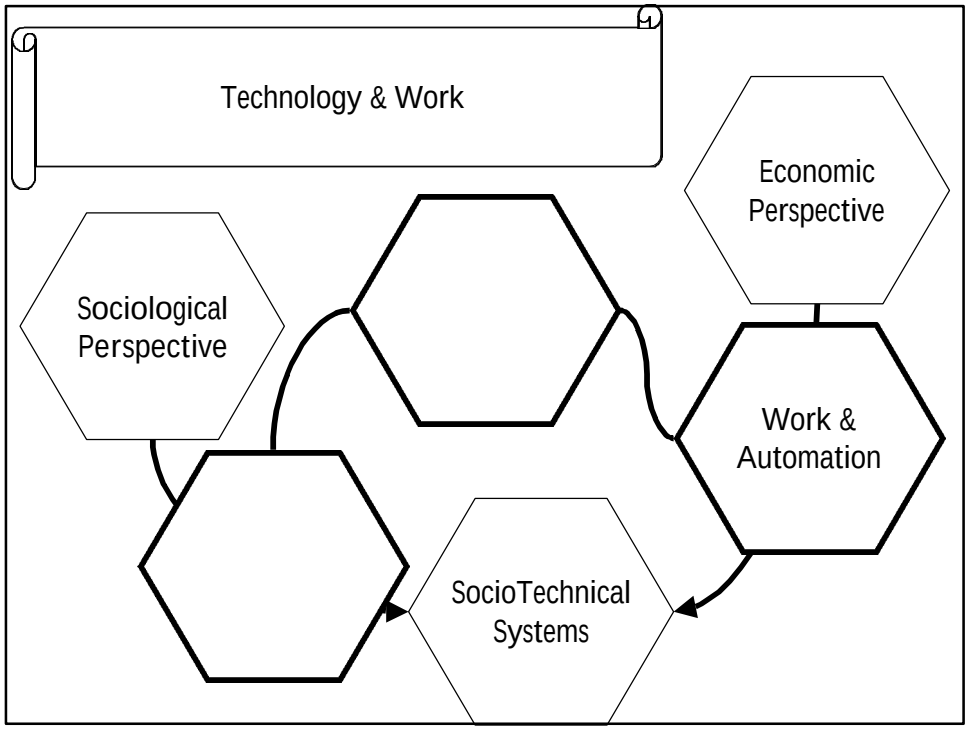


Agenda

- Elsewhere in your studies, you may be thinking about technology from a technical perspective - as a branch of engineering.

- In this module, we shall be looking at technology from a business perspective.
  - Economics
  - Ethics
  - Sociology
  - Systems Theory
- Technical details are relevant to this module only if they illustrate something interesting outside the technical domain.

What is Technology? (Think more broadly)

Scope and Focus

- Both Tools and Processes
- Both Old-Tech and High-Tech
- Many accounts of technology apparently regard Old Stone Age technologies (and their modern equivalents) as more important / interesting than New Stone Age ones. But social historians such as Lewis Mumford and Dora Russell suggest that this preference reflects gender bias.
- While certain technologies attract more attention than others, similar theoretical principles apply to all technologies, however old-fashioned and unglamorous.

Old Stone Age

- Moving, manipulating, assaulting
- Fire, spears, arrows
- Hunting, gathering

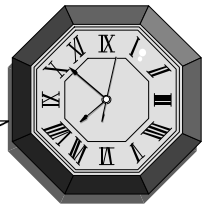

New Stone Age

- Containing: protecting and preserving
- Baskets, pots, bins, vats, barns
- Cooking, milking, dyeing, tanning, brewing, gardening.

Perhaps the defining technology of the past millennium

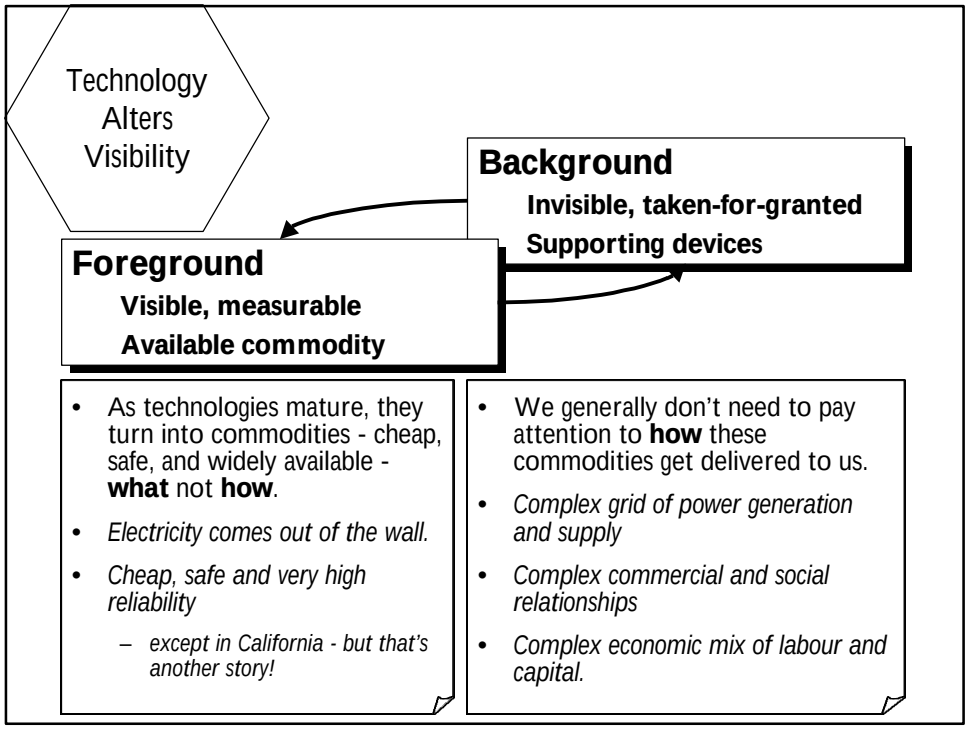
The clock.

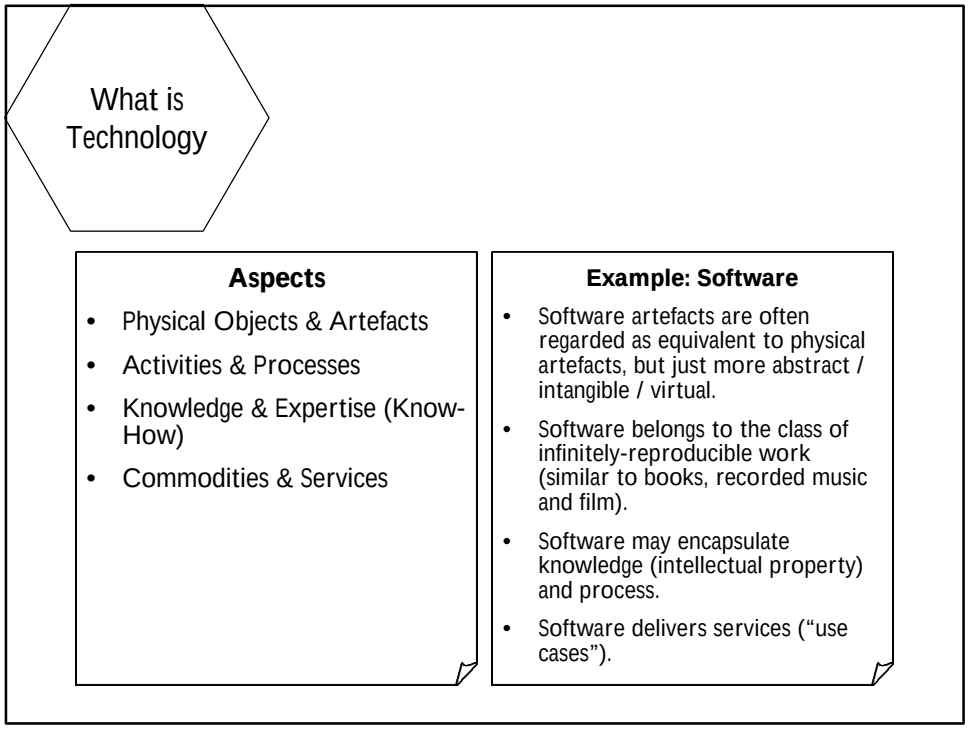
"I was your slave, now you are mine, I am Time."



- Mechanical clocks were invented around 1000 CE.
  - *Pope Sylvester II*
- Monasteries used the clock to control work and prayer. Early factories took over the clock-based work ethic. The industrial revolution was regulated by the clock.
  - *Lewis Mumford*
- Clocks are now everywhere. Clocks have transformed our conception of time.

- Business obsession with time: productivity, time to market, just-in-time, cycle time, …
- Technological obsession with time: frequency, speed, acceleration, …
- Sometimes this obsession equates to a foreshortening of **distance**.





Historical Patterns

- Each wave of technologies and new products tends to follow some familiar system patterns.
- These system patterns can be explained by some common economic and sociological factors.
- Many working technologists are unaware of these factors, and fail to learn anything useful from the history of technology.
- These factors are important for the management and business exploitation of technology.

- Technology Adoption - S-curve growth
- Technology Maturity
  - increasing stability
  - increasing invisibility
- Technological Invisibility - technology vanishes into a set of the device paradigm

Three Types of Innovation

Product Innovation

- Inventing new products or devices

Examples

- Discovering a new drug - for example, a herb extract with medicinal properties.
- Building a wholly new kind of information system

Process Innovation

- Inventing new processes

Examples

- Being able to make the drug in the laboratory.
- Experimenting with software components.

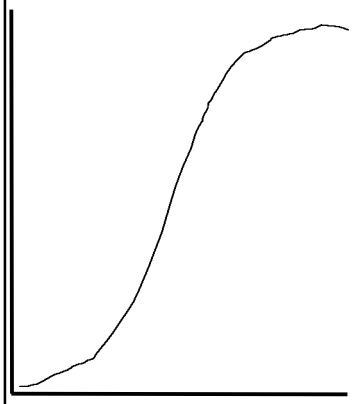
Production Innovation

- Institutionalizing the innovation - establishing organizational forms and infrastructures to make the new process flexible and scaleable

Examples

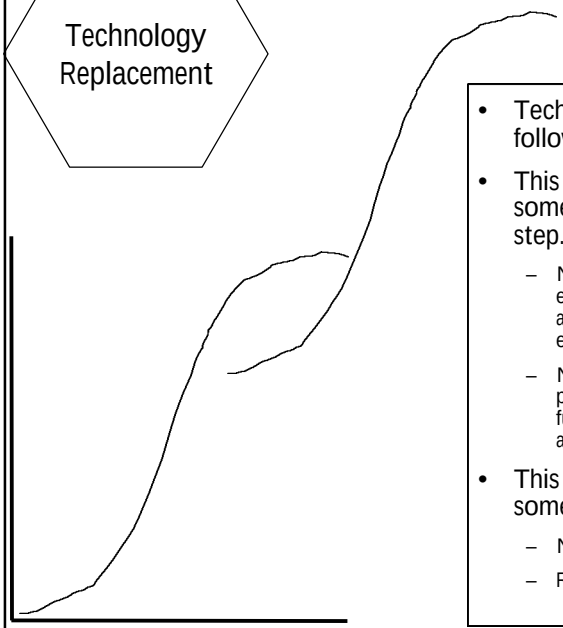
- Being able to make large quantities of the drug to high standards of purity from cheap raw materials.
- Achieving high levels of software reuse.

Technology Adoption



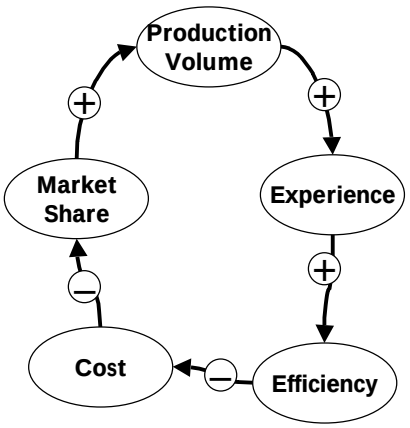
- Technology adoption typically follows an S-curve.
- Adopters can be divided into groups with different behaviours and attitudes
  - early adopters
  - mainstream
  - late adopters
- There are different economic characteristics at each stage.
  - Loss-making
  - Rapid growth
  - Profitable exploitation
  - Saturation

Technology Replacement



- Technology replacement sometimes follows a double S-curve.
- This indicates that innovation sometimes involves a downward step.
  - New technologies may be initially less efficient, because their providers haven't accumulated as much knowledge and experience - "learning by doing".
  - New technologies may be initially less productive because their users have not fully integrated them - e.g. work systems are optimized for the old technology.
- This means that new technology sometimes demands a leap of faith.
  - Nuclear Energy
  - Renewable Energy

Learning by Doing



- Learning by Doing is the name given by economists to incremental improvements in efficiency/productivity. These depend on the total historical production.
- This systems diagram shows an attractive positive feedback loop, but it makes some simplifying assumptions. What are they?
- The model appears to show that large companies gain more from learning-by-doing than small companies? Does this make sense?
- The learning-by-doing cycle is typically disrupted by major new technologies. This is one of the reasons why new technologies are often initially less efficient than the older technologies they replace.
- So who benefits more from new technologies - large companies or small companies? *(Hmm, that depends …)*

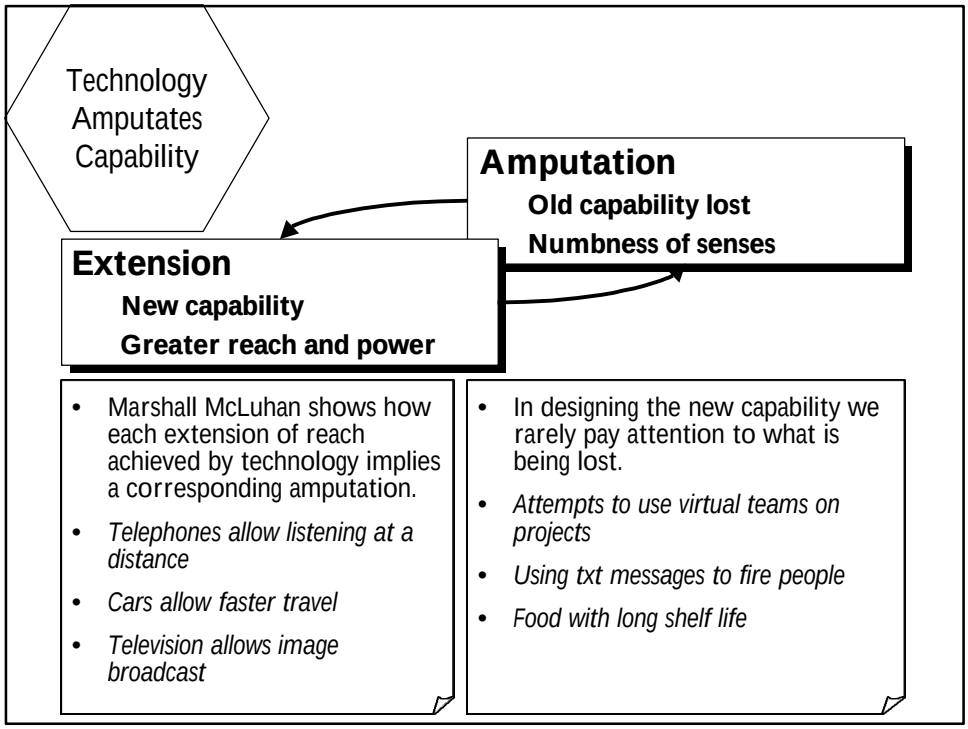
Technology Alters Visibility

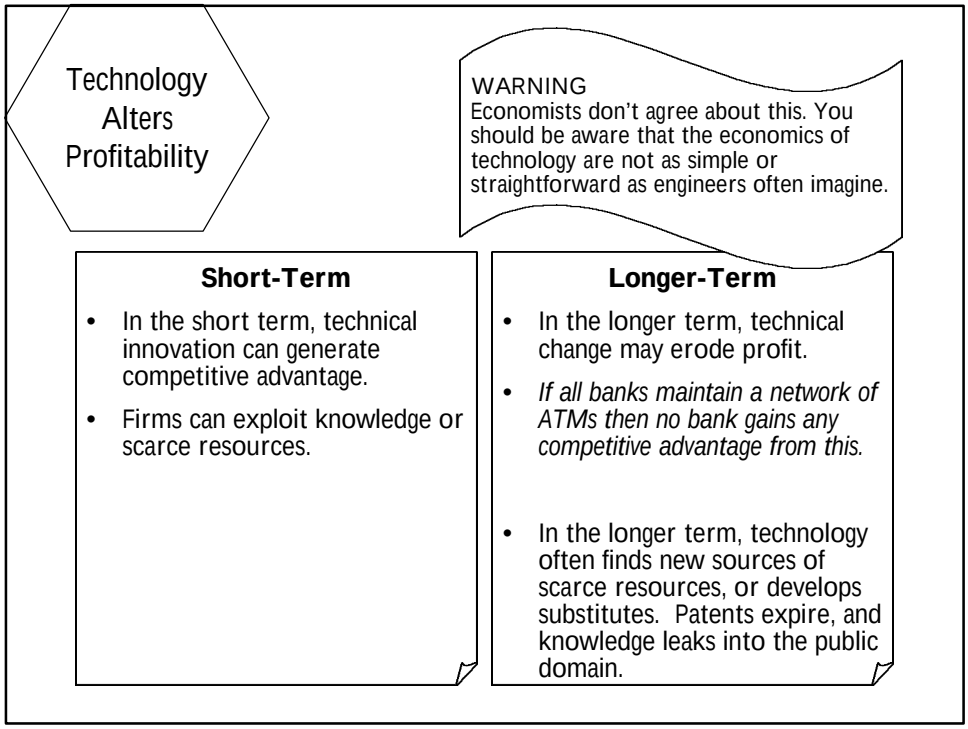
Background
Invisible, taken-for-granted
Supporting devices

Foreground
Visible, measurable
Available commodity

- As technologies mature, they turn into commodities - cheap, safe, and widely available - **what** not **how**.
- *Electricity comes out of the wall.*
- *Cheap, safe and very high reliability*
  - *except in California - but that's another story!*

- We generally don't need to pay attention to **how** these commodities get delivered to us.
- *Complex grid of power generation and supply*
- *Complex commercial and social relationships*
- *Complex economic mix of labour and capital.*





Technology - Novelty and Maturity

Which perspective allows you to answer the key questions, and to appreciate the management of technology?

Two Perspectives

- New Technologies for Early Adopters
  - Early adopters talking to other early adopters.
  - Focus on technical novelty and potential of each innovation
  - Attracted towards glamorous new technologies
  - Evaluating technology largely by technological criteria.
- Whole Technology Lifecycle
  - for mainstream and late adopters as well
  - Looking at technologies that are no longer new and glamorous

Key Questions

- How do technologies develop and mature over time?
- How do technologies make the transition from experimental pilots to widespread use? How long does it take, and what factors affect the timescales?
- How do technologies designed for early adopters meet the needs of mainstream users?
- What are the risks of technology transfer, and how can they be assessed and managed?

Automation

Purpose of Automation

- Improved performance: speed, efficiency, productivity, reliability
- Improved management & manageability: predictability, feedback, control.

Measuring the Impact

- Cost
- Risk
- Return
- Side-Effects
  - "The Revenge of the Good Fairy"

Division of Labour

Pioneers

- Adam Smith
  - "Wealth of Nations"
- Eli Whitney
  - Mass production
  - Interchangeable parts
- FW Taylor
  - "Scientific Management"
- Henry Ford
  - "Fordism"
  - Production-line factory

Technical Aspects

- Specialization of skills and equipment.
- Efficient utilization of labour and capital.

Socio-Political Aspects

- Largest share goes to the bosses who divide up the work.
- Alienation
  - Charlie Chaplin's film ***Modern Times***

Technical systems have social context

Reification of human work

- All technical artefacts imply previous human work
  - design and development
  - innovation and tool-building
- Most technical artefacts imply present and future human work
  - usage and maintenance
- Technology is the product of a process.
  - "reification" means turning verbs into nouns, focusing on the (present) thing rather than the (past) activity

Human purpose

- Technical artefacts are used by people in organizations for business and social purposes
- Technical artefacts exist because they are perceived to serve some business or social purpose.
- However, technical artefacts often fail to serve the intended purpose, or have unintended side-effects.
- Technical artefacts are capable of perverting human purposes.
  - To the man with a hammer, everything seems to be a nail.

Social systems have technical context

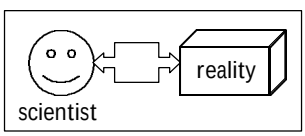
- Important social processes are mediated by technology
  - Information gathering and decision-making
  - Communication
  - Collective memory and organizational learning
- Human agents may sometimes be replaced or represented by technical artefacts.
  - Automation
  - Proxies

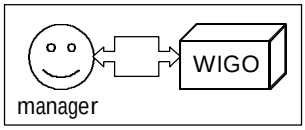
Screen

- We get an increasing amount of information about our social world through technical media.
  - Email, Telephone, Management Information Systems, Television, Reuters newswire
- These technologies screen information for us, screen information from us.
- For example, both computers and televisions provide information as services through a screen. The screen is both literal and metaphorical. It is a surface on which the data are presented, and also a filter that controls what the user sees.
- The screen is a two-sided device - it both reveals information and hides information.

Viewing the world through technological spectacles

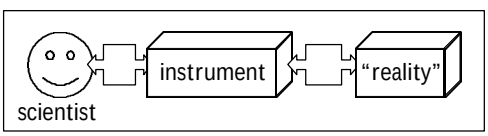
A simple view is that people have direct access to reality (WIGO: What is Going On)

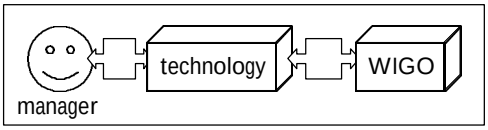




But our knowledge of "reality" is typically mediated by technology.

- Galileo & telescope
- Nuclear physicist & particle accelerator





- Computer systems
- News media

Social and Technical are loosely coupled.

- The "same" machinery can coexist with different social arrangements.
- The costs, benefits and risks of the technology belong to the whole socio-technical system, not just the machine in isolation.

- Some people like to think that all benefits can be attributed to the machine, and any implementation problems belong to the social system.
  - "resistance"
- Some people like to attach the benefits of automation to the social system.
  - "workforce productivity"

Cultural Lag

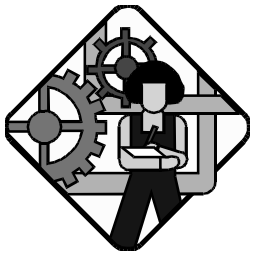
- Significant organizational change often involves/demands technical change.
- However, social change and technical change are often out of synch.
- This may be caused by differential rates of change.
- Early use of a new technology may be tame. Users try to treat the new technology as an exact substitute of the previous technology.
- Users may suddenly switch to a new mode of using the same technology.

- This interferes with theories of technological determinism
  - Technology rarely if ever causes instantaneous social or behavioural change
- It also interferes with notions of technological freewill
  - The fact that a community or organization hasn't yet succumbed to a particular technology doesn't prove that it isn't going to be.

Design of Safety-Critical Systems

There are some interesting (and alarming) differences (both technical and social) between aircraft controls and powerplant controls.

People Control Machines



Or is it the other way around?

Situation 1

- Machine = Aeroplane
- Man = Pilot
- Training = Intensive, Complex, Realistic Simulation

Situation 2

- Machine = Nuclear Power Plant
- M an = Operator
- Training = Simplistic, Linear

Two views of sociotechnical decomposition

Simple Division

- A system can be divided into subsystems.
- A sociotechnical system is divided into a social subsystem and a technical subsystem.
- There is an interface (internal boundary) separating the social and the technical
  - "Man-Machine Interface"
  - "Person-Computer Interface"

Fractal Division

- All subsystems of a sociotechnical system are themselves sociotechnical
- Each subsystem has a social element and a technical element.
- For some purposes we may focus on the social element or the technical element of a particular subsystem.