survival* price strategy prices goods to cover variable costs and some fixed costs
    - It's a short-run strategy
- The *maximize current profits*. Under this pricing strategy, the firm first estimates costs and demand and then sets the price to maximize cash flow or rate of return on investment
    - Emphasizes current performance, but may sacrifice long-term performance
- For new technological innovations, a *maximum market skimming* objective or a *maximum market share* objective should be emphasized. To skim the market, firms will initially set prices high on new products
- If costs are expected to decline rapidly with the volume of units produced, a skimming strategy can actually prove less profitable than a pricing strategy that stimulates more rapid customer adoption
- When achieving high volume is important, firms will often emphasize a maximum market share objective
- To maximize market share, firm often use **penetration pricing**
    - **Penetration pricing**: when the price of a good is set very low to maximize the good's market share
    - The firm will set the lowest price possible hoping to rapidly attract customers, driving volume up and production costs down
    - Short run, the firm may bear significant risk from this capital investment, and it may lose money
    - It can have a low-cost position that enables it to earn profits despite a low price, and it can have a substantial share of the market
    - Sometimes firms price below cost because the losses are expected to be recouped through profits on complementary goods or services
- Firms can also influence cash flow and the customers' perception of costs through manipulating the timing of when the price of a good is paid
- **Freemium**: a pricing model where a base product or service is offered for free, but a premium is charged for additional features or service
- When it's unclear how customers will respond to a particular price point, firms often use introductory pricing that indicates the pricing is for a stipulated time

Distribution

Firms can sell their products directly to users through their direct sales force or an online ordering system or mail-order catalog.

- Firms can use intermediaries such as **manufacturer's representatives, wholesales**, and **retailers**
    - **Manufacturer's representatives**: independent agents that promote and sell the product lines of one or a few manufacturers. Often used when direct selling is appropriate but the manufacturer doesn't have a sufficiently large direct sales force to reach all appropriate market segments
    - **Wholesalers**: companies that buy manufacturer's products in bulk, and then resell them to other supply channel members such as retailers
    - **Retailers**: companies that sell goods to the public

- Selling direct gives the firm more control over the selling process, pricing, and service
    - It also enables the firm to capture more information about customers and can facilitate the customization of products for customers
- Selling direct can be impractical or overly expensive
- Intermediaries provide a number of important services that can make distribution more efficient
    - Wholesalers and retailers *break bulk*
    - Intermediaries also provide a number of other services such as transporting goods, carrying inventory, providing selling services, and handling transactions with customers
- **OEM**s provide an even more crucial role in the distribution process
    - An OEM buys products from other manufacturers and assembles them into a product that is customized to meet user needs
    - The OEM then sells this customized product under its own name and often provides marketing and service support for the product
- **Disintermediation**: when the number of intermediaries in a supply channel is reduced

To determine whether to use intermediaries and what type of intermediaries would be appropriate, the firm should answer the following questions:

- Whether the firm already has an existing sales channel that would suit the product will be a primary consideration in how the product should be distributed
- If customers are dispersed but require little product education or service, mail order, or online ordering may suffice
- The firm must consider how competing or substitute products are sold, because this both determines the nature of the existing distribution channel options and shapes customer expectations about how products will be purchased
    - Market research can assess how the sales channel influences the customer's perception of the product

Strategies for accelerating distribution

When the industry is likely to select a single tech as the dominant design, it can be very important to deploy the tech rapidly.

- Rapid deployment enables the tech to build a large installed base and encourages the developers of complementary goods to support the tech platform
- The firm can use a variety of strategies to accelerate distribution:
    - **Alliances with distributors**
    - **Bundling relationships**
    - **Contracts and sponsorship**
    - **Guarantees and consignment**

Marketing

The marketing strategy for tech innovation must consider both the nature of the target market and the nature of the innovation

Major marketing methods

The 3 most commonly used marketing methods include:

- **Advertising**
- **Promotions**
- **Publicity/PR**
    - **Viral marketing**: sending information directly to targeted individuals in effort to stimulate word-of-mouth advertising. Individuals are typically chosen on the basis of their position or role in particular social networks

Tailoring the marketing plan to intended adopters

- Innovators and early adopters are typically looking for very advanced technologies to offer a significant advantage over previous generations
    - Marketing channels that enable high content and selective reach are appropriate for this market
- To market to the early majority requires that the company communicate:
    - The product's completeness
    - It's easy of use
    - Its consistency with the customer's way of life
    - Legitimacy
    - Detailed technical information isn't as important as using market channels with high reach and high credibility
- To target the late majority and laggards, firms will often use similar channels as those used to target the early majority, although emphasizing reducing cost per exposure. The marketing message at this stage must stress:
    - Reliability
    - Simplicity
    - Cost-effectiveness

A firm that aggressively promotes its products can increase both its actual installed base and its perceived installed base.

When a firm is poised to introduce a new tech innovation, its reputation for both technological and commercial competence will critically influence the market's expectation about its likelihood of success.

A firm can also signal its commitment to an industry by making substantial investments that would be difficult to reverse.