Innovation

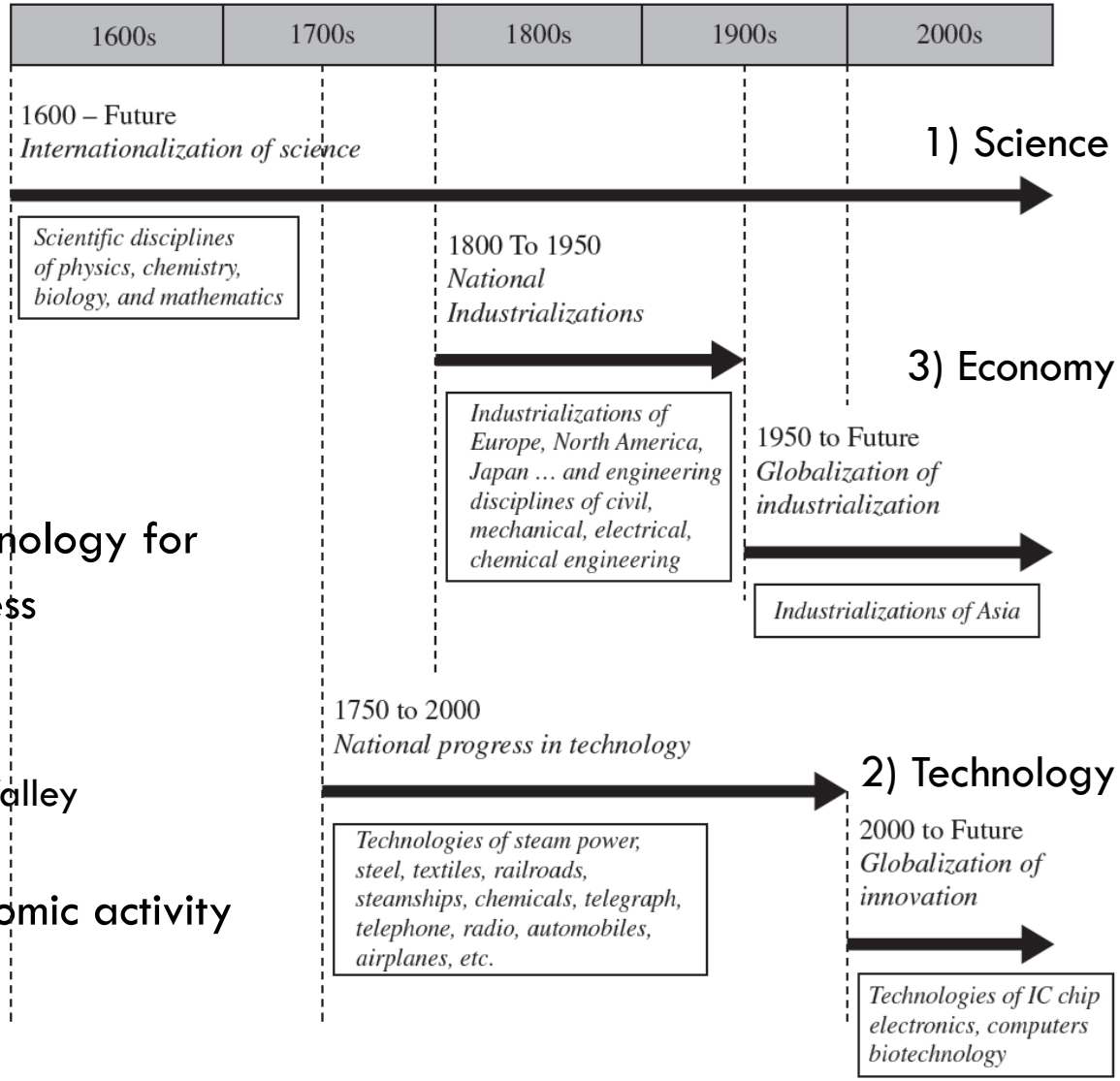
- Formerly: Business side
  - Focus on technological progress to
    - Design
    - Produce
    - Market new services, products, processes
- Technical side
  - Required engineering management (EM)
  - Technical personnal reqirement grew esp. in IT:
    - Programmers
    - Mathematicians
    - Computer scientists
- Now: Management of engineering and technology (MOT)
  - Empirical: describes historical patterns of change in science, technology and economy
  - Theoretical:develops useful concepts, techniques and tools for managing future change in science, technology and economy

Questions to be answered

- How is innovation organized as a process?
- What is technology?
- What kind of technologies are there?
- Why is progress in any technology eventually finite?
- How does technological progress impact a nation?
- How can innovation strategy be formulated for a nation?
- How does technological progress impact a business?
- How can a manager identify technologies relevant to the future of a business?
- How should high-tech research and development projects be managed?
- How should innovation strategy be formulated in a business?
- How does the innovation differ in hardware, software and sciences?
- What is the ethical context of technology?

Timeline of events

- Gunpowder + printing press
- Invented in China
- Innovated in Europe
- Newton: physics+math
- Industrialization trends
  - (1765 – 1865) — Europe
  - (1865 – 1965) — North America
  - (1965 – 2065) — Asia
- Appreciation of science and technology for international economic competitiveness
- Strategic collaboration between academia and high-tech companies
  - Stanford and UCBerkeley: Silicon Valley
  - Singapore, Taiwan, South Korea…
- Global trade = 26% of all economic activity

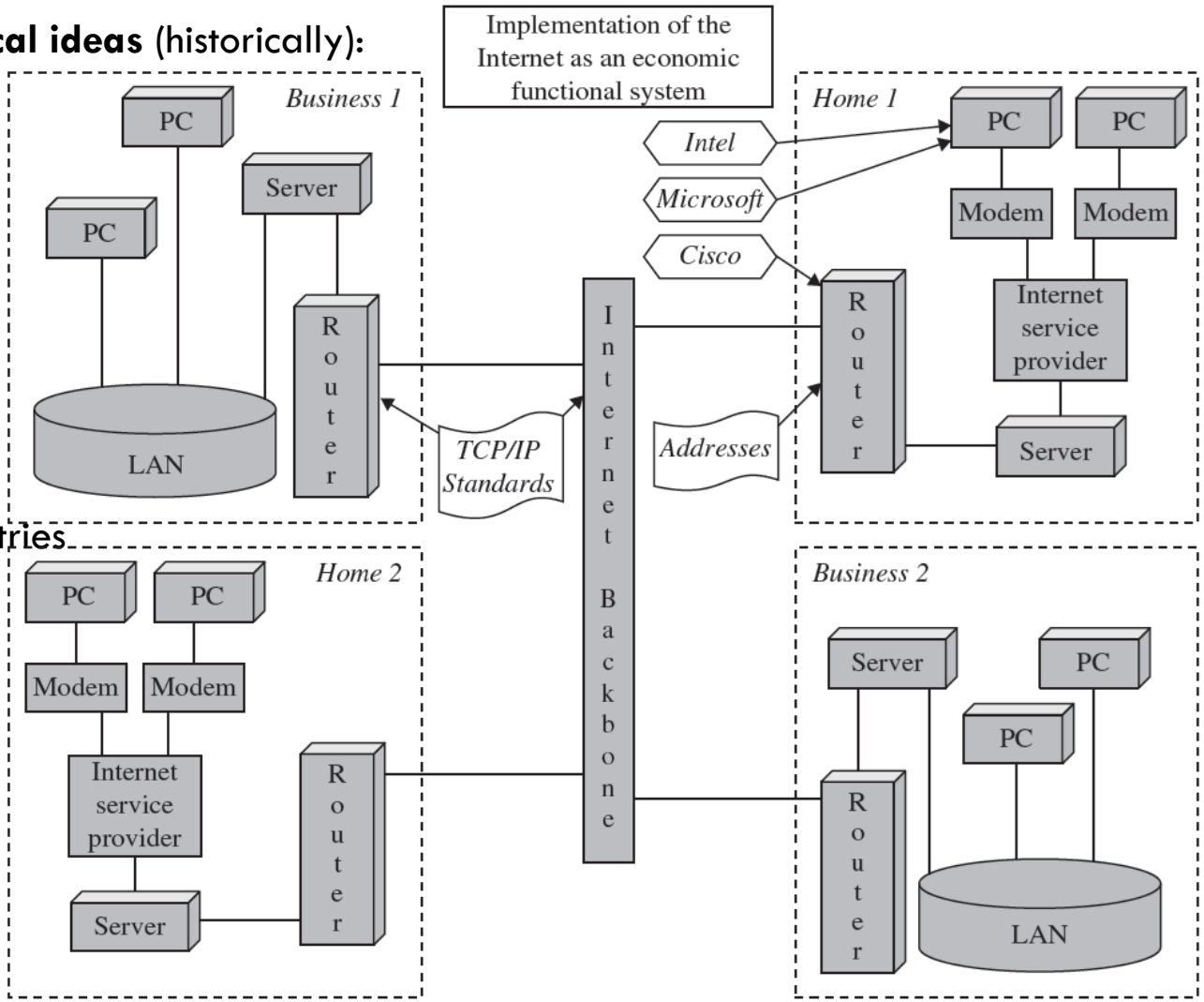


Always keep in mind: Key factors in globally effective industrialization

- political forms
- national and industrial infrastructures
  - police and judicial systems
  - public health and medical systems
  - energy systems
  - transportation systems
  - communication systems
- domestic markets
- firm strategies

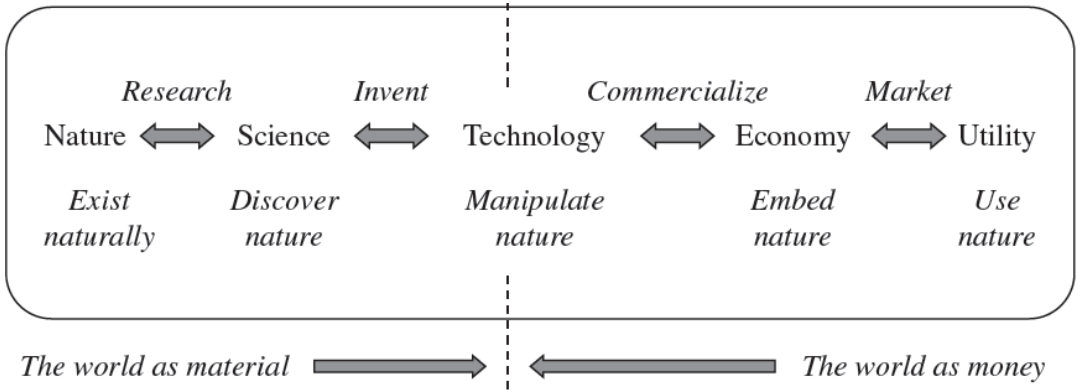
Case Study: (Macro-)Innovation of the Internet (~1960s-today)

- Two important components for an innovation
- Required invention of **technical ideas** (historically):
  - PC-PC comm.
  - Packet-switching
  - Standards, protocols
  - Routing
  - HTML
  - WWW
  - Browser
  - Search Engine
  - Web page publication
- Growth of **commercial** industries
  - PC's
  - Microproc.
  - OS
  - Modems
  - ISPs
  - Server+router
  - LAN, WAN
  - Backbones
  - Search services, etc.



Innovation Process - Overview

- **Nature**: Totality of the essential qualities of the observable phenomena of the universe. (Material, sovial, biological, etc.)
- **Science**: Discovery and explanation of nature
  - Knowledge about nature – what it is (discovery) and how it operates (expl.) - is gained by ***research***
- **Technology**: Knowledge of the manipulation of nature for human purpose
  - Scientific knowledge is used to create new technologies through the act of ***invention***
- **Economy**: Social process of the human use of nature as utility
  - Technical knowledge is embedded within a product through design. ***Commercialization*** is the act of embodying technology into the products/services/processes.



Characteristics of Innovations

- Innovations are new products, processes or services aimed to be **commercialized**.
- Innovations can be **offered in the market** (products or services) or applied **within a firm** (mainly as processes).
- Innovations result in a **considerable benefit** or **increase of efficiency** (leap in progress); this distinguishes them from improvements.
- Innovations generate substantial **benefits for the users**.
- Within innovations we differentiate between **incremental** and **radical** innovations. Radical innovations are breakthroughs with a major impact on production and application patterns. (i.e. drive by wire, biodegradable packages)
- Innovations include **high risks**.
- Innovations need **long time** to ripe and enter the market.
- The emergence of innovations is in most cases a **complex process**.

Case Study: (Micro-)Innovation of Google Inc.

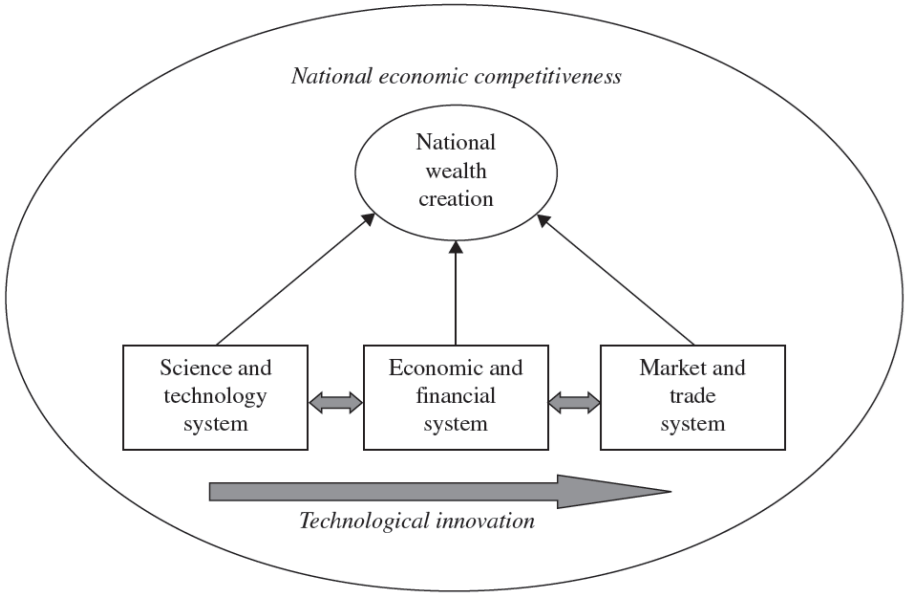
- The company used the **macro-level technology** of the Internet to begin a new business in the **micro-level technology** of a search engine.
- Founded in 1998 by Sergey Brin and Larry Page (PhD students in Stanford Uni.)
- Idea: The importance of the page is measured by the number of links pointing to it.
- Licensing at the university
- Spin-off company
- Funded by Sun Microsystems ($100,000)
- How to earn money?
- By 2005, advertising revenues: $6 bln. (98.8% of all)
- It started by licensing its «software», but later became an advertising company.
- Compared to Yahoo! (first search engine), accuracy, speed, ease of use, and objectivity was superior.
- It also charged the advertisers not on view but only on click-throughs.
- Business model: Provide values: (1) search value to its users (market base), (2) sales value to its advertisers (Google's customers)
- Always in search of new services -> Improved brand name

Technology and Wealth

- Technological innovation is commercialized in economic systems to add value to markets and to international trade.
- Technological innovation provides a competitive advantage for exports and for the businesses in a nation, thus contributing to wealth creation.
- To create wealth, two stages are necessary in innovation:

(1) inventing new technology and

(2) commercializing new technology in high - tech products or services.



Innovations within Systems or System Products

Three types of innovations:

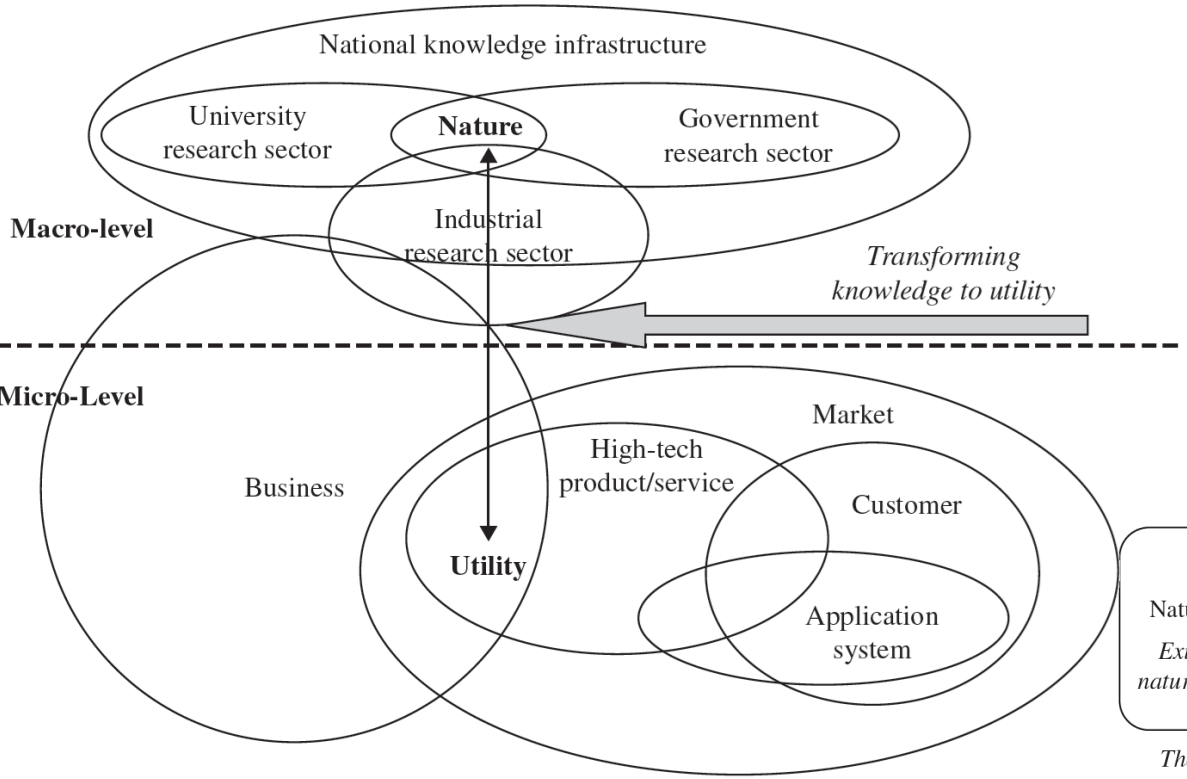
- *Radical innovation* — a basic technological innovation that establishes a new functionality (e.g., Internet, steam engine, or steamboat)
- *Incremental innovation* — a change in an existing technology system that does not alter functionality but incrementally improves performance or lowers cost (e.g., regulator on a steam engine)
- *Next-generation technology innovation* — a change in an existing technology system that does not alter functionality but dramatically improves performance, features, safety, or quality, or lowers cost — to open new applications (e.g., substitution of jet propulsion for propellers on airplanes, transistors for electron vacuum tube)
- Discuss the innovation on computers throughly 1950-201X.

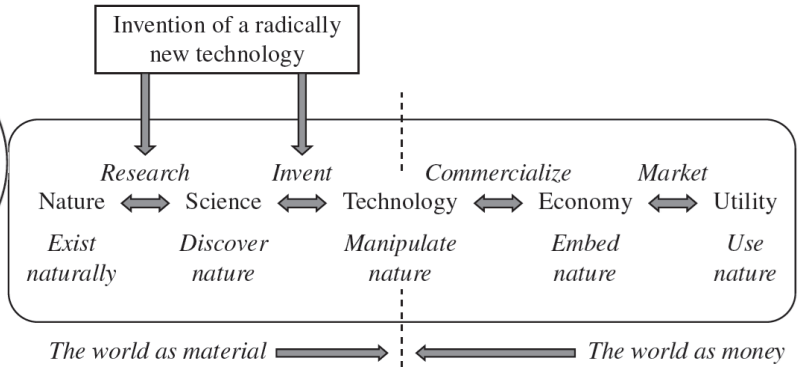
Economic Scale of Innovations

- Radical innovations occur as (1) basic new technologies or (2) next – generation technology innovations.
- Incremental innovations occur as small but significant improvements in an existing technology.
- Discontinuous technological innovation provides the competitive conditions for displacing older businesses — by beginning new businesses and growing a new industry.
- Continuous (incremental) technological innovation enables an existing firm to defend against competitors and to grow its markets.

Transforming knowledge to utility

- The process of radical innovation consists of many interactions between (1) national research sectors of university and government and industry and between (2) high - tech firms and markets of customers.

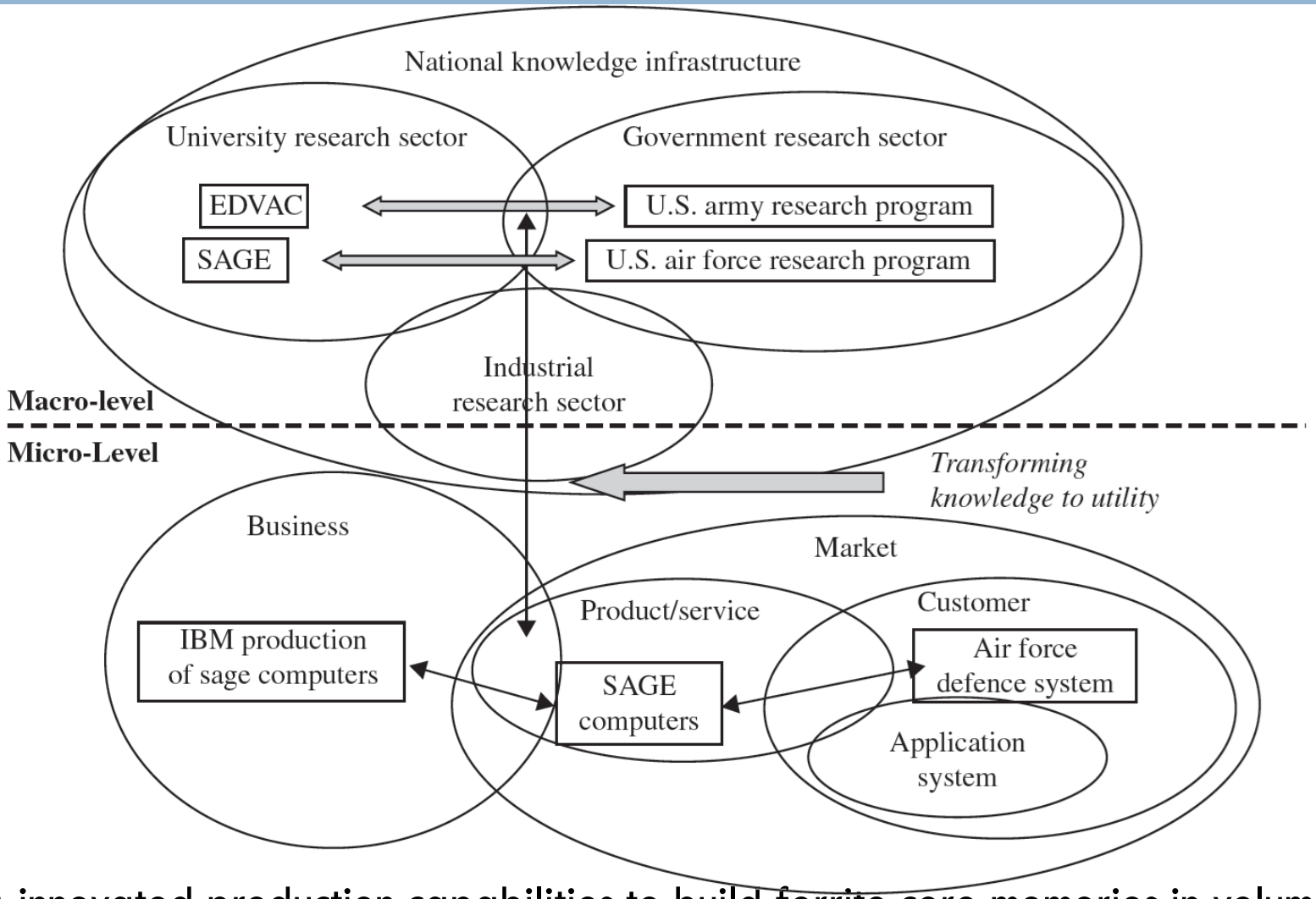




3 Highlights from the national innovation system

- The technological sophistication of a high-tech business is bounded by the *research capability* of the industrial, university, and governmental R & D infrastructure.
- The research and technological capability of a business is known to a customer only through the business's products. In a high-tech business, research and technical capability that do not directly contribute to product performance, quality, or price are not valuable to the business because they are not seen by a customer.
- Since the satisfaction of a customer with a product depends on its performance in an application (and since a business does not directly experience the application), it is the *application* that is the greatest source of uncertainty about commercial success in the design of a product.

Case Study: Radical Innovation of Computer

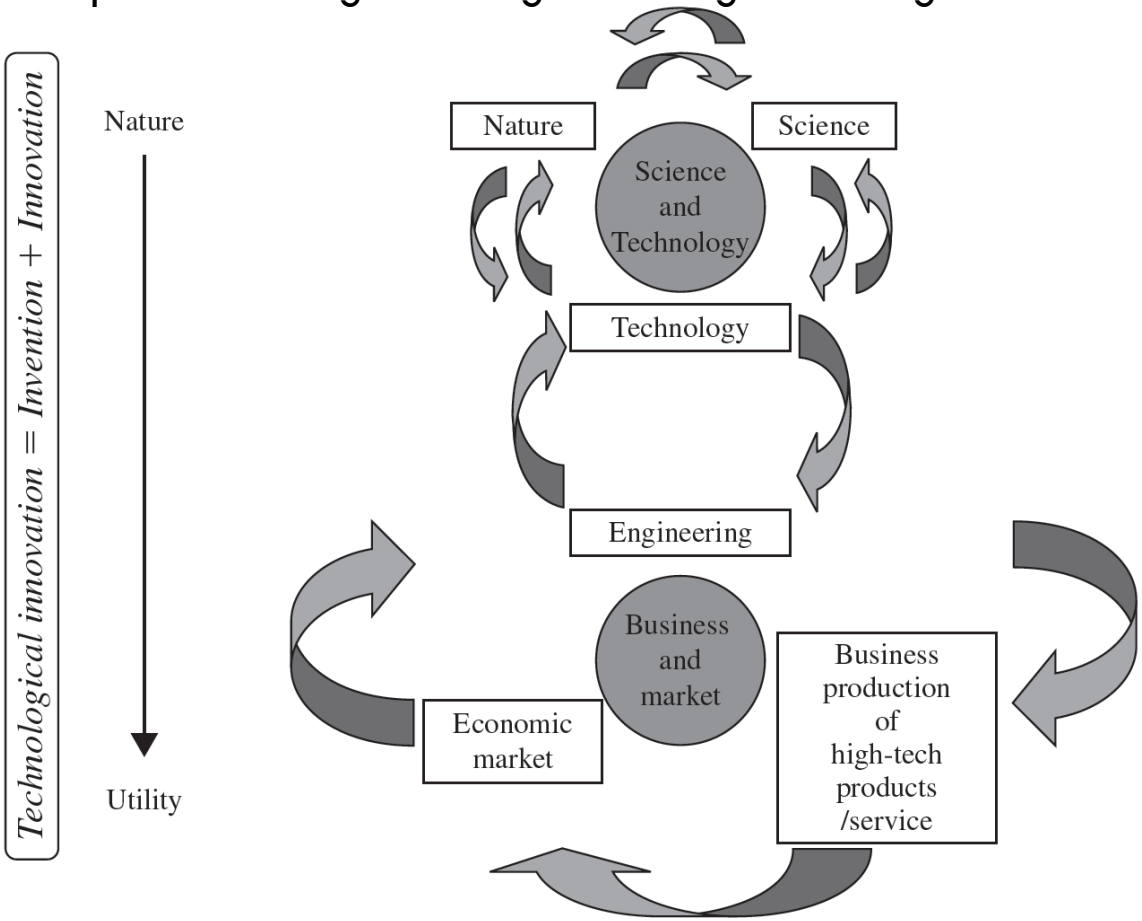


- IBM innovated production capabilities to build ferrite core memories in volume

Circular Interactions in an Innovation System

The flow of knowledge in the process of radical technological innovation is *linear*, in that knowledge does ultimately flow from nature into utility.

Yet the infrastructure processes of generating and using knowledge are interactive and *circular*



Performance of National Innovation Systems

- A national innovation system should have **strong research capabilities** in its **industrial sectors.**
- A national innovation system should have a **high - quality research – oriented university** sector.
- A national innovation system should have **at least one strong internationally competitive industrial or service sector.**
- A national innovation system should have a **culture of valuing high quality of performance.**
- A national innovation system should be **supported by government** policies that strongly fund appropriate R & D activities in universities and selected mission areas.
- A way to identify **cutting-edge science** (which can help surpass current technology) should be a national science and technology policy priority.
- Science and technology policy must support research for technology improvement in current industries, and research **to establish new internationally competitive industries** in new technologies.