TECHNOLOGICAL CHANGE: ‘GALES OF CREATIVE DESTRUCTION’

Lecture 4

EAS 501

Thursday, September 4, 2025

Technological Change

- Technological Change is which of the following?
  - A fundamental force in shaping the patterns of transformation of the economy
  - One of the most important processes underlying the globalization of economic activity
  - A socially and institutionally embedded process
  - Must be viewed within social and economic context, informed by values and motivations

Four Types of Technological Change

- Incremental innovations
  - Small-scale, progressive modifications of existing products and processes
- Radical Innovations
  - Discontinuous events that drastically change existing products or processes; a cluster of such innovations
- Changes of technology system
  - Extensive changes in technology that impact several parts of the economic system
- Changes in techno-economic paradigm
  - Large-scale revolutionary changes, embodied in new technology systems

Kondratiev Long Waves

- Capitalism goes in cycles of prosperity, recession, depression, and recovery
- K-Wave: +- 50 years in duration
- Each wave associated with change in techno-economic paradigm

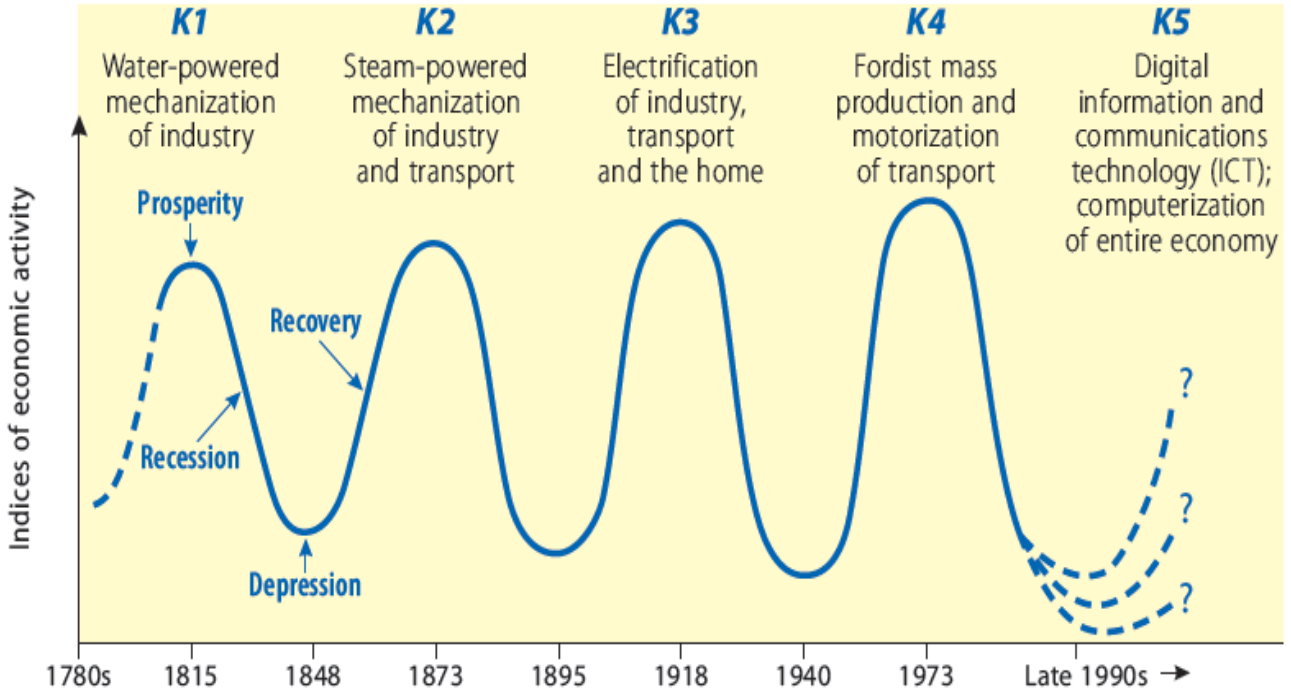


Figure 4.2 Kondratiev long waves

Source: based, in part, on Freeman and Louçã, 2001: Table II.1

Key Characteristics of Successive K-Waves

	K1	K2	K3	K4	K5
Main 'carrier' branches	Textiles; Textile chemicals; Textile machinery; Iron working/castings; Water power; Potteries.	Steam engines; Steamships; Machine tools; Iron and steel; Railway equipment.	Electrical engineering; Electrical machinery; Cable and wire; Heavy engineering/ armaments; Steel ships; Heavy chemicals; Synthetic dyestuffs.	Automobiles; Trucks; Tractors; Tanks; Aircraft; Consumer durables; Process plant; Synthetic materials; Petrochemicals.	Computers; Digital information technology; Internet; Software; Telecommunications; Optical fibres; Robotics; Ceramics; Nanotechnology; Biotechnology.
Core input and other key inputs	Iron; Raw cotton; Coal.	Iron; Coal.	Steel; Copper; Metal alloys.	Oil; Gas; Synthetic materials.	'Chips' (integrated circuits).
Transport and communications infrastructure	Trunk canals; Turnpike roads; Sailing ships.	Railways; Shipping.	Electricity supply and distribution.	Highways; Airports/airlines.	Digital networks; Satellites.
Organization of firms and forms of cooperation and competition	Factory systems. Individual entrepreneurs and small firms (<100 employees) competition. Partnership structure facilitates cooperation of technical innovators and financial managers. Local capital and individual wealth.	High-noon of small-firm competition, but larger firms now employing thousands rather than hundreds. As firms and markets grow, limited liability and joint stock company permit new pattern of investment, risk-taking and ownership.	Emergence of giant firms, cartels, trusts, mergers. Monopoly and oligopoly becomes typical. Regulation or state ownership of 'natural' monopolies and public utilities. Concentration of banking and 'finance-capital'. Emergence of specialized 'middle management' in large firms.	Mass production and consumption. 'Fordism'. Oligopolistic competition. Transnational corporations based on direct foreign investment and multi-plant locations. Competitive subcontracting on 'arm's length' basis or vertical integration. Increasing concentration, divisional-ization and hierarchical control. 'Techno-structure' in large corporations.	'Networks' of large and small firms based increasingly on computer networks and close co-operation in technology, quality control, training, investment planning and production planning ('just-in-time') etc.
Geographical focus: core country or countries	Britain.	Britain (spreading into Europe and USA).	USA and Germany forging ahead and overtaking Britain.	USA (with Germany at first competing for world leadership), later spreading to Europe.	USA (spreading to Europe and Asia).

Figure 4.3 Key characteristics of successive K-waves

Source: based, in part, on Freeman and Perez, 1988: Table 3.1; Freeman and Louçã, 2001: Table II.1; Perez, 2010: Table 1

Information and Communications Technologies: A Convergence

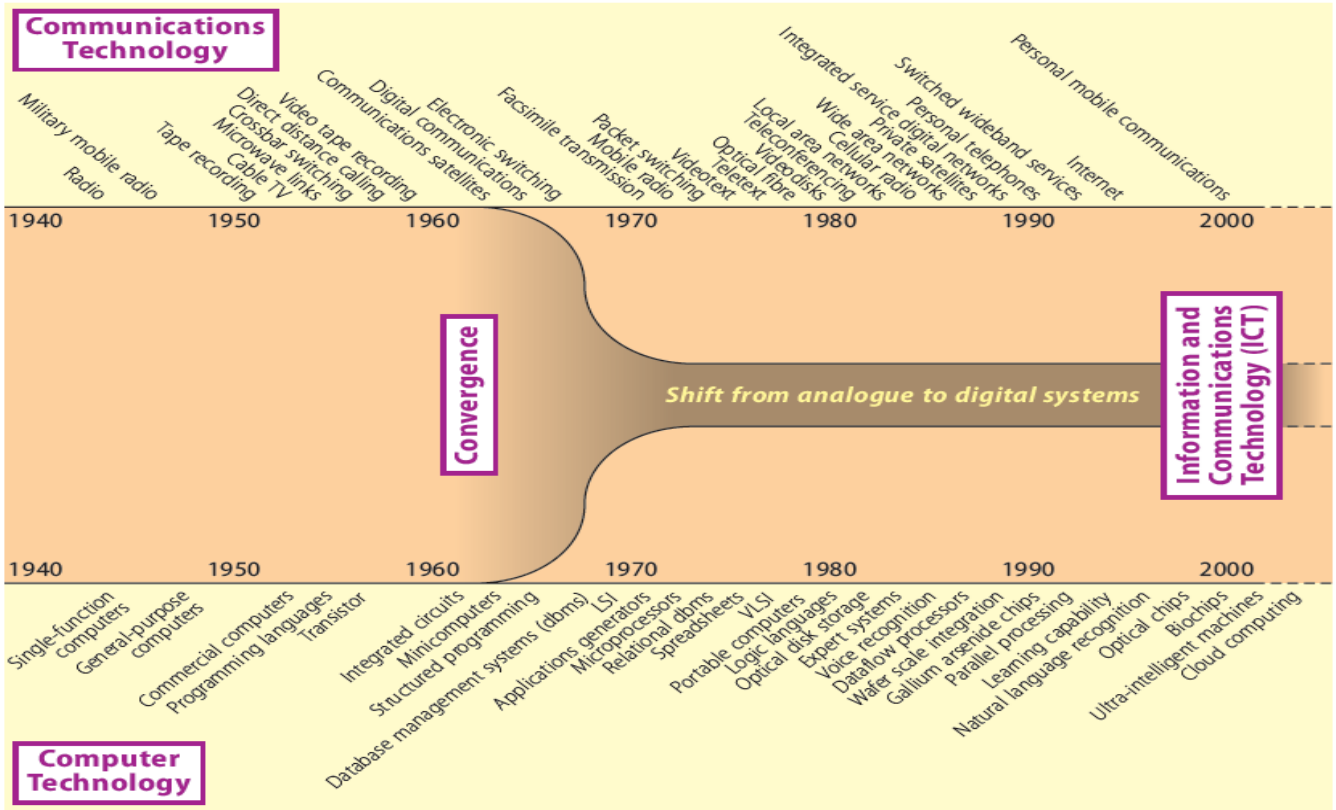


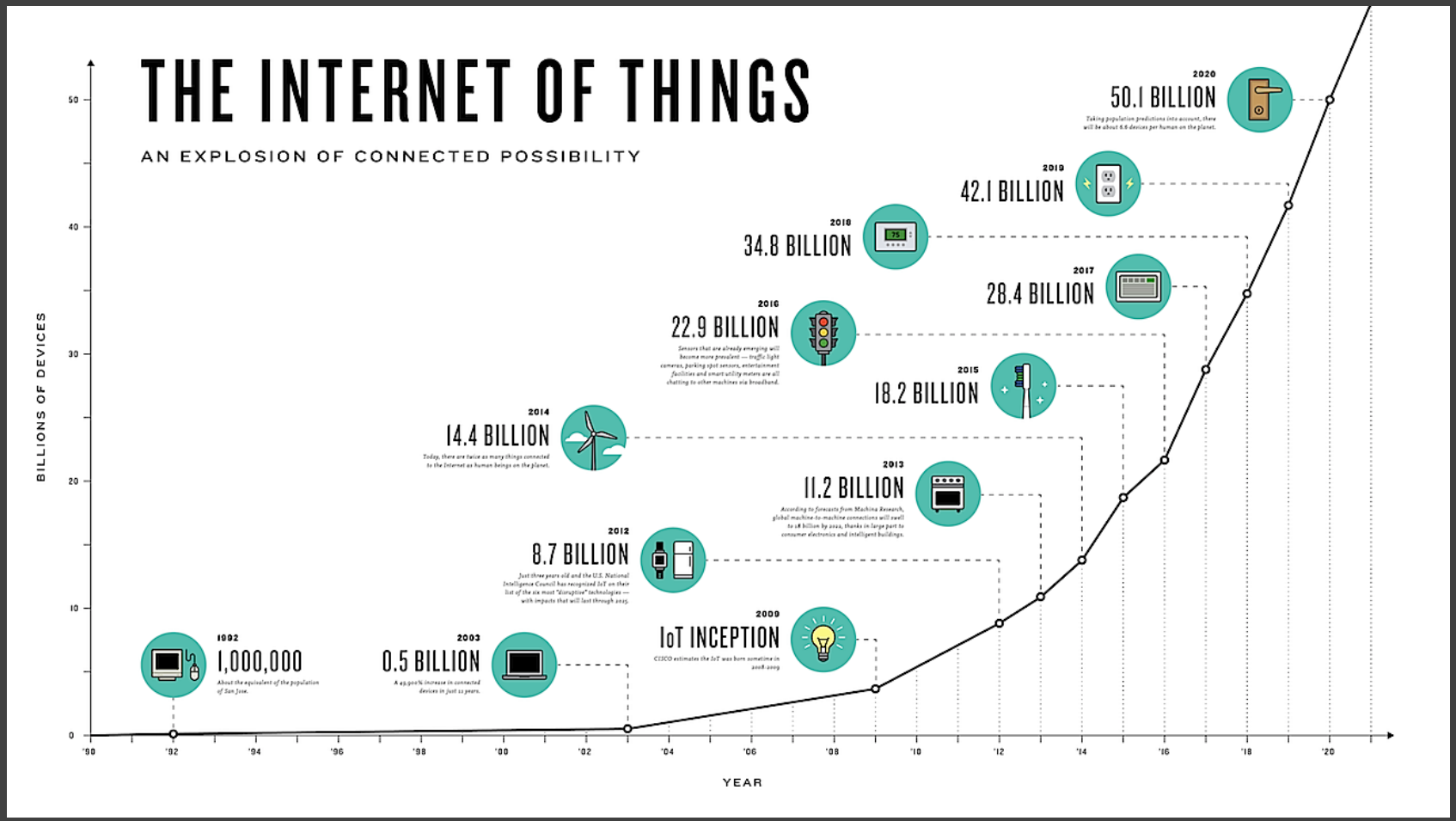
Figure 4.4 Information and communications technologies: a process of convergence

Source: based, in part, on Freeman, 1987: Figure 2

Time-Space Shrinking Technologies: Circulation Technologies

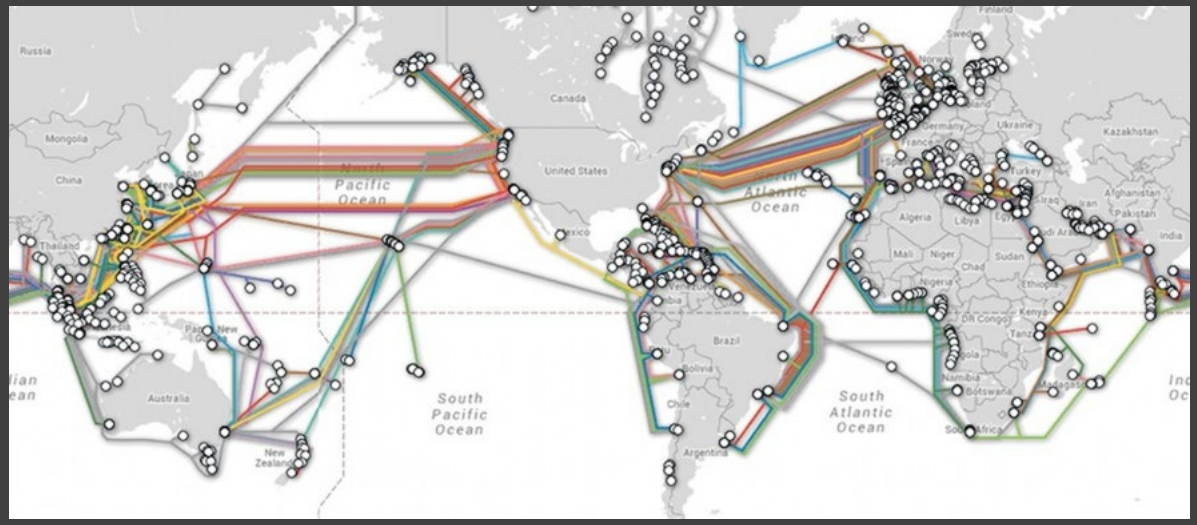
- Communications Systems
  - Means by which information is transmitted from place to place in form of ideas, instructions, images, and so on.
- Transportation Systems
  - Means by which materials, products and other entities (including people) are transferred from place to place

Exponential Growth of the Internet



Growth in Information Carrying Capacity of Submarine Cable Systems

- 90% of all international telecommunications is via optical fiber cables
- Internet Traffic spurring growth



Example: Commercial Jet Aircraft

- Introduced in the 1950s
- Between 1950 and 2004, air freight prices fell from $3.87 per ton to less than $.30 in 2000 US dollars
- Fostered growth of Transnational Corporations
- Move freight in addition to people!
- Sockeye Salmon from Alaska

Example: Containerization

- First container ship launched in 1956
- Shrunk the planet and brought about a revolution because the cost of shipping “boxes” is so cheap
- Intermodal transport

World's Leading Container Hubs

Source: Lloyd's List Top 100 Ports Ranking

Logistics Processes in a Transnational Context

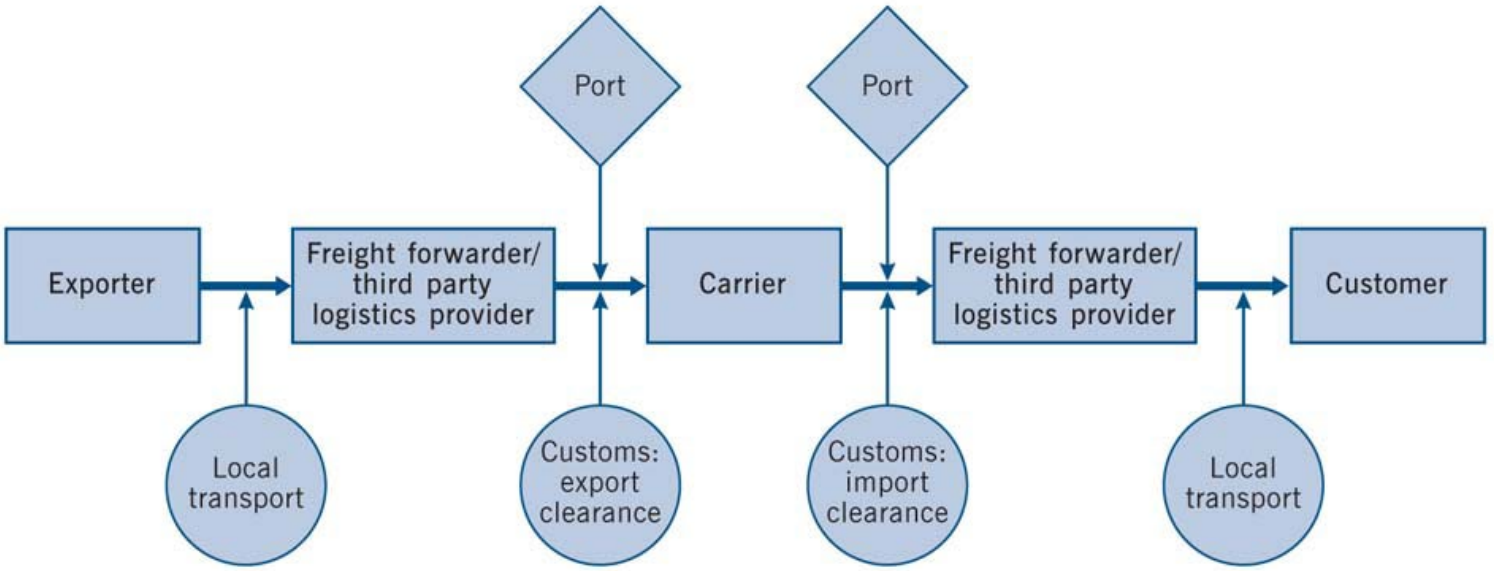


Figure 13.2 Logistics processes in a transnational context

Source: adapted from Schary and Skjøtt-Larsen, 2001: Figure 11.7

The World is Shrinking

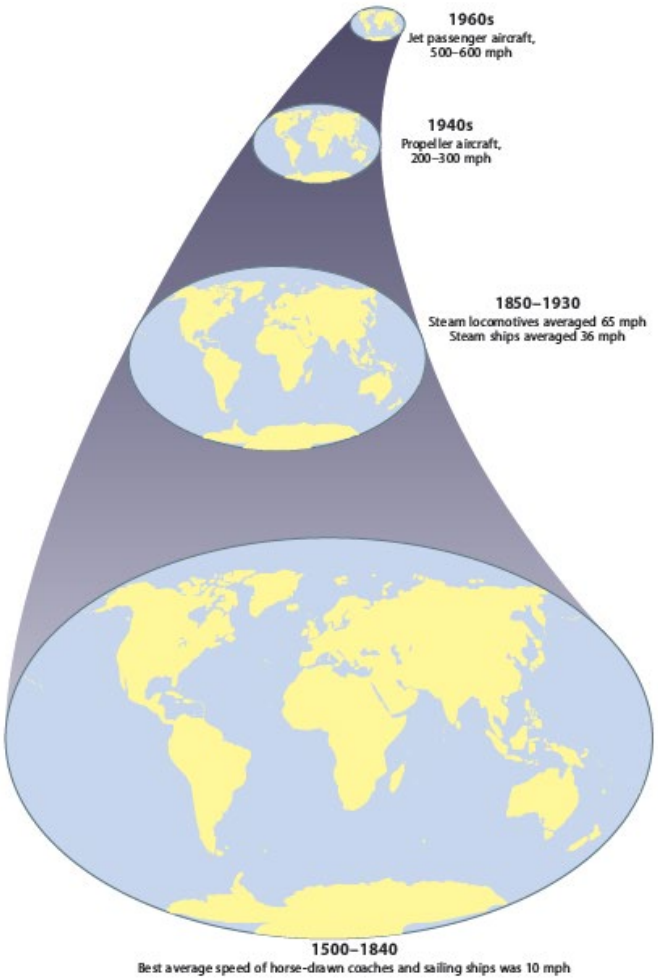
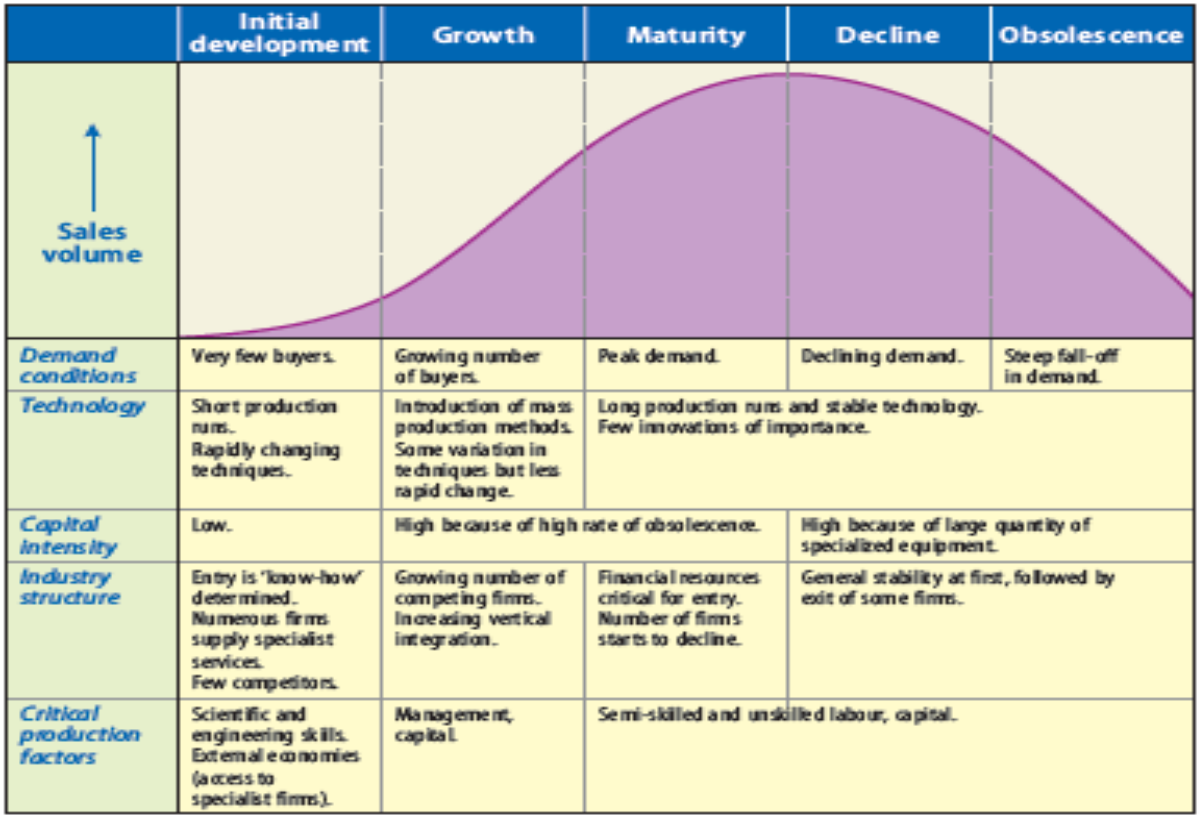


Figure 4.7 Global shrinkage: the effects of transportation innovations on 'real' distance

Source: based on McHale, 1969: Figure 1

Technological Innovations in Products, Production Systems and Organizational Forms



	Initial development	Growth	Maturity	Decline	Obsolescence
Demand conditions	Very few buyers.	Growing number of buyers.	Peak demand.	Declining demand.	Steep fall-off in demand.
Technology	Short production runs. Rapidly changing techniques.	Introduction of mass production methods. Some variation in techniques but less rapid change.	Long production runs and stable technology. Few innovations of importance.		
Capital intensity	Low.	High because of high rate of obsolescence.		High because of large quantity of specialized equipment.	
Industry structure	Entry is 'know-how' determined. Numerous firms supply specialist services. Few competitors.	Growing number of competing firms. Increasing vertical integration.	Financial resources critical for entry. Number of firms starts to decline.	General stability at first, followed by exit of some firms.	
Critical production factors	Scientific and engineering skills. External economies (access to specialist firms).	Management, capital.	Semi-skilled and unskilled labour, capital.		

Figure 4.15 The product life cycle

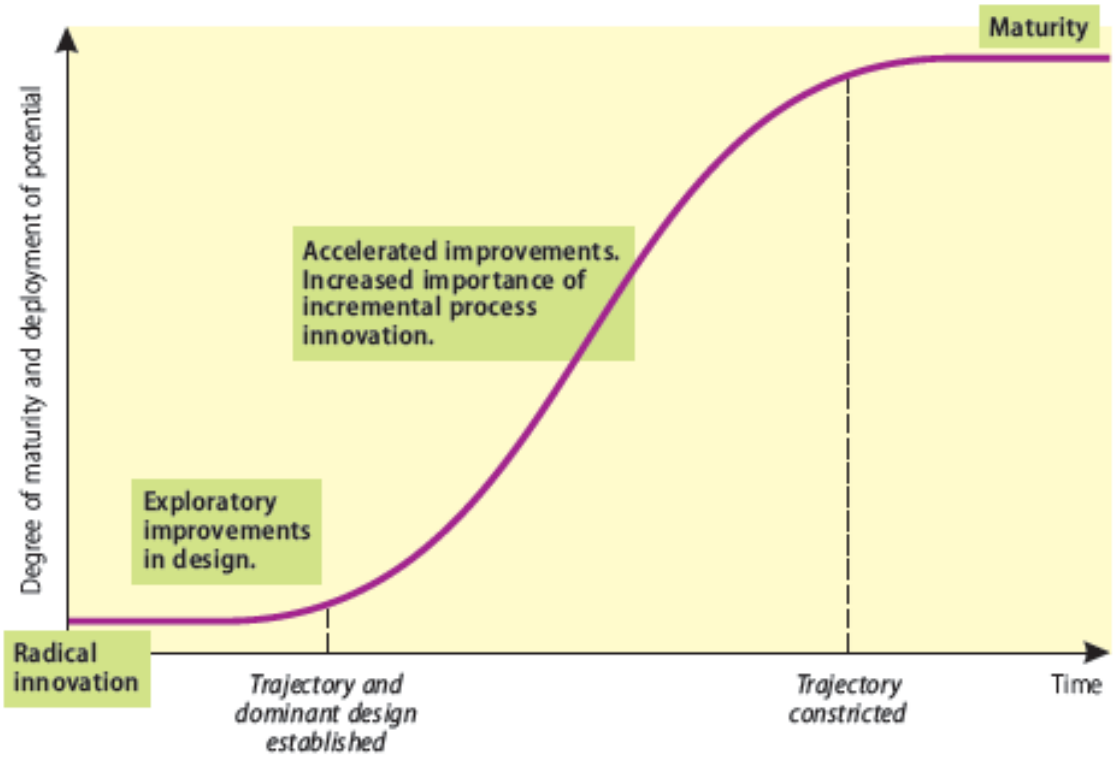


Figure 4.1 **Technological innovation: an idealized developmental trajectory**

Source: based on Perez, 2010: Figure 1

Craft Production > Mass Production > Flexible/lean Production

Characteristic	Craft production	Mass production	Flexible/lean production
Technology	Simple but flexible tools and equipment using non-standardized components.	Complex but rigid single-purpose machinery using standardized components. Heavy time and cost penalties in switching to new products.	Highly flexible production methods using modular component systems. Relatively easy to switch to new products.
Labour force	Highly skilled in most aspects of professional production.	Very narrowly skilled workers design products but production itself performed by unskilled/semi-skilled 'interchangeable' workers. Each performs a relatively simple task repetitively and in predefined time sequence.	Multi-skilled, polyvalent workers operate in teams. Responsible for several manufacturing operations plus simple maintenance and repair.
Supplier relationships	Very close contact between customer and supplier. Most suppliers located within single city.	Distant relationships with suppliers, both functionally and geographically. Large inventories held at assembly plant 'just in case' of supply disruption.	Very close relationships with functionally-tiered system of suppliers. Use of 'just-in-time' delivery systems encourages geographical proximity between customers and suppliers.
Production volume	Relatively low.	Extremely high.	Extremely high.
Product variety	Extremely wide: each product customized to specific requirements.	Narrow range of standardized designs with only minor product modifications.	Increasingly wide range of differentiated products.

Figure 4.17 The major characteristics of craft production, mass production and flexible/lean production

Source: based, in part, on material in Womack et al., 1990

Change in Techno-Economic Paradigm: Fordism ➲Post-Fordism

- Fordism: System of mass production and consumption, highly industrialized economies during the 1940s-60s.
  - Largely national-scale, centralized production sytems
- Post-Fordism: System of flexible production, emerging throughout the world.
  - Increasingly globalized commodity production-consumption networks
- What technological changes have brought about post-Fordism?

Changing Organizational Forms

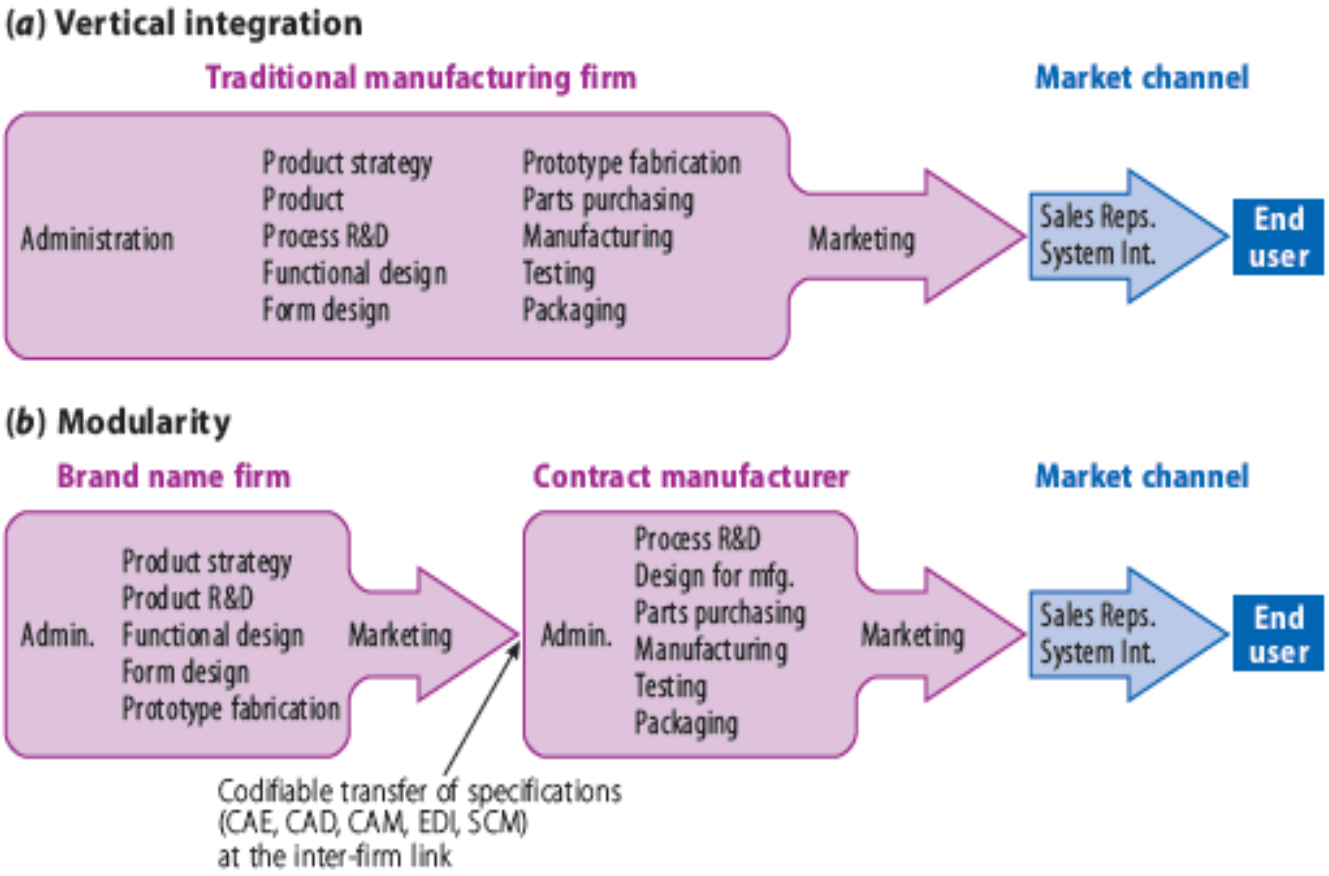


Figure 4.18 From vertical integration to a modular production network

Source: based on Sturgeon, 2002: Figure 1

Towards a Network Organization

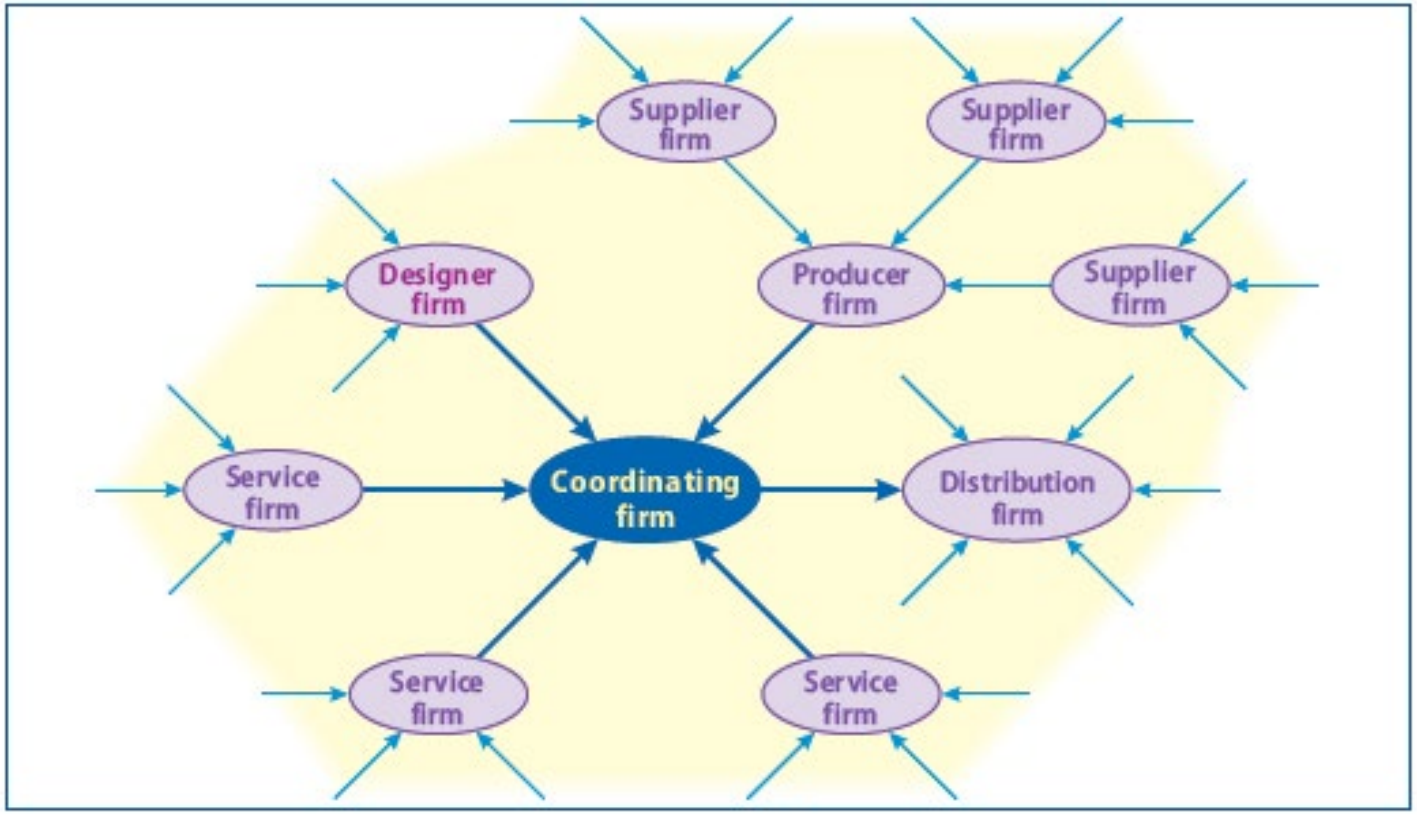


Figure 4.19 A cellular network organization

Source: based, in part, on Miles and Snow, 1986: Figure 1

Geographies of Innovation

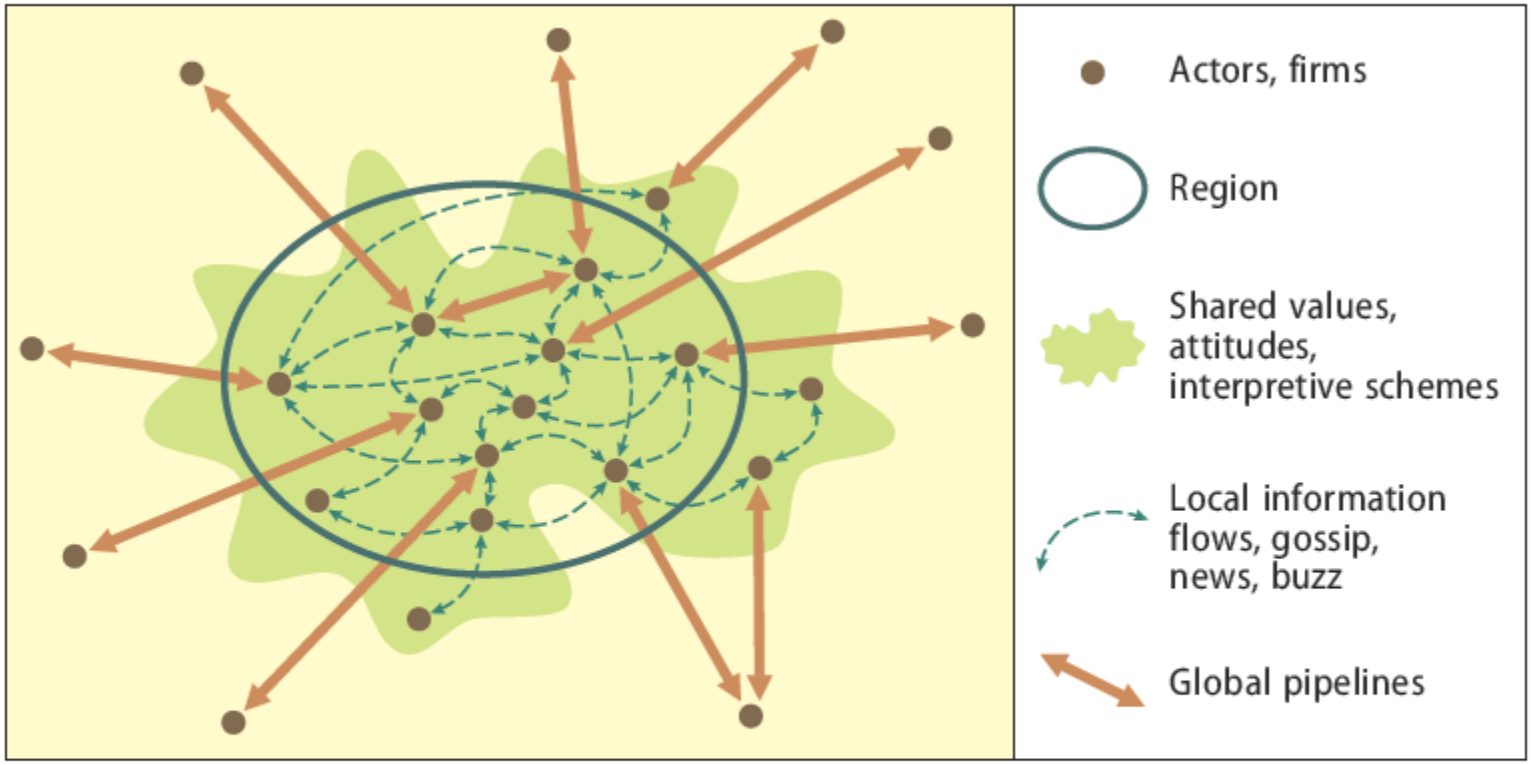


Figure 4.22 Localized knowledge clusters in a wider context: local buzz and global pipelines

Source: based on Bathelt et al., 2004: Figure 1

Technological Change and Supply Chains

- What have been the most influential technological innovations in your lifetime?
- How have these reconfigured GVCs/GPNs?
- What do you see at the most influential innovations that have not yet emerged? How might these affects GVCs/GPNs?

Blockchain Technologies

"A digital ledger in which transactions made in Bitcoin or another cryptocurrency are recorded chronologically and publicly"

- No single point of control and no single point of failure.
- Robust, transparent and virtually incorruptible
- Heralded as a new internet

Blockchain and Environment

- Blockchain can be used to track environmental compliance and the impact of Treaties — decreasing fraud and manipulation.
- Donations to charities can be tracked to ensure that they are being attributed efficiently and as planned.
- Products can be tracked from origin to source. This can help reduce carbon footprints, increase ethical accountability and reduce unsustainable practices.
- Schemes such as recycling can be incentivized by offering token rewards to participants.
- Peer-to-peer localized energy distribution is possible, rather than the current system of a centralized hub.
- Blockchain can also be used to track the carbon footprint of products, which can then determine the amount of carbon tax to be charged.

Technological Change and Jevon's Paradox

- Where a technology that increases the efficiency of resource use actually increases, rather than decreases, the rate of consumption of that resource.
- Coal demand increased with more energy efficient steam engines in the 1800s
- Technological innovation may actually lead to resource decline, degradation, and other environmental problems

Role of Technology

- "Wild Card" in IPAT Equation
- Dematerialization of individual products, but not overall reduction in environmental impact over the past fifty years.
- In fact, it has been increasing.
- As our ecological/sustainability consciousness evolves will "gales of creative destruction" change accordingly?

Group Work

- Consider *Technological Change* within your extractive industry supply chain
- How has it changed this GVC/GPN so far?
- How might it change in the future?
- How could it be deployed to foster sustainability and/or equity?