ITM515 STRATEGIC TECHNOLOGY MANAGEMENT

Chapter 3

Types and Patterns of Innovation

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- Types of Innovation
- Technology S-curves
- Technology Cycles

Overview

➢ Types of innovation

- Several dimensions are used to categorize innovations
- These dimensions help clarify how different innovations offer different opportunities (and pose different demands) on producers, users, and regulators

➢ Patterns of innovation

- Technology trajectory refers to the path a technology follows through time
- Many consistent patterns have been observed in technology trajectories, helping us understand how technologies improve and are diffused
  - ✓ Technology S-curve: the rate of technology improvement and technology diffusion
  - ✓ Technology cycle: several stages a technology pass through

Types of Innovation

➢ Product Vs. Process Innovation

- Criteria: object of an innovation
- Product innovation: innovation that is embodied in the outputs of an organization - goods or services
- Process innovation: innovation in the way an organization conducts its business
  - ✓ Techniques of producing or marketing goods or services
  - ✓ Improving the effectiveness or efficiency of production
- Features
  - ✓ Product and process innovation occur in tandem
    - New process may enable the production of new products
    - Product innovations can enable process innovations (e.g. Advanced workstations → Computer-aided manufacturing process)
  - ✓ A product innovation for one organization might be a process innovation for another
    - e.g. UPS creates a new distribution service (*product innovation*) that enables its customers to distribute their goods more widely or more easily (*process innovation*)

Types of Innovation

➢ Radical Vs. Incremental Innovation

- Criteria: radicalness of an innovation
  - ✓ The degree to which it is *new* and *different* from previously existing products and processes
  - ✓ The degree of risk or uncertainty
- Incremental innovation: only a minor change from (or adjustment to) existing practices
- Radical innovation: major change from existing practices
- Feature
  - ✓ The radicalness of an innovation is relative; it may change over time or with respect to different observers
    - e.g., digital photography for Kodak and Sony

Types of Innovation

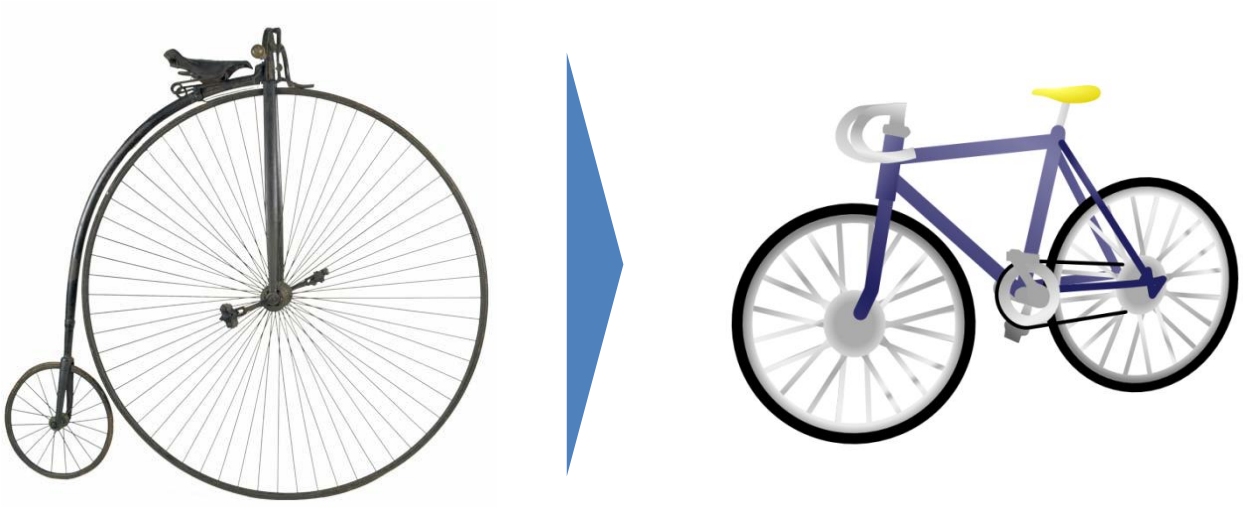
➢ Competence-Enhancing Vs. Competence-Destroying Innovation

- Criteria: effects on an existing knowledge base of a firm
- Competence-enhancing innovation: innovation that builds on the firm's existing knowledge base
  - ✓ e.g. iPhone 6 is built on iPhone 5
- Competence-destroying innovation: innovation that renders the firm's existing competencies obsolete
  - ✓ e.g. The smartphone innovation led the fall of Nokia
- Feature
  - ✓ Whether an innovation is competence enhancing or competence destroying depends on the perspective of a particular firm.

Types of Innovation

➢ Architectural Vs. Component Innovation

- Component innovation (or modular innovation): changes to one or more components of a product system without significantly affecting the overall design
  - ✓ e.g. developments of mountain bike
- Architectural innovation: changes in the overall design of the system or the way components interact
  - ✓ e.g. transition from high-wheel bicycle to safety bicycle



Types of Innovation

Summary

- Dimensions are not independent; nor do they offer a straightforward system for categorizing innovations in a precise and consistent manner

Radical	Incremental
Competence-destroying	Competence-enhancing
Architectural	Component

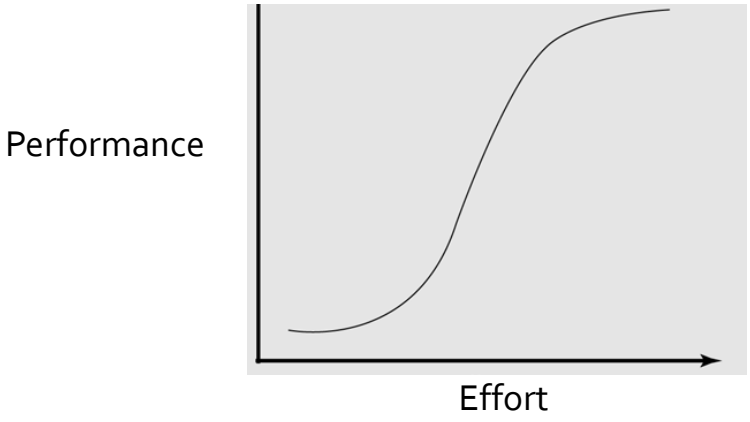
- The distinctions depend on the time frame and industry context

Technology S-curves

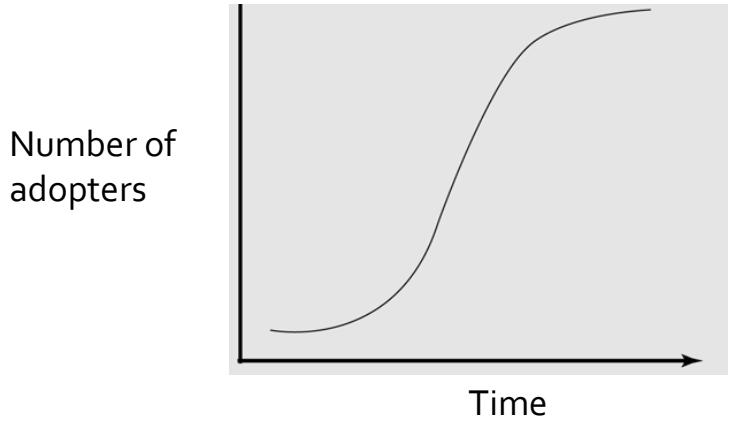
➢ Two S-curves

- S-curves for technology's performance improvement
- S-curves for technology diffusion

→ They are related, but fundamentally different processes



S-curve of technology improvement

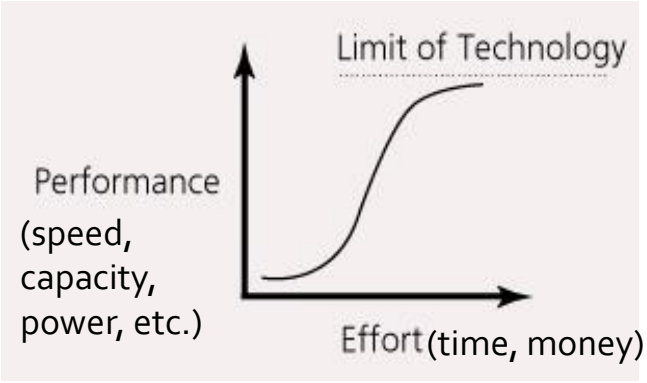


S-curve of technology diffusion

Technology S-curves

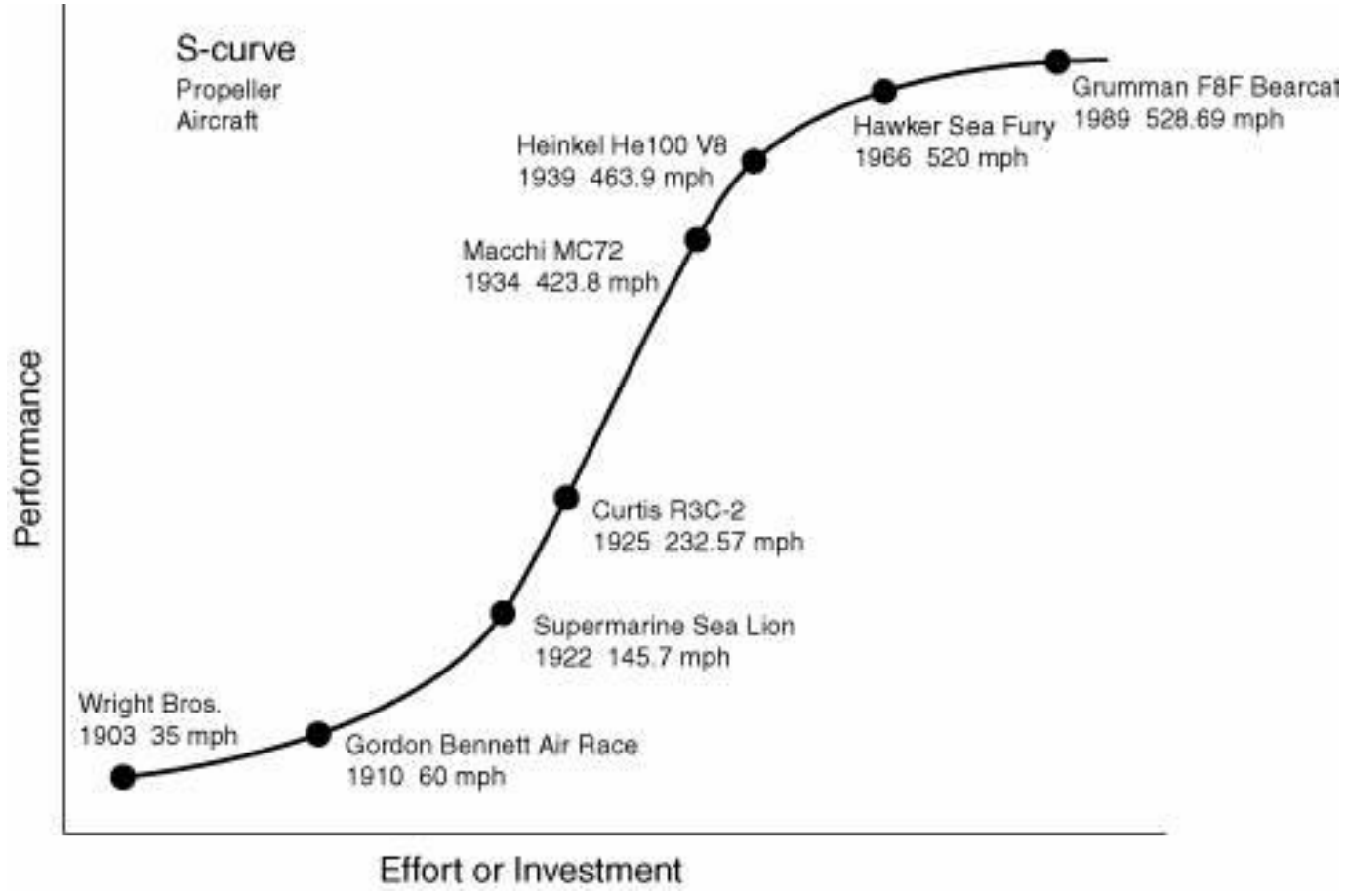
➢ S-curves in technological improvement

- Patterns of improvement – the reason for the S-shape
  - ✓ Slow initial improvement
    - The fundamentals are poorly understood
    - It may be difficult to attract researchers to participate in its development
  - ✓ Accelerated improvement
    - Technology starts to gain a deeper understanding and legitimacy as a worthwhile endeavor
    - Many investments are made
  - ✓ Diminishing improvement
    - Technology reachs its inherent limits
    - The cost of marginal improvement increases



Technology S-curves

- S-curves in technological improvement
  - Patterns of improvement – an example: single-engine propeller aircraft



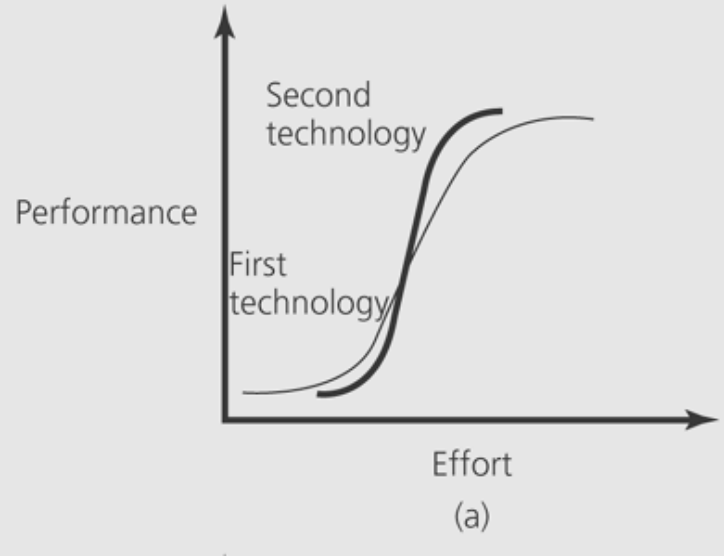
Technology S-curves

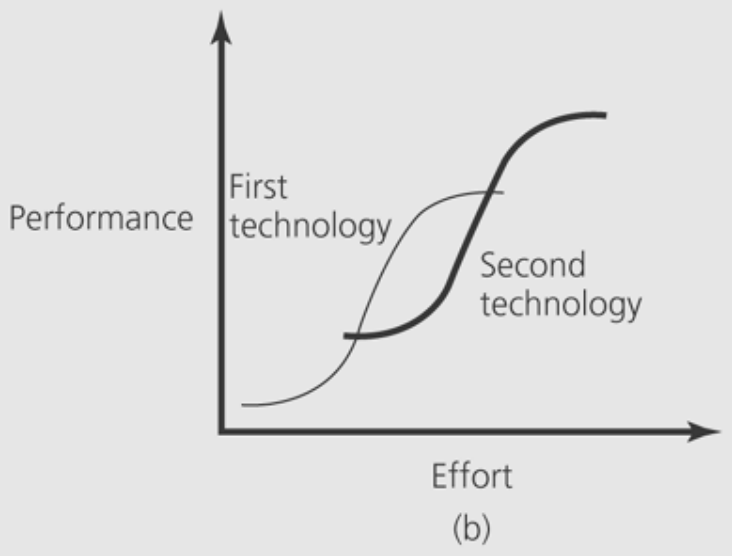
- S-curves in technological improvement
  - Disruptive technology (Discontinuous technology)
    - ✓ Technologies do not always get to reach their limits; may be displaced by new, discontinuous technology
    - ✓ A discontinuous technology fulfills a similar market need by means of an entirely new knowledge base
    - ✓ Established firms may be reluctant to adopt the new technology
      - Technological discontinuity may initially have lower performance and lower returns than incumbent technology
      - They may have significant investment in incumbent technology

Technology S-curves

➢ S-curves in technological Improvement

- Disruptive technology (Discontinuous technology)
  - ✓ A disruptive technology displaces the incumbent technology if it has
    - a steeper s-curve (a)
    - an s-curve increasing to a higher performance limit (b)

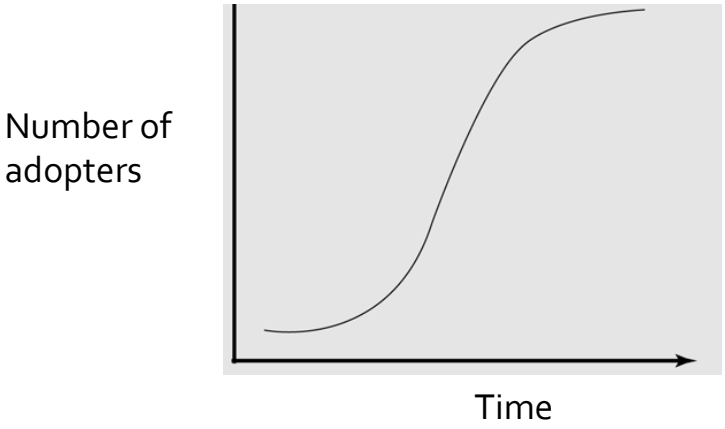




  - ✓ The market structure is totally revolutionized and established firms with the incumbent technology are declined

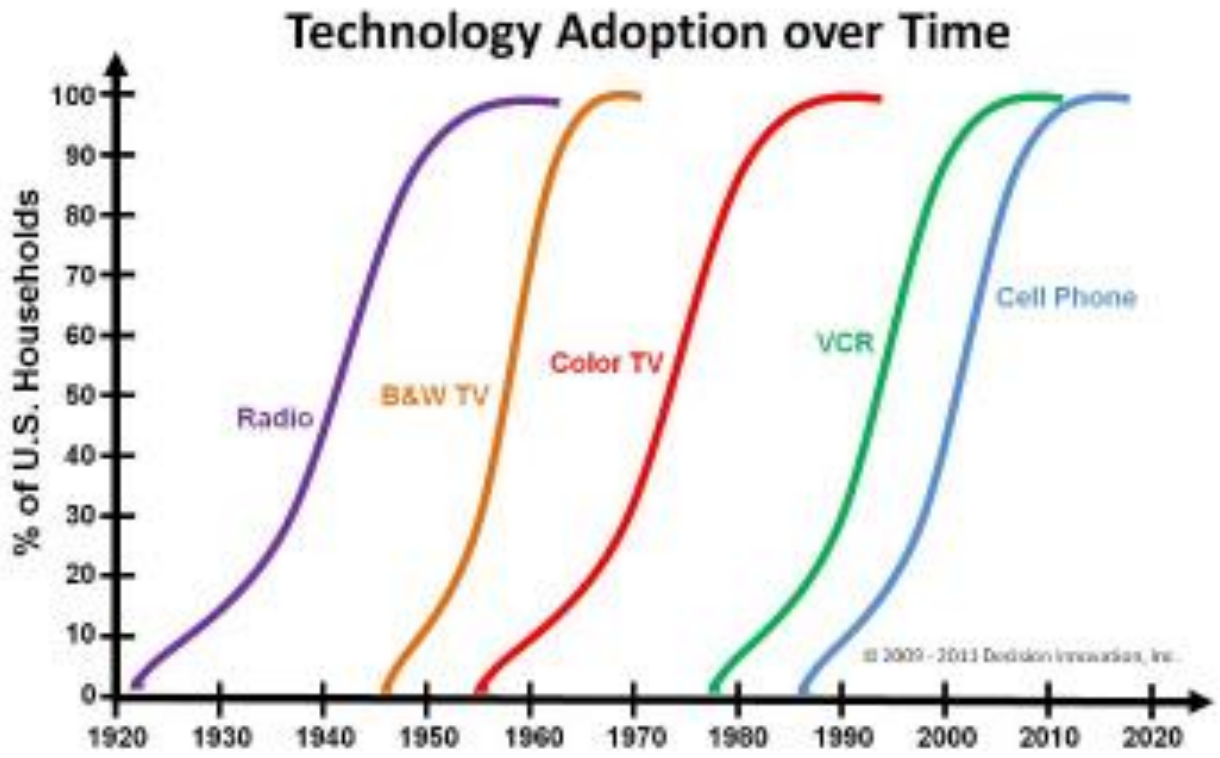
Technology S-curves

- S-curves in technology diffusion
  - Diffusion
    - ✓ The spread of a technology through a population caused by the adoption of customers
  - Patterns of diffusion – the reason for the S-shape
    - ✓ Adoption is initially slow because the technology is unfamiliar
    - ✓ It accelerates as technology becomes better understood and utilized by the mass market
    - ✓ Eventually market is saturated and rate of new adoptions declines



Technology S-curves

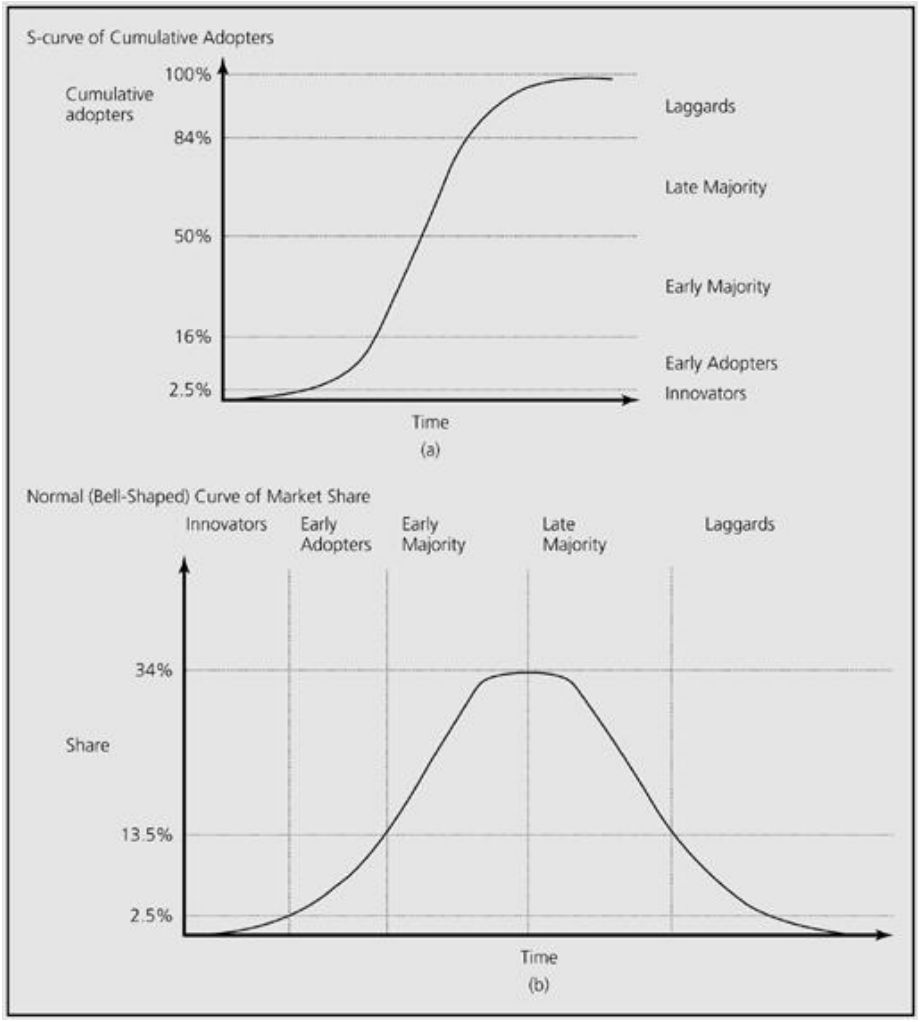
- S-curves in technology diffusion
  - Patterns of diffusion – examples



Research Brief

Diffusion of Innovation and Adopter Categories

- Categories of adopters by Everett M. Rogers



Research Brief

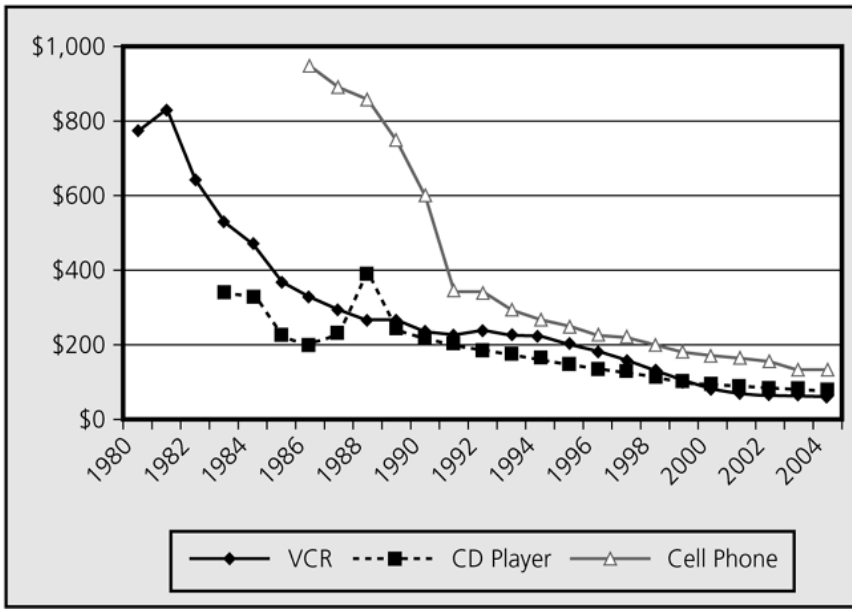
Diffusion of Innovation and Adopter Categories

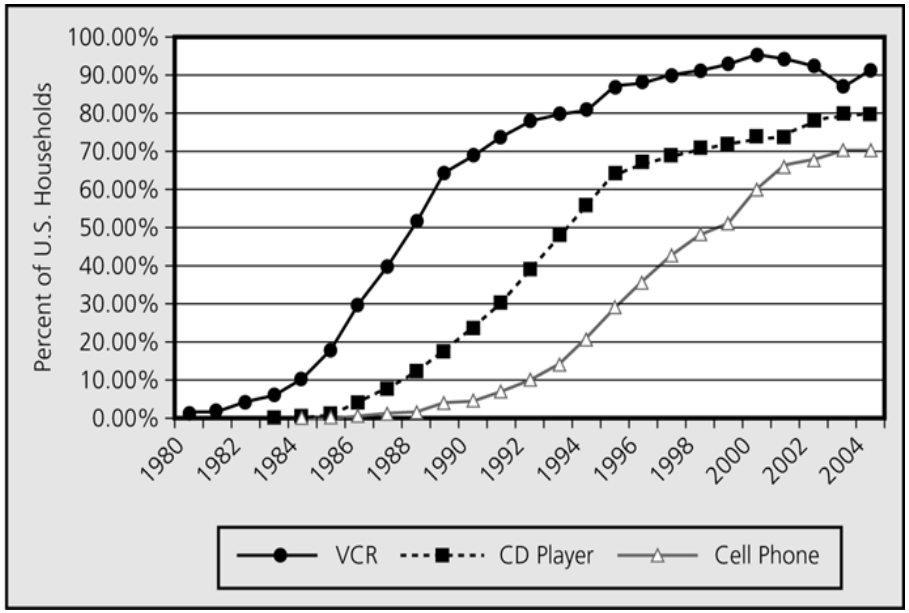
- Categories of adopters by Everett M. Rogers
  - Innovators (2.5%)
    - ✓ Adventurous, comfortable with a high degree of complexity and uncertainty
    - ✓ Have access to substantial financial resources
    - ✓ Bring new ideas into the social system
  - Early Adopters (13.5%)
    - ✓ Well integrated into social system and have great potential for opinion leadership
    - ✓ Want to make sound innovation adoption decisions to retains respect from peers
  - Early Majority (34%)
    - ✓ Adopt innovations slightly before the average member of a social system
    - ✓ Not opinion leaders, but interact frequently with their peers
  - Late Majority (34%)
    - ✓ May not adopt the innovation until they feel pressure from their peers
    - ✓ Have scarce resources
  - Laggards(16%)
    - ✓ Highly skeptical of innovations and innovators
    - ✓ Base decisions primarily upon past experience

Technology S-curves

➢ The relationships between two S-curves

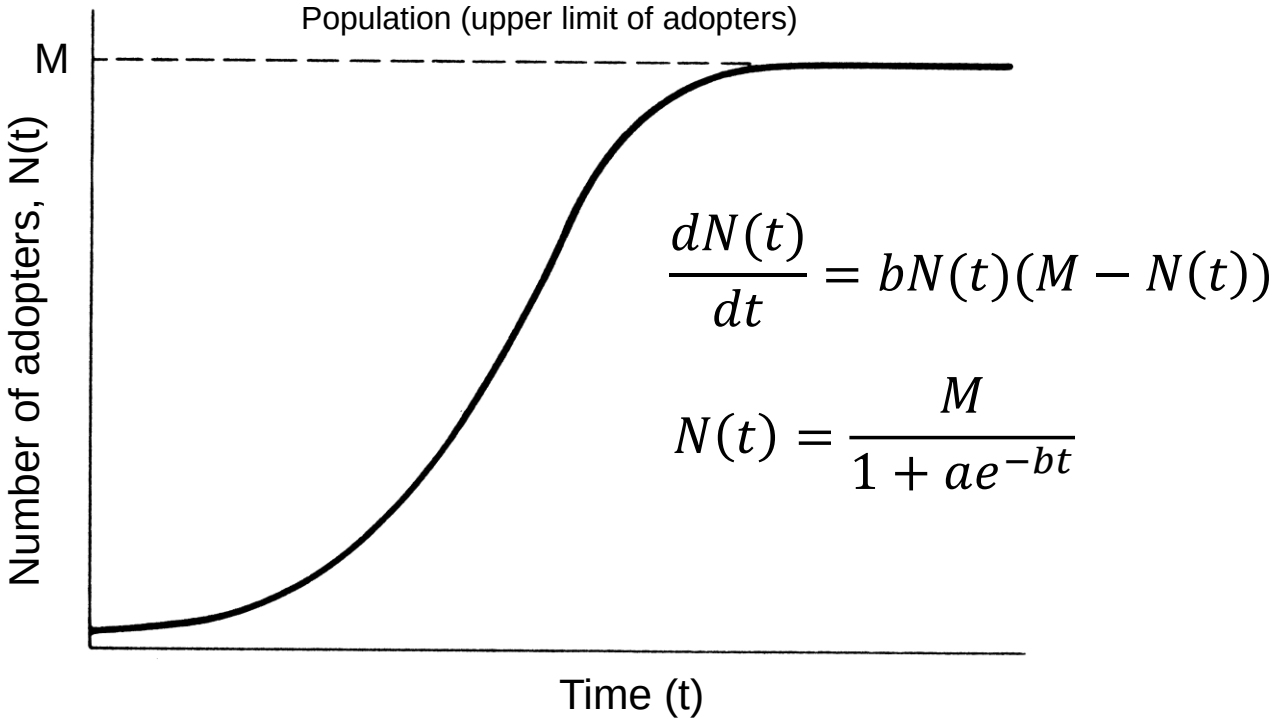
- S-curves of diffusion are in part a function of the S-curves in improvement
  - ✓ As technologies are better developed, they become more certain and useful to users, facilitating adoption
  - ✓ As learning-curve and scale advantages accrue to the technology, the price of goods drops, further accelerating adoption by users





Technology S-curves

- S-curve modeling
  - Logistic function
    - ✓ Developed for modeling the spread of infections during an epidemic
    - ✓ Assuming the diffusion rate is proportional to the product of the number of adopters and the number of the potential adopters who have not yet adopted the technology



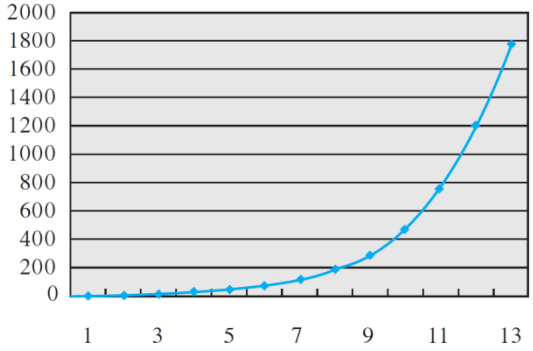
$$\frac{dN(t)}{dt} = bN(t)(M - N(t))$$

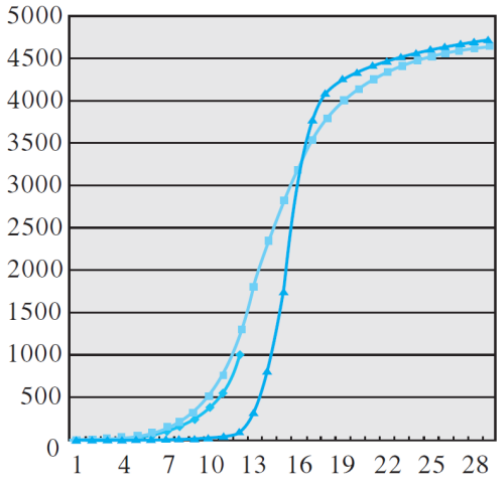
$$N(t) = \frac{M}{1 + ae^{-bt}}$$

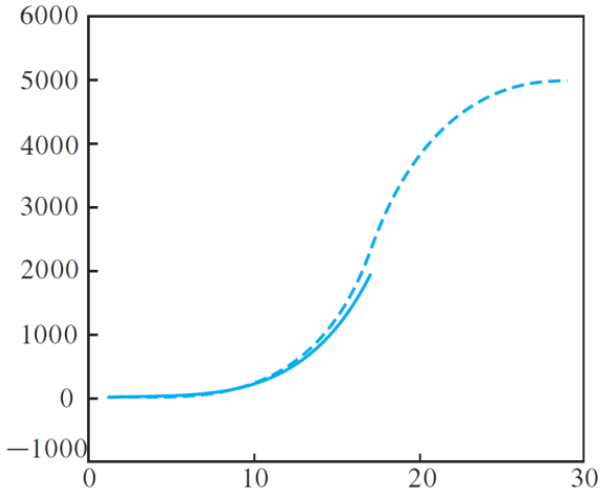
Technology S-curves

➢ S-curve modeling

- Procedure: Plotting → Fitting (regression) → Forecasting







Set M=5,000
→ a=0.1141, b=0.6947
(R^2=0.971)

$$N(t) = \frac{5{,}000}{1 + 0.1141e^{-0.6947t}}$$

Technology S-curves

➢ S-curves as a Prescriptive Tool

- Use of s-curve
  - ✓ as a tool for predicting when a technology will reach its limits
  - ✓ as a prescriptive guide for whether and when the firm should adopt a new technology
- Limitations of s-curve
  - ✓ True limits of technology may be unknown
  - ✓ Shape of s-curve can be influenced by changes in the market, component technologies, or complementary technologies
  - ✓ Firms can change a technologies trajectory through their own R&D activities

Technology Cycles

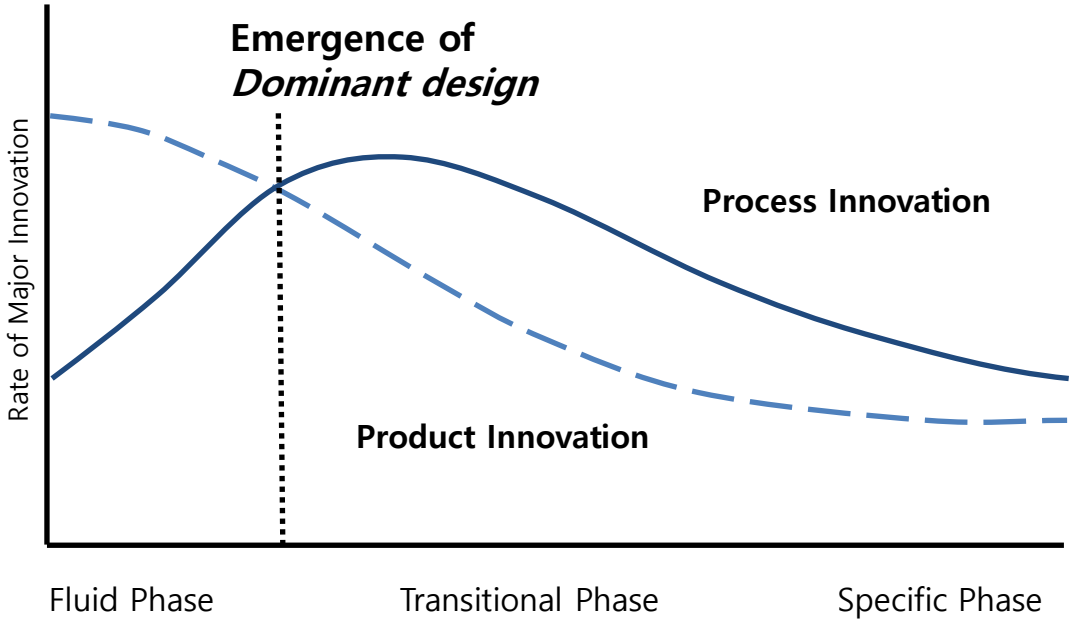
- Cyclical technological change
  - Each new s-curve ushers in an initial period of turbulence, followed by rapid improvement, then diminishing returns
  - Ultimately, it is displaced by a new technological discontinuity

- 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
  - Not necessarily world-first or world-best, but world-most!
  - Example: QWERTY keyboard

Technology Cycles

➢ Technology evolutionary cycle by Utterback & Abernathy

	Fluid phase	Transitional phase	Specific phase
Product innovation	Frequent major product changes	Incremental innovations to improve components within the architecture; frequency decreases	Rarely
Process innovation	Rarely	Actively occur for more effective and efficient production	Partially



Technology Cycles

- Technology cycle by Anderson & Tushman
  - Era of ferment
    - ✓ Period of turbulence and uncertainty
    - ✓ Considerable competition as firms experiment with different forms of technology
  - Era of incremental change
    - ✓ Attempts to achieve greater market segmentation by offering different models
    - ✓ Attempts to lower production costs by simplifying the design or improving production process