Chapter 3: Types and Patterns of Innovation

Overview

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

- most often used to represent the technology's rate of performance improvement or its rate of adoption in the marketplace
- show some patterns

Types of Innovation

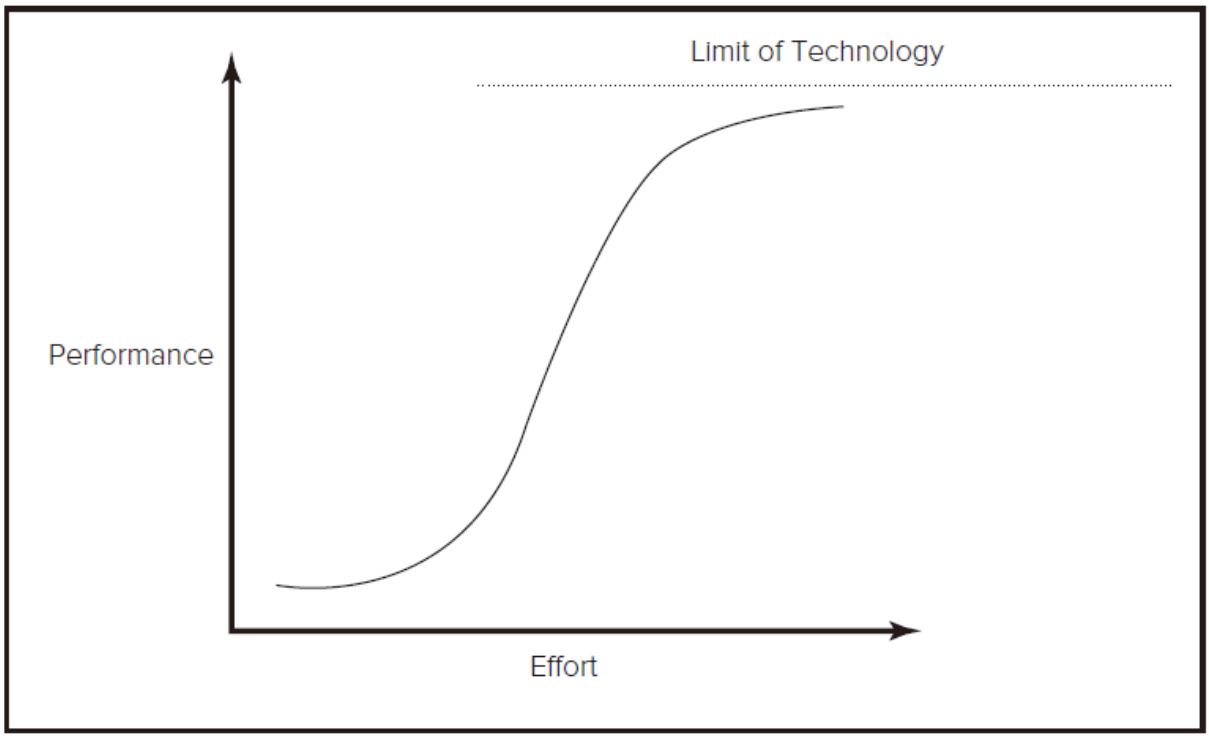
- product versus process
    - Product innovation: embodied in the outputs of an organization—its goods or services.
    - Process innovation: oriented toward improving effectiveness or efficiency of product
    - in tandom:
        - new processes may enable the production of new products
        - new products may enable the development of new processes
        - a product innovation for one firm may simultaneously be a process innovation for another
- radical versus incremental
    - hinge on the degree to which an innovation represents a departure from existing practices
    - Radical innovation: new and different innovation from prior ones e.g. wireless telecommunication
        - radicalness = the combination of newness and the degree of differentness
        - radicalness brings some risk: customer response vary in their judgment of its usefulness or reliability
        - the radicalness of an innovation is relative, and change over time or with respect to different observers
    - Incremental innovation: might not be particularly new or exceptional; it might have been previously known to the firm or industry, and involve only a minor change from (or adjustment to) existing practices.
        - e.g. change cell phone configuration from exposing keyboard to a flip cover
- competence enhancing versus competence destroying
    - Competence-enhancing innovation: innovation builds on the firm's existing knowledge base
        - e.g. each generation of Intel's microprocessors (e.g., 286, 386, 486, Pentium, Pentium II, Pentium III, Pentium 4)

    - Competence-destroying innovation: innovation that does not build on firm's existing competencies or render them obsolete
- architectural versus component
    - component/modular innovation: entails changes to one more components but does not significantly affect the overall configuration
        - e.g. bicycle seat
    - architectural innovation: changing the overall design of the system or the way components interact with each other
        - have far-reaching and complex influences on industry competitors and technology users

Technology S-curve

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.

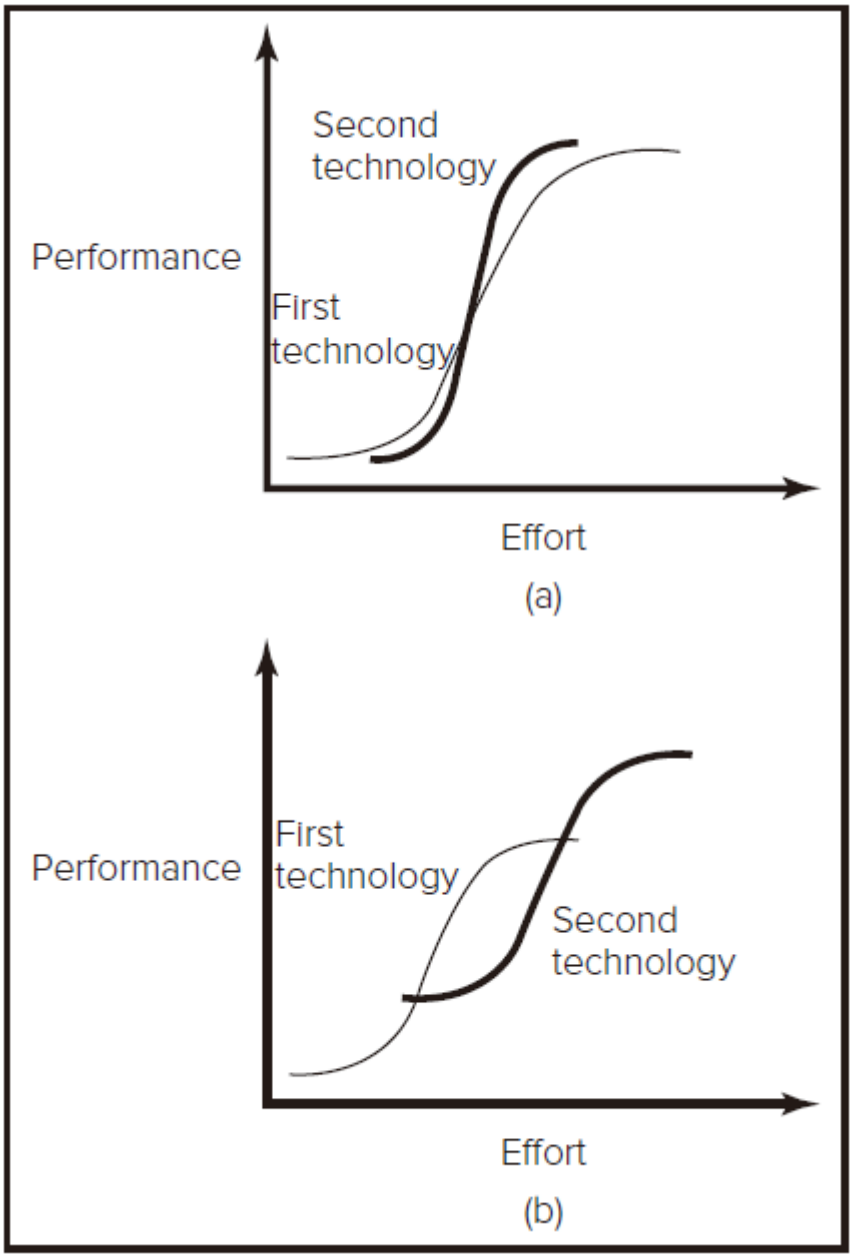
S-curve in Technological Improvement



- Performance on y-axis(speed, capacity, power etc) and Effort on x-axis(amount of effort and money invested in the technology)
- slow initial improvement -> accelerated improvement -> diminishing improvement
- reason:
    - initial performance is slow because the fundamentals of the technology are poorly understood
    - as scientists or firms gain a deeper understanding of the technology, improvement begins to accelerate. The technology begins to gain legitimacy as a

worthwhile endeavor, attracting other developers
    - As the technology begins to reach its inherent limits, the cost of each marginal improvement increases, and the s-curve flattens
- Discontinuous technology: a new innovation fulfils a similar market need but bases on entire new knowledge base
    - technologies do not always get opportunity to reach their limit, might be rendered obsolete by discontinuous technology

S-curve in Technology Diffuse

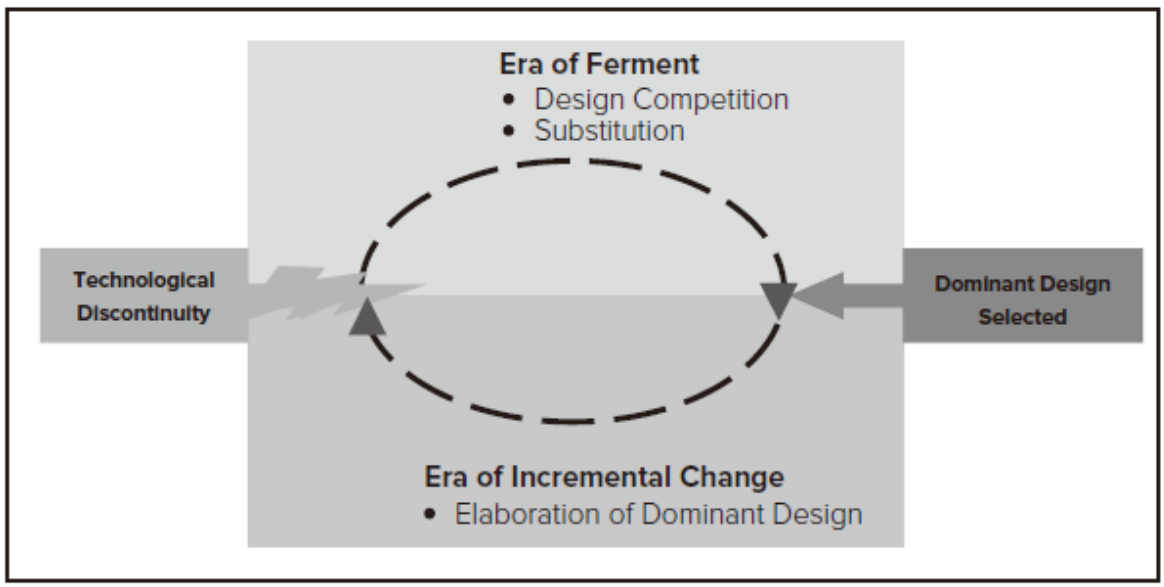


- Performance on y-axis(cumulative adopters of the technology against time) and Effort on x-axis
- reason for S-shape: adoption is initially slow when an unfamiliar technology is introduced to the market; it accelerates as the technology becomes better understood and utilized by the mass market, and eventually the market is saturated so the rate of new adoptions declines

S-Curve as a prescriptive tool

- Goal: use the s-curve model as a tool for predicting when a technology will reach its limits and as a prescriptive guide for whether and when the firm should move to a new, more radical technology
- limitation as a prescriptive tool
    - it is rare that the true limits of a technology are known in advance, and there is often considerable disagreement among firms about what a technology's limits will be
    - the shape of a technology's s-curve is not set in stone. Unexpected changes in the market, component technologies, or complementary technologies can shorten or extend the life cycle of a technology.
    - firms can influence the shape of the s-curve through their development activities e.g. stretch the s-curve through implementing new development approaches or revamping the architecture design of the technology

Technology cycles



A technological discontinuity causes a period of turbulence and uncertainty, and producers and consumers explore the different possibilities enabled by the new technology. As producers and customers begin to converge on a consensus of the desired technological configuration, a dominant design emerges. The dominant design provides a stable benchmark for the industry, enabling producers to turn their attention to increasing production efficiency and incremental product improvements. This cycle begins again with the next technological discontinuity.

Chapter 4: Standards Battles and Design Dominance

Overview

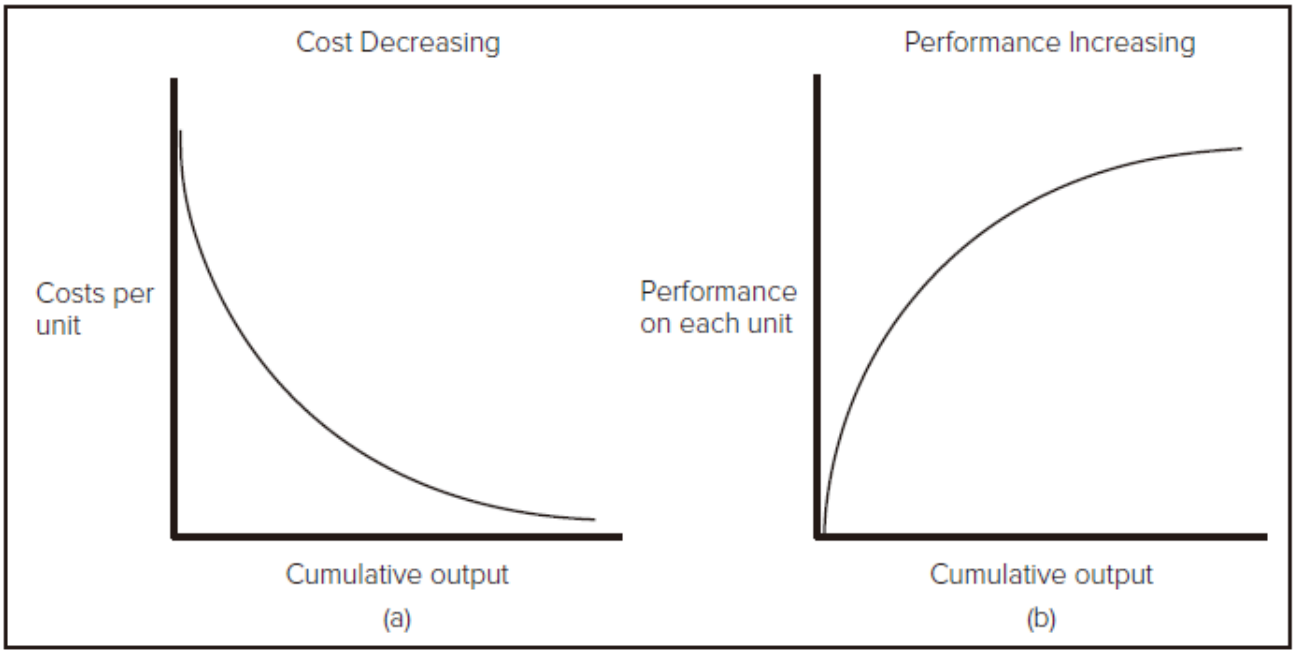
Dominant design: a single product or process architecture that dominates a product category

WHY DOMINANT DESIGNS ARE SELECTED

- More a technology is adopted, the more valuable it becomes.
- A technology that is adopted usually generates revenue that can be used to further develop and refine the technology.
- as a technology becomes more widely adopted, complementary assets are often developed that are specialized to operate with the technology

Two of the primary sources of increasing returns are (1) learning effects and (2) network externalities.

Learning Effects



- learning curve is modelled as a function of cumulative output: Performance increases, or cost decreases, with the number of units of production, usually at a decreasing rate
- be formylated as formulated as $y = ax^{-b}$, where y is the number of direct labor hours required to produce the xth unit, a is the number of direct labor hours required to produce the first unit, x is the cumulative number of units produced, and b is the learning rate.
- can be influenced by factors such as the nature of the task, firm strategy, and the firm's prior experience

Prior Learning and Absorptive Capacity

- A firm's investment in prior learning can accelerate its rate of future learning by building the firm's absorptive capacity.
- **Absorptive capacity**: The ability of an organization to recognize, assimilate, and utilize new knowledge.
- reason: in developing a new technology, a firm will often try a number of unsuccessful configurations or techniques before finding a solution that works well. This experimentation builds a base of knowledge in the firm about how key components behave, what alternatives are more likely to be successful than others, what types of

projects the firm is most successful at, and so on. This knowledge base enables the firm to more rapidly assess the value of related new materials, technologies, and methods.
- learning effects suggest that early technology offerings often have an advantage because they have more time to develop and become enhanced than subsequent offerings.

Network Externalities

- **network externalities / positive consumption externalities**: when the value of a good to a user increases with the number of other users of the same or similar good.
    - physical networks: railroad, telecommunications
    - markets: Windows has largest installed base
- **installed base**: The number of users of a particular technology

Network externalities also arise when complementary goods are important.

- complementary goods: Additional goods and services that enable or enhance the value of another good.

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.

The Result: Winner-Take-All Markets

- While some alternative platforms may survive by focusing on niche markets, the majority of the market may be dominated by a single (or few) design(s).
- standards battles are high-stakes games—resulting in big winners and big losers.
- **path dependency**: When end results depend greatly on the events that took place leading up to the outcome. It is often impossible to reproduce the results that occur in such a situation.
- Dominant design influences the knowledge that is accumulated by producers and customers, and it shapes the problem-solving techniques used in the industry.

MULTIPLE DIMENSIONS OF VALUE

The value a new technology offers a customer is a composite of many different things.

increasing returns: When the rate of return (not just gross returns) from a product or process increases with the size of its installed base.

A Technology's Stand-Alone Value

- Kim and Mauborgne developed a "Buyer Utility Map":it is important to consider six different utility levers, as well as six stages of the buyer experience cycle, to understand a new technology's utility to a buyer.
- The six stages are purchase, delivery, use, supplements, maintenance, and disposal.
- The six utility levers they consider are customer productivity, simplicity, convenience, risk, fun and image, and environmental friendliness.

- Creating a grid with stages and levers yields a 36-cell utility map. Each cell provides an opportunity to offer a new value proposition to a customer.
- A new technology might offer a change in value in a single cell or in a combination of cells.

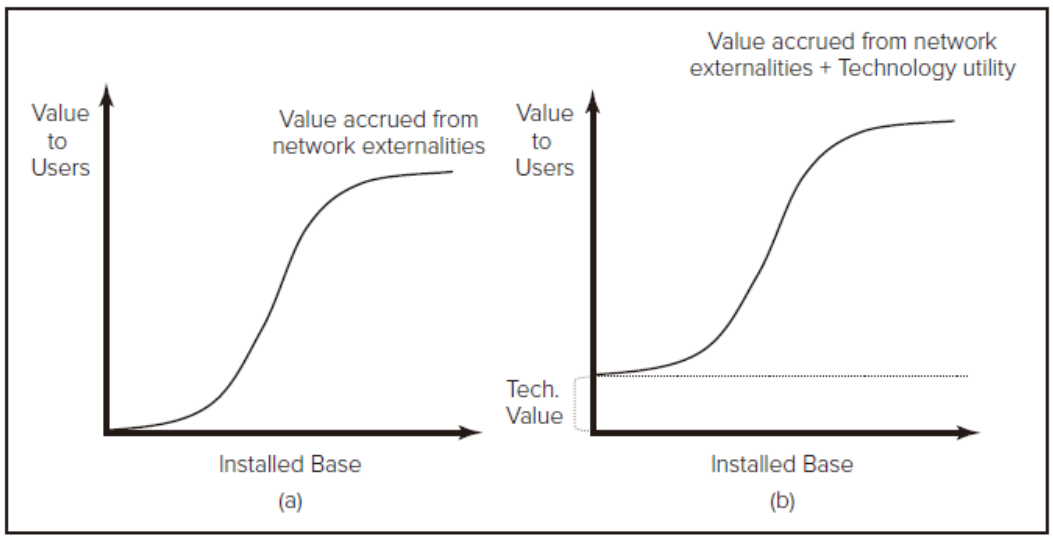
Network Externality Value

- The value of a technological innovation includes value created by the size of its installed base and the availability of complementary goods.
- Firms can take advantage of the fact that users rely on both objective and subjective information in assessing the combined value offered by a new technology. For example, even a technology with a small installed base can achieve a relatively large mind share through heavy advertising by its backers.
- vaporware: products that are not actually on the market and may not even exist but are advertised—by many software vendors

Competing for Design Dominance in Markets with Network Externalities

- when an industry has network externalities, the value of a good to a user increases with the number of other users of the same or similar good. The value of a good is likely to increase in an s-shape
- reason: 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.

FIGURE 4.8
Network Externality Returns to Market Share



- a base level of technological utility has been added to the graph, which shifts the entire graph up.
- When two technologies compete for dominance, customers will compare the overall value yielded (or expected) from each technology,

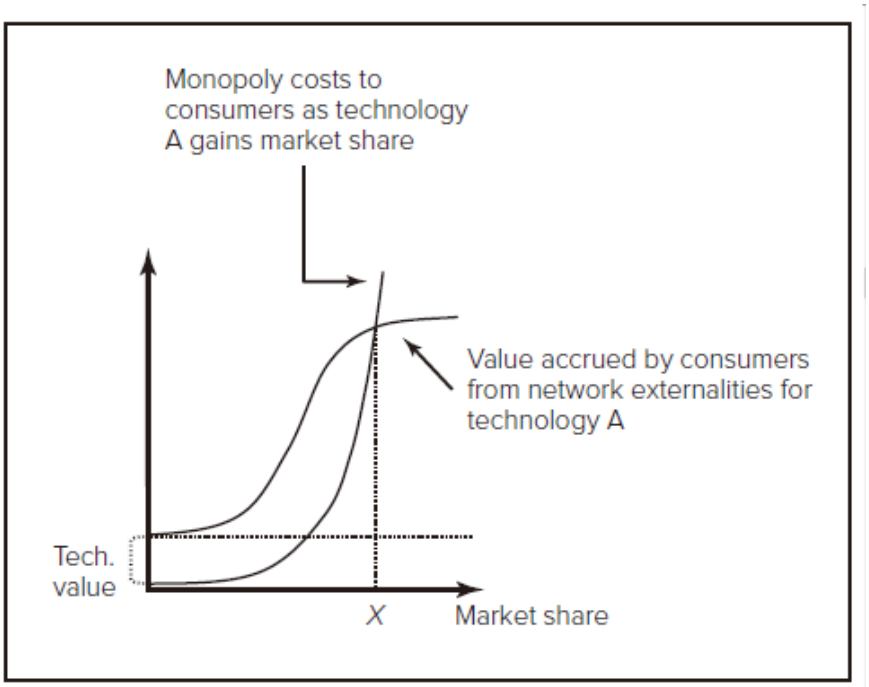
Are Winner-Take-All Markets Good for Consumers?

How to decide when a firm has become too dominant?

- compare the value customers reap from network externalities at different levels of market share with the corresponding monopoly costs.

- Network externality returns refers to the value customers reap as a larger portion of the market adopts the same good (e.g., there is likely to be greater availability of complementary goods, more compatibility among users, and more revenues can be channeled into further developing the technology).
- Monopoly costs refer to the costs users bear as a larger portion of the market adopts the same good (e.g., a monopolist may charge higher prices, there may be less product variety, and innovation in alternative technologies may be stifled).

FIGURE 4.11
Network Externality Benefits and Monopoly Costs



Chapter 5: Time to Entry

overview

- timing can be crucial—a technology that is adopted earlier than others may reap self-reinforcing advantages such as greater funds to invest in improving the technology, greater availability of complementary goods, and less customer uncertainty.
- Entrants are divided into three categories:
    - **First movers**(or pioneers): are the first to sell in a new product or service category;
    - **Early followers** (also called early leaders): are early to the market first;
    - **Late entrants**: but not enter the market when or after the product begins to penetrate the mass market.
- whether it is better to be a first mover, early follower, or late entrant yields conflicting conclusions

FIRST-MOVER ADVANTAGES

- brand loyalty and technological leadership
- preemption of scarce assets
- exploitation of buyer switching costs

Brand Loyalty and Technological Leadership

- The company that introduces a new technology may earn a long-lasting reputation as a leader in that technology domain
- The organization's position as technology leader also enables it to shape customer expectations about the technology's form, features, pricing, and other characteristics.
- yield sustained monopoly rents
- **monopoly rents**: The additional returns (either higher revenues or lower costs) a firm can make from being a monopolist, such as the ability to set high prices, or the ability to lower costs through greater bargaining power over suppliers.

Preemption of Scarce Assets

- Firms that enter the market early can preemptively capture scarce resources such as key locations, government permits, patents, access to distribution channels, and relationships with suppliers.
- e.g. for wireless communication service provider must get the rights to broadcast over particular radio frequencies. The spectrum was auctioned by a Commission.

Exploiting Buyer Switching Costs

- If buyers face switching costs, the firm that captures customers early may be able to keep those customers even if technologies with a superior value proposition are introduced later.

- e.g. QWERTY typewriter keyboard

Reaping Increasing Returns Advantages

- In an industry with pressures encouraging adoption of a dominant design, the timing of a firm's investment in new technology development may be particularly critical to its likelihood of success

FIRST-MOVER DISADVANTAGES

- Market pioneers have a high failure rate
- first movers earn greater revenues than other entrants, but also face higher costs
- A later entrant often can capitalize on the research and development investment of the first mover, fine-tune the product to customer needs as the market becomes more certain, avoid any mistakes made by the earlier entrant, and exploit incumbent inertia
- **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

- Developing a new technology often entails significant research and development expenses, and the first to develop and introduce a technology typically bears the brunt

of this expense.
- By the time a firm has successfully developed a new technology, it may have borne not only the expense of that technology but also the expense of exploring technological paths that did not yield a commercially viable product.
- This firm also typically bears the cost of developing necessary production processes and complementary goods that are not available on the market.

Undeveloped Supply and Distribution Channels

- When a firm introduces a new-to-the-world technology, often no appropriate suppliers or distributors exist.
- The firm may face the daunting task of developing and producing its own supplies and distribution service, or assisting in the development of supplier and developer markets.

Immature Enabling Technologies and Complements

- **enabling technologies**: Component technologies that are necessary for the performance or desirability of a given innovation.
- When firms develop technologies, they often rely on other producers of enabling technologies.
- When new technologies are introduced to a market, important complements may not yet be fully developed, thus hindering adoption of the innovation.

Uncertainty of Customer Requirements

- A first mover to the market may face considerable uncertainty about what product features customers will ultimately desire and how much they will be willing to pay for them.
- first movers may find that their early product offerings must be revised as the market begins to reveal customer preferences.
- First movers have an opportunity to shape customer preferences by establishing the precedent for product design in the newly emerging market and by investing in customer education. Customer education efforts are expensive, however. If the product is slow to begin to reap revenues for the sponsoring firm, it may collapse under the weight of its R&D and marketing expenses.

FACTORS INFLUENCING OPTIMAL TIMING OF ENTRY

In very early market stages, a technology may be underdeveloped and its fit with customer needs unknown.

In late market stages, a technology may be well understood, but competitors may have already captured controlling shares of the market.

Factors on whether to attempt to pioneer a technology category or to wait for others:

- certainty of customer preferences
    - Both producers and customers may face considerable ambiguity about the importance of various features of the technology.
    - As producers and customers gain experience with the technology, features that initially seemed compelling may turn out to be unnecessary, and features that had

seemed unimportant may turn out to be crucial.

- improvement the innovation provide over previous solutions
    - when a technology makes a dramatic improvement over previous generations or different technologies that serve similar functions, it will more rapidly gain customer acceptance.
- require enabling technologies, and are these technologies sufficiently mature
    - More mature enabling technologies allow earlier entry; less mature enabling technologies may favor waiting for enabling technologies to be further developed.
- Do complementary goods influence the value of the innovation, and are they sufficiently available?
    - If the value of an innovation hinges critically on the availability and quality of complementary goods, then the state of complementary goods determines the likelihood of successful entry.
- How high is the threat of competitive entry?
    - If there are significant entry barriers or few potential competitors with the resources and capabilities to enter the market, the firm may be able to wait while customer requirements and the technology evolve.
    - if entry barriers are low, the market could quickly become quite competitive, and entering a market that has already become highly competitive can be much more challenging than entering an emerging market
- Is the industry likely to experience increasing returns to adoption?
    - If a competitor's offering builds a significant installed base, the cycle of self-reinforcing advantages could make it difficult for the firm to ever catch up.
- Can the firm withstand early losses?
    - The first mover must be able to withstand a significant period with little sales revenue from the product.
    - Firms with significant resources also may be able to more easily catch up to earlier entrants
- Does the firm have resources to accelerate market acceptance?
    - A firm with significant capital resources not only has the capability to withstand a slow market takeoff, but also can invest such resources in accelerating market take off.
    - The firm can invest aggressively in market education, supplier and distributor development, and development of complementary goods and services.
- Is the firm's reputation likely to reduce the uncertainty of customers, suppliers, and distributors?
    - A firm's reputation can send a strong signal about its likelihood of success with a new technology.

Chapter 8: Collaboration Strategies

Overview

REASONS FOR GOING SOLO

ADVANTAGES OF COLLABORATING

TYPES OF COLLABORATIVE ARRANGEMENTS

CHOOSING A MODE OF COLLABORATION

Chapter 13: Crafting a Deployment Strategy

Chapter 2: Sources of Innovation

technology cluster

INNOVATION IN COLLABORATIVE NETWORKS

Collaborative research is especially important in high-technology sectors, where it is unlikely that a single individual or organization will possess all of the resources and capabilities necessary to develop and implement a significant innovation

Technology Clusters

Sometimes geographical proximity appears to play a role in the formation and innovative activity of collaborative networks.

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.

- One primary reason for the emergence of regional clusters is the benefit of proximity in knowledge exchange.
- knowledge that is complex or tacit may require frequent and close interaction to be meaningfully exchanged
    - **complex knowledge**: Knowledge that has many underlying components, or many interdependencies between those components, or both.
    - **tacit knowledge**: Knowledge that cannot be readily codified (documented in written form).
- closeness and frequency of interaction can influence a firm' to exchange knowledge willingness

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

downside:

- the proximity of many competitors serving a local market can lead to competition that reduces their pricing power in their relationships with both buyers and suppliers
- close proximity of firms may increase the likelihood of a firm's competitors gaining access to the firm's proprietary knowledge
- clustering can potentially lead to traffic congestion, inordinately high housing costs, and higher concentrations of pollution.

Technological Spillovers

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

Chapter 6: Defining the Organization's Strategic Direction

Porter's five forces

overview

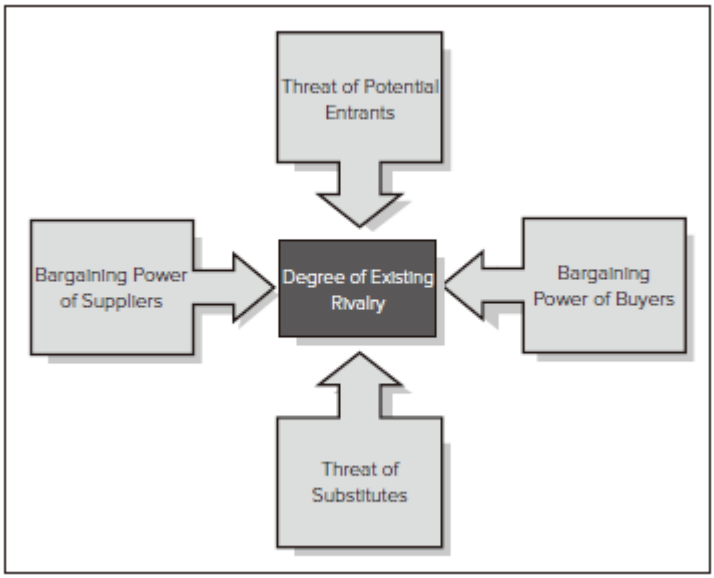
The first step in formulating a company's technological innovation strategy is to assess its current position and define its strategic direction for the future.

ASSESSING THE FIRM'S CURRENT POSITION

External Analysis

Porter's Five-Force Model

This model originally developed to assess industry attractiveness (i.e., "Is this a desirable industry in which to compete?"), in practice the model is often used to assess a specific firm's external environment (i.e., "What factors in the firm's external environment create threats and opportunities for the firm?").



The five forces are:

- The degree of existing rivalry
    - the number and relative size of competitors will shape the nature of rivalry
        - Generally the more firms competing that are of comparable size, the more competitive the industry will be.
        - But oligopolistic industries (those that have a few large competitors) can be fiercely competitive if firms choose to engage in price wars
        - **oligopolistic industries**: Highly consolidated industries with a few large competitors.
    - the degree to which competitors are differentiated from each other
        - if competitors are highly differentiated, they will experience less direct rivalry because their products are likely to appeal to different market segments
    - demand conditions
        - When demand is increasing, there are more revenues to go around and firms will experience less competitive pressure.
        - when demand is declining, firms have to compete for a shrinking pool of revenues, and competition can become very aggressive.
        - **exit barriers**: Costs or other commitments that make it difficult for firms to abandon an industry (large fixed-asset investments, emotional commitment to the industry, etc.).
- Threat of potential entrants
    - The threat of potential entrants is influenced by both the degree to which the industry is likely to attract new entrants (i.e., is it profitable, growing, or otherwise alluring?) and the height of entry barriers.
    - **entry barriers**: Conditions that make it difficult or expensive for new firms to enter an industry (government regulation, large start-up costs, etc.).
- 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.
        - If there are few suppliers or suppliers are highly differentiated, the firm may have little choice in its buying decision, and thus have little leverage over the supplier to negotiate prices, delivery schedules, or other terms.
        - If the firm's purchases constitute the bulk of a supplier's sales, the supplier will be heavily reliant upon the firm and the supplier will have little bargaining power.
        - If the firm faces switching costs that make it difficult or expensive to change suppliers, this will also increase the supplier's bargaining power.
        - If the firm can backward vertically integrate (i.e., produce its own supplies), this will lessen supplier bargaining power, and if the supplier can threaten to forward vertically integrate into the firm's business, this will increase the supplier's bargaining power.
    - **switching costs**: Factors that make it difficult or expensive to change suppliers or buyers, such as investments in specialized assets to work with a particular supplier or buyer.

    - **vertical integration**: Getting into the business of one's suppliers (backward vertical integration) or one's buyers (forward vertical integration).
- 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.
        - If the firm's product is highly differentiated, buyers will typically experience less bargaining power, and if the firm's product is undifferentiated, buyers will typically experience greater bargaining power.
        - If buyers face switching costs, this is likely to lower their bargaining power, and if the firm faces switching costs to work with other buyers, this will increase the buyer's bargaining power.
        - if the buyers can threaten to backward vertically integrate, this will increase their bargaining power, and if the firm can threaten to forward vertically integrate, it will lower customer bargaining power.
- Threat of substitutes
    - **Substitutes** are products or services that are not considered competitors, but fulfill a strategically equivalent role for the customer.
    - The more potential substitutes there are, and the closer they are in function to the firm's product or service, the greater the threat of substitution.
    - The threat of substitutes will also be shaped by the relative price.

Complements: Products or services that enhance the usefulness or desirability of another product.

Chapter 9: Protecting Innovation

Chapter 7: Choosing Innovation Projects

patent trademark

Chapter 10: Organizing for Innovation

Chapter 11: Managing the New Product Development Process

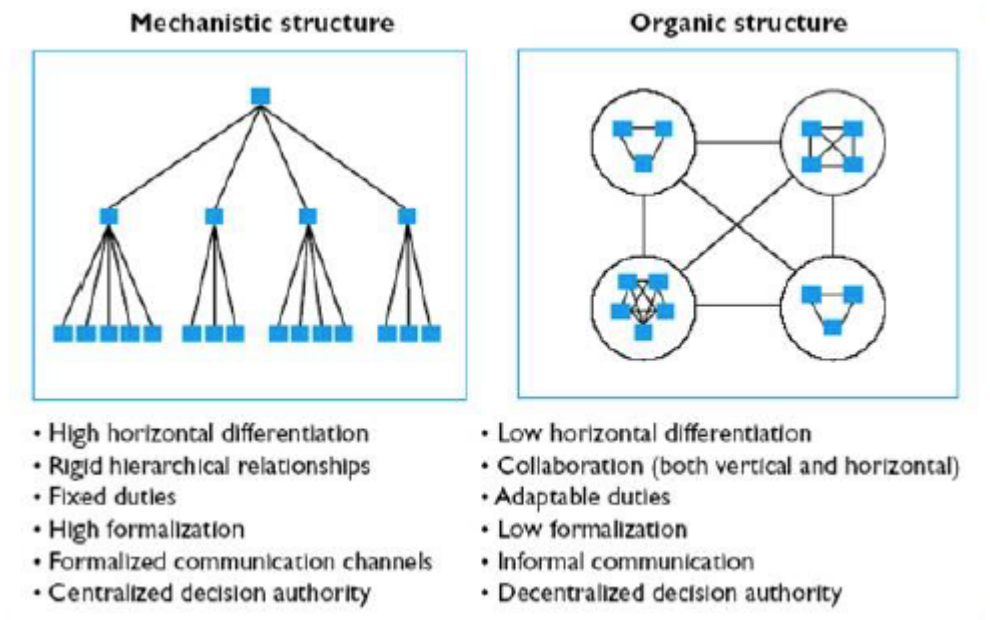
Mechanistic versus Organic Structures

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

- Mechanistic structures are often associated with greater operational efficiency, particularly in large-volume production settings.

- Mechanistic structures achieve efficiency by ensuring rigid adherence to standards and minimizing variation, potentially stifling creativity within the firm.

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.



Chapter 12: Managing New Product Development Teams