UNIVERSITÀ DEGLI STUDI DI TERAMO

Contamination Lab UniTe

SUMMER SCHOOL C-LAB_REP-EAT

Business opportunity and technology transfer of scientific research outputs

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Centri di ricerca

Contamination Lab - UniTe

HAC - Herzliya Accelerator Center

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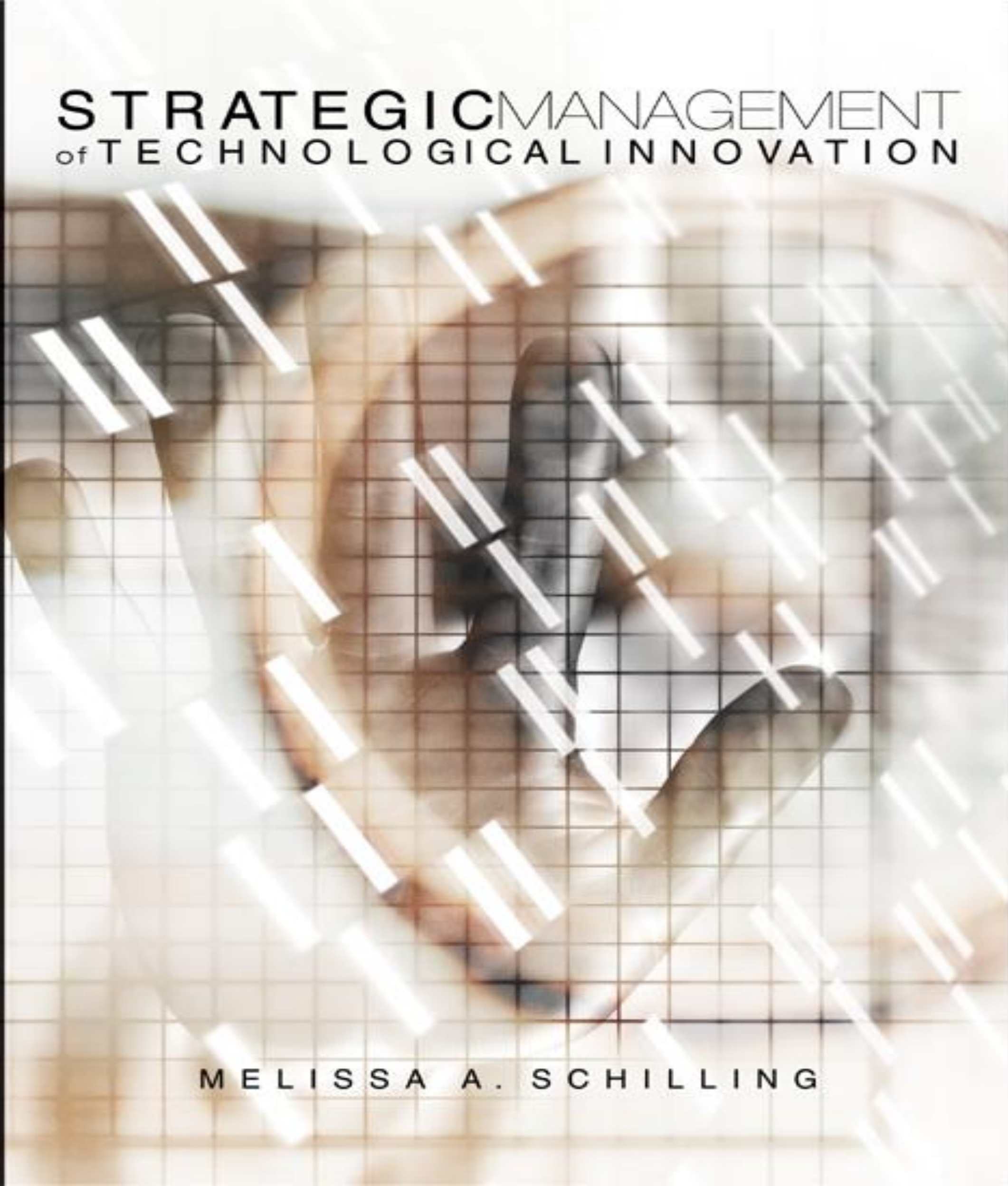
Oltre 500 collegamenti

Riepilogo

Project Manager of Contamination Lab (Technology Transfer Lab of the University of Teramo) and Ph.D. candidate in Innovation Management.

+ 3 years of experience in managing Innovation Hubs (2018 and 2019 in Israel)

+ 4 years of experience in consulting for business development, innovation and marketing strategies.


STRATEGIC MANAGEMENT
of TECHNOLOGICAL INNOVATION
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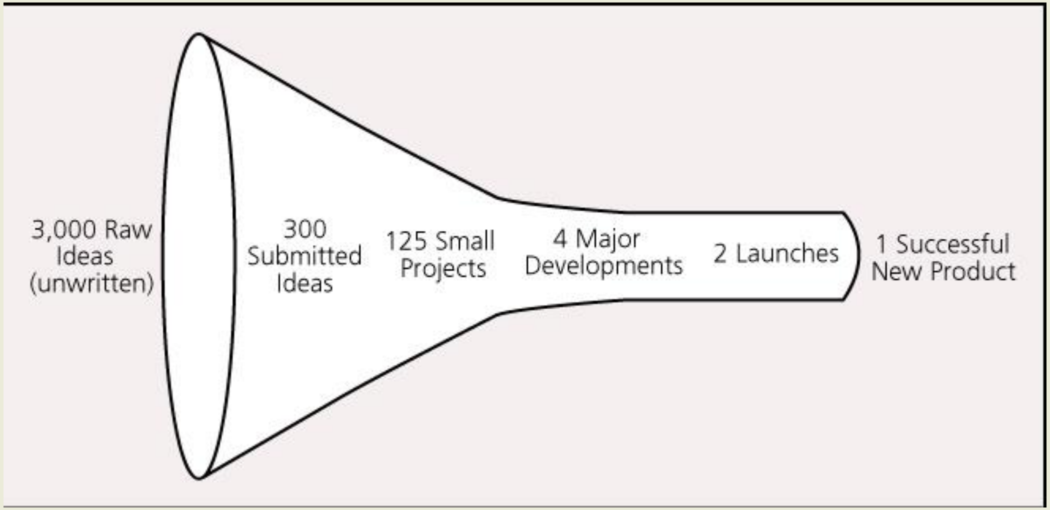
Innovation by Industry: The Importance of Strategy

- To be successful at innovation, firms need carefully crafted strategies and implementation processes.
- Innovation funnel
  - Most innovative ideas do not become successful new products.



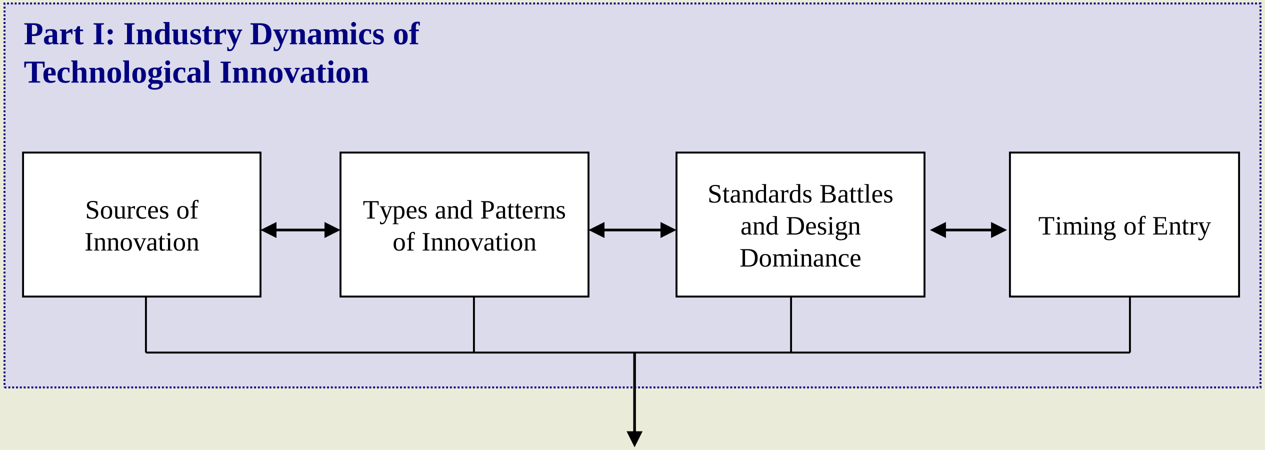
Research Brief

How long does new product development take?

- Study by Abbie Griffin of 116 firms found:
  - Length of development cycle varies with innovativeness of project
  - Incremental improvements took 8.6 months from concept to market introduction
  - Next generation improvements took 22 months.
  - New-to-the-firm product lines took 36 months
  - New-to-the-world products took 53 months.
  - Half of the companies had reduced their cycle time by an average of 33% over last five years.

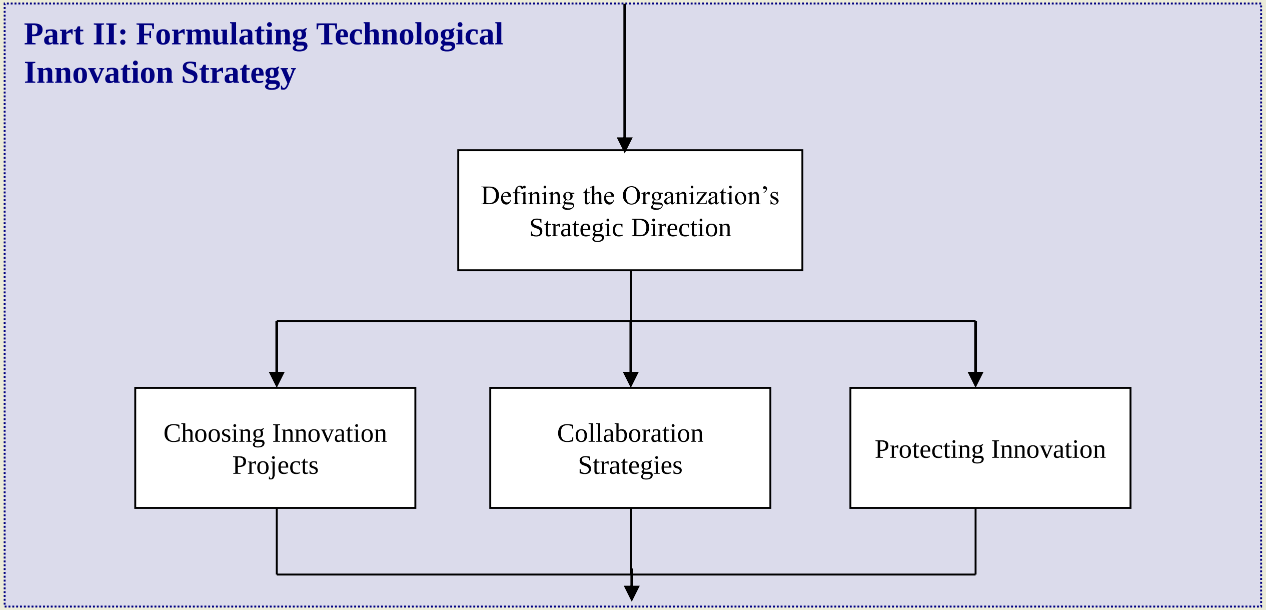
The Strategic Management of Technological Innovation

- **Part One**: The foundations of technological Innovation
  - Sources of innovation
  - Types and patterns of innovation
  - Standards battles and design dominance
  - Timing of Entry



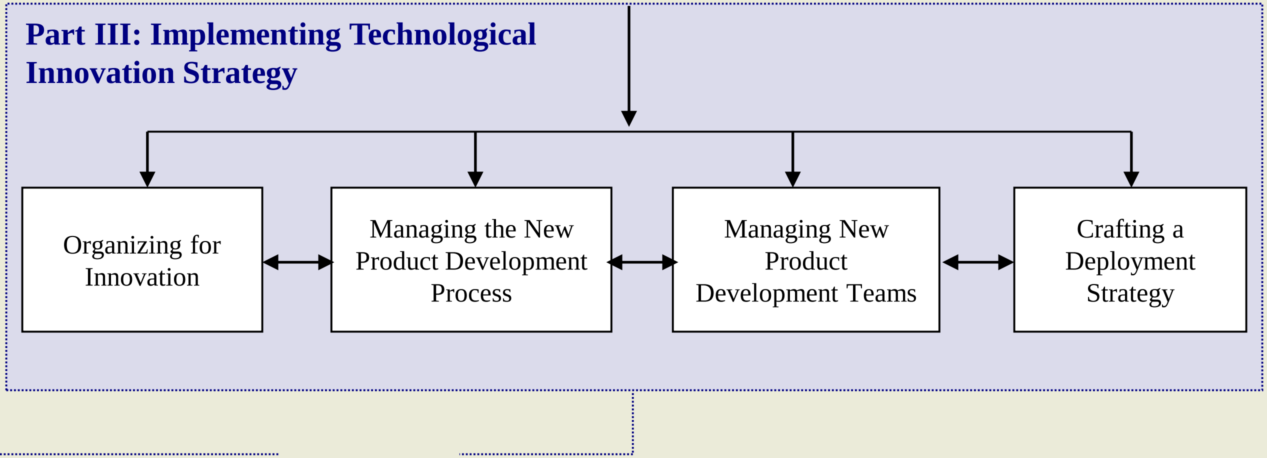
The Strategic Management of Technological Innovation

- **Part Two**: Formulating Technological Innovation Strategy
  - Defining the organization’s strategic direction
  - Choosing innovation projects
  - Collaboration strategies
  - Protecting innovation



The Strategic Management of Technological Innovation

- **Part Three**: Implementing Technological Innovation Strategy
  - Organizing for innovation
  - Managing the new product development process
  - Managing new product development teams
  - Crafting a deployment strategy

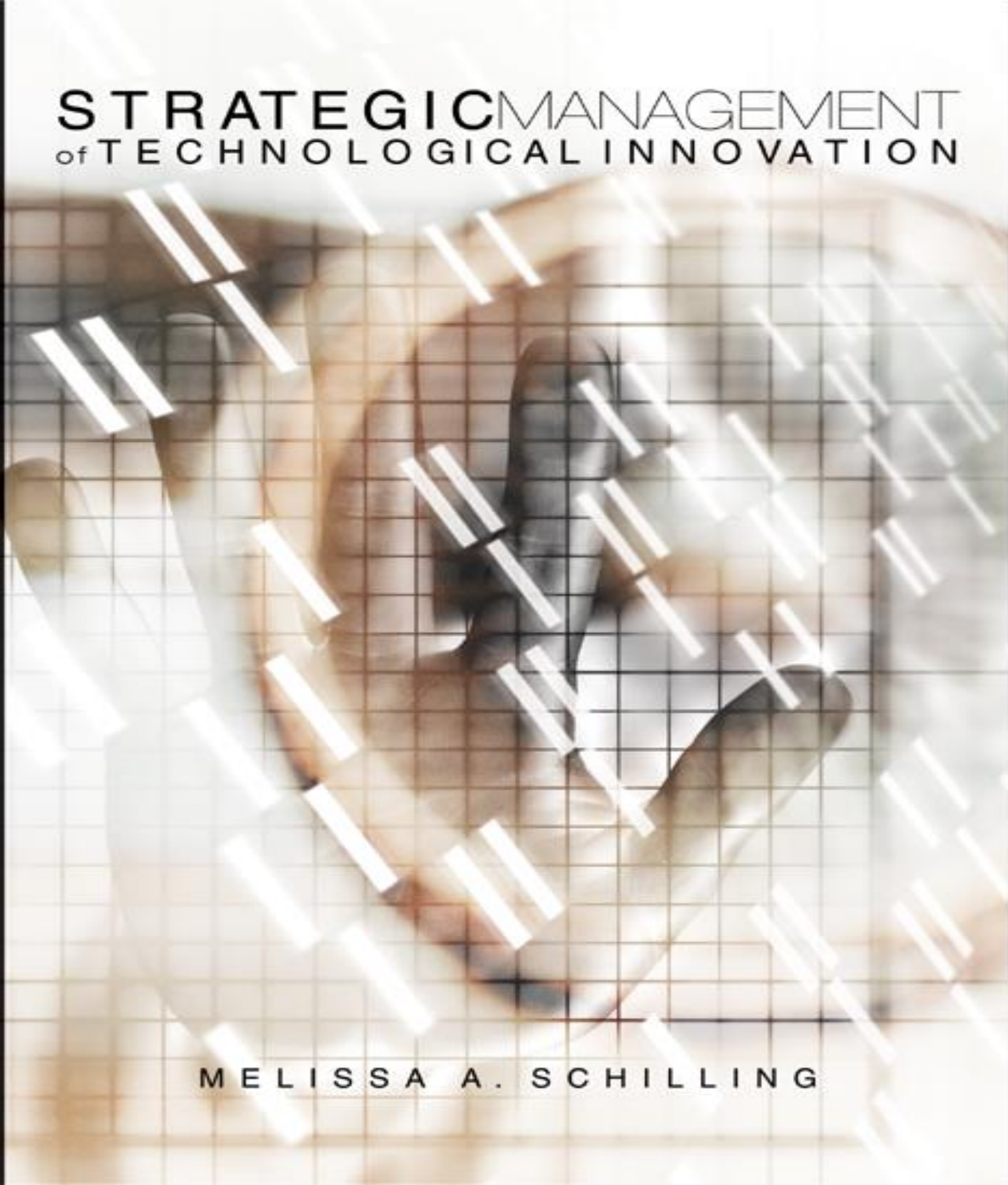


Discussion Questions

1. Why is innovation so important for firms to compete in many industries?

2. What are some of the advantages of technological innovation? Disadvantages?

3. Why do you think so many innovation projects fail to generate an economic return?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Part One: Industry Dynamics of Technological Innovation

Covers:

- The **<u>SOURCES</u>** from which innovation arises, including the role of individuals, organizations, government institutions, and networks;
- **<u>TYPES</u>** of innovations, and common industry patterns of technological evolution and diffusion;
- The **<u>FACTORS</u>** that determine whether industries experience pressure to select a dominant design, and what drives which technologies dominate others;
- Effects of **<u>TIMING</u>** of entry, and how firms can identify (and manage) their entry options.

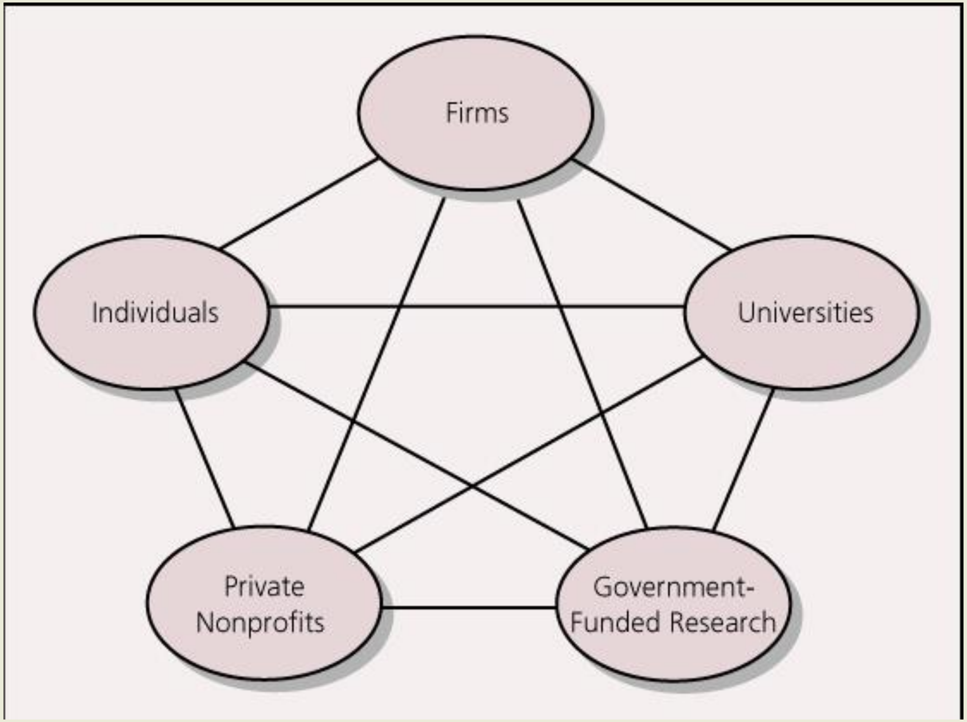
Chapter 2

Chapter 2

Sources of Innovation

Overview

- Innovation can arise from many different sources and the linkages between them.



What is innovation?

- <u>Innovation</u> is NOT technology
  - It includes organizational and market change.

- <u>Technology</u> is NOT research and development
  - It includes engineering, production, suppliers and users.

Transforming Creativity into Innovation

- Innovation is the implementation of creative ideas into some new device or process.
- Requires combining creativity with resources and expertise.
- **Inventors**
- Such individuals may develop many new devices or processes but commercialize few.

Transforming Creativity into Innovation

- **Research and Development by Firms**

  - **Research** refers to both *basic* and *applied* research.
    - **Basic research** aims at increasing understanding of a topic or field <u>without an immediate commercial application</u> in mind.
    - **Applied research** aims at increasing understanding of a topic or field to meet a <u>specific need</u>.

  - **Development** refers to activities that apply knowledge to produce useful devices, materials, or processes.

Want to innovate?

Become a "now-ist”

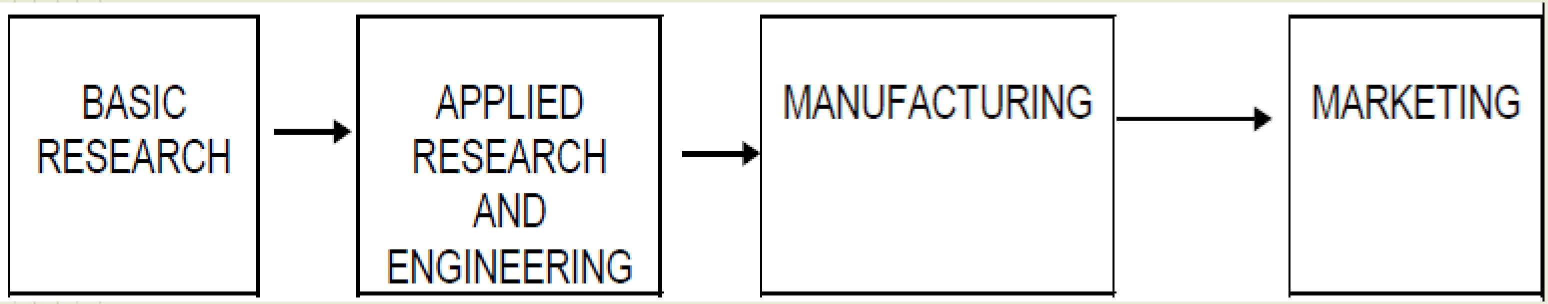
https://www.ted.com/talks/joi_ito_want_to_innovate_become_a_now_ist?language=en#t-43553

"Remember before the internet?" asks Joi Ito. "Remember when people used to try to predict the future?" In this engaging talk, the head of the MIT Media Lab skips the future predictions and instead shares a new approach to creating in the moment: **building quickly and improving constantly, without waiting for permission or for proof that you have the right idea**. This kind of bottom-up innovation is seen in the most fascinating, futuristic projects emerging today, and it starts, he says, with being open and alert to what's going on around you right now.

Don't be a futurist, he suggests: be a now-ist.

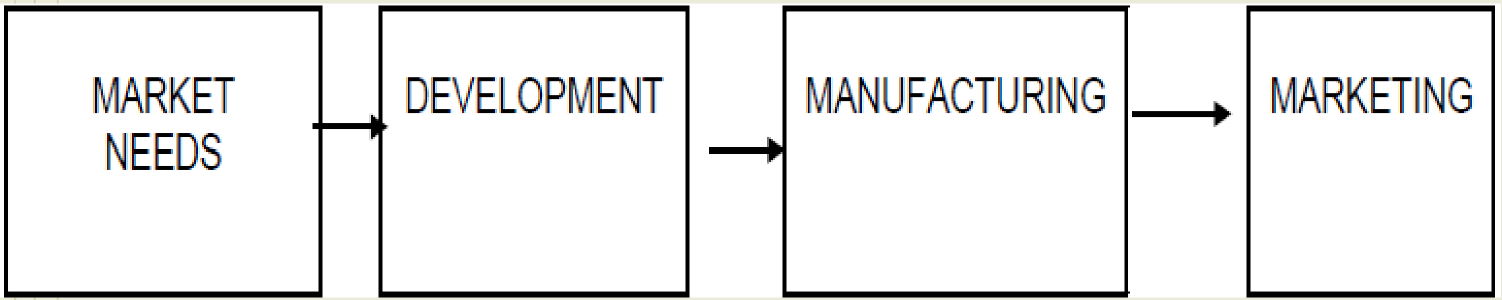
Innovation Process

First Generation Innovation Process (Rothwell, 1985)



Innovation Process

Second Generation Innovation Process (Rothwell, 1985)



Transforming Creativity into Innovation

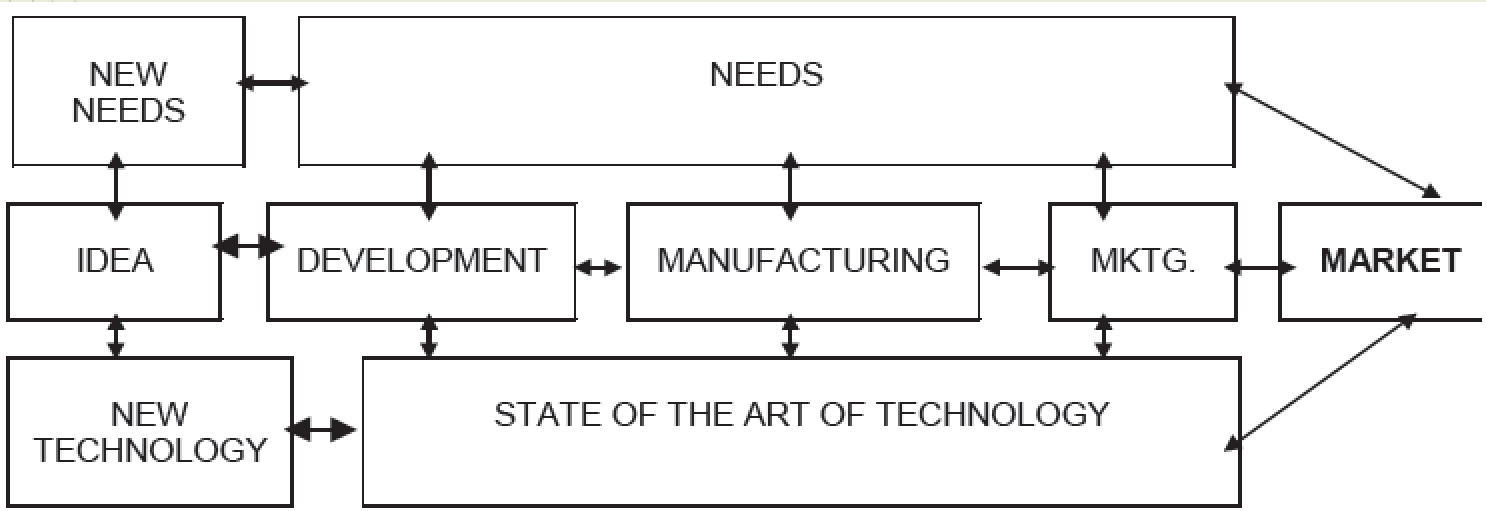
- **Research and Development by Firms**
  - *Science Push* approaches suggest that innovation proceeds linearly:

    Scientific discovery → invention → manufacturing → marketing
  - *Demand Pull* approaches argued that innovation originates with unmet customer need:

    Customer suggestions → invention → manufacturing

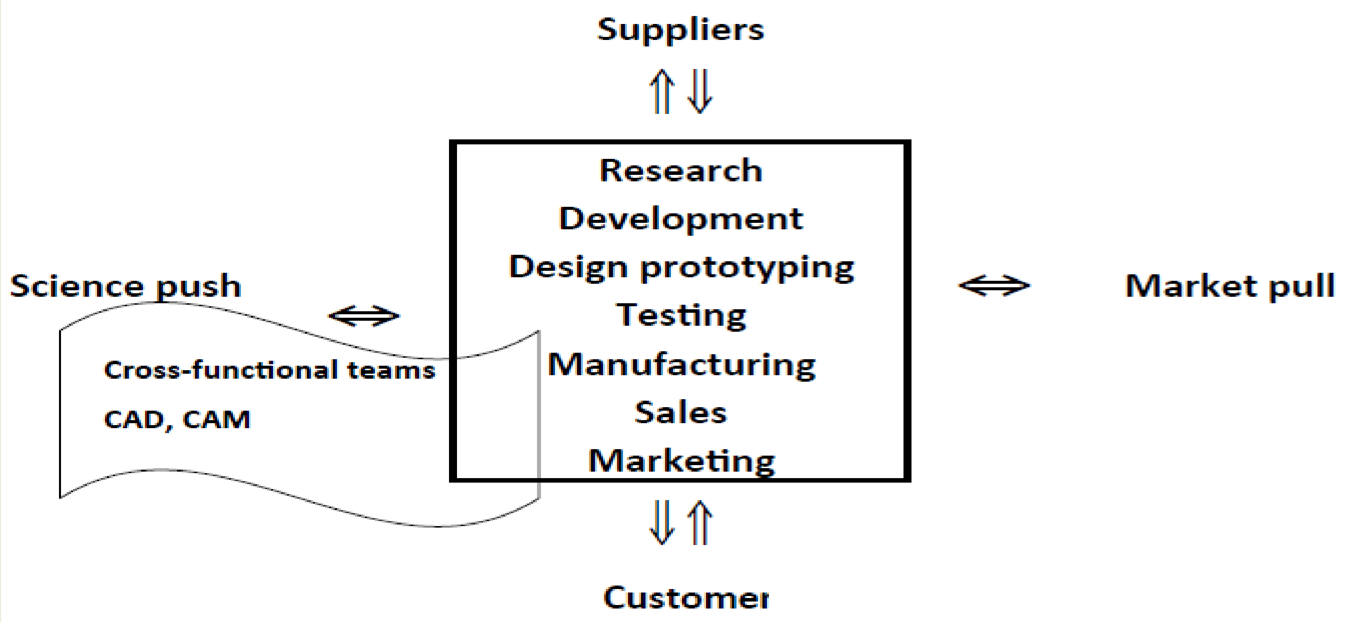
Innovation Process

Third Generation Innovation Process (Rothwell, 1985)



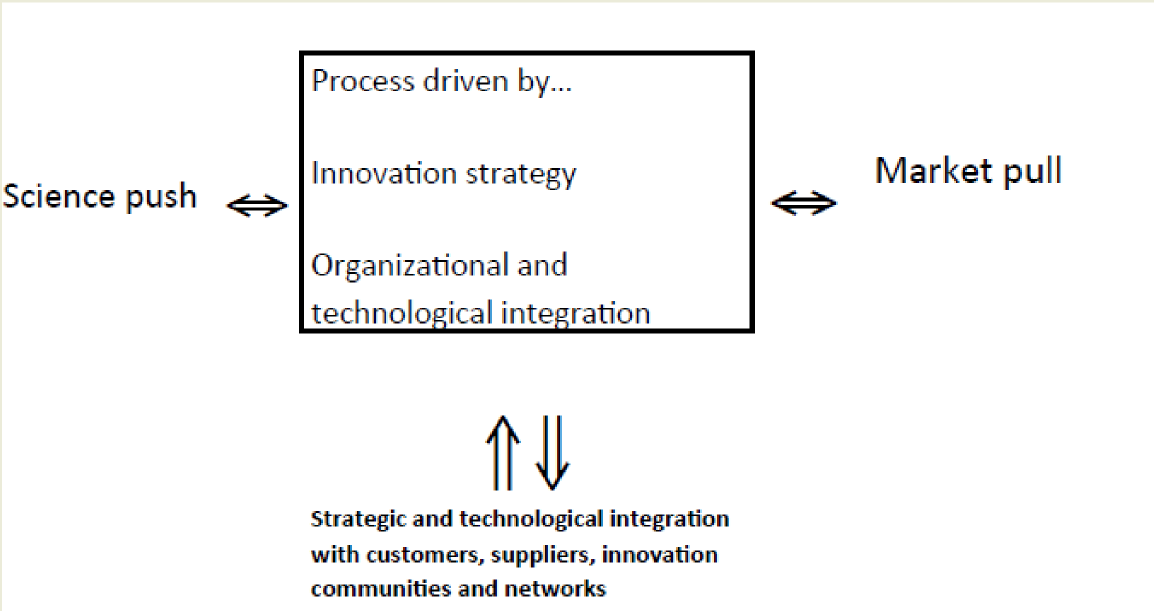
Innovation Process

Fourth Generation Innovation Process (Rothwell, 1985)



Innovation Process

Fifth Generation Innovation Process (Rothwell, 1985)



Transforming Creativity into Innovation

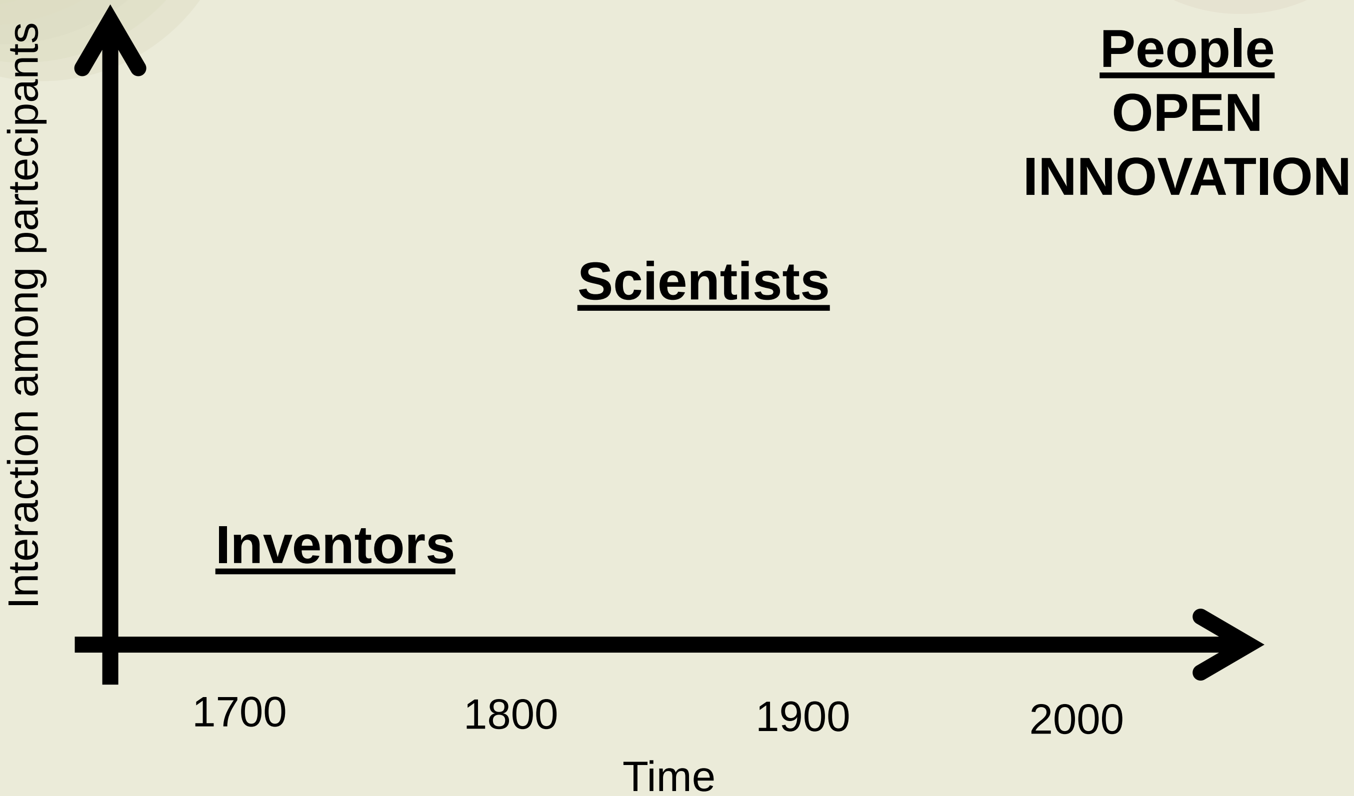
- **Firm Linkages with Customers, Suppliers, Competitors, and Complementors**
  - Most frequent collaborations are between firm and their customers, suppliers, and local universities.

	North America	Europe	Japan
Collaborates with:			
Customers	44%	38%	52%
Suppliers	45	45	41
Universities	34	32	34

Transforming Creativity into Innovation

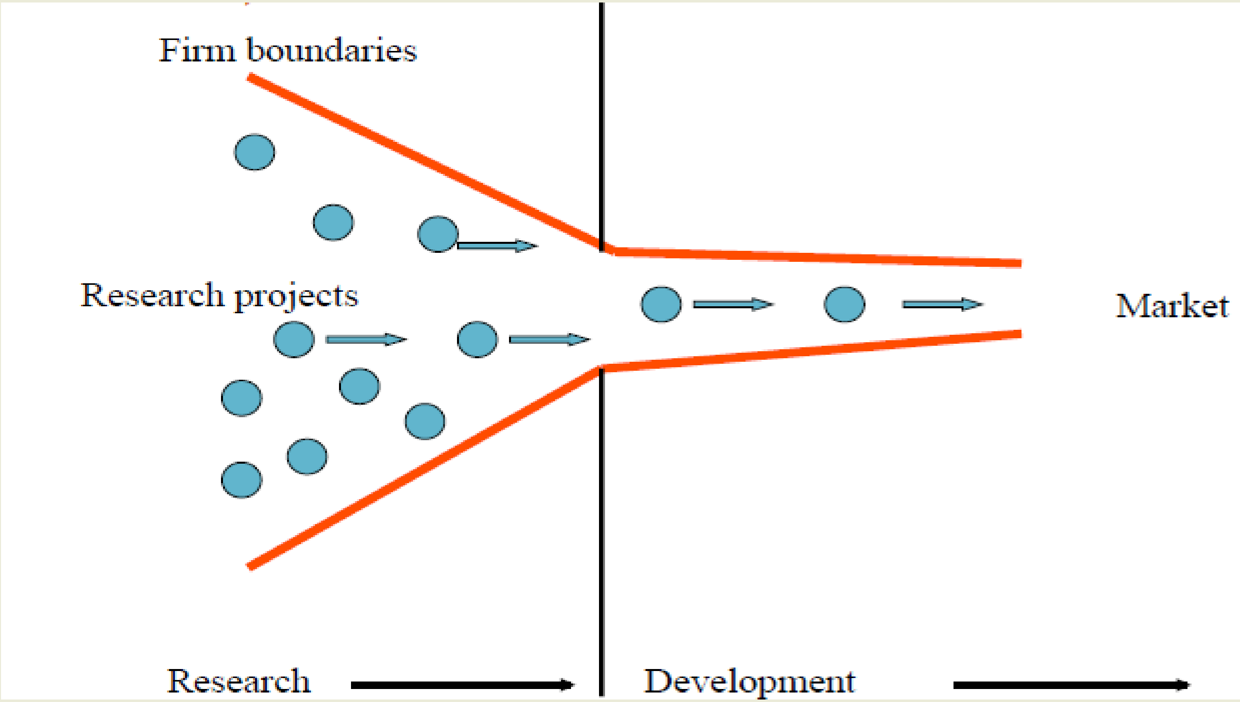
- **Universities Research**
  - Many universities encourage research that leads to useful innovations
  - TTO
  - Spin-off

Changes in the innovation process



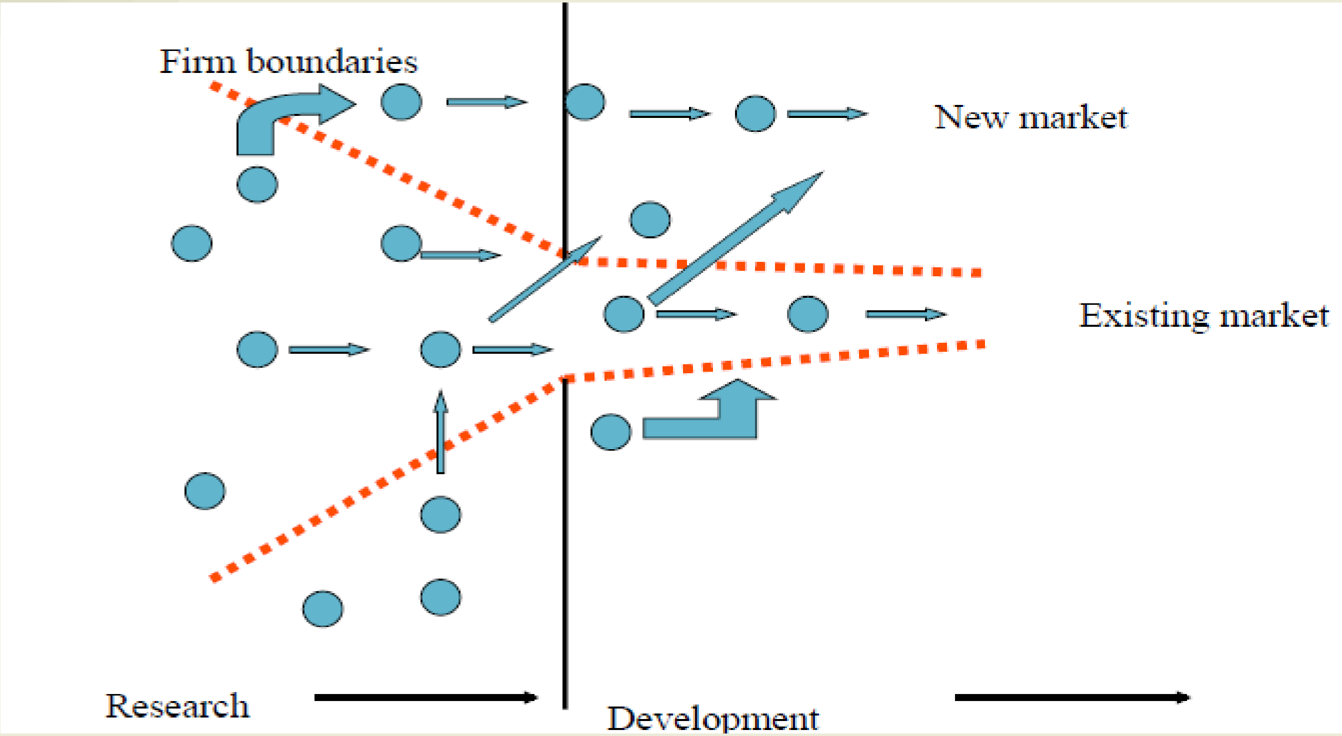
Innovation model

Traditional model (Chesbrough, 2003)



Innovation model

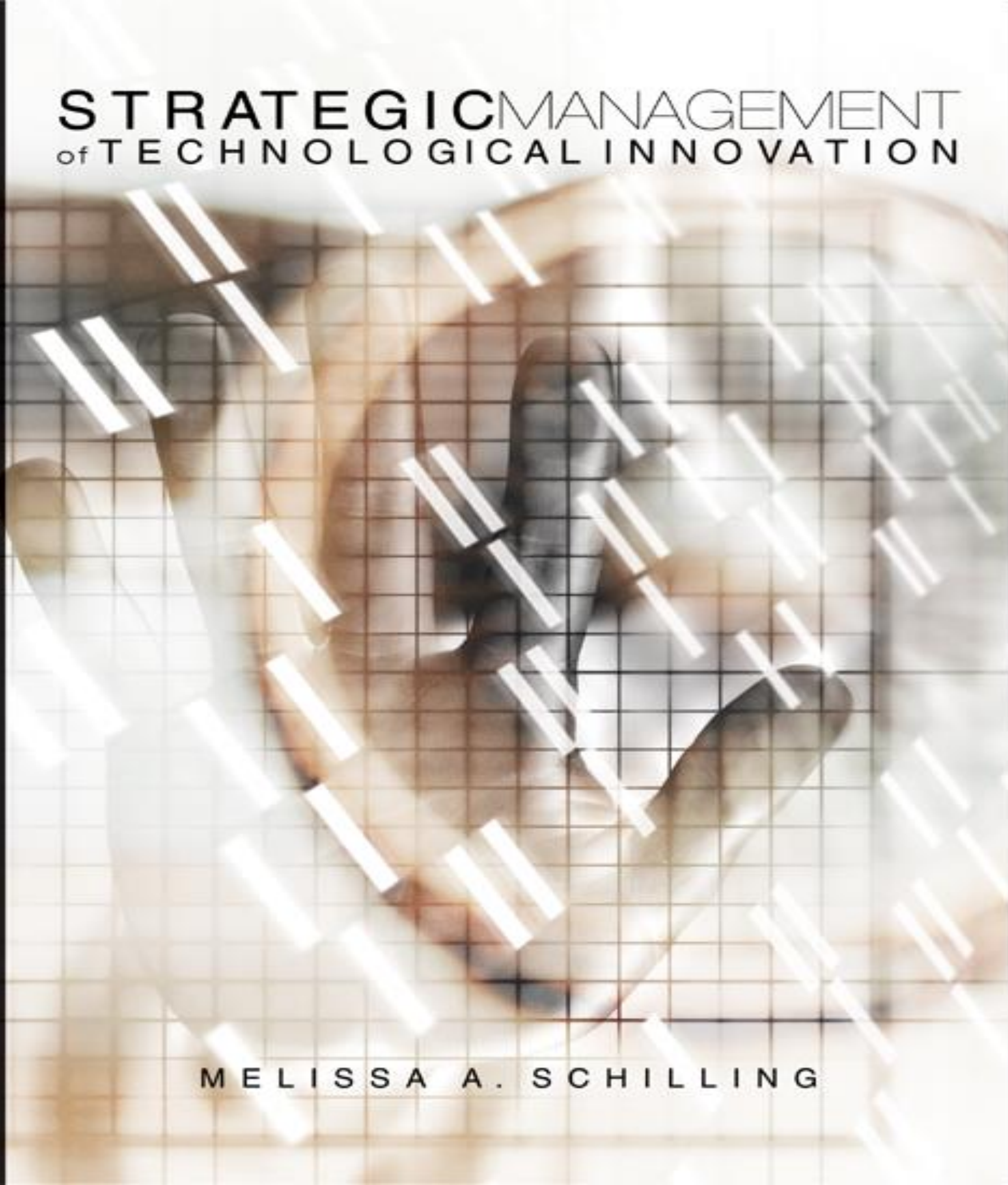
Open model (Chesbrough, 2003)



Innovation in Collaborative Networks

- Collaborations include (but are not limited to):
  - Joint ventures
  - Licensing and second-sourcing agreements
  - Research associations
  - Government-sponsored joint research programs
  - Value-added networks for technical and scientific exchange
  - Informal networks

- Collaborative networks are especially important in high-technology sectors where individual firms <u>rarely possess all necessary resources and capabilities</u>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Types and Patterns of Innovation

Ericsson's Gamble on 3G Wireless

- Ericsson, founded as a telegraph repair shop in 1876;
  by end of 2002 was the largest supplier of mobile telecommunications systems in the world.

- First generation of cell phones had been analog.
  Second generation (2G) was digital.
  By end of 1990s, sales of 2G phones were beginning to decline.

Mobile System Generations

Technology	1G	2G	2.5G	3G	4G
Design Began	1970	1980	1985	1990	2000
Implementation	1984	1991	1999	2002	2010
Service	Analog Voice, Synchronous Data to 9.6kbps	Digital Voice, Short Massages	Higher Capacity, Packetized Data	Higher Capacity, broadband data unto 2Mbps	Higher Capacity completely IP-Oriented, Multimedia Data
Standards	AMPS, TACS, NMT, etc.	TDMA, CDMA, GSM, PDC	GPRS, EDGE, 1XRTT	WCDMA, CDMA2000	Single Standard
Data Bandwidth	1.9 kbps	14.4 kbps	384 kbps	2 Mbps	2000Mbps

- Telco leaders began to set their sights on 3G phones that would utilize broadband channels, enabling videoconferencing and high-speed web surfing.

Ericsson’s Gamble on 3G Wireless

- In late 1990s, Ericsson began focusing on 3G systems, and put less effort on developing and promoting its 2G systems.
- However, transition to 3G turned out to be more complex than expected, and there were worries that users might not value them as much as hoped. Had Ericsson gambled too much (and too early) on 3G?

Ericsson’s Gamble on 3G Wireless

Discussion Questions:

1. Is 3G a radical innovation or an incremental innovation?
2. Is Ericsson trying to offer more technological capability than consumers really need?
3. Is Ericsson's focus on 3G technologies a good strategy? Why or why not?

Overview

- 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.

- The path a technology follows through time is termed its *technology trajectory*.
  - Many consistent patterns have been observed in technology trajectories, helping us understand how technologies improve and are diffused.

Types of Innovation

Product versus Process Innovation

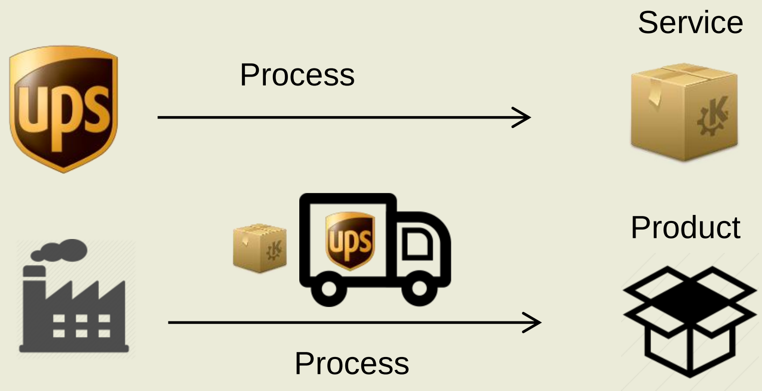
- *Product innovations* are embodied in the *outputs* of an organization – its goods or services.

- *Process innovations* are innovations in the way an organization conducts its business, such as in techniques of producing or marketing goods or services.

Types of Innovation

Product vs Process Innovation

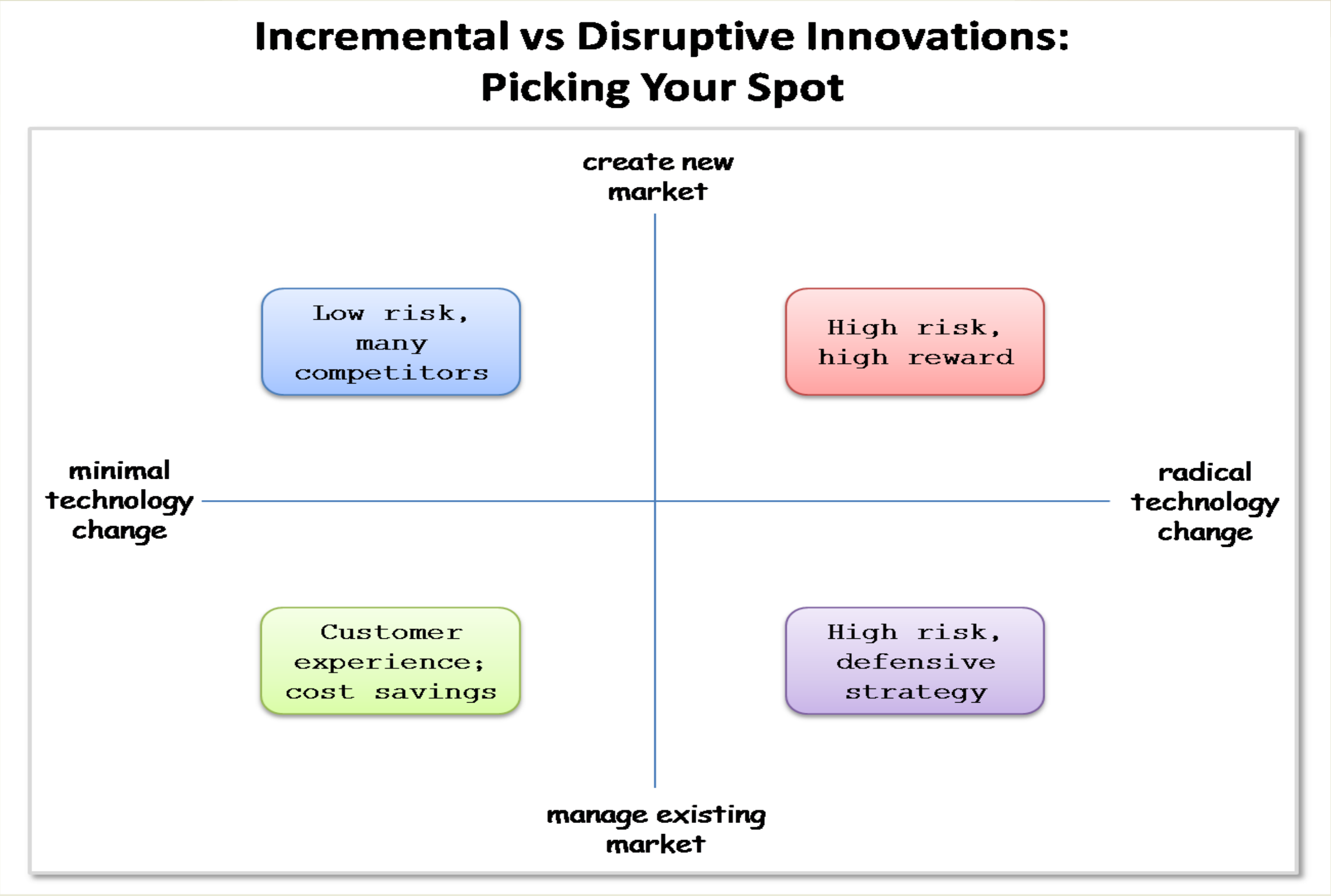
- *<u>Product innovations</u>* can enable *<u>process innovations</u>* and vice versa.
- What is a *product innovation* for one organization might be a *process innovation* for another
  - E.g., UPS creates a new distribution service (*product innovation*) that enables its customers to distribute their goods more widely or more easily (*process innovation*)



Types of Innovation

- **Radical versus Incremental Innovation**
  - The *radicalness* of an innovation is the *degree to which it is new and different* from previously existing products and processes.
  - *Incremental innovations* may involve only a minor change from (or adjustment to) existing practices.
  - The radicalness of an innovation is relative; it may change over time or with respect to different observers.
    - E.g., digital photography was a more radical innovation for Kodak than for Sony.

Types of Innovation



Types of Innovation

Incremental Innovation

Types of Innovation

Radical Innovation

Types of Innovation

Competence-Enhancing vs Competence-Destroying Innovation

- **Competence-enhancing** innovations build on the firm's existing knowledge base
  - E.g., Intel's Pentium 4 built on the technology for Pentium III.
- **Competence-destroying** innovations renders a firm's existing competencies obsolete.
  - E.g., electronic calculators rendered Keuffel & Esser's slide rule expertise obsolete.

Whether an innovation is competence enhancing or competence destroying depends on the perspective of a particular firm.

Types of Innovation

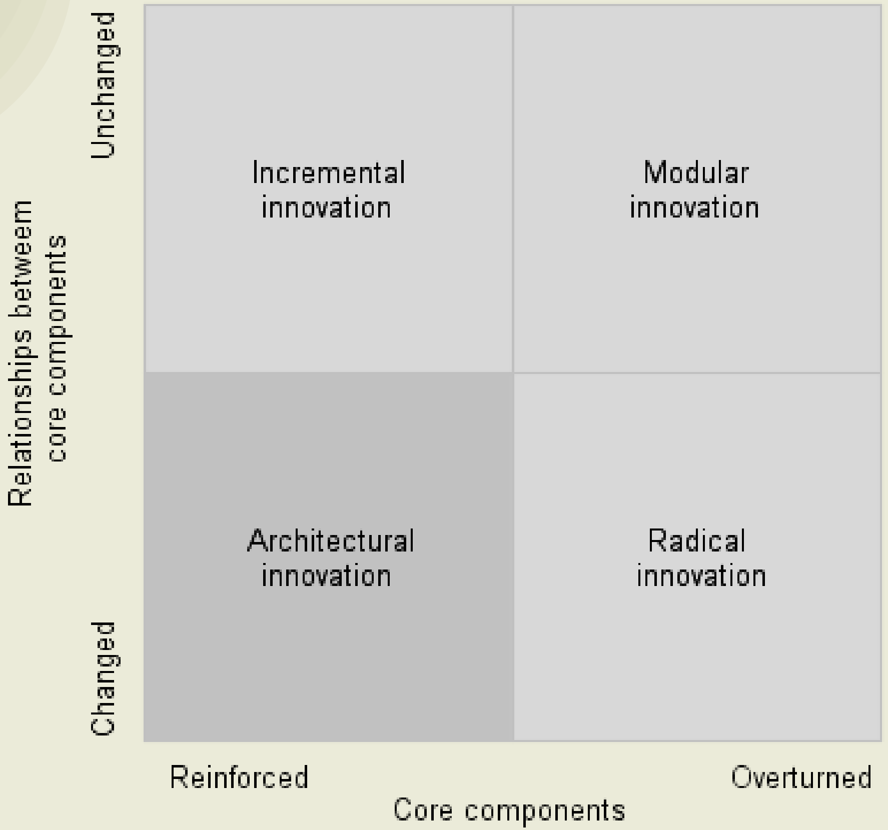
Architectural versus Component Innovation

- A **component innovation** (or modular innovation) entails changes to one or more components of a product system without significantly affecting the overall design.
  - E.g., adding gel-filled material to a bicycle seat

- An **architectural innovation** entails changing the overall design of the system or the way components interact.
  - E.g., transition from high-wheel bicycle to safety bicycle.

Most architectural innovations require changes in the underlying components also.

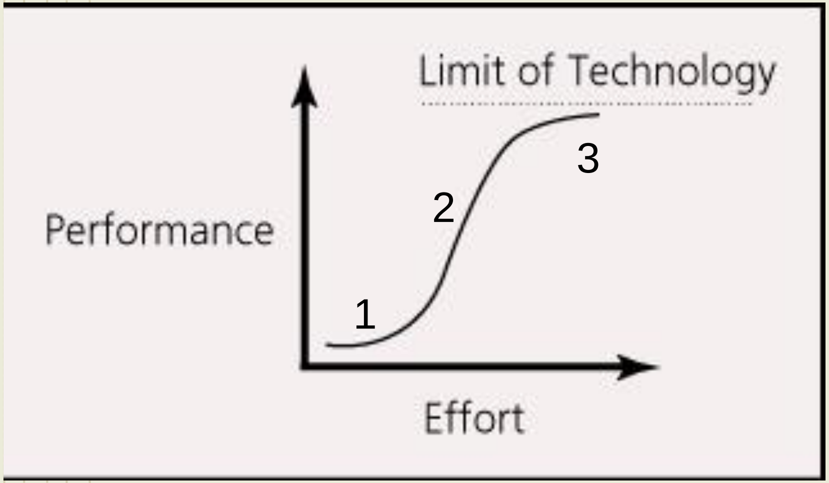
Types of Innovation



Technology S-Curves

- Both the rate of a technology's improvement, and its rate of diffusion to the market typically follow an s-shaped curve.

- **S-curves in Technological Improvement**



1. Technology improves slowly at first because it is poorly understood.

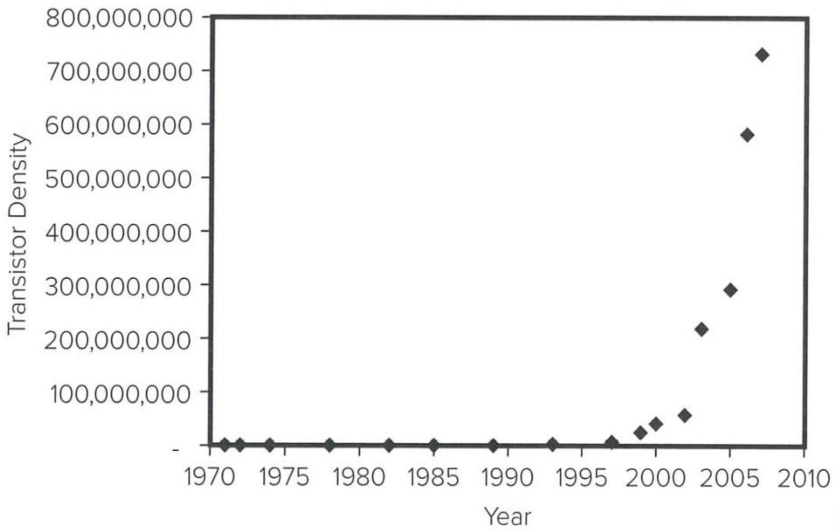
2. Then accelerates as understanding increases.

3. Then tapers off as approaches limits.

Moore’s law

Improvements in Intel’s Microprocessor Transistor Density over Time

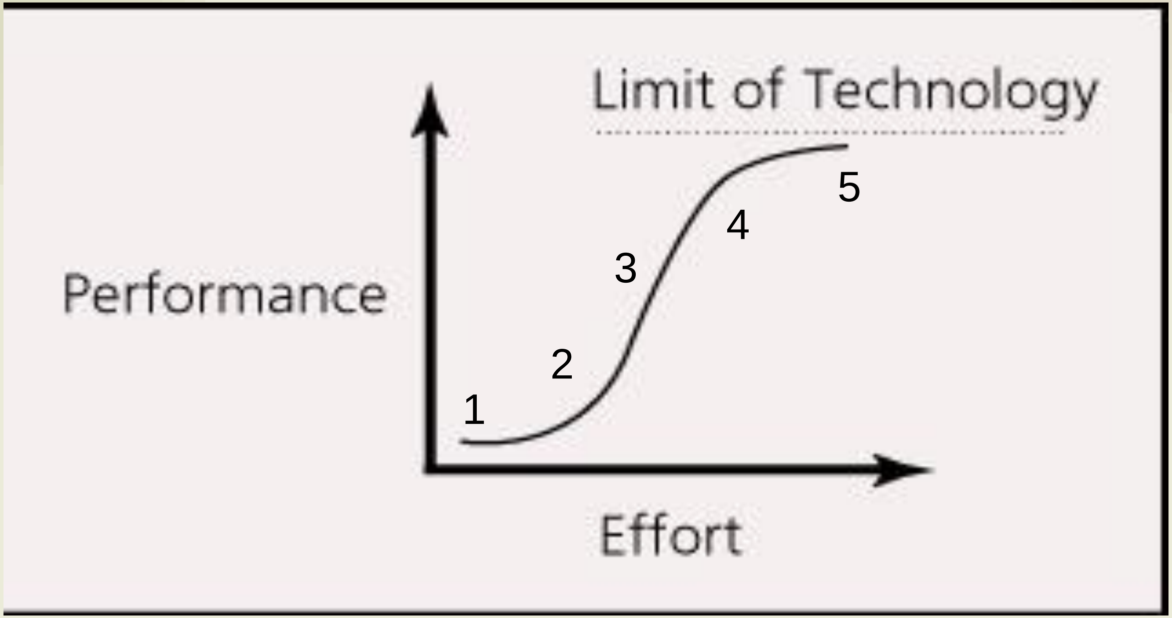
Year	Transistors	Intel CPU
1971	2,250	4004
1972	2,500	8008
1974	5,000	8080
1978	29,000	8086
1982	120,000	286
1985	275,000	386™
1989	1,180,000	486™ DX
1993	3,100,000	Pentium®
1997	7,500,000	Pentium II
1999	24,000,000	Pentium III
2000	42,000,000	Pentium 4
2002	55,000,000	Pentium M
2003	220,000,000	Itanium 2
2005	291,000,000	Pentium D
2006	582,000,000	Core 2 Quad
2007	731,000,000	Core i7 (Quad)



Moore’s law, 1965 – The density of transistors on integrated circuits had doubled every year since the integrated circuits was invented.

- **When will it reach it physical limit?**

Technology S-Curves



- ❑ **Electric car**
- ❑ **Mobile phone**
- ❑ **GPS and Sat Navigation**
- ❑ **TV**
- ❑ **Virtual currency**

Technology S-Curves

S-Curves in Technology Diffusion

1. Adoption is initially slow because the technology is unfamiliar.
2. It accelerates as technology becomes better understood.
3. Eventually market is saturated and rate of new adoptions declines.
4. Technology diffusion tends to take far longer than information diffusion.
    a. Technology may require acquiring complex knowledge or experience.
    b. Technology may require complementary resources to make it valuable (e.g., cameras not valuable without film).

Research Brief

Diffusion of Innovation and Adopter Categories

- Everett M. Rogers created a typology of adopters:

  Innovators are the first 2.5% of individuals to adopt an innovation. They are adventurous, comfortable with a high degree of complexity and uncertainty, and typically have access to substantial financial resources.

  Early Adopters are the next 13.5% to adopt the innovation. They are well integrated into their social system, and have great potential for opinion leadership. Other potential adopters look to early adopters for information and advice, thus early adopters make excellent "missionaries" for new products or processes.

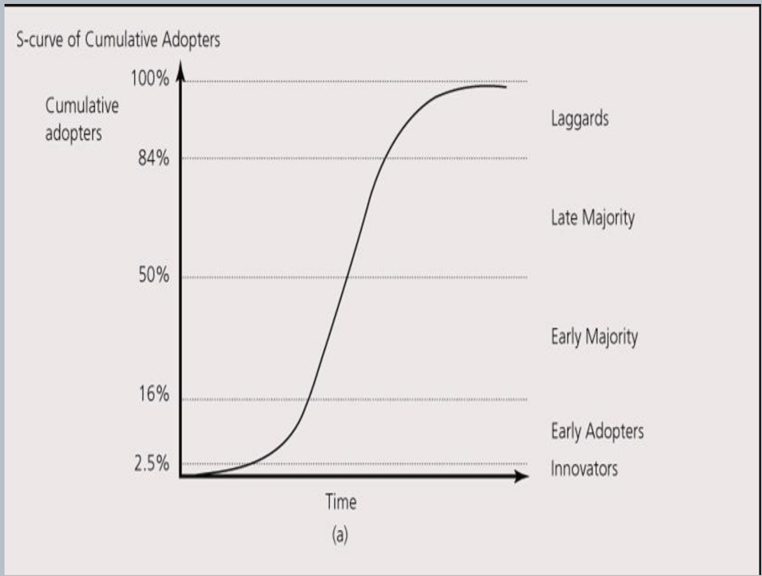
  Early Majority are the next 34%. They adopt innovations slightly before the average member of a social system. They are typically not opinion leaders, but they interact frequently with their peers.

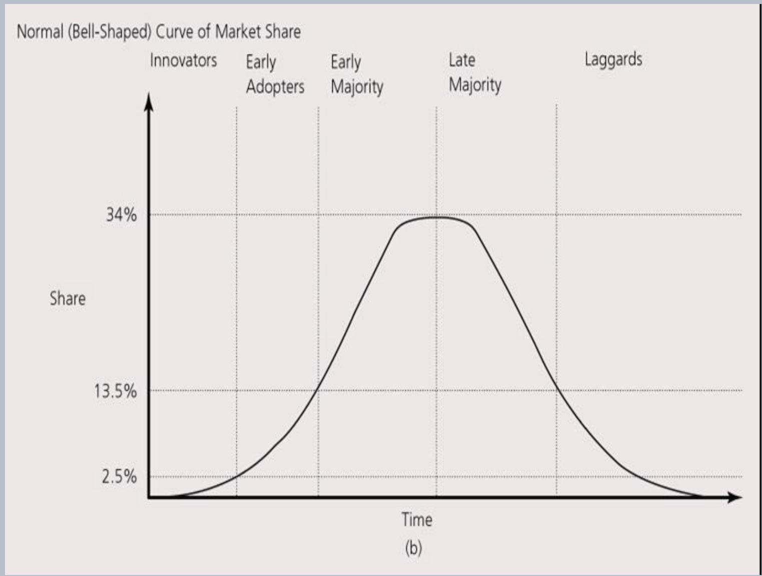
  Late Majority are the next 34%. They approach innovation with a skeptical air, and may not adopt the innovation until they feel pressure from their peers. They may have scarce resources.

  Laggards are the last 16%. They base their decisions primarily on past experience and possess almost no opinion leadership. They are highly skeptical of innovations and innovators, and must feel certain that a new innovation will not fail prior to adopting it.

Research Brief

Diffusion of Innovation and Adopter Categories

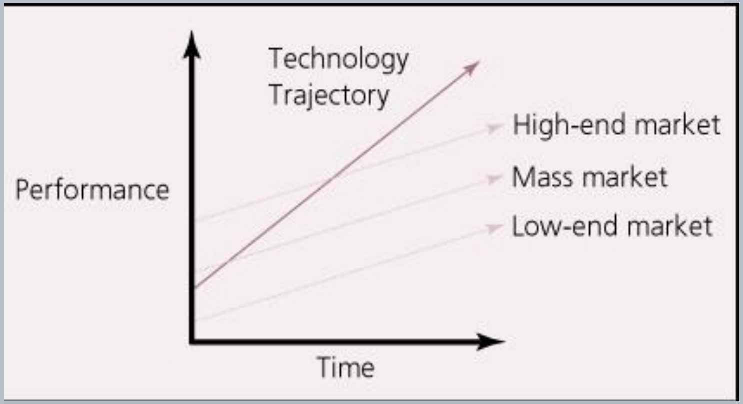


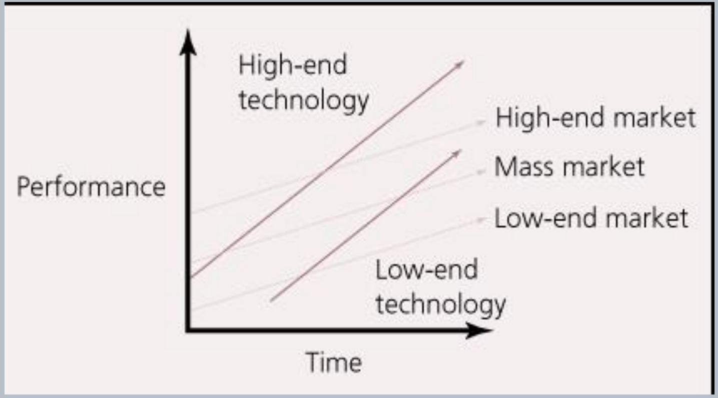


Theory in Action

Technology Trajectories and "Segment Zero"

- Technologies often improve faster than customer requirements demand (E.g. 3D printer)
- This enables low-end technologies to eventually meet the needs of the mass market.
- Thus, if the low-end market is neglected, it can become a breeding ground for powerful competitors. (E.g. Polaroid)



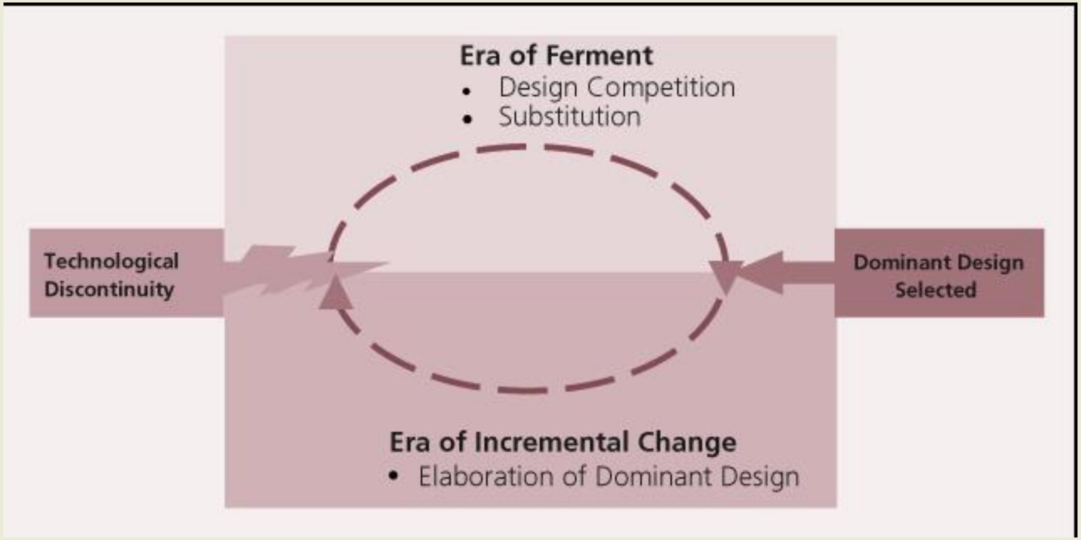


Technology Cycles

- Technological change tends to be <u>cyclical</u>:
  - Each new s-curve ushers in an <u>initial period of turbulence</u>, <u>followed by rapid improvement</u>, <u>then diminishing returns</u>, and ultimately is displaced by a new technological discontinuity.
  - <u>Utterback and Abernathy</u> characterized the technology cycle into two phases:
    - The ***fluid phase*** (when there is considerable uncertainty about the technology and its market; firms experiment with different product designs in this phase) (E.g. Virtual currencies)
    - After a <u>**dominant design**</u> emerges, the *specific phase* begins (when firms focus on incremental improvements to the design and manufacturing efficiency). (E.g. Electric car, Smartphone)

Technology Cycles

- Anderson and Tushman also found that technological change proceeded cyclically.
  - Each discontinuity inaugurates a period of turbulence and uncertainty (era of ferment) until a dominant design is selected, ushering in an era of incremental change.



Chapter 4

Standards Battles and Design Dominance

(First part)

The Rise of Microsoft

- In 1980, Microsoft didn’t even have a personal computer (PC) operating system – the dominant operating system was CP/M.
- However, in IBM’s rush to bring a PC to market, they turned to Microsoft for an operating system and Microsoft produced a clone of CP/M called “MS DOS.”

The Rise of Microsoft

- The success of the IBM PCs (and clones of IBM PCs) resulted in the <u>rapid spread of MS DOS, and an even more rapid proliferation of software applications designed to run on MS DOS</u>.

The Rise of Microsoft

Discussion Questions:

1. What factors led to Microsoft's emergence as the dominant personal computer operating system provider? Is Microsoft's dominance due to luck, skill, or some combination of both?

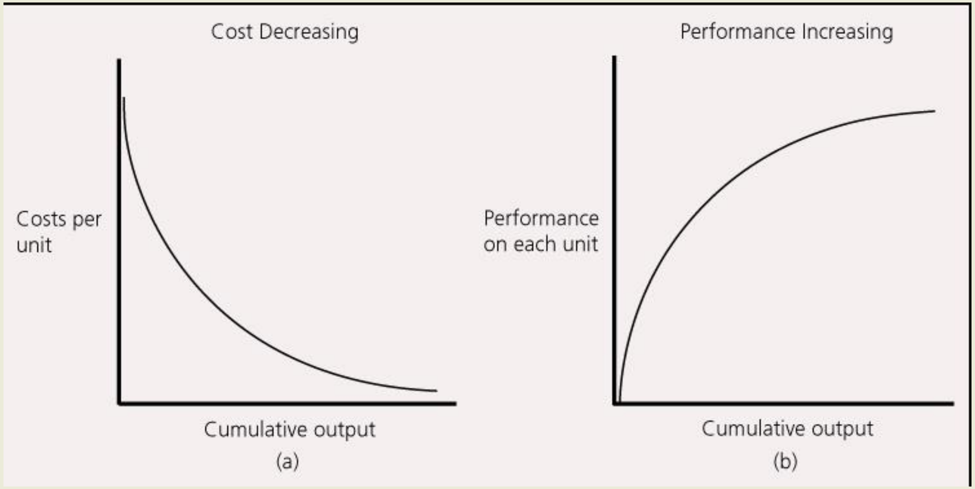
2. Does having a dominant standard in operating systems benefit or hurt consumers? Does it benefit or hurt computer hardware producers?

Overview

- Many industries experience strong pressure to select a single (or few) dominant design(s).
- There are multiple dimensions shaping which technology rises to the position of the dominant design.
- <u>Firm strategies can influence</u> several of these dimensions, enhancing the likelihood of their technologies rising to dominance.

Why Dominant Designs Are Selected

- **Increasing returns to adoption** occurs when a technology <u>becomes more valuable the more it is adopted</u>. Two primary sources are:
- **Learning Effects**
  - **The Learning Curve**: As a technology is used, producers learn to make it more efficient and effective.



Why Dominant Designs Are Selected

- **Prior Learning and Absorptive Capacity:** A firm's prior experience influences its ability to recognize and utilize new information.
  - Use of a particular technology builds knowledge base about that technology.
  - The knowledge base helps firms use and improve the technology

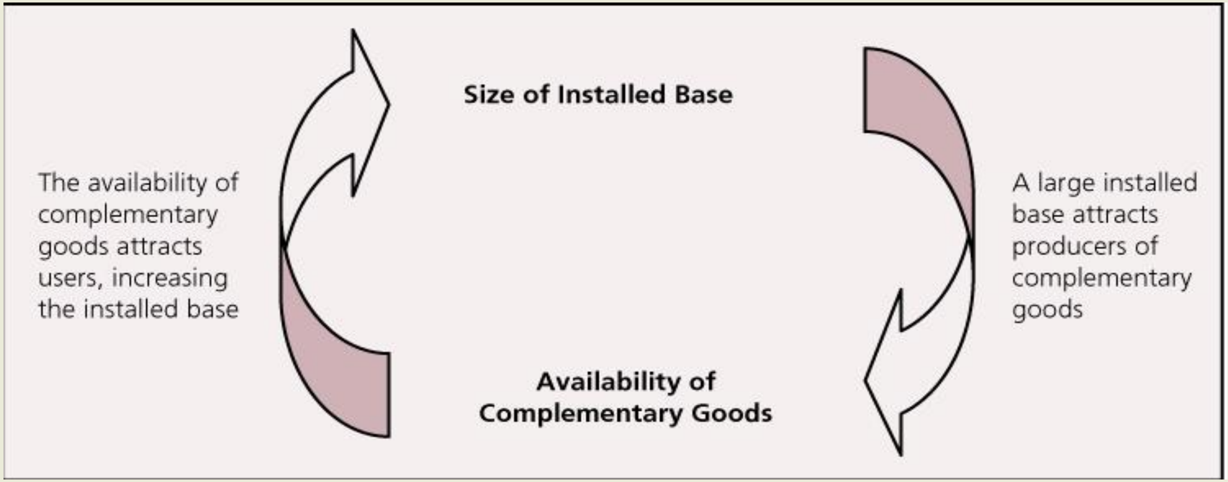
    → Suggests that technologies adopted earlier than others are likely to become better developed, making it difficult for other technologies to catch up.

Why Dominant Designs Are Selected

- **Network Externalities**
  - In markets with network externalities, <u>the benefit from using a good increases with the number of other users of the same good</u>.
  - Network externalities are common in industries that are physically networked
    - E.g., railroads, telecommunications
  - Network externalities also arise when compatibility or complementary goods are important
    - E.g., Many people choose to use <u>**Windows**</u> in order to maximize the <u>number of people their files are compatible with</u>, and the <u>range of software applications they can use</u>.

Why Dominant Designs Are Selected

- A technology with a large installed base attracts developers of complementary goods;
- A technology with a wide range of complementary goods attracts users, increasing the installed base.
  - A self-reinforcing cycle ensues:



Case study

Why Dominant Designs Are Selected

- **Government Regulation**
  - Sometimes the consumer welfare benefits of having a single dominant design prompts <u>government organizations</u> to intervene, <u>imposing a standard</u>.
    - E.g., the NTSC color standard in television broadcasting in the U.S.; the general standard for mobile communications (GSM) in the European Union.
- **The Result: Winner-Take-All Markets**
  - <u>Natural monopolies</u>
    - Firms supporting winning technologies earn huge rewards; others may be locked out.

Why Dominant Designs Are Selected

- Increasing returns indicate that technology trajectories are characterized by *path dependency*:
  - End results depend greatly on the events that took place leading up to the outcome.

- A dominant design can have far-reaching influence; it shapes future technological inquiry in the area.

- Winner-take-all markets can have very different competitive dynamics than other markets.
  - *Technologically superior* products do not always win.
  - Such markets require different firm strategies for success than markets with less pressure for a single dominant design.

Pioneers vs Followers

	Pioneers	Followers
MP3		
Printers		

Pioneers vs Followers

	Pioneers	**Followers**
MP3	Diamond	Apple
Printers	Xerox	HP

Pioneers vs Followers

	Pioneers	Followers
MP3	Diamond	**Apple**
Printers	Xerox	**HP**

Leaders