Prof. Ing. Marco Cantamessa

Innovation Management

How do the algorithms provide value to a company (how to earn salary)?
Providing value and showing it

What are the key things that are happening in this world of innovation?

Tricky «trivial pursuit» questi

- Who would ***you*** want to be?
- Who were the ***innovators*** and how did they do it?
- What's the value of technology without the management of innovation?

•Who invented the light bulb?

Scientists discover

Sir Humphry Davy

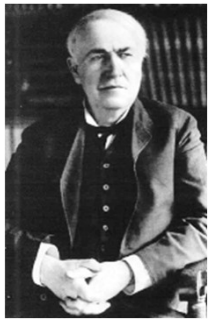
(1778-1829)

electricity is able to generate light

Joseph Wilson Swan

(1828-1914)

high resistance in electricity generates light (Technologist)



Thomas Alva Edison Innovator

(1847-1931)

brought some technical good stuff to the market, that is called innovation (light bulb)

Alessandro Cruto

(1847-1908)

exactly did as Edison, but small market in Italy

Nikola Tesla

(1856-1943)

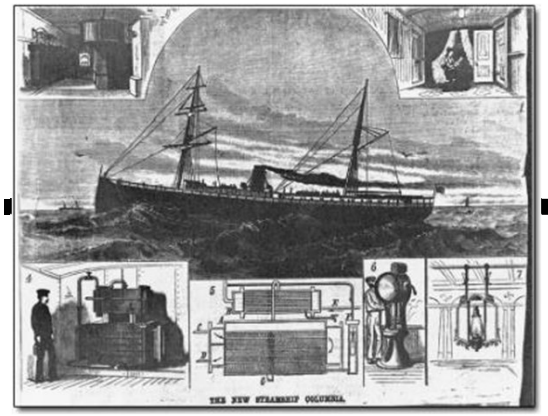
using AC (alternate current), long distances. generate the electricity far away

George Westinghouse Innovator

(1846-1914)

rich entrepreneur, worked with Tesla (Scientist) and Galileo Ferrari (Technologist) to generate AC.
Competing against Edison and won.
Generated AC far away but Edison couldn't

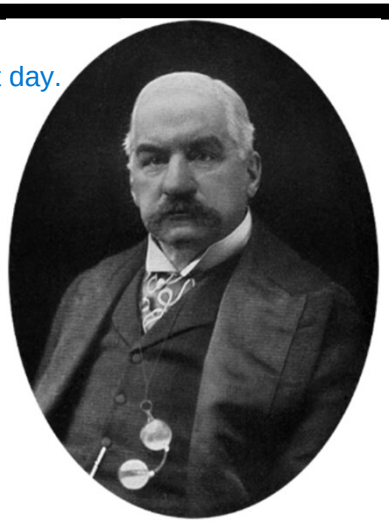
steam power ships: first customer of light bulb.
1- complementary good: because they have generator inside ship
2- gas lights are dangerous for the ship



S.S. Columbia

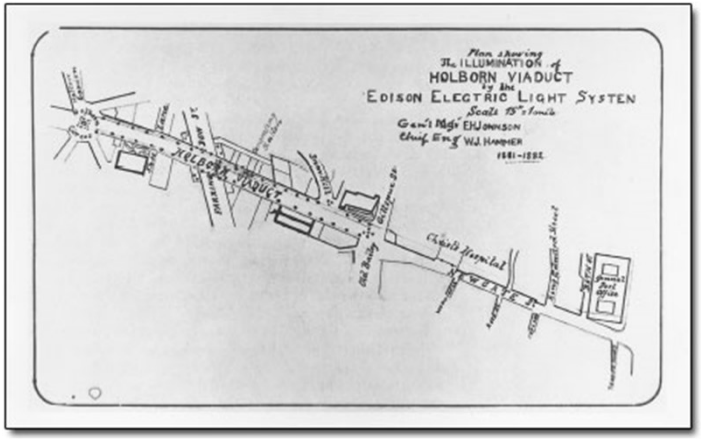
May 1880

JP Morgan customer of Edison: light in home. and his home fired in the next day.



J.P. Morgan's home, New York

June 1880



Holborn Viaduct, London

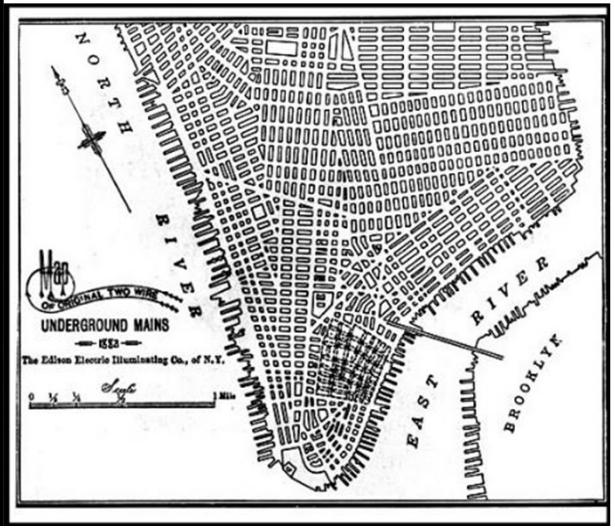
January 1882

Edison always was searching for opportunities, grasp them and find the sequences. Strategy: where first and where next. 2- Engage people to actually do something. Moving people. 3- the need behind the light bulb. thinking long term.

Landon accepted

Pearl Street Station, New York

September 1882



2nd step: Street lights but not accepted
Later they did

The one who adopt the innovations is also innovator. e.g. major of New York, JP Morgan

A few definitions

The five Ws of (technological?**) innovation**	
What	• "*The economic exploitation of an invention"* (Roberts, 1998) related to technology. tech has has some sort of technology to sum degree. • "*The act or process of introducing new ideas, devices, or methods*" (Merriam Webster dictionary) The difficult process of bringing the innovation to the world
Who	• Supply → People or organizations who *propose* the innovation (taking risks) Edison, Elon Musk • Demand → People or organizations who *adopt* the innovation (taking risks) JP Morgan
Why	• Craftsmanship and ingenuity making it *possible* (= technology?) • Competition making it *necessary* • Culture making it *agreeable* That's good people say It's a cultural issue! Think about the Aeneid, or read Alfred Tennyson's Ulysses aloud
When	• Cost of *change* < Cost of *staying put* e.g. Using zoom in the time of covid

Where	• Products, processes, organizations, business models, society
	• "Promethean" places (national/regional innovation systems, entrepreneurial ecosystems) where Zoom: what kind of innovation: it depends who you are and what you do. Zoom itself: Product, professor: process, polito: process, business model. Also social innovation because impacts society.
	  • a 'dynamic' and 'modern' culture prevails (Phelps 2013)
	  • resistance to change is weaker or manageable (Juma 2016)
	  • institutions and culture are oriented to growth and change, and not to conservation (Mokyr 2016)
	  • B2B technology adoption is not encumbered by 'socioemotional wealth' biases typical of family firms (Souder et al., 2017)

A perspective from 2000 years ago

Aeneid, VIII book

- Aeneas has fled Troy, tries to settle in Latium, but ends up in war with the locals
- Venus "asks" Vulcan to build new weapons for him
- Vulcan accepts and heads for the Aeolian islands to build the weapons
- Aeneas' shield is decorated with scenes of the future of Rome, which Aeneas does not understand. However, he enjoys the pictures and, unaware of it, he bears the fate of future generations on his shoulders

A. Van Dyck, 1632

Venus asking Vulcan for the Armour of Aeneas

(Musée du Louvre, Paris)

Rostowian take offs: a handful of key new industries start to emerge in the national economy that help drive further economic growth. For example, the development of a steel industry may drive growth in an economy with ready access to iron ore.

Modern culture, according to Phelps (2013)

Growth boom: Edison days, after ww2. Matter of place and time. Depends in society
Knightian uncertainty: ex: elon musk about space commercial travel

To what extent does this contrast the concept of "industrial policy" and Mazzucato's "entrepreneurial state" (2013)?

Modern economies have witnessed "Rostowian take offs" thanks to "flourishing" systems of "indigenous" innovation

Societies valuing "modern" culture

- Jeffersonian individual pursuit of happiness
- Dynamism and radical change vs. tradition
- Dealing with Knightian uncertainty — top level of uncertainty
- Accepting failure *and* success — Silicon Valley culture; failure is accepted, you learn
- Innovation vs. trade — trade important

Institutions that

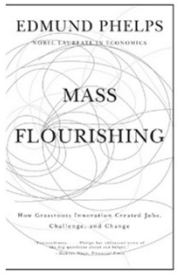
capitalism: someone who have money with someone who have idea to innovate. role of competition for innovation along with capitalism. covid vac

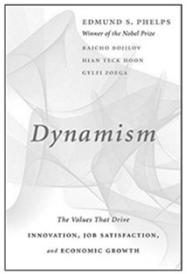
- Allow capitalism and competition (interpreted as a Hayekian "discovery process") to prevail over corporativism and socialism — socialism: central control: bad; corporativism: avoiding innovation in order to sustain old businesses. ex: hotels complain about airbnb
- Facilitate business and do not have a claim to direct or co-manage it — State wants to control: ex: gps by state, wants to control apple
- Place incentives for long-term value creation vs. short-term opportunistic behavior

Economic knowledge (supply and demand side)

The knowledge it takes to generate innovation:

- Technical creativity (making new things) — The ability to design and create new things
- Entrepreneurial and strategic insight (perceiving opportunities and understanding how to exploit them) — The ability to see the future. e.g. Edison.
- Technical and managerial capability (executing and scaling technology and firms) — does your tech work in a larger scale (real world).
- Financial judgement (discerning where and when to invest)





A few definitions

- What is the role of this "perennial gale of creative distruction" in the capitalist system?
- Should it be studied by economists (= what portion is endogenous to the economy)? What about historians and technologists?
- Can you also manage innovation?
  - Use history and look for patterns (Suddaby et al., 2019)
  - Balance risk and reward

For example the climate change should be studied because it is an endogenous thing not exogenous.

Schumpeter:
innovative actor:
1- innovator entrepreneur (Edison, Bill Gates...) make something new and becomes large
2- large business

Joseph Schumpeter
1883-1950

Not so right model;
not all discoveries become product
or single discovery can't lead to an single product.
multiple discoveries to multiple products. E.g. autonomous cars are made of traditional cars and sensors

Failed innovations -
economists: still an innovation because they see only the supple side
Managers: not innovation because it is not defused

A few definitions

When does "innovation" really happen?

Discovery — *Invention / Technology (demonstrator)* — *Invention (prototype)* — *Product* — *Innovation*

this thing can work in principle

reach to society (innovation)

Basic research → **Applied research** → **Product development (pre- and post- competitive)** → **Diffusion**

Should you really believe in this "linear model"?

first spend money then earn

If

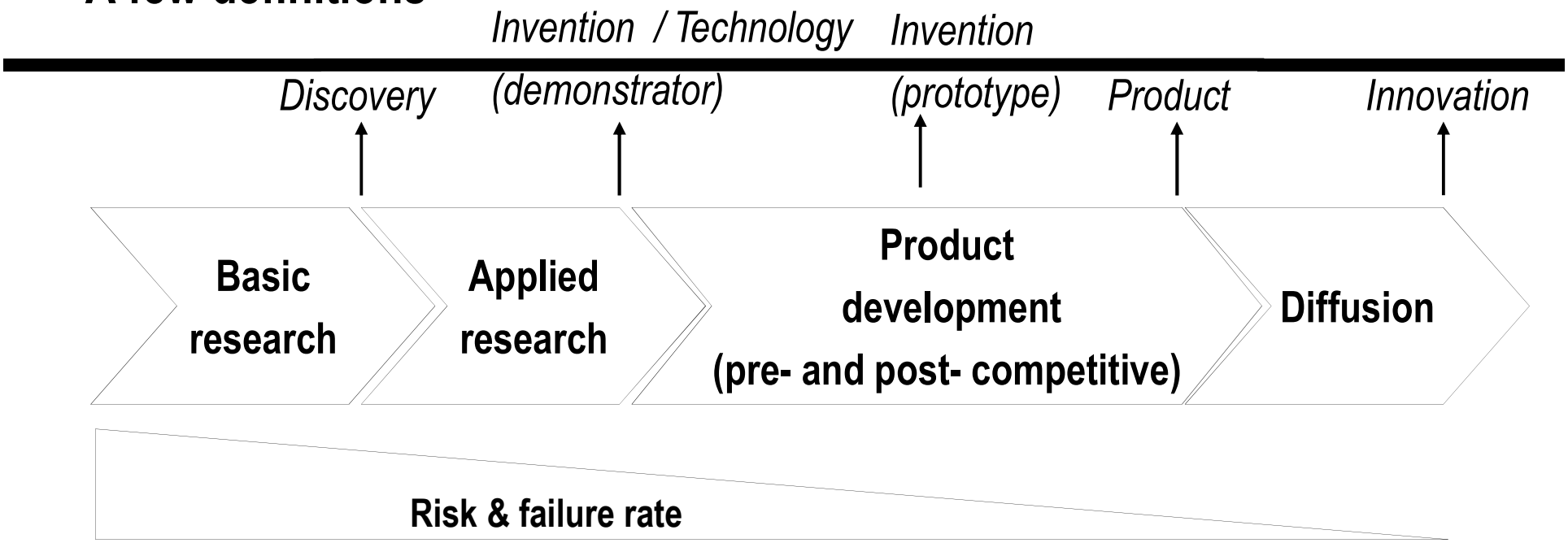
"research and invention = using $ to generate ideas and knowledge"

Then

"Innovation = using .... to generate ....."

Mokyr's definition of "useful knowledge", made up of "propositional" and "prescriptive" knowledge

A few definitions



Selection: bad for person but good for society.
Spillover: for example: two companies work on same issue, one succeed and the other fails. the winner grows big an needs to work with others. the failed company people are the best option.
another example: Trees grow, some of them grow big and some not, the losers will fall and become food for the bigger ones.
or silicon Valley: failed guys join with winners to work together.
So failure is not bad.

Failure can be beneficial for society because of

- Selection
- Competition (i.e. stimulus)
- Spillovers

A few definitions

Invention / Technology *Invention*

Discovery *(demonstrator)* *(prototype)* *Product* *Innovation*

Basic **Applied** **Product development (pre- and post- competitive)** **Diffusion**

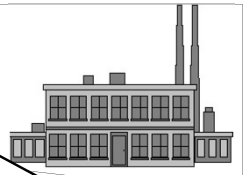
- Not enough ROI ($ & time!)
- Keeping results secret would be socially suboptimal
- Markets for technology allow waiting

businesses don't invest big on startups because ROI is low.

ure rate

Government, academia, research institutions

Business



- funding
- public knowledge
- skilled workforce

Indirect actions can be enacted

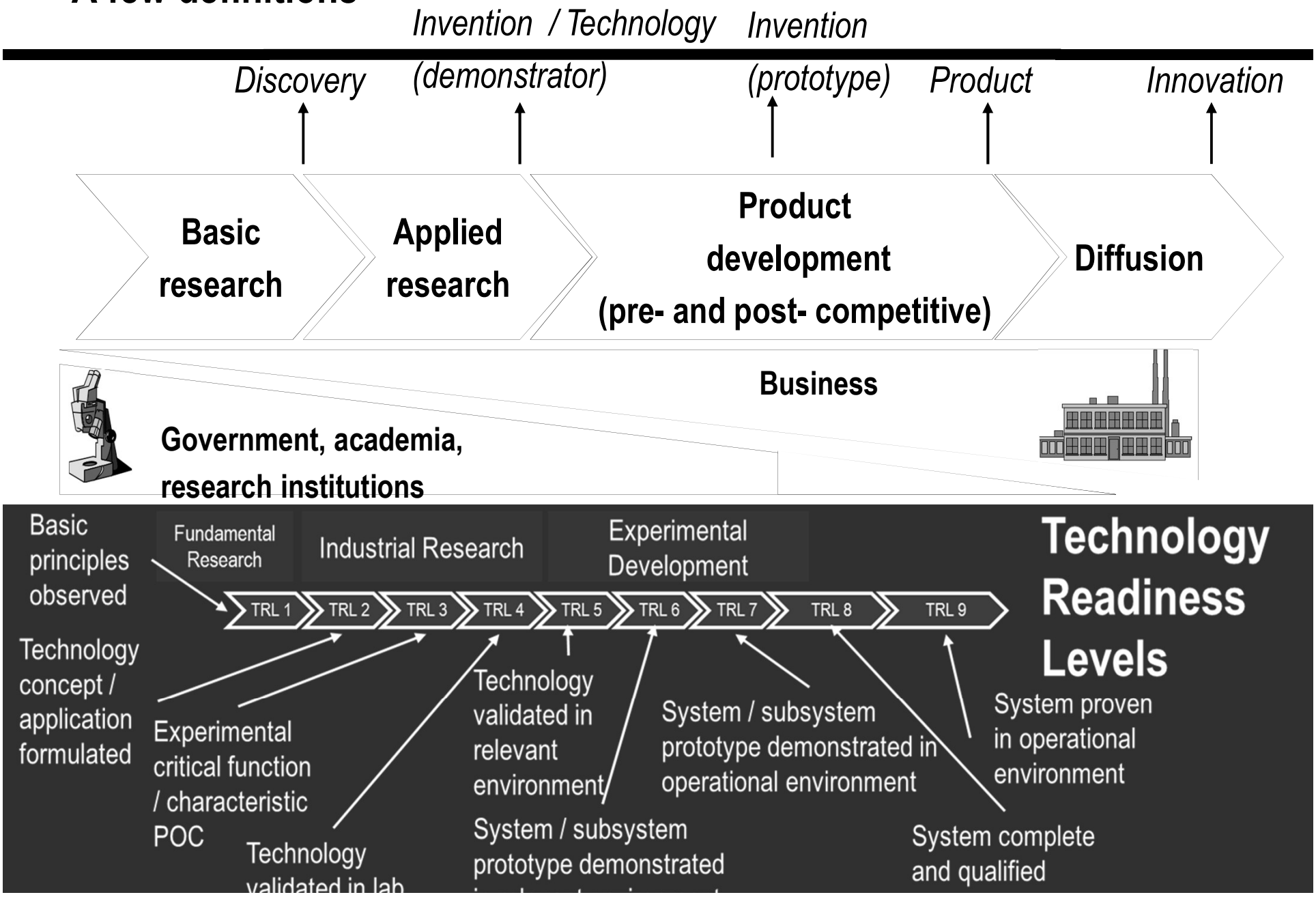
- Schumpeterian innovator-entrepreneurs (*widening* innovations)
- Schumpeter's large firms (*deepening* innovations)
- Chesbrough's Open Innovation networks and ecosystems
- Dougherty and Dunne's ecologies (*complex innovations*)
- Ramaswamy's co-creative customers (?)

people should publicize their results.(standing in shoulders of the giant)
The most important thing is the researcher.

Apple why worth: ecosystem of suppliers that work with them. e.g. gorilla glass makers
Complex innovations: requires connections that is unprecedent. e.g. Automotive cars
Innovation should have a platform.

this chart used in government and firms.(no need to memorize it). The liner model is important we should use in process.

A few definitions



Market failure: When the market don't provide enough money that society would think is optimal. e.g. private don't pay to build roads.
Grant: Gov pay money for the project which is more worthy. Not paying back. e.g. EU grants. Cons: allocation way (to who should give the money), bureaucracy
Incentive: Gov contribute with you on paying investors or loans. problems: cost of policy, bureaucracy. e.g. if business provide value, then no tax

Policy	Rationale	Tools	Pros	Cons
Supply side / Direct funding	State provides resources that Market does not supply	Grants, low interest loans (e.g., Smart&Start, H2020 SME instrument)	Speed (depending on procedures) Ex-ante definition of budget	Allocational efficiency (picking winners based on proposals?) Bureaucracy (time and cost)
Supply side / Incentives	State increases ROI to Market by reducing immediate outflows or risk	Matching funds Tax breaks (e.g., for startup financing) Guarantees (e.g. for bank loans)	Speed Market involvement	Needs a market cpable of selecting Risk of opportunistic behavior Cost of policy difficult to quantify ex-ante
Supply side / Boosting outcomes	State increases ROI by boosting potential inflows, if and when results are achieved	Rebates to income tax (e.g., 10-year tax waivers on corporate income tax, tax exemptions for capital gains, "patent boxes")	Market involvement Lower risk for state (resources go those who 'risk *and reap*' if and only if, and after, benefits have accrued)	Needs a market capable of selecting Difficult to quantify ex-ante cost of policy (still a problem?)
Demand side / procurement	State stimulates innovation by creating an early market for innovation	Public Technology Procurement (e.g., US SBIR, DoD)	Award given to effective results and not to promises Creates a market and supply chain State benefits from improved technology	Requires an entrepreneurial culture and appropriate rules within civil service
Demand side / regulation, standardization	State creates and shapes the demand for innovation	Product-specific regulation (e.g., biodegradable bags, CO2 emissions for vehicles)	No immediate cost	Technical choices / targets can be non-neutral and difficult to achieve Risk of technological lock-in Requires a credible State and a capable Market

e.g. US state went to high robot creators to build mine detection robot.
In EU it is not possible due to regulations.

the market risk is going down as it is created by state

EU is strong in stimulating regulations.
e.g. plastic bags: the cost is zero.

It works: paves the way for innovation
whichever technology is a little front, the innovation happens there and the one which is behind no one will invest on it. e.g. Standard: no traditional car anymore, companies will invest on battery car instead on H2 (hydrogen). Even H2 might be better because H2 technology lacks behind battery.

Failure law: if there is no consequences of like going to jail, then everybody would start an startup

Public funding

Policy	Rationale	Tools	Pros	Cons
Demand side/incentives	State reduces the cost/boosts the benefits of *adopting* the innovation	Direct incentives to adopters when purchasing (e.g., purchase rebates for Evs, hyperamortization for capital goods) Incentives to the usage (e.g., feed-in tariffs for renewable energy producers)	Strong and immediate impulse to adoption Award given to effective results and not to promises Creates a market and supply chain Society benefits from rapid diffusion	Applicable to technology that is market-ready Risk of benefiting producers abroad Cost can be high and difficult to quantify Risk of technological lock-in Can induce volatility in demand before and after the policy is active Could be fiscally regressive, could not generate additionality and lead to unused goods
Demand side / complementary assets	State facilitates and shapes the demand for innovation	Investment in complementary assets (e.g., BEV recharging stations	High probability of having impact e.g. gov builds more recharging stations to encourage people to buy electric cars.	No technological neutrality and risk of lock-in High cost H2 vs battery Battey: cost so much and no investment in H2
Non-specific	State improves general "business friendliness"	General reforms (tax, education, infrastructure, judicial system, education, etc.)	Stable and visible impact throughout the economy No ex ante directional choice w.r.t. industry or field	Time required

Golden Power:

Dilution: is the reduction in shareholders' equity positions due to the issuance or creation of new shares. Dilution also reduces a company's earnings per share (EPS), which can have a negative impact on share prices.

Private financing	How does it work?	Pros	Cons
Bootstrapping Reinvest	Use margins from operations to finance innovation Huge company can do it. not only the money but it should be stable cashflow. you might squeez the budget because of company situation	No dilution and total independence	Time required, entity and variability of margins
Debt	Get loans from bank or issue bonds… and then pay it back (or convert to equity, if the loan is convertible)	No dilution	Not acceptable for high-risk projects
Customer financing	Early customers finance your innovation (from pilots to reward crowdfunding) Finding a customer to finance the innovative project. Problems: 1- the product would be specific to the customer that you cant sell anywhere else. 2- technical risk.	Deep engagement with market needs No dilution commercial point of view Risk sharing	Narrow engagement with customer needs Can you find such customer(s)?
Business angels rich entrepreneur	Wealthy people with industry experience, alone or in club deals, provide "smart money" as equity (or future equity if SAFE is used) to high-risk startups wants to become shareholder, put money to company to expand it. rich people diversify there assets. This adds to reputation of company	High risk acceptance Competencies and relations	Dilution Possible intrusiveness
Venture Capital serial entrepreneur sells one, then invest on another one	VC funds (GPs) raise money from investors (LPs) and provide staged financing to high-risk startups, supporting their growth and looking for an exit (IPO/trade sale). A few "home runs" compensate for failures and write-offs	High risk acceptance Need an exit	Dilution Need an exit
Private Equity already grown startup ups	Like VC, but for less risky firms, might not need an exit and entails greater PE involvement in management	Risk acceptance	Dilution Loss of control
Equity redemption	Like VC, for firms with less risk/growth potential. Fund buys a stake, and put/call options make/allow founders to redeem it later, via retained earnings/LBO, at predefined conditions (multiples of investment and/or financials)	Useful for firms that VCs would shun. VCs exit, leaving founders in the firm	Very uncommon structure Risk of failing exit
IPO	Raise money from public markets	Amount that can be raised Founders can keep control Liquidity of shares	Dilution Costly and complex process

Generals partners (GP): they don't have enough money themselves but come together to invest. ask venture capital companies.
How GP give money to LP (limited partners): go to public to stock market. trade sell:

A few definitions

- Need to go beyond the linear model of innovation, since history tells us that invention and innovation are *usually not* the direct outcome of science, but of extensive trial and error within the domain of technology (e.g., steam and IC engines, airplanes, etc.)
- Alternative models consider that
  - You have "feedforward" and "feedback"
  - The links along the model are not necessarily 1:1
- Is innovation about having scientists and entrepreneurs (Schumpeter), or a society that exhibits dynamism (Mokyr, Phelps)?

economies of scale: a larger company more efficient than small.
economies of agglomeration: When many companies are in the same place, they are collectively more efficient than when they are spread around the world despite the might not be large. Actors: companies and also locals.

A few definitions

- Innovation tends to occur in confined geographies

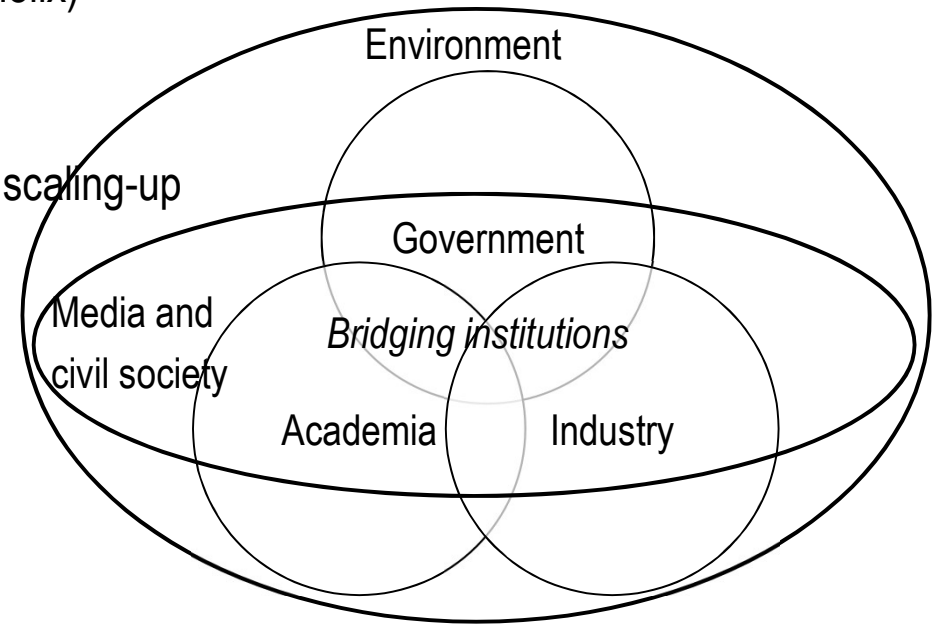
Not happens everywhere at the same level
Local systems of innovation (the academic term)

- Local (i.e., national or regional) systems of innovation exhibit
  - A Marshallian district-like behavior, based on economies of agglomeration
    - specialization around a focal + complementary technology/industry,
    - labor and resource pooling among multiple and flexible firms,
    - low transaction costs due to spatial, cultural and relational proximity
    - knowledge spillovers

e.g. you have everything when you stablish company.

Emerging places to become silicon valley:
Need: Digitals and startups is a combination that allows places to become to some extend.
- geography is not so important now.
- infrastructure: no need now. e.g. cloud
Mayors: happy to happen but cost a lot of money.

  - A "knowledge producing and sharing" interplay betwen heterogeneous actors (from Etzkowitz's triple helix to Carayannis' quadruple/quintuple helix)
- Autio et al. (2018) propose an "entrepreneurial ecosystems model" centered around
  - high-growth opportunity discovery, pursuit and scaling-up
  - digital and business model innovation
  - a community of (serial) entrepreneurs and complementary actors
  - a common "economic knowledge" and culture
  - continual recycling of resources



Basics of economics of innovation

Hyman (2018) argues that technology does not "shape" society and work. Pre-existing trends leverage technology and are empowered and amplified by it (e.g., gig economy vs. Manpower)

- Technological innovation is hugely relevant to society today
  - Social impact of technology
    - job displacement and "industry disruption"
    - adoption divides between social strata and countries
    - wealth/income inequality, mostly between-firm, due to enduring monopolistic power
  - Philosophical and ethical aspects (from Heidegger to Galimberti)
    - Technology is a strong and pervasive force acting on the environment and on humankind
    - Impact can be inherently irreversible (e.g., nuclear war) or self-sustaining (e.g., dystopian visions of AI/robotics)
    - People are *identified* by the technology they adopt, with varying levels of consciousness

→ society needs time to develop "proper" use modes (Anders' «Promethean discrepancy»)

- Absent social norms, technology is not a neutral ("innocent") tool that humans use (or do not use) as means to a (consciously deliberated) end → it can become *the* end, obeying own criteria of effectiveness and efficiency (e.g., designer babies, critical decisions delegated to opaque deep learning algorithms, etc.)

1- Technology in the past has displaced the low level jobs but AI now middle and high level. e.g. drafts of lawyers, now an algorithm doing it. AI might displace lawyers more than waiters in a restaurant.

2- adoption: poor classes will have less access to new innovation. e.g. in covid time poor's have no access to fiber optic internet. Also rich people encourage kids to use internet to study. In poor it is the opposite.

- network effects
- users' switching costs
- combined effect of big data and machine learning

until ww2: tech used to protect human against nature.
Atomic bomb: tech can destroy earth
Also can destroy society. it is not a neutral tool. when we use it we become somebody different. we can become the protector or the attacker. it takes time for people to learn the usage of it.
implication: if you don't have rules, people misuse it.
AI discrimination: e.g. prejudice against race, gender...

Basics of economics of innovation

- Technological innovation is hugely relevant to society today
  - Different approaches to ethics of technology
    - The «Promethean discrepancy» (Anders) calls to go beyond both «ethics of intention» and «ethics of responsibility»
    - Anglo-saxon approach (utilitarian, based on deontological principles and specialization)
    - Continental approach (principles-based, stresses “unintended consequences” and tends to view technology as a whole)

More pragmatic; like ethics of AI

More theoretically : like EU the philosophy of tech innovation

  - Business-level aspects
    - Business ethics and Corporate Social Responsibility
    - Risks associated to non-acceptance of technology (e.g., GMOs, nanotech, AI, etc.)
    - Legal liability risks due to "unforeseeable" consequences of innovation
      - Objective liability vs. liability associated to behavior
      - Liability vs. compliance with regulatory processes
      - The definition of liability regimes requires a tradeoff between consumer protection and incentive to conduct proper investigations vs. incentive to innovate (e.g., development risk clause in the EU)
      - What about liability for AI-based products? Who is responsible?

Paradigms

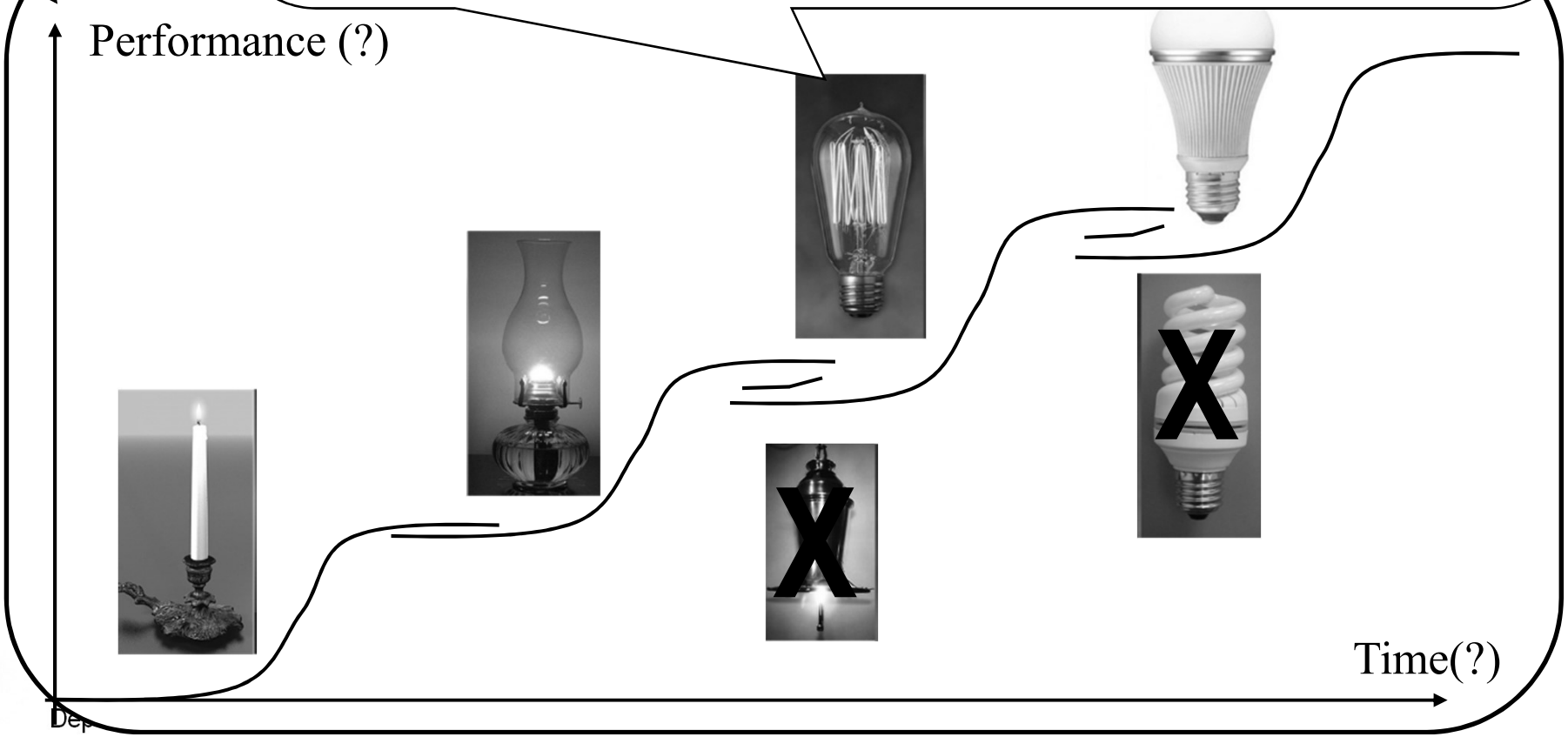
Does it look like a story characterized by continuous progress?

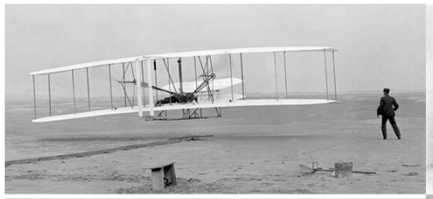
Paradigms

R&D and marketing have different roles within the process

Not really! Dosi and Freeman show that innovation follows a continuous alternation of

- Evolutionary and revolutionary change
- Performance s-curves
  - Bounded by technological limits
  - Initiated by tapping into new technical solutions (*technology push*)
  - Emerging after a period of uncertainty (*revolution*)
  - Evolving in accordance to the emergent paradigm (*demand pull*)



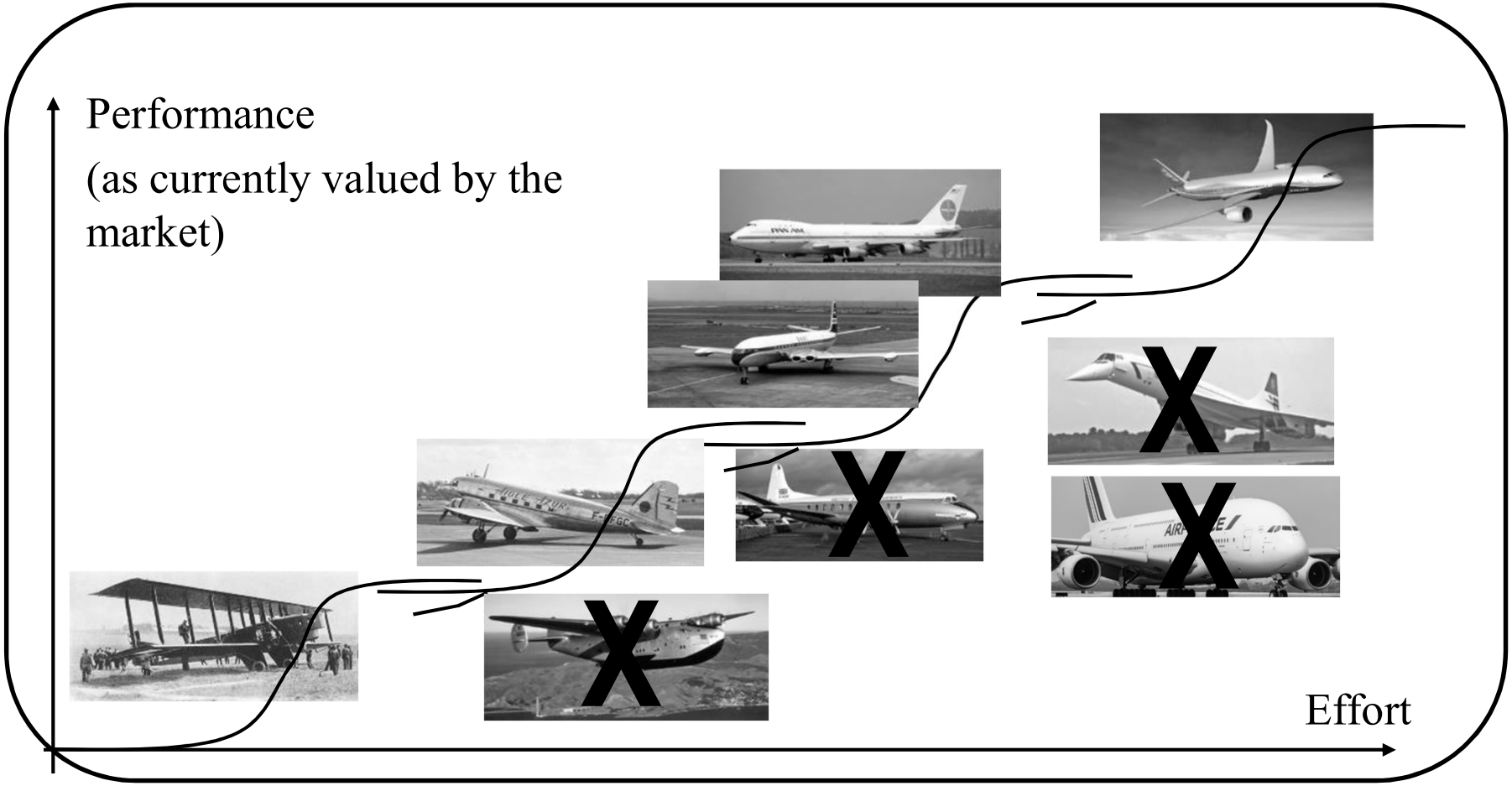







Airliner	Year	Airframe	Engines	Cruise speed (km/h)	Range (km)	Max pass.	Fuel eff. (km seat/l)
Flyer	1903	Wood + fabric	1 piston + propeller	48	-	1	-
Farman Goliath	1919	Wood + fabric	2 piston + propeller	120	400	14	13.4
Douglas DC-3	1936	Metal	2 piston + propeller	333	2400	32	8.4
Boeing 314	1938	Metal	4 piston + propeller	340	5900	74	23.5
Vickers Viscount 700	1948	Metal	4 turboprop	496	2220	48	15.3
De Havilland Comet	1949	Metal	4 turbojet	740	2400	44	3.56
Boeing 747-100, 200	1970	Metal	4 turbojet	893	12690	550	26.9
Concorde	1976	Metal	4 turbojet	2158	7222	120	6.4
Airbus 380	2007	Metal	4 turbofan	903	15460	853	31.6
Boeing 787	2011	Composites	2 turbofan	913	15400	440	36.6

Paradigms

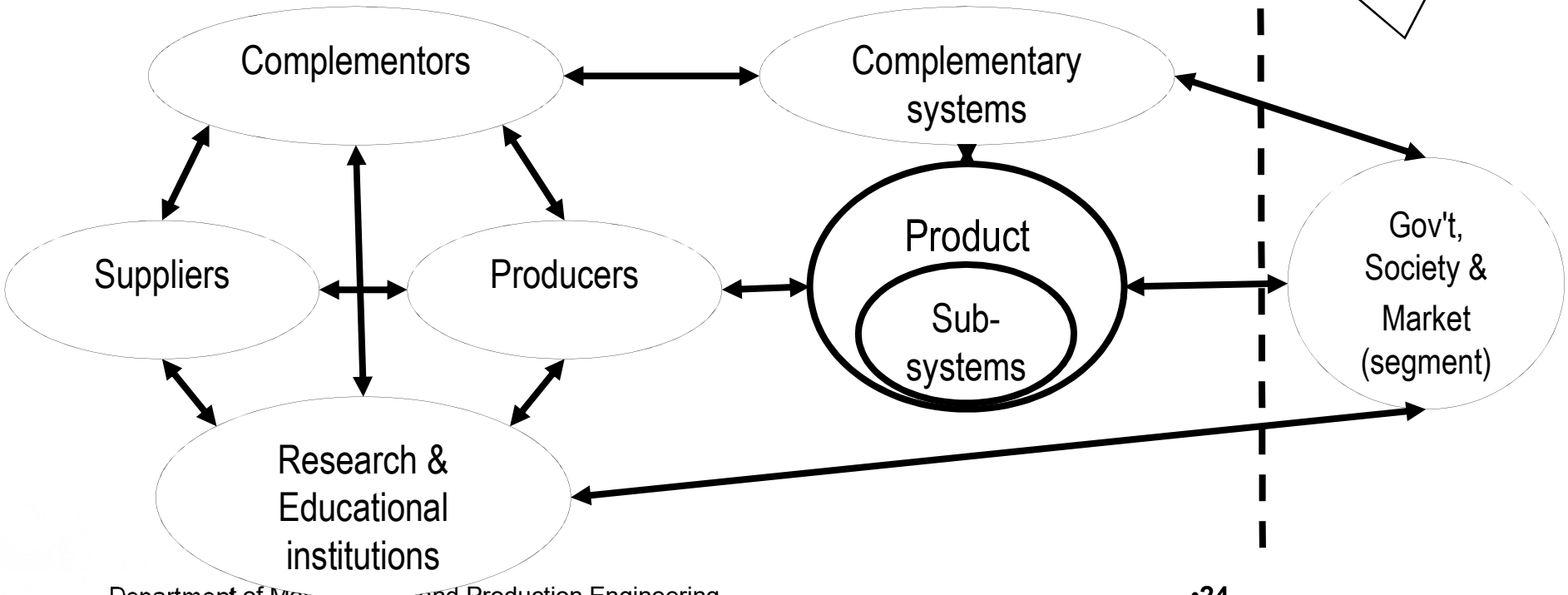


The distinction between
- suppliers (integration done by producers)
- complementors (integration done by customers)

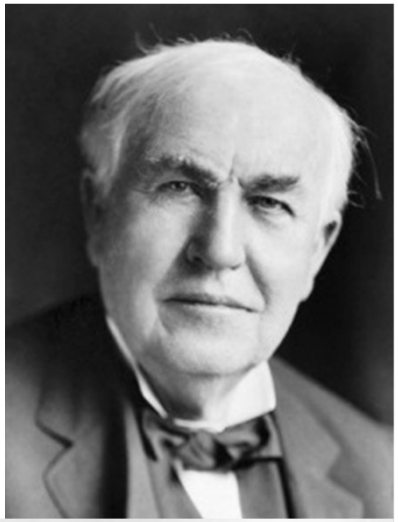
is not 'objective', but depends on producers' integration choices

Supply side
- Technological regime (knowledge, methods and tools)
- Sustainability of all actors' business models

Demand side
- Needs and objectives,
- Beliefs and meanings
- Norms and rules



Paradigms



- What were the competing paradigms they proposed?
- Which one won?
- Why?

Types of innovation

Criterion (look at...)	An "evolutionary" innovation is called	A "revolutionary" innovation is called
Product and the technical tradeoffs that define it	Incremental innovation	Radical innovation
Producer and its organization	Competence enhancing innovation	Competence destroying innovation
Product architecture	Peripheral innovation	Core innovation
Business impact	Sustaining innovation	Disruptive innovation

"Disruptive" is here intended in its broader sense

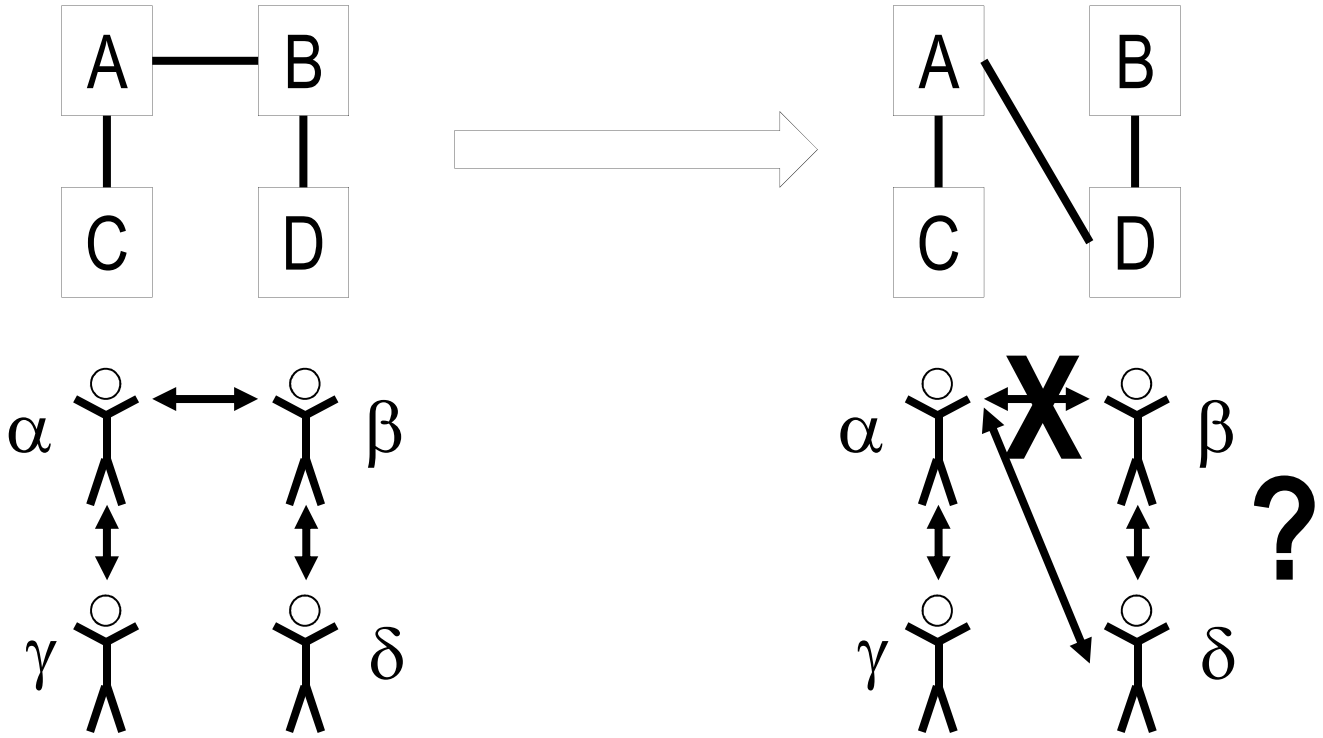
What kind of innovation is it?

It depends on who you are!

Types of innovation

Product architecture ≈ components and their mutual relationships

- Innovation and product architecture (Henderson and Clark)
  - Product architecture and the organization are coupled
  - What must happen if product architecture changes?

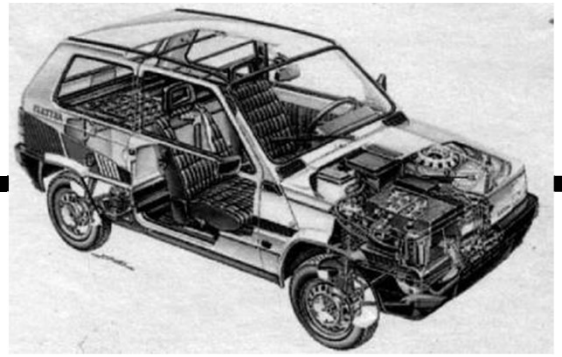


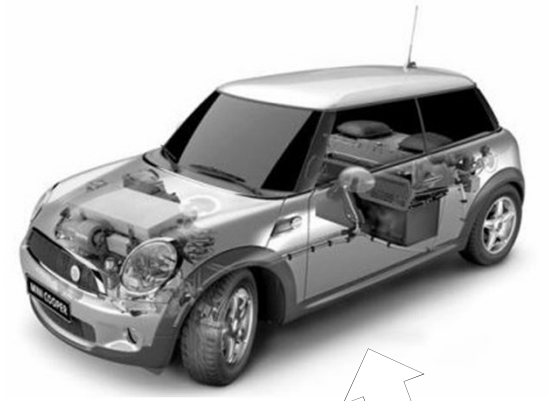
Types of innovation

- Innovation and product architecture (Henderson and Clark)
  - Product architecture and the organization are coupled
  - It is generally harder to change architecture than technology
  - Innovations often are not incremental or modular (but incumbents tend to downplay them as such)

Incremental innovation: Small, gradual improvements to existing products, processes, or services. Example: Ongoing updates in software applications such as Microsoft Office.
Modular innovation: Development of independent components that can be easily combined or exchanged.
Example: Lego building blocks.
Architectural innovation occurs when new products or services use existing technology to create new markets and/or new consumers that did not purchase that item before. For example, the smart watch used existing cell phone technology and was repackaged into a watch.

Relationships between components / Reference technologies	Do not change	Change
Change	Modular innovation	Radical innovation
Do not change	Incremental innovation	Architectural innovation





Relationships between components / Reference technologies	Do not change	Change
Change	Modular innovation	Radical innovation
Do not change	Incremental innovation	Architectural innovation

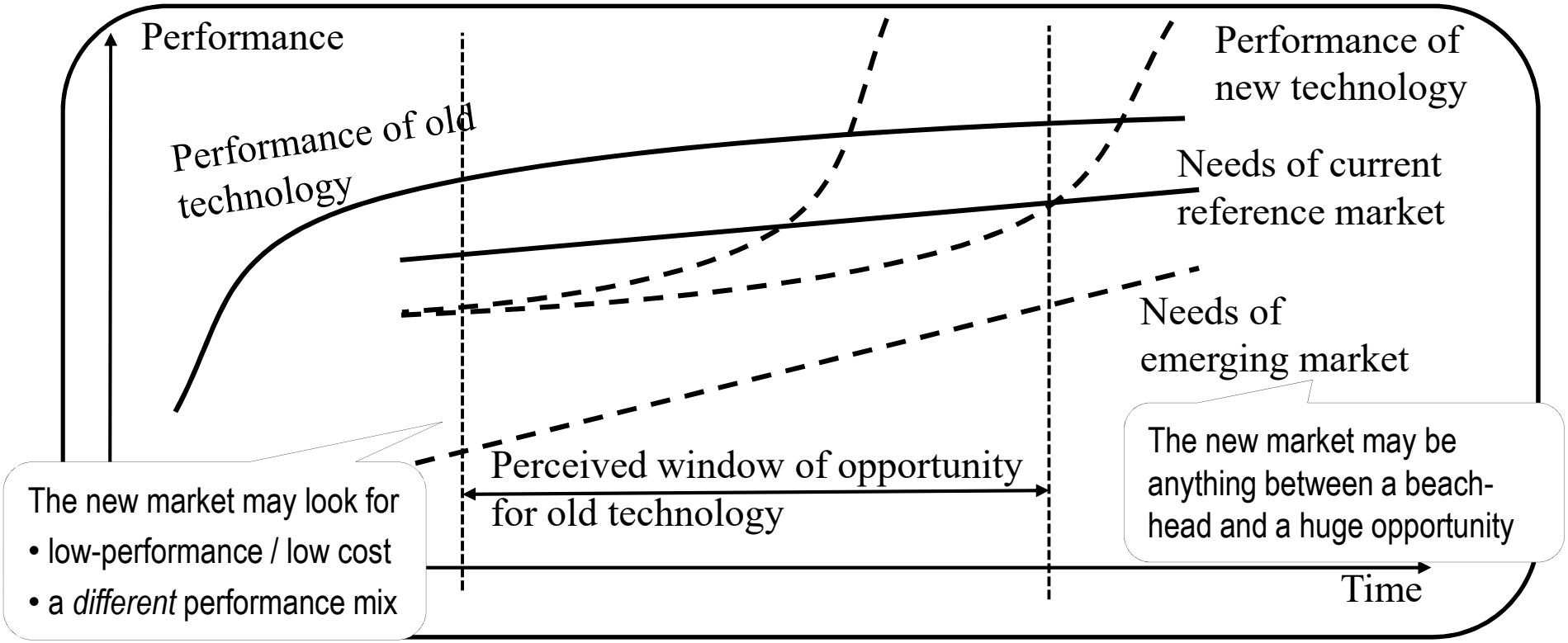
Types of innovation

- Why can innovations be *disruptive* (i.e. why do *incumbent* firms fail to tackle them)? e.g. 1- going from gas lamps to electric lights. customer needs it, old tech can't compete, incumbent business doesn't have resources to produce. 2- Refrigerators vs ice box. Assets: ships, cars, warehouses, lakes. Competence: logistics. Things you can do: 1- fight, 2- use your resources in a different way like logistics. 3- lower the price(not so smart) they did it but failed.
  1. The old technology does not keep pace with growing or new customer needs, but new technology does AND misaligned resources and organizational inertia → refrigerators
     - *competence destruction* and *competency traps* often arise in firms that have survived highly competitive industries (a weapon is valued when you've won many battles with it... Microsoft's focus on Windows and losing out in upcoming markets)
     - the effect is increased by three additional "traps"
       - Sunk cost trap ("*the old technology is more profitable because we already have assets associated to it*"... will this true beyond the short term, when assets will have to be replaced or maintained?)
       - Status quo trap ("*our old technology is more profitable because it is superior*"... for how long?)
       - Incentive trap (Employees lack high-powered incentives linked to expected firm growth and do not go "above and beyond", Bennet and Levinthal 2017)

e.g. Personal Computers: PC vs mainframes. PC was so in a low level. PC: playing games, calculations, writing documents... everybody started to buy it. The big guys kicked out. only survivor IBM which needed Microsoft and Intel for OS and processor.
e.g. Digital Camera vs Kodak: Kodak mistake was that they made a camera for only professionals and forgot the mass market of ordinary people.
Why these happens: 1- Market research: you focus on current customer and you neglect the potential big market. (Next Slide)

Types of innovation

- Why can innovations be *disruptive?*
  2. New technology satisfies *unmet or changing customer needs* or *entirely new markets* … while incumbents focus on reference markets and powerful customers (Christensen) → PCs, digital cameras, Blackberry vs. touch-screen smartphones, cars.



Types of innovation

- Why can innovations be *disruptive?*
  - The "Christensen effect" is mainly due to
    - Criteria used for resource allocation and project selection, (market risk is overweighted w.r.t. technical risk)
    - Market research dominating over envisioning

Market research: you focus on current customer and you neglect the potential big market.

    - The choice of suboptimal technology trajectories / business models that may leverage on existing complementary assets, often leading to «hybrid» products and services (e.g., Polaroid and Kodak)

e.g. Camera for consumers: Camera with a printer inside of it. (Failed)

    - Middle managers, who are in the position of championing innovative projects… but can't "change the givens" (and don't even think of escalating)

An employee can propose the change of business model to middle manager, but the middle manager is not able to. And also the top manager will not do it. Kodak: happened

Legacy complementary assets create incentives to invest in disruptive technology, but following biased and suboptimal strategies (Wu et al., 2014)

Types of innovation

- Why can innovations be *disruptive?*
  - The "Christensen effect" is mainly due to
    - Top managers' rigid cognitive framing (which may be overcome by introducing "frame flexibility" and playing with emotions, Raffaelli et al., 2019)
    - Profitability of existing business and shareholders' expectations to go on "milking the cash cow" until the very last moment (Kodak/film vs. Netflix/streaming)
    - Moving to commercialization implies managing heterogeneous business models → conflicts within the organization / value chain (risk of being deserted and "stuck in the middle") and diseconomies of scope (Greenstein 2017)

Top manager: we can adopt new tech but we will go from profitable to less profitable business model in order to survive.
Investors: The shares in the market will lose their value so you postpone the change.
Netflix: They did it. first they were renting DVDs through a site and sending DVDs to people by mail. And they disrupted blockbuster because it was website vs physical stores, flashcards vs recommendation system. As streaming technology came up, Netflix was able to change their business model.
Problem: How to move customers to new tech?
Streaming Low prices. and with mail: high prices. Lost some value in stock market in the process. How happened?
1- The top manager was different and realized the need to change.
2- Investors were smart. Not "milking the cash cow".

Institutional shareholding determines incentives to CEOs that positively influence innovation in general (Aghion et al., 2013), but does this hold for radical/disruptive innovation as well?
Is there a risk of "uniqueness paradox" (i.e., to be successful the CEO must have a unique strategy, but this increases his personal risks), unless shareholders are cognizant enough (Oehmichen et al., 2021)?

Types of innovation

- Why can innovations *not become* disruptive (with follower-incumbents win over innovators-new entrants)? Lock-in: You have so much utility from old technology that you will not switch to new technology.
  1. Adoption might be delayed / rejected because of lock-in and/or switching costs e.g. electric car vs traditional: 1- show me it is better? 2- is it compatible with the way I use the car like charging. 3- complexity 4- can I try it? 5- Can I see it? (next slide first part)
  2. "Appropriability regimes" and complementary assets matter a lot
  3. Many things can happen within a "maturing" S-curve → weak forecasting power
  4. Markets for technology allow incumbents to acquire new entrants

     Before disrupting, an incumbent can buy the entrants. Startups funded by venture capitalist, and venture capitalist is looking for exit. e.g. even if you don't want to sell your startup to a big company, the venture capitalist which you signed a "drag along" with, will sell the startup. They exit and get a lot of money and again trying to invest in other startups. This might avoid disruptions, and monopolies remain monopolies.

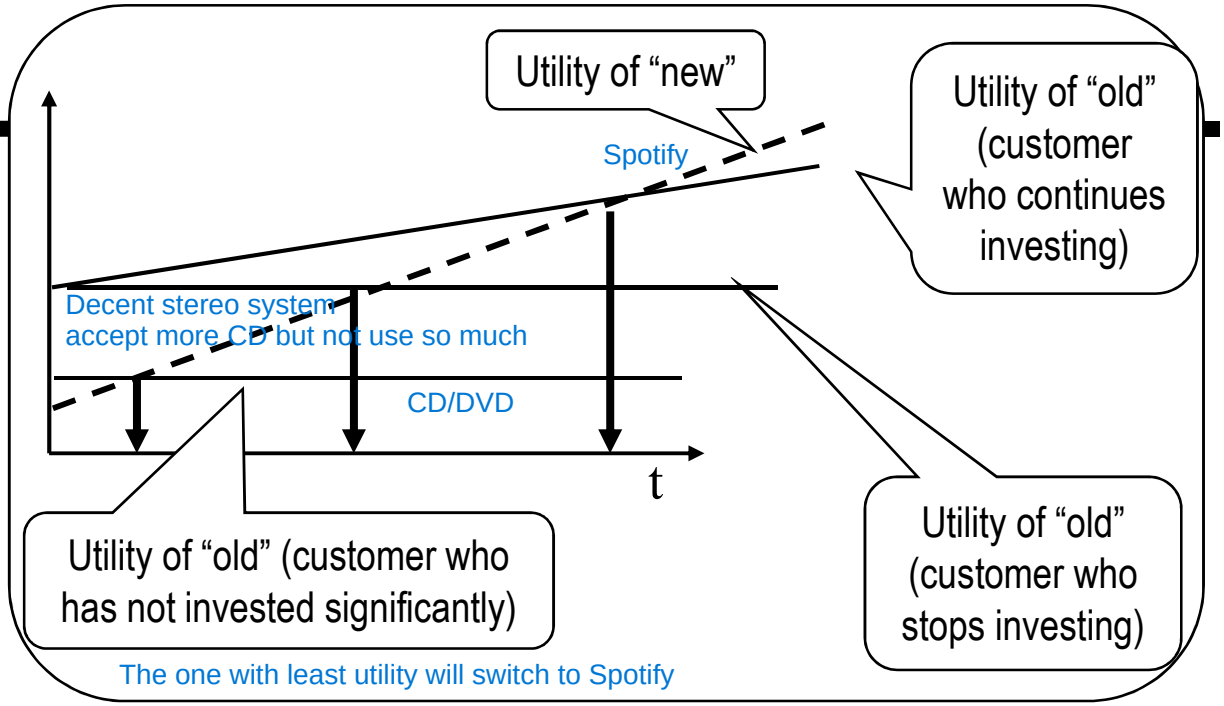
Tag-along or co-sale rights are essentially the opposite of drag-along rights. Whereas tag-along rights give minority shareholders negotiating rights in the event of a sale, drag-along rights force the minority shareholders to accept whatever deal is negotiated by majority shareholders.

Types of innovation

- Adoption decisions are based on 5 factors (Rogers, 2003)
  - Relative advantage
  - Compatibility
  - Complexity
  - Trialability
  - Observability

Last Slide

- Technological change is 'localized' (Antonelli, 2012)
  - Each customer continuously evaluates the opportunity of switching from "old" to "new"
  - The customer will switch if/when utility of "new" is greater than utility of "old"



Utility of "old" is path-dependent and depends on (*endowment advantage*):
- Costs and revenues accruing from "old"
- Experience gained with "old"
- Complementary assets to "old"

Utility of "new" depends on:
- Costs and revenues accruing from "new"
- Switching costs to "new"
- Expected value of costs needed to switch back to "old" (cost x probability)

Types of innovation

- Risk of focusing on product innovation and neglecting market-making (Godley 2013)
  - In the case of durables and experience goods (≠ search goods), customers can be
    - Risk averse
    - Afraid of miscalculating utility deriving from adoption
    - Wary of information asymmetries w.r.t. the utility of the innovation
  - Producers must invest in «market-making»
    - Lower price (can backfire!)
    - Make customers aware of their latent needs and their proximity to product specifications
    - Generate trust on the product and on their own future actions
  - The far-reaching complexity of this process opens doors to entrepreneurial firms

- Enroll key influencers and opinion leaders This mostly works with medical field
- Make credible commitments to get credibility to your solution
  - warranties
  - license parts of the process to competitors (e.g., production, after-sales service, etc.) technology not disrupted
  - sell a service (not the product), or offer a cheap and reliable service subsidized by a high purchase price (Singer sewing machines)

Two things matter a lot in disruption:
1- Appropriability Regime: you develops something new which has potential value and you are able to get the money out of it. Weak if: any competitor able to imitate. You can use Copyright to avoid it, but it is not easy, you might go to the court and it takes ages and in the meanwhile you may probably dead.
2- Complementary assets: supporting asset for process's of innovation. e.g. factory to build the product, sales. Case1: It is generic. assets which do not need to be tailored to a particular innovation. case2: When you need a specific complementary asset. You have to add a lot of money. The type of complementary asset can tell whether a entrant can disrupt or not.

Types of innovation

e.g. Tesla: CA: battery, charging station. Elon Musk did it by himself. He had a lot of money to do it.

- Appropriability and relationship with complementary assets required to develop the business / ecosystem / paradigm (Teece)

Entrants may have to

- develop an ecosystem from scratch
- work from within the existing ecosystem → «disrupters' dilemma» requiring a well-thought coopetion strategy with incumbents and complementors (Ansari et al., 2016)

The "appropriability regime" of technology can be strong or weak (w.r.t. legal protection or nature of technical knowledge)

Complementary assets can be generic, specialized (technology shaped on asset, or *viceversa*) or co-specialized → ownership is critical

The innovator may attempt to own complementary assets (→ need for finance), buy them on the market, or leverage on the existing ecosystem (→ coopetion)

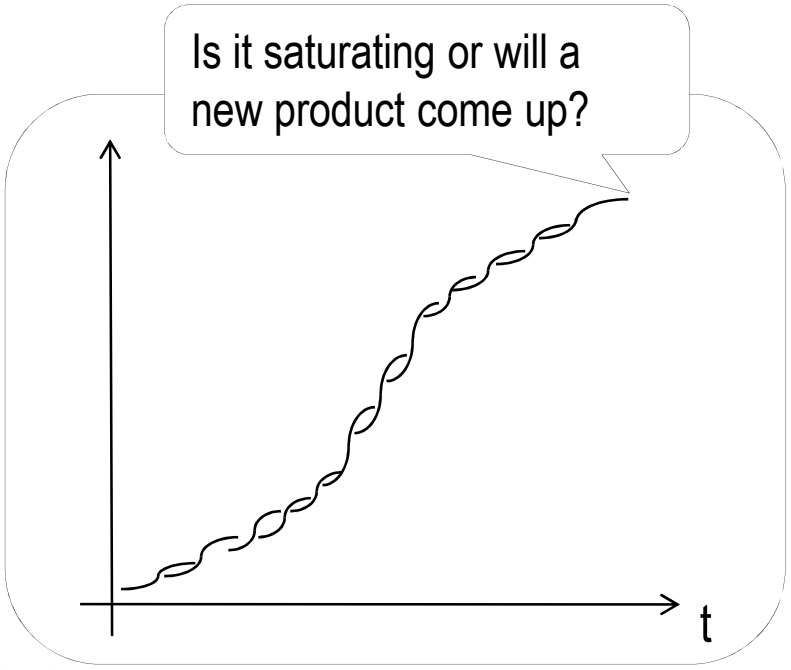
Appropriability / Owners of complementary assets are	Strong	Weak	
		Commissioning complementary assets easy for innovator	Commissioning complementary assets easy for all
Weak	Contract → Innovator should win	Contract → Innovator should win	Contract → Either innovator or imitator could win.
Strong	Contract or integrate → Innovator should win but profits will be shared with asset holders	Integrate → Innovator should win, but profits will be shared with asset holders	Contract → Innovator will probably lose to imitators and/or asset holders

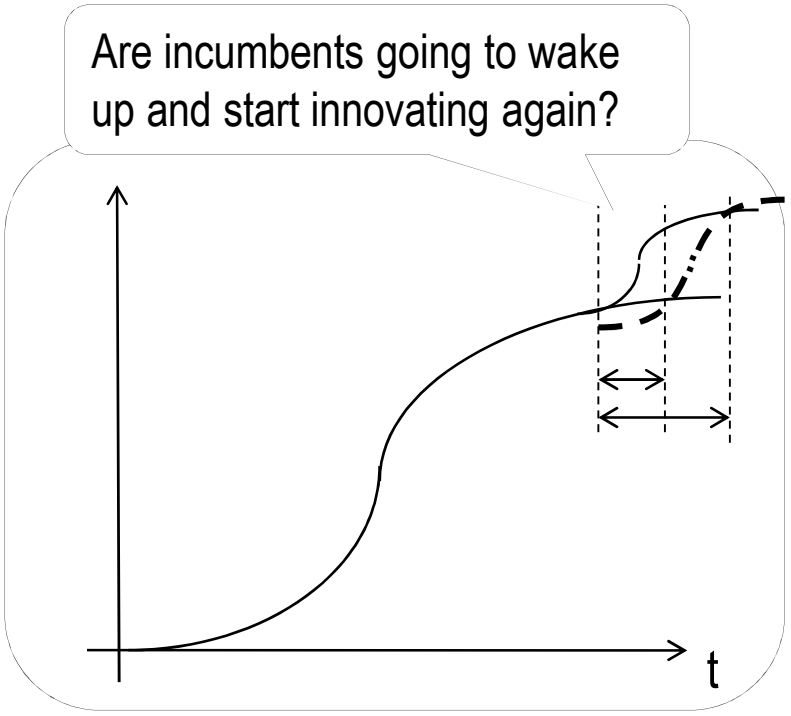
Two things matter in s-curves:
1- Generation of same technology one after. small s-curves. It is not a real separation.
e.g. Why Intel wait for i9: Because they have to use smaller nano meter processor. The second part it all about sailing ship effect.
2- time in x axes of s-curve (drawing the x axes of the s-curve with time is wrong actually because the technology needs investment in order to improve, not time).
e.g. Traditional car makers improved their gasoline based cars instead of investing on electric cars.

Types of innovation

The sailing ship effect: is a phenomenon by which the introduction of a new technology to a market accelerates the innovation of an incumbent technology.

- It is often misleading to use s-curves to predict radical and disruptive change
  - s-curves exhibit *some* discontinuity because of *nested* s-curves (product generations, individual products) → difficult to understand *what* is saturating
  - s-curves are often drawn with time on the x axis (just add effort + retreat to the applications where technology can stay stronger for a while! →"sailing ship effect", Harley 1971)

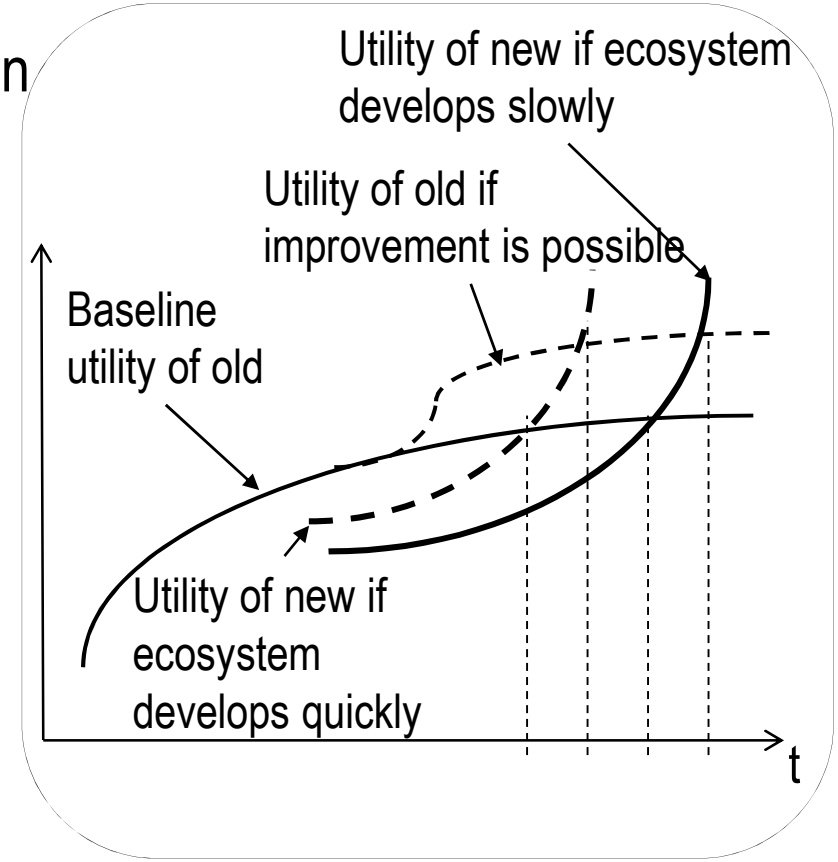




Sailing Ship effect: The sailing ship makers woke up and innovated steam ships, disrupted in only costal voyages but in 100 years in all travels.
Market segmentation: Costal navigation and long distance navigation. sailing ships had a chance in long distance navigation because steam power ships needed a lot of coal to carry in the ship. And in costal navigation the steam ships had the advantage. They made ships of steel which is bigger than wooden one and also less crew is needed than sailing ships.

Types of innovation

- Adner and Kapoor (2016) blend the impact of the sailing-ship effect and of the ecosystem (or paradigm) building challenge
- Adoption of potentially disruptive technology can be delayed by the
  - ease with which the old technology can still improve
  - difficulty with which the new technology can develop a utility-creating ecosystem



Is digital photography disrupted: it depends who you are?. not completely disrupted because it was a component of a complex system.
Disruption: reflex Camera: A modular innovation happened as film camera changed to digital one. Very less disruption in reflex cameras happened.
Compact camera: it was a radical innovation as the architecture changed.

Types of innovation

- Analyzing maturity of s-curves is especially tricky at component level

- If a supposedly radical innovation really occurs at component-level
  - This causes limited disruption to the organization (switch suppliers!)
  - Component-level innovation *tends* to be incremental and enhances performance indicators valued by current markets → incumbents still have an advantage

- Radical change (maturing s-curves) <u>at architectural level</u> are more disruptive to incumbents, since architectural innovation
  - is disruptive to the organization and the value chain
  - *tends* to be radical (i.e. it alters the tradeoffs between performance indicators) → creates a potential offering for "new" markets

Did you see disruption in reflex cameras?

What about compact cameras?

Why?

- Resistance: When you don't want to strengthen you old business' model and also not going to the new one.
- Do something to the old and avoid new (sailing ship effect).
- Abandon the old and right away jump to the new. e.g. Netflix.
- Car companies: They are improving their cars and moving to the new technology as well (exploitation + exploration). Problem: To manage the old and new at the same time (Ambidexterity). e.g. Ford they split the company to old and new.

Types of innovation

- When a radical innovation is upcoming what could your strategy as incumbent be?
  - Aside from «objective» rigidities, the main problem lies in top management's ability to perceive the risk of disruption and react by changing business models
  - 2 possible strategies are exploitation and exploration (Osiyevskyy and Dewald, 2015)

Exploitative strengthening of current business model **Explorative adoption of disruptive business model**	**No**	**Yes**
Yes	Pure exploration (jump ship quickly)	Integration (complex migration or create a spinoff)
No	Defiant resistance (no change)	Pure exploitation (incremental innovation)

Car companies

  - Empirical research tells us that the choice depends on
    - The perception of the innovation, as an opportunity (→ leads to exploration) or as a threat (→ leads to doing nothing)
    - Managers' prior experience in dealing with risk (→ leads to doing something)
    - Industry experience (→ leads to doing nothing)

Ambidexterity: The ability to manage the old and new at the same time. Old: managed for profitability, New: for potential future profitability.
Vacillation: The ability of the company to realize when is time to move to the new.

Types of innovation

- When a radical innovation is upcoming what could your strategy as incumbent be?
  - There always will be tension between the need for renewal and the cannibalization of the current business
  - In principle, exploitation and exploration are complements but – at organizational level – they induce negative externalities on one another
  - Literature proposes two major approaches (Boumgarden et al., 2012)

Ambidexterity

- Exploitation and exploration activities occur simultaneously within the company
- Exploitation and exploration are located in different organizational units, with different KPIs and management approaches
- Top management must mediate / balance / integrate appropriately between then two
- Ambidexterous behavior must be induced throughout the firm (down to each BU, team and individual)
- Ambidexterity should allow a smoother transition (but beware of reactions when "the new puppy starts eating into the old dog's bowl")

Vacillation

- The organizational focus alternates between phases of exploration and exploitation
- Organizational changes determine the shift (e.g., centralize / decentralize), but be aware that, while formal organizational change can be discontinuous, informal routines will adapt with inertia
- Vacillation lessens the risk of being «stuck in the middle»
- Vacillation is more effective when it is not too abrupt, especially if resources are limited (Kang and Kim, 2000)

Types of innovation

- So, when a radical innovation is upcoming what could your strategy as incumbent be?
  - Pre-emptively lock customers in your technology
  - Try “killing” the new technology or buy time
    - improve the old technology
    - start a price war
  - Segment the market by “needs” and closely monitor (or serve) them all (“incumbent’s advantage”)
  - Be wary of “sunk cost” and “status quo” traps
  - Migrate to the new technology
    - Listen to “people on the edges”
    - Fund R&D top-down and/or go for acquisitions
    - Bring new champions on your top management team on time and allow some tension
    - Look for the “right” market and business model
    - Involve entrants in your ecosystem and work on the new paradigm in order to minimize disruption
  - Retreat to a niche or relocate to a different market where you can use your assets

Acquiring a «complementary» large incumbent with vested interests is dangerous (Sony/CBS, AT&T/AOL)... inertia is simply amplified

A beachhead market is the place where, once you gain a dominant market share, you will have the strength to attack adjacent markets with different opportunities, building a larger company.

Types of innovation

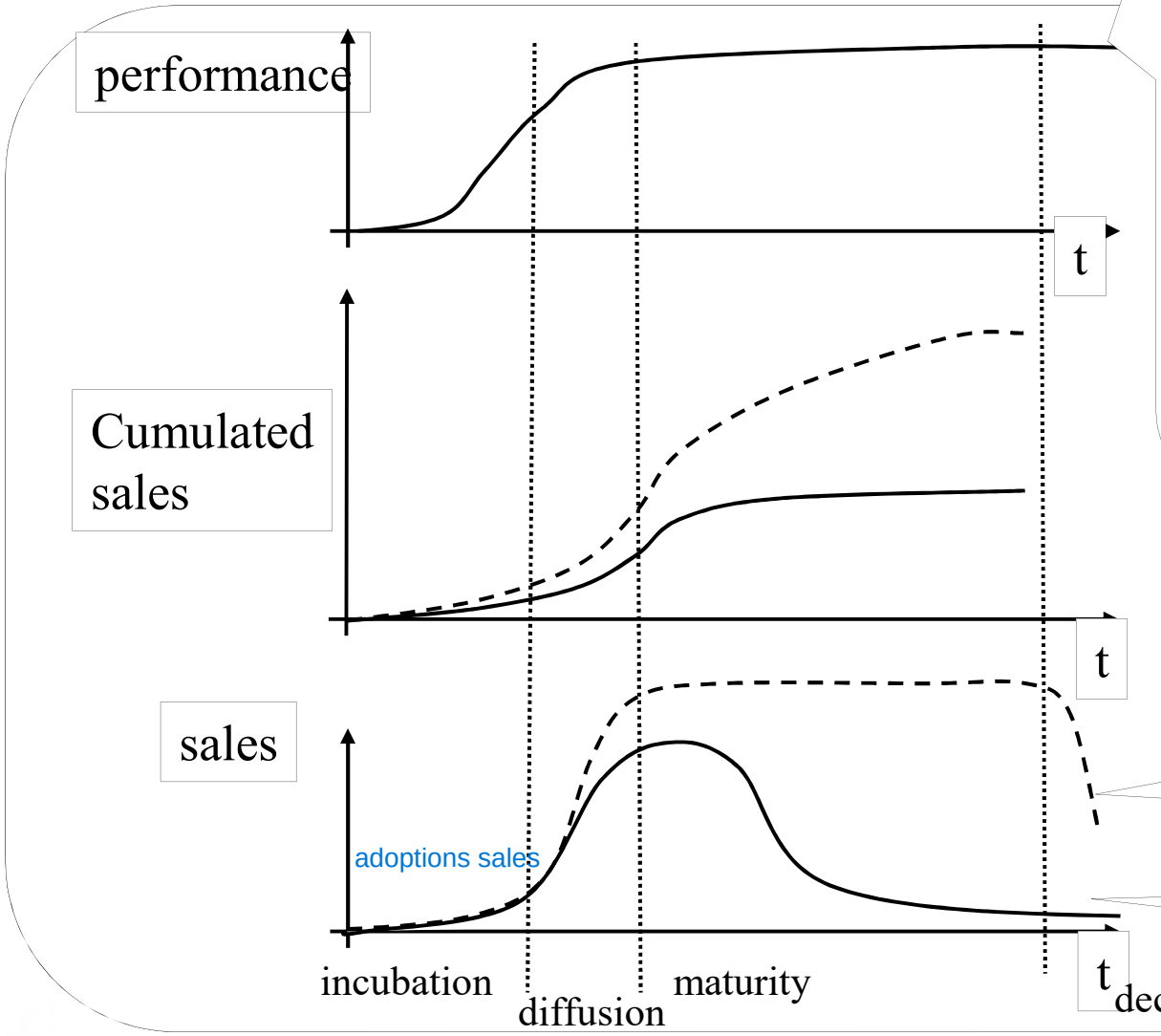
Speed of diffusion and technical progress, cash burn rates are key elements to consider

- ... and what if you are a new entrant?
  - Find the right beach-head market that is
    - right for your immature technology
    - likely to be overlooked by incumbents
  - Stay away from markets that are overserved and locked-in the old technology
  - Make the right vertical integration choices
  - Strengthen your IPRs
  - Be wary of your lack of complementary assets and develop the right strategy, eventually coopeting with incumbents (e.g., B2C fintech firms moving to B2B2C)
  - Watch out for improvements in the existing technology
  - Consider selling your business to an incumbent

S-curves are a dynamic state that can be studied with differential equations. (diffusions in innovations)
Why S curve: 1- Diffusion phenomenon: it is not linear
Company: you should know where you are. e.g. incubation: having smart phone is cool. you need it. diffusion: buy new which is better.

Dynamics of innovation

- S-Curves and diffusion



The product life-cycle model works for most products that have to do with new technology.

The **co-constructivist perspective** says that "*products stay alive as long as there is a social network of actors that see value and meaning in producing and purchasing them*" (think about food, fashion, design, etc.)

Performance and ***meaning***, can be weighted differently by markets as time goes by

subsequent purchases (additional and replacement sales)

1° purchase (adoption sales)

Dynamics of innovation

- S-Curves and diffusion can be studied under a number of perspectives
  - Mathematically (Bass model and its variants)
  - Diffusion of Innovation (Rogers, Moore and others)… the technology is assumed to be value creating, and will be gradually accepted by a sequence of market segments
  - Technology Acceptance Models (Davis) / Unified Theory of Acceptance and Use of Technology (Venkatesh) …
  - Social Network Threshold theory (Valente)…

differential equations

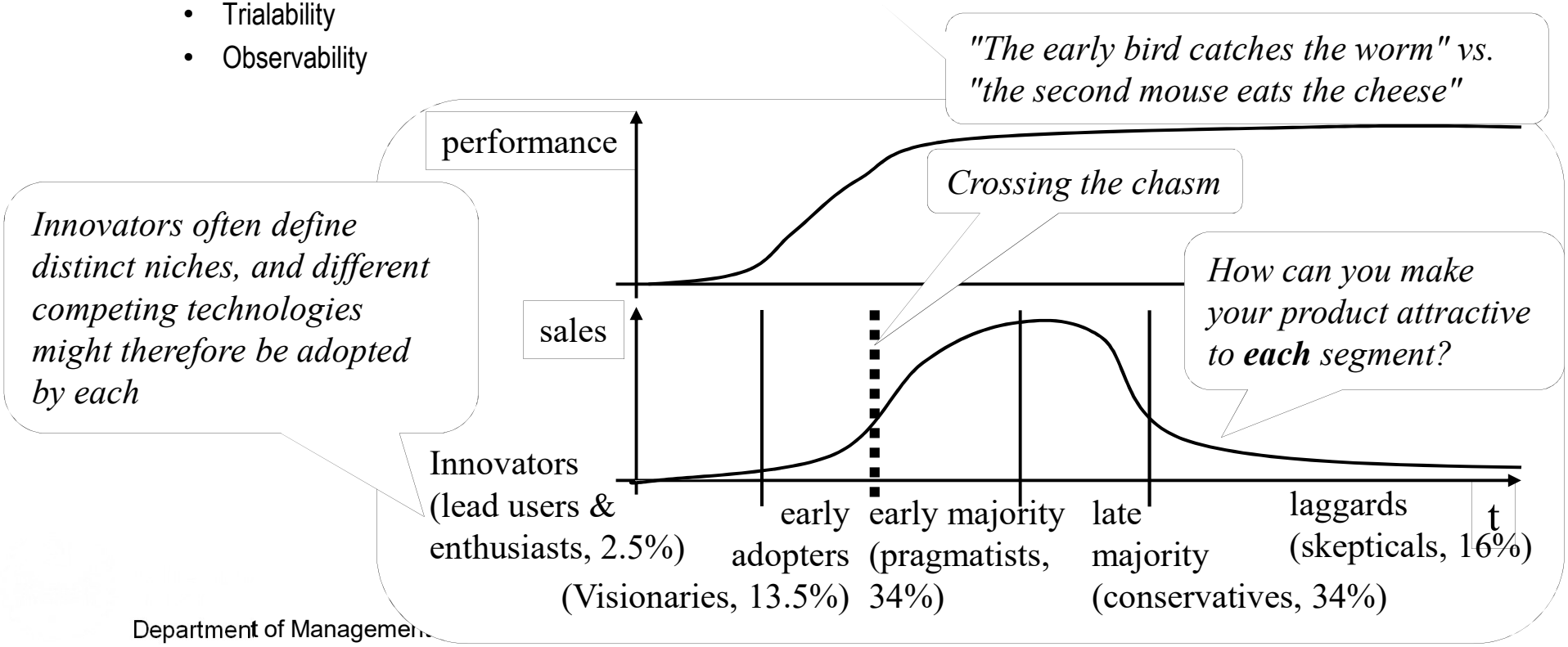
When the technology is good but when you approach with a good value creating technology in a market, it will not diffused immediately because people are different.

Market segments: Ones who buy right away and those who buy later on.

Rogers theory: Based all the difficulty all adopted, usually any technology will find 5 segments. 2.5% population called innovators, 13.5% early adopters, 34% early majority, 34% late majority, 16% laggards. There is no scientific reason for this but it is true.
Innovators: are the customers who are completely different from the rest of population.
Early adopters: are called visionaries. They see the potential growth. The incumbents might buy them.

Dynamics of innovation

- Rogers (1962) DoI theory
  - 5 segments, profiled w.r.t. their attitude towards innovation
  - Key features are
    - Relative advantage
    - Compatibility
    - Complexity
    - Trialability
    - Observability
- Moore (1991) shows that moving to the early majority requires new competencies and assets
- Is it better to be leaders or followers?
  - It depends on capability to lock-in the early market, rate of learning and observability of lessons learned (iPods)
  - If diffusion is fast, crossing the chasm is much easier for incumbents that for de alio entrants and startups



Crossing the chasm: the challenge that technology companies face when trying to transition from serving early adopters of their products to reaching a broader market of mainstream customers.

It doesn't mean if you are early in the market, you will win because it depends on who you are and what you do. e.g. Apple released iPods later than other companies (Archos), but won the market. Here the theory of first mover advantage doesn't work. Archos entered the market early but they couldn't cope with the technology change that was going on.

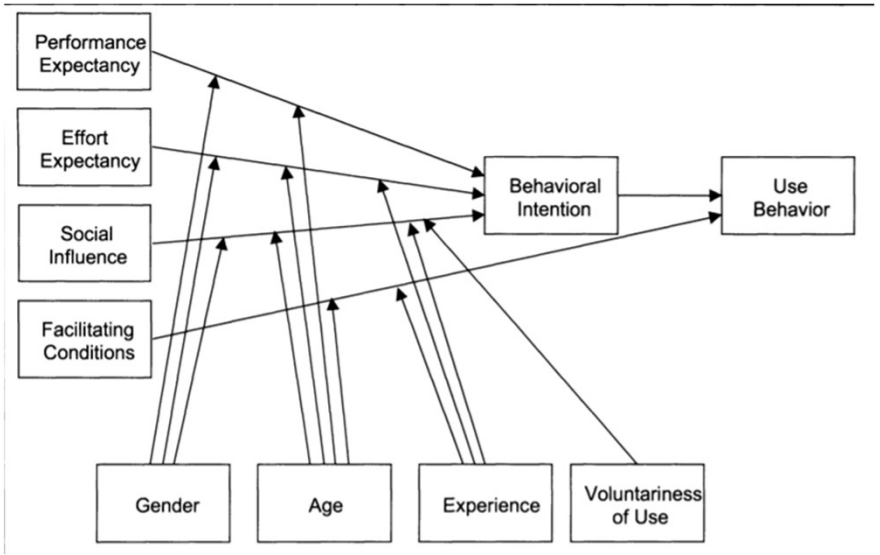
Dynamics of innovation

- How can you make your radically innovative product attractive to ...

Innovators?	Early Adopters?	the Early Majority?
• Understand who these beach-head innovators are and their specific needs • Find a way to contact them • Make sure that initial technical shortcomings can be overcome by users and field service • Engage in dialogue with them	• Start creating a solid “adoption network” (distributors, complementors, etc.) • Start working on ancillary features such as ease of use, design, etc. • Define a satisfactory (if not perfect) price-benefit ratio • Ensure that the product is reliable and “cool”, so that early adopters can start a positive imitation effect • Lower purchasing risk (“get your money back”, razor-blade business models, etc.)	• Work hard on ease of use, design, etc. • Consolidate the “adoption network” (ensure that complementary products & services are made available) • Sell as a bundle with other goods with which the user is familiar • Make technical features “just good enough” but not more • Look carefully at pricing (not too high to discourage, not too low to kill margins) • Lower risk in purchasing

Dynamics of innovation

- Technology Acceptance Models (Davis 1989, Venkatesh 2000 and others)
  - Developed in the field of Information Systems research
  - Users must first *intend* to use the new product, then start using it
  - Key constructs of TAM/TAM 2 are
    - Perceived usefulness (create a gain / relieve of a gain)
    - Perceived use of use
    - Subjective norm (ie, the perception that people who are important to you think you should act)
  - UTAUT (Unified Theory of Acceptance and Use of Technology) expands TAM/TAM2 with constructs from DoI



Dynamics of innovation

- Social Network Threshold theory
  - Each individual adopts after the "pressure to adopt" has passed a given threshold
  - Each individual is characterized by a specific threshold (this recalls Rogers' segments)
  - The "pressure to adopt" depends on
    - individuals' exposure to their social network,
    - the adoption behavior of those who are connected with him
    - external influences (e.g., advertising)
  - Therefore, each individual can be categorized differently, if you look at the overall social system vs. his specific social network.

Dynamics of innovation

e.g. cars, airplanes. not services.

- Abernathy-Utterback (assembled products)

Only one of the possible emerging designs becomes the dominant design.

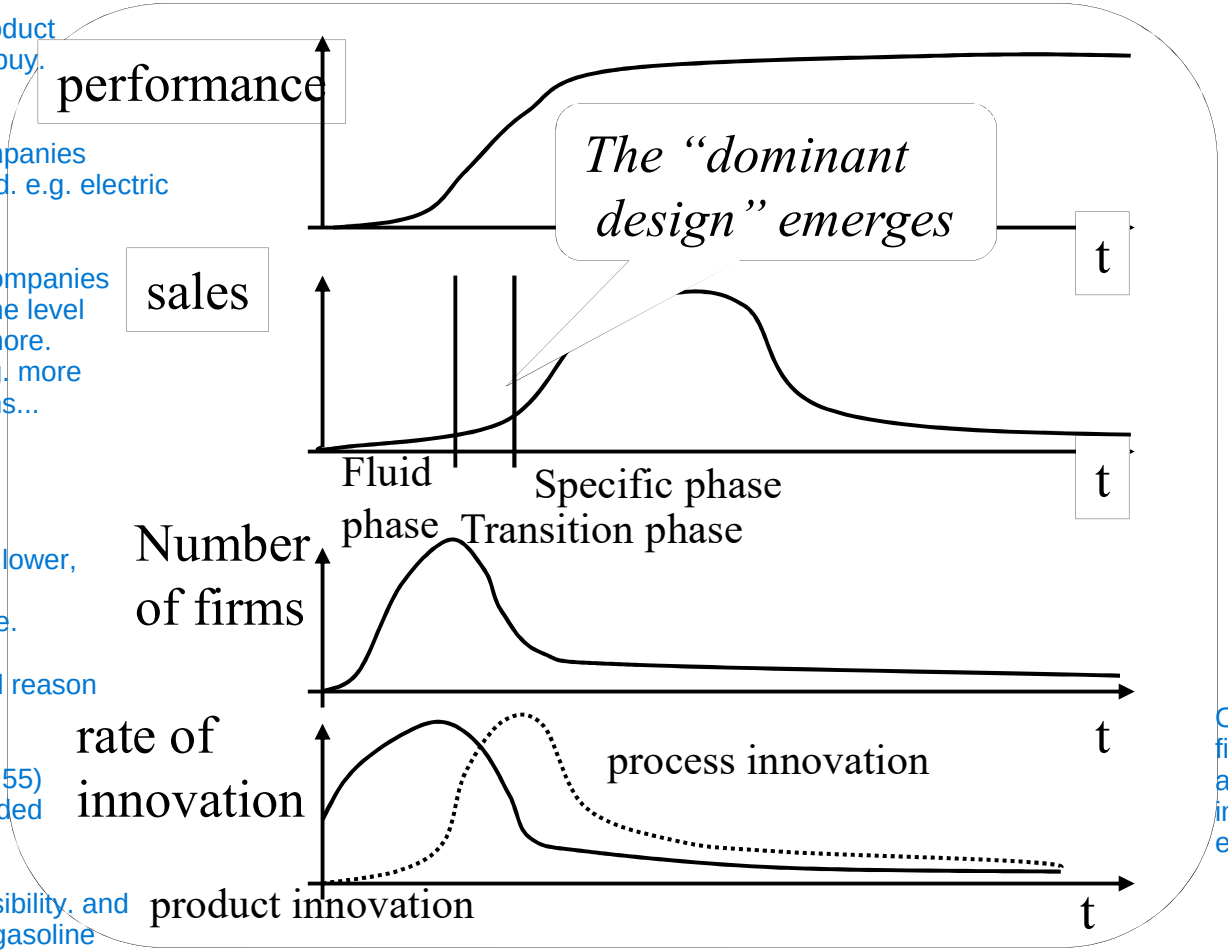
Early phase which is called fluid phase, there are different types of a certain product and people are confused which one to buy. e.g. Steam cars vs gasoline, electrical.

Initial shakeout (technological): the companies with wrong technology will be eliminated. e.g. electric and steam cars went out of market.

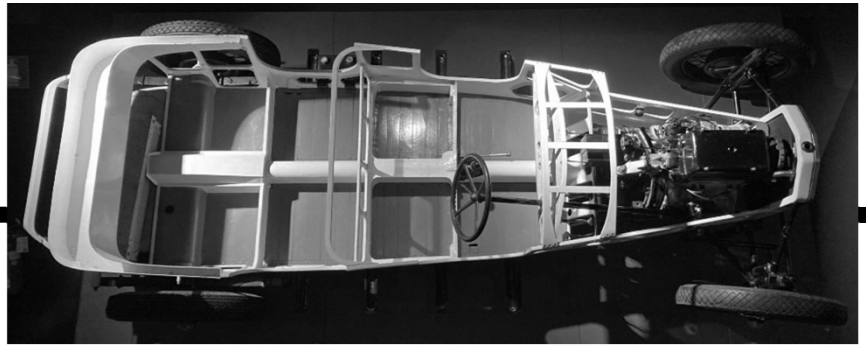
if the sales go up, and the number of companies goes down, what happens to sales at the level of individual firm? they increase even more. good news but not easy to manage. e.g. more people, managers, bigger building, loans... The survivors must be more efficient.

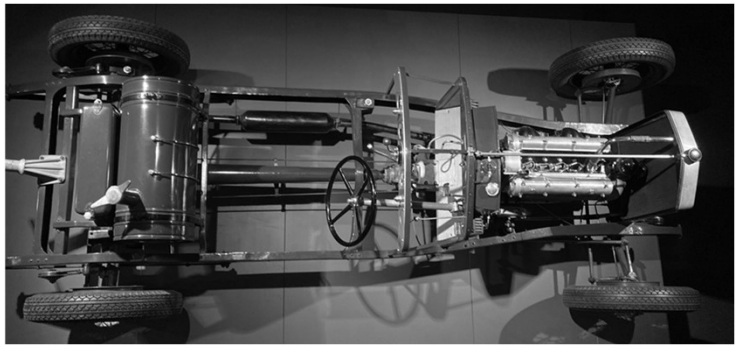
What happens if you start having very efficient process, you will have:
Economies of Scale: the cost becomes lower, when the production increases.
only a handful of companies can survive.
Process innovations:
1- Technological reasons 2- Managerial reason
3- Efficiency reasons

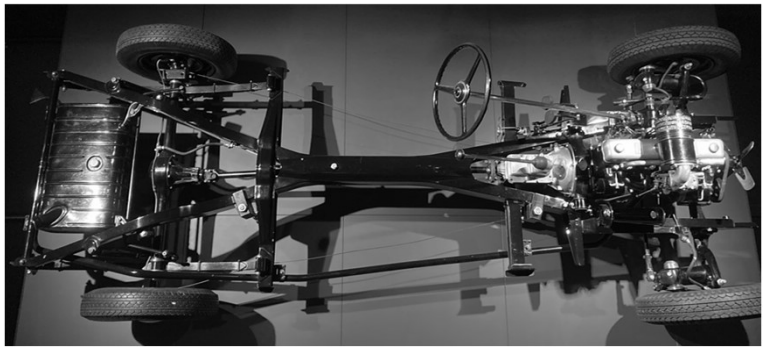
e.g. Why gasoline car dominant? (slide 55) Customers make the choice. They decided based on their need. Typical customer: rich people to drive to country side, and the electric car didn't have the possibility, and steam also were so complicated. Only gasoline was possible. Also farmers in US wanted such cars.

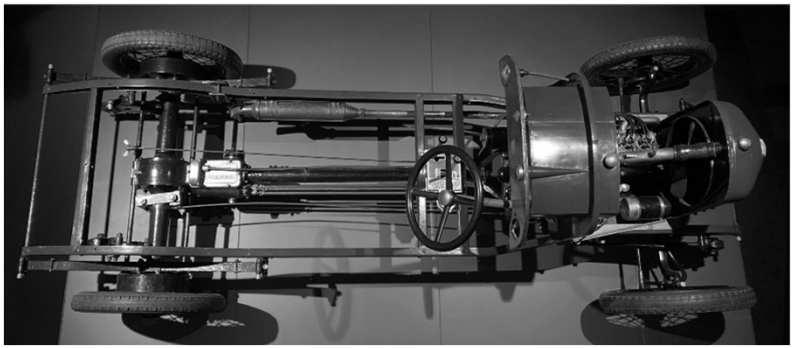


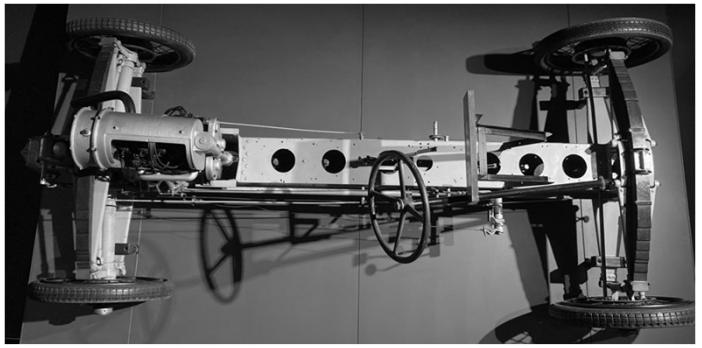
Only the fittest can survive, fittest are the one who are able to transition to process innovation and become more efficient.











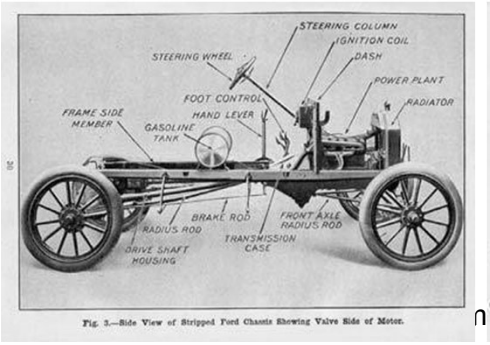
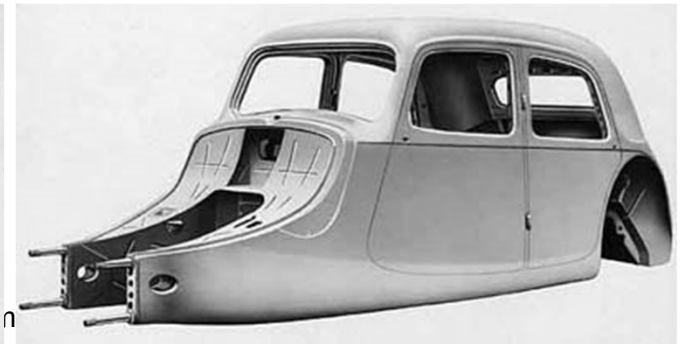


Fig. 3.—Side View of Stripped Ford Chassis Showing Valve Side of Motor.



Dominant design that could last up to 90 years.

	Fluid	Transitional	Specific
Main strategic challenges	Entering • with the "right" technology / product concept, making best use of technological assets and vision of the future (Benner and Tsipras 2012) • at the «right time» in the «window of opportunity» (Christensen et al. 1998) Trying to make *your* design / technology dominant Keeping some options open with other competing technologies	Switching to the «right» technology at the right time, if feasible Readjusting specific and wrong choices associated to the right technology (which is hard – Eggers 2014) Managing initial growth and surviving the shakeout	Surviving further shakeouts Surviving commoditization (looking for further innovations) Anticipating the next S-curve
Competitive emphasis	Functional performance on the «right» product features	Product variation	Cost and quality
Favored firms (diversifying entrants vs. startups)	Probably no difference between diversifying entrants and startups who make the «right» choice. Among the others, diversifying entrants may switch technology with greater ease.	Diversifying entrants (because of scale and complementary assets)	Startups might find it easier to keep abreast with technology and have no fear of cannibalizing existing products Diversifying entrants may find the «transition to incumbency» easier because of prior experience (Chen et al. 2012)

Dynamics of innovation

	Fluid	Transitional	Specific
Innovation stimulated by opportunities in	Market and technology	Internal technical capability	Pressure to reduce cost and improve quality
Predominant type of innovation	Radical on product	Radical on process (to scale volume up)	Incremental on product and process
Production processes	Flexible	Becoming rigid	Rigid
Equipment	General purpose, requires skilled labor	Islands of automation	Special-purpose and highly automated
Materials and components	Generally available or internally developed (critical decision!)	Specialized, from suppliers or through vertical integration	Specialized, sometimes through vertical integration
Plant	Small-scale	Growing	Large-scale
Organizational control	Informal and entrepreneurial	Project- and task-based	Bureaucratic

Dynamics

Case of gasoline-powered vs. steam-powered and electric cars (Geels 2005)

- prevailing initial niches and seamsless progression to new ones (taxis, luxury urban transport, sports, tourism, followed by doctors, salesmen and farmers, but **not** freight transportation)
- gasoline as "surplus" of oil cracking already having an initial distribution network
- Ransom Olds attending 1895 car race
- horse troughs shut down because of livestock diseases
- technical improvements (e.g., clutch and gearbox) and spillovers from competing dominant designs (e.g., electric starter)

- Dominant designs emerge because of selection criteria that are endogenous to the technical and economic environment
  - Superior technology (as perceived by the initial customer niches) and opportunity to improve products and processes
  - Seamless diffusion across market niches, with little reaction by actors affected by disruption
  - Reputation of the firm(s) following the design, especially if the leader allows some technological spillover to competitors
  - Existence of complementary assets
  - Public policy (regulation, taxation, infrastructure)

The best technology (in the eyes of consumer) and the one customers want. (example in the slide 51)

Not important

e.g. Tesla (leader) made their intellectual property available to competitors, so they can have some followers behind them.

By products of oil: 1- gasoline for cars(which was being burnt before). 2- Tar for building roads. another reason on domination of gasoline cars.

Can move to a new technology. e.g. making more recharging stations to move to electric cars.

Spillovers reduce competitors' incentives to develop

- a different technology → lower risks and shorter time
- own competencies → weaker competitors

(Pacheco de Almeida and Zemsky 2012), e.g. Intel and AMD, Tesla

Lock-in (Producers or supply side perspective): You have so much utility from old technology that you will not switch to new technology.
Network externality: is an economics term that refers to how the demand for a product is dependent on the demand of others buying that product. In other words, the buying patterns of consumers are influenced by others purchasing a product.

Dynamics of innovation

- Dominant designs remain stable (*lock-in*) because of
  - Economies of scale in production
  - Organizational learning within firms & value chains
  - Network externalities
  - Investment in complementary assets
- Unsuccessful designs tend to disappear… or serve niches

e.g. The dominant design of cars are from 90 years ago and still dominating. The cost of design is cheap so they don't move to new technology.

e.g. cities full of refueling stations for gasoline based cars, that's why going to battery cars is not easy.

serve niches: e.g. by the emerge of gasoline cars, electric cars for example served in warehouse to move objects.
Or batteries of electric cars used in internal combustion engine.

Service: have the architecture of the process which the service run. First there is a dominants process, based on that new products will run on it. Two problems: 1- Building a huge infrastructure for future innovations which might not happen.2-You build the infrastructure in a conservative way, then realize you are building lock in. e.g. ATM machines initially were developed to withdraw money (dominant design) but later on some features like paying bills, transferring money...were added. If you are either too little or too much ambitious, you're gonna make mistake. e.g. in 80s IBM designed a powerful ATM (too ambitious) machine to handle future additional services, other companies made cheaper and simpler ATM machine (little ambitious). e.g. Fast-Web created A-DSL internet connections for people instead of fiber optic because the infrastructure was already built for that (telephone lines). Later on people started to use downloading and uploading videos which require more data and A-DSL was not enough for that.

Dynamics of innovation

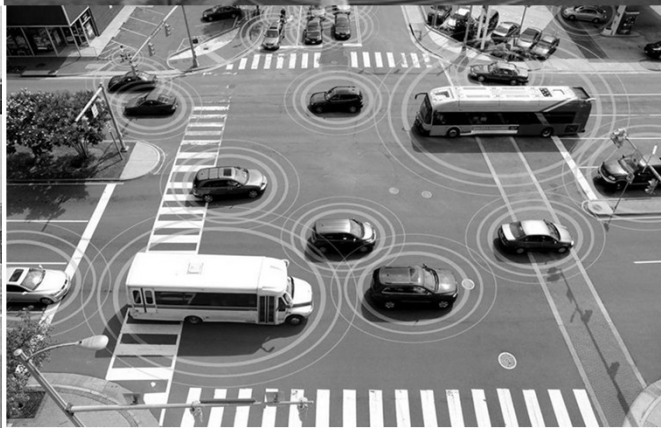
- The model by Abernathy and Utterback applies to non-assembled goods (process industry) and services (Barras) too but
  - In such industries it is difficult to observe innovation (organizationally embedded)
  - Dominant designs emerge in the process (not in the product)
  - Rates of innovation for product and process are inverted
  - The process/infrastructure determines lock-in

Clearinghouses in legacy ATM infrastructure

RF-ID vs. GPS/V2I tolling systems in German autobahns

Cable vs. FTTC/xDSL vs. FTTH in telecommunications

WiFi V2V vs. 5G C-V2X infrastructure for connected cars



Products have the dominant design in product and services have in process.(Different dynamics)

Dynamics of innovation

- Does the Abernathy-Utterback model still hold today? yes but some cautions
  - Modularity might make dominant designs less important (Cebon et al., 2002)
    - Specialization resides within modules (not architectures)
    - Economies of scale are found at the level of modules (not products)
    - The role of organizational learning is reduced by functional independence
  - The Abernathy-Utterback model does not deal with product-services
  - The model doesn't say much about vertical integration choices, which are critical
  - The fluid phase is very complex

    Even before commercialization, there is a long and complex "investment-incubation" process

    The dominant design emerges as a process, with an «innovation shock» (launch of a highly successful product, Argyres et al., 2015, or emergence of a «dominant category», Suarez et al., 2015) → simultaneous attraction of entrants and initial shakeout → emergence of the related dominant design
  - There can be «false starts»
    - Subsequent process (process) innovation may or not effectively allow the long-term establishment of a dominant design emerging in the product (process)
    - Uncertainty is such that later adopters «follow leaders» blindly, allowing initial diffusion of soon-to-be-abandoned innovations (Greve and Seidel, 2015)
  - Innovation is not only "product" and "process"

    Abernathy-Utterback model says there are two types of innovation: product and process or process and product where product innovation is about performance(S-curve), and process innovation is about performance expecting in process which basically means cost.

Dynamics of innovation

- Given that assembled products and services exhibit opposite behavior, what happens for bundles of product-services (e.g., navigation devices and mapping services)?
- What happens if these bundles are *also* based on modular architectures (in the product *vs.* in the infrastructure)?
  - You have to look at standards (where do they make sense?, e.g. DRM in music)
  - You have to look for components where economies of scale might arise (e.g. SIRF chips and maps for navigators)
  - The “typical” dynamics (dominant design, innovation rates, etc.) arises in the part (product vs. infrastructure) where you have less modularity

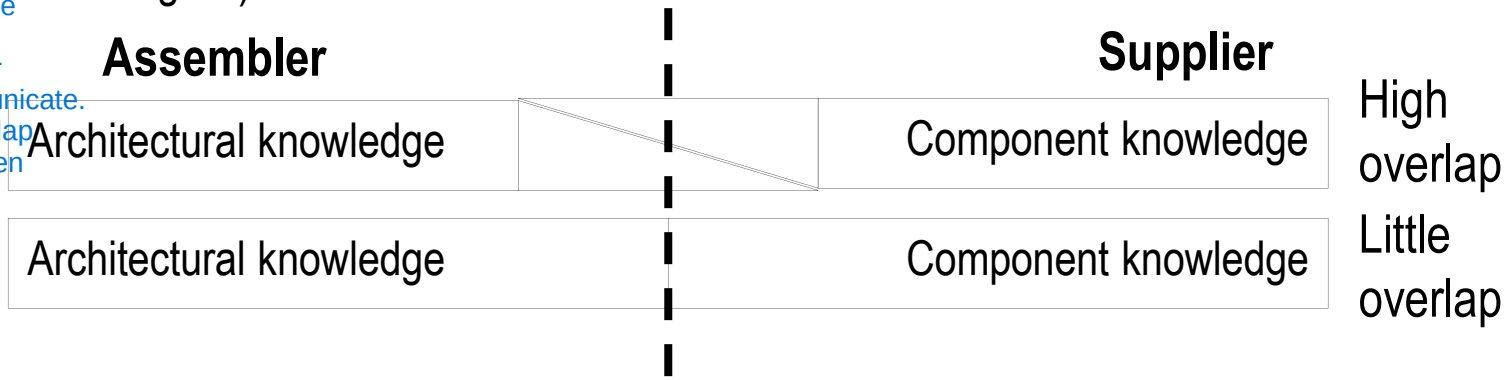
Idea of something is simultaneously a product and service (the model doesn't allow this idea). e.g. scooter sharing: You have to choose if it is fundamentally a product with architecture and dominant design, and also component of a service. Another vision: it is fundamentally a mobility service and scooter is simply a component of it.

Vertical integration: is the decision of a company to make components upstream or deal with activities downstream. e.g. Tesla by deciding to make their own batteries is a vertically integrated company. The model doesn't say much. Additionally to model: 1- Usually you will not a the possibility to vertically disintegrated at the beginning of S-curve because the component makers are not there. e.g. Ford: Henry Ford needed tires providers, but nobody was there. Solution: you make your own tires, so you have to go to vertical integrations. Tires need rubbers... Only when the dominant design emerges the providers will appear, but at the beginning you should go for vertical integration. Vertical Integration goes in waves, high at the beginning, then lower, but high at the end. Abernathy-Utterback model doesn't say anything about this.

Dynamics of innovation

- Vertical integration choices are strategically important
  - The degree of vertical integration will be lower if (Christensen et al., 2002)
    - Initial architectural problems have been solved, and the architecture / dominant design allows the development of a value chain
    - the market values component-level (i.e. localized) product performance instead of performance that is determined by system integration
  - Architectural and component knowledge is partitioned among assemblers and suppliers with some overlap. Overlap will decrease (Lee and Veloso 2008).
    - as the paradigm progresses along the s-curve (at first *both actors* mus focus on architectural innovation)
    - if modular architectures arise
    - as long as the trajectory does not encounter significant uncertainties (market or technological)

Even if you disintegrate after some time, you should still know about the component which the supplier provides in order to better communicate. And also there should be an overlap of architectural knowledge between assembler and supplier.



Model says, Product innovation: Dominant design emerges then innovation shifts to process. By shifting to process it enables the cost reduction.(Which is technically possible) e.g. when the batteries built in huge volume, they would be cheaper over time. Still not cheap. The process innovation always will not take care of the dominant design.

Dynamics of innovation

- The rise of a dominant design requires interplay between product and process innovation
  - Abernathy and Utterback's model assumes that, once the dominant design has been established in the product, process innovation will take care of ensuring manufacturability and economies of scale (for continuous products and services, product innovation will allow a fuller economic exploitation of the infrastructure)
  - However, a candidate dominant design could fail prematurely if this does not happen, i.e., if the product dominant design is not easy to manufacture (for continuous products and services, if it is not easy to generate new products)
  - The transition phase can therefore take a long time and exhibit a sequence of «false» dominant designs, and the final will be the one for which the second stream of innovation (process or product) becomes feasible

«Ease» is not necessarily in absolute terms... could be in «local» terms (w.r.t. industry, geography,e tc.)

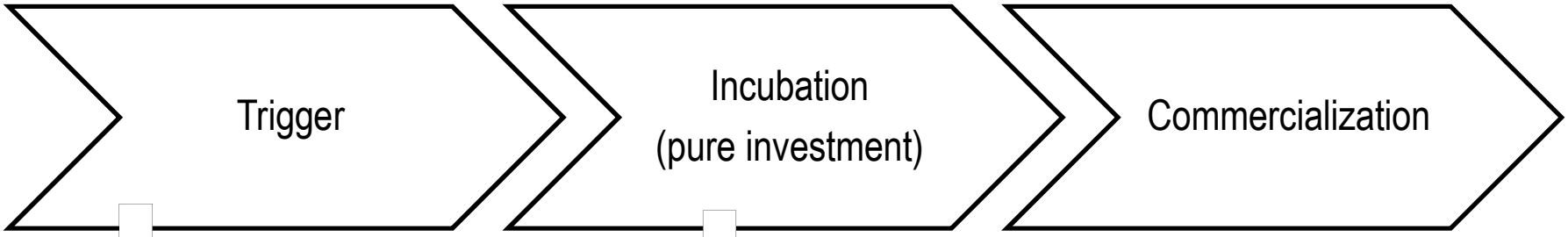
e.g., integrated photonics chips, many contemporary battery designs

e.g., proprietary network protocols before TCP/IP

Abernathy-Utterback model doesn't say anything about fluid phase as well. What happens in fluid phase? The dominant design emerge out of the fluid phase. How is it built? Trigger: something that starts the process. Incubation: pure investments, no sales. Finally we move to commercialization. The process built in fluid phase depends a lot in type of trigger. Triger event gives shape to the rest. e.g. scientific discovery (high level thing that has not application yet). For example inventing laser can be used in many ways, cut metals, laser pointer, measurements... The point is that technology is up there and where this technology best suited to solve which practical problem (technology push). Other types of fluid phase: 2- Unmet user needs as trigger. e.g. inventing dish washer. 3- Missions oriented grand challenges: Bring forward a lot of new technologies coming from many different places. e.g. sending man to the moon led computing inventions....

Dynamics of innovation

- Industry dynamics in the incubation period is critical, and 'entry' must consider both the incubation and the commercialization phases (Moeen and Agarwal, 2017, Agarwal et al, 2017, Moeen 2017)



Trigger event	Key actors	Technological actions	Market actions
Scientific discovery (e.g., GMOs)	Academia and research Firms	Developing core and complementary technologies in absolute terms and for the 'right' applications	Finding the 'right' applications Building identity and acceptance
Unmet user needs (e.g., dishwashers)	User inventors, entrepreneurs, communities	Moving from prototype to product	Finetuning user requirements
Mission-oriented 'grand challenges' (e.g., antibiotics)	Government agencies, nonprofits, academia and research, firms	Moving from prototype to product Developing core and complementary technologies	Moving from 'generic' to 'commercial' need Finding new applications

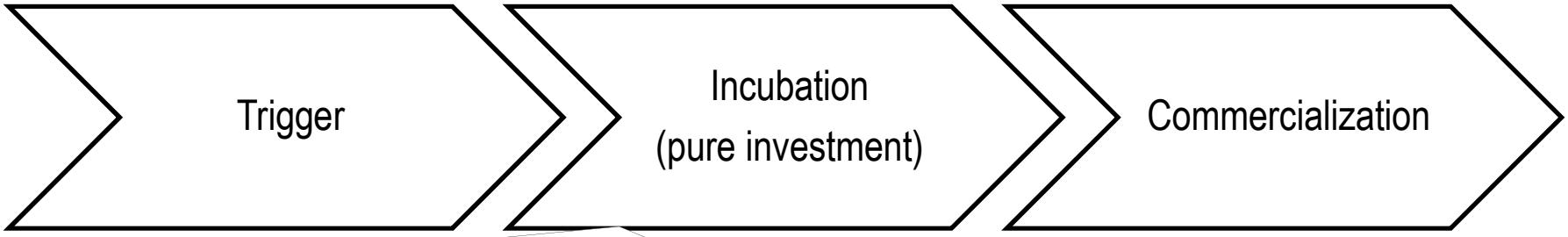
Incubation implies

- A trigger event
- Heterogeneous actors
- Knowledge sharing
- Iterative activities aimed at reducing technology and market uncertainty (technology as 'enabler' or 'affordance', Gibson 77)

Companies enter the industry and then kicked out or try and fail which leads to spillovers. e.g. a company trying to use laser beams to cut metals, they fail not because of the bad idea, but simply they are not able to do it. Then they get hired by a company which needs laser beams for surgery, and transfer the knowledge to them and they might be successful. (Everybody is learning in the shoulders of everybody else)

Dynamics of innovation

- Industry dynamics in the incubation period is critical, and 'entry' must consider both the incubation and the commercialization phases (Moeen and Agarwal, 2017, Agarwal et al, 2017, Moeen 2017)



Three types of firms enter and exit

- Incumbents from closest industry,
- De alio (diversifying) entrants,
- De novo (startup) entrants

Different knowledge bases are brought to the industry

- Obsolescing
- Emerging
- Complementary

Firms operate a flurry of activity (competition, alliances, acquisitions) leading to

- Knowledge and technology transfer
- A first shakeout
- A variety of modes for capturing value (i.e., getting to commercialization, being acquired, licensing)

Hype cycle: Whenever you have a new technology come out, first you have the incubation period, then companies get excited and invest a lot (the next big thing) and reach to HYPE (Hyperinflated expectation). It drives investments and the money will generate new ideas. e.g. AI (it will change the world) until the bubble occurs. Then it will reach the low level (Disillusion). Then the right application for new technology will be found and the technology will emerge. e.g. blockchain was a boom years ago but now we realized it isn't applicable to most of the things, like you can't buy a coffee with blockchain as the cost of power consumed to generate it (bitcoin) is too high. But it can be used in bigger transactions between companies in order to avoid huge bank fees (applicable area).

- Practitioners often use Gartner's "hype cycle", representing emerging technologies' evolution (at different speeds) over 5 phases.
- When is the dominant design *really* determined?

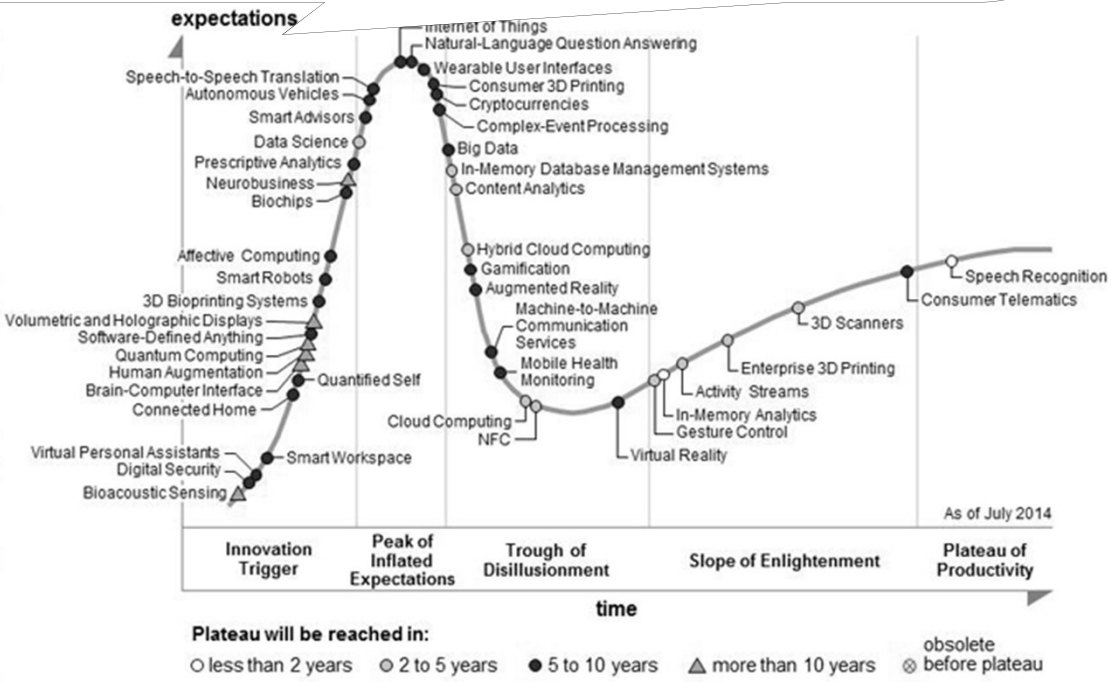
  Prior to commercialization, based on sequential experimentations of "variants" of technology, which then are "frozen" (Roy et al, 2019)?

  vs.

  After initial commercialization, during the "slope of enlightment", and as an emergent recombination of technological alternatives (→ "technical performance") and application "verticals" (→ "economic value")?
- We see Rosenberg's (1994) "economic experiments", and Gans et al.'s (2016) "paradox of entrepreneurship" (i.e., to make the best choice you must learn. To learn, you must experiment. By experimenting in a given direction, you foreclose other options)

Slope of enlightenment: The technology sees renewed interest as it becomes more widely understood, with second- and third-generation products released.

		actions
Scientific discovery (e.g., GMOs)	Academia and research Firms	Developing core complementary technologies in absolute terms the 'right' applic
Unmet user needs (e.g., dishwashers)	User inventors, entrepreneurs, communities	Moving from pr to product
Mission-oriented 'grand challenges' (e.g., antibiotics)	Government agencies, nonprofits, academia and research, firms	Moving from pr to product Developing core complementary technologies



Why to know Hype cycle: To avoid being caried by waves. To make the right investments in the right time. And don't fall for bullshits.
Killer application: When the technology is so powerful than you can do anything with it. In this case you don't have the hype cycle. e.g. internal combustion engines, powering ships and also small things. Another: Email, you can send anything, documents, formal, informal texts....

The dominant design is part of a paradigm. Therefore, you not only need to make sure that you can go beyond the technical solution attached to product, but you are actually enable to create the paradigm that has to go with it.

Dynamics of innovation

- It is possible to link innovation content at (upstream) component level and (downstream) complementary good level (Adner and Kapoor, 2010)... look at Project Better Place
  - Challenges have to be managed both upstream and downstream... and this is tough
    - With multiple challenges, probabilities are multiplied, and lead times may not be in parallel!
  - Impact on "first-mover advantage"
    - greater if challenges are at component level (creates room for improvement)
    - lower if challenges are at complementor level (slower demand reduces progress on the learning curve and buys time for imitators)
  - Impact on vertical integration choices
    - At the beginning of the s-curve vertical integration should be focused on solving technological uncertainty AND behavioral ambiguity in the market
    - Later on, it should mostly be focused on behavioral ambiguity

Also depends on degree of modularity

Also depends on whether complementary goods are proprietary or not

External *complement* challenges External *component* challenges	Easy	Tough
Easy	Only internal innovation challenges	Internal challenges + constraint on demand
Tough	Internal challenges + constraint on production	Internal challenges + constraints on demand and production

Traditional and reverse innovation

- Traditionally, innovations diffused in developed countries and then «trickled down» to emerging countries Abernathy-Utterback model
- In «reverse innovation» (Govindarajan and Ramamurti, 2011), innovation diffuses in developing countries and «trickles up» to developed countries
- 5 main reasons

Features of the emerging country innovation	Determinants of diffusion in the developed country
Low cost	Appeals to poor people in rich countries
Low cost	Expands demand in rich countries
Particular features (e.g. ruggedness, portability)	Creates new market segments in rich countries
«Good enough» product, with room for improvement	Mainstream customers adopt improved versions of the product
Incorporation of radically innovative technology (leapfrogging) thanks to large demand, absence of legacy technology, low regulatory barriers	The emerging country leads the dominant design-formation process, and the innovation quickly enjoys economies of scale

e.g. Cheap mobile ultra sound machines. Came from India to western countries.

leapfrogging: you jump a generation of technology, and go straight to new one. e.g. Africa went straight to smartphones (jumped the landline phones). Therefore, the diffusion of smartphone was faster than Europe and US, because Europe is locked-in in old technology.
Regulations: Weak regulations in Africa. e.g. you can easily start digital payment system easily than you can in Europe.

Abernathy-Utterback model says there are two types of innovation: product and process or process and product where product innovation is about performance (S-curve), and process innovation is about performance expecting in process which basically means cost. But there many types of innovation and they are happening in waves. Product part of system: e.g. Apple, the value of product could lead to innovation not only in product but in whole system around it (accessories). Service: Companies buying services, not the product. e.g. photocopy service instead of a photocopy machine. Or airlines rent engines not buying them, benefits: reduce the risk for customers, and better cashflow to the maker of engine. Channel: Innovation by Dell: Not product or process innovation, but it was a channel innovation that don't sell from distribution but sell directly. Their computers are sold as components. As soon they receive order, they assemble the components and ships it.

Dynamics of innovation

- Doblin and Keeley – innovation categories, types and landscapes
- As with Abernathy and Utterback, innovation follows "waves"… product, process, followed by the rest
  - if you miss them out, you risk disruption even within the same s-curve (Netflix vs. Blockbuster)
  - need to keep constant watch on the business model, change management team, recruit talent, with a long-term (5-7 years) view (Nunes and Breene 2011)

Four innovation categories, 10 types

Finance	Processes	Offerings	Delivery
1. Business model How you make money	**3. Enabling process** How you support the company's core processes and workers	**5. Product performance** How you design your core offerings	**8. Channel** How you get your offerings to market
2. Networks and alliances How you join forces with other companies for mutual benefit	**4. Core process** How you create and add value to your offerings	**6. Product system** How you create product systems and platforms	**9. Brand** How you communicate your offerings
		7. Service How you provide value to customers and consumers beyond and around your products	**10. Customer experience** How your customers feel when they interact with your company and offerings

10 Types of Innovation

Corporate competencies will become obsolete before it shows on P&L statement

You can have incremental or radical innovations in each of these categories!

The more categories are affected, the more radical is the overall innovation

Brand: brand is not a company, but usually a brand is something that defines a product. Purpose of brand: message to consumer on how the product should be in very concise way. e.g. You don't buy cars based on technical specifications, but that brand represents a given pattern of technical features. for example, BMW is sporty. Or I know that car is safer. Why important? 1- every producer needs a brand to communicate the technical offering without saying it. 2- any producer needs to develop the technology coherent to the brand. e.g. Ferrari won't design cars to be fuel efficient because their customers won't care about that, opposite to Porsche customers.

Can be observed in case of

- Broad change in product (→ revenue model) and process (→ cost structure) (e.g., low-cost airlines)
- «complex innovations» emerging in an «ecology of firms» (Dougherty and Dunne, 2011)

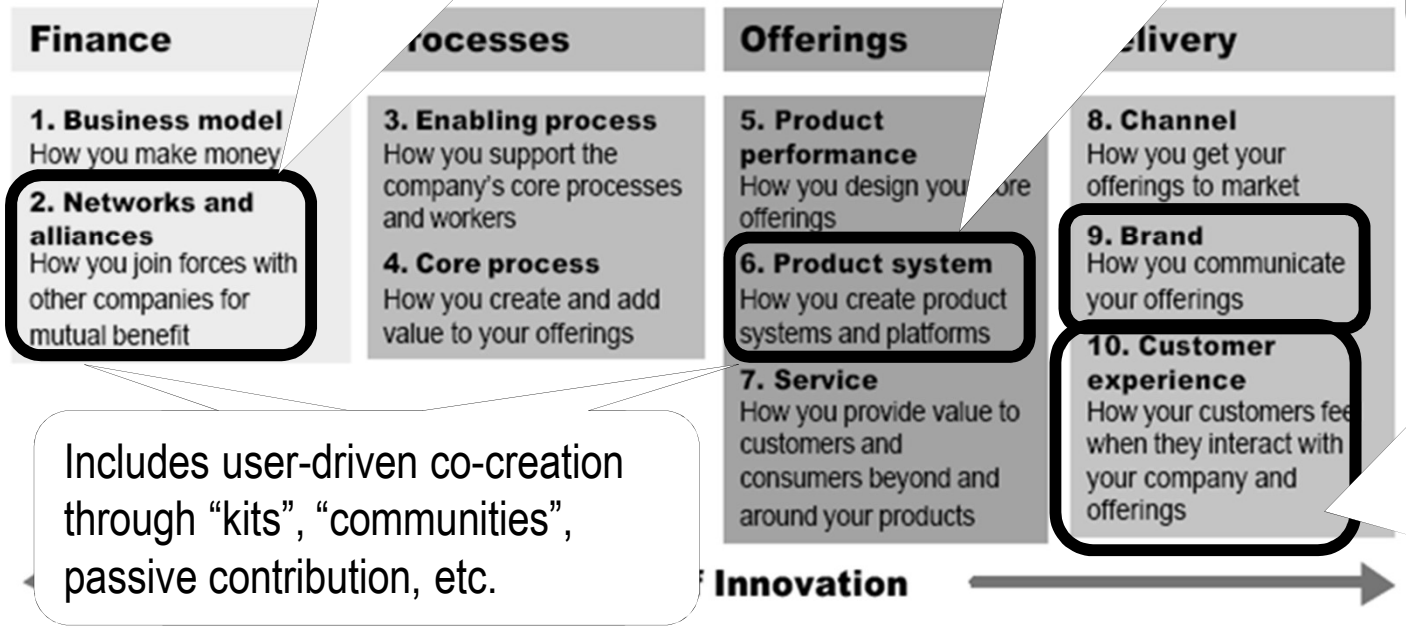
Strategic integration choices and strong tradeoffs when dealing with platforms (Boudreau 2010):

- "Completely open" vs. "open but with controls" vs. "closed" systems
- "adoption vs. appropriability" tradeoff
- "investment vs. appropriability" tradeoff (for all actors!)
- "diversity vs. control" tradeoff

Brands as easy-to-recognize "tradeoff solutions" in complex products

The innovation content has to be coherent to the brand

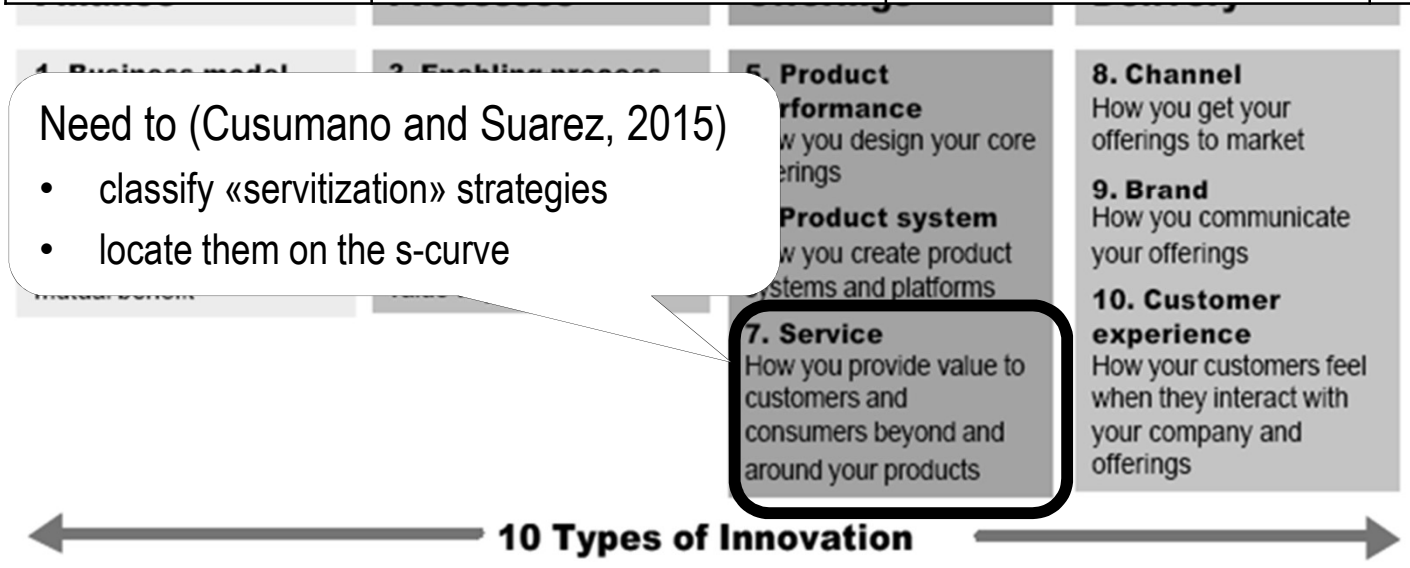
When dealing with radically innovative products should firms use new brands or extend old ones? (Klink and Athaide 2010)



Includes user-driven co-creation through "kits", "communities", passive contribution, etc.

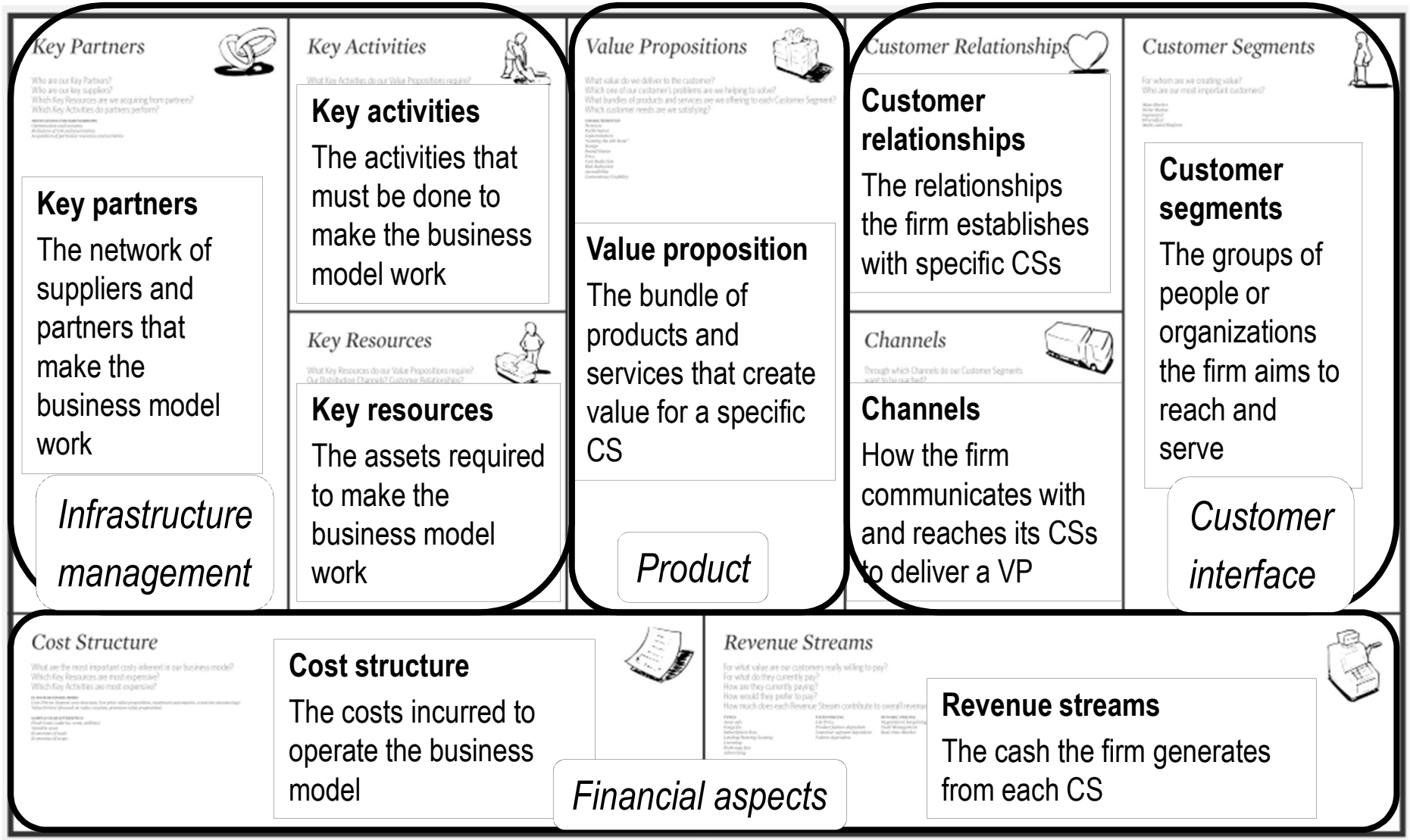
ıcludes "design-driven" innovations, which affect the *aesthetics* of the product and the *meanings* attached to it (e.g. B&O as furniture, Swatch as fashion item, etc.)

Type	The service complements product purchase		The service substitutes product purchase
	Smoothing	**Adapting**	**Substituting**
Definition	The service does not significantly alter product functionality (e.g., insurance, technical support, EV charging stations)	The service significantly expands or alters product functionality (e.g., customization of «solutions», consulting)	X as a service (e.g., SaaS, «pay by the hour», etc.)
Role in fluid phase	Provide services needed to solve «chicken and egg problems»	Educate the market to introduce the innovation	Reduce risks of ownership
Role in transitional phase	Capture value from the «profit pool»	-	-
Role in specific phase	Capture value	Capture value, educate the market to new sophisticated functions	Capture value, stimulate replacements



Dynamics of innovation

- Osterwalder's business model representation (www.businessmodelalchemist.com)



Standard: A set of specifications (not necessarily technology). e.g. AAA battery: voltage, size, length, diameter, acid, interface... These are the specifications of a battery. Standard(set of specifications): That if you stick, standard provide value not because it is technically better, but it is a standard. e.g. changing a battery(AAA) form 1.5v to 1.3v to make it cheaper, no value is created here because by deviating from specifications, we are destroying the value. Size and voltage matters but capacity doesn't matter.
Dominant design vs standard: Are somehow related, sometimes very closely, sometimes not at all.

Dominant designs and standards

- Standard:

"*set of specifications that provide value to the product <u>because of its conformity to the standard</u>*"

- Standards can be dominant designs or not

	Dominant design	Non dominant design
Standard	GSM, BlueRay	Layout of pedals in cars
Non standard	Unibody automobile architecture	--

it isn't dominant design the place of pedals in the car.

it is dominant design but not a standard,
you can change it without destroying value.

Externalities: is when in a economic transaction between two parties, this creates an impact on a third party. Could be positive or negative.

Dominant designs and standards

Lee et al. (2016) show that the effect is significant if the underlying social network exhibits relatively low degrees of separation

- Standards can provide value through
  - Network externalities (e.g., fax, e-mail, data exchange formats) when these transactions create network. e.g. WhatsApp: convincing other users to use it. it leads to standardization.
  - Complementarity with other goods (e.g. HW & SW, VCRs & content) e.g. Appstore a complementary good for iPhone
  - Specific learning (e.g., human interfaces)

e.g. Keyboard ("qwer" row): typewriter machine was jamming when two neighboring keys were pushed so they put "w" and "q" together as they are not used together in a word. Later they solved the problem but still the traditional keyboard is a standard.

  - Economies of scale (e.g., screws, threads)
  - Modularity (es. BUS architectures on PCs)

You can put in and take out specific modules of a PC (e.g. hard drive, memory...) without changing the architecture of the PC. Thanks to BUS architecture (standard).

Why IBM failed (PC v2.0): 1- More expensive. 2- Difficult to use. 3- No applications. (Microsoft already sat some standards)
How apple made second standard: 1- possibility of having a Windows partition in the machine. 2- UI is different from Windows but not so much. 3- computer is not only about the box but cloud and all the rest.

By agreement: Similar companies agree to create same standard. If they don't, one will become the monopolist and some will fail and some have to buy license from the monopolist to use their specifications.

Dominant designs and standards

Standards can arise

- De facto (standards war → monopoly)
- By agreement
- De iure The governments steps in and define the standards

Standards war dilemma

- Agreeing («let's make sure there is one big cake and then we can compete for a slice»)

vs.

fighting («let's try to get 100% of the cake, with the risk of getting nothing... and a possibly a smaller cake)"

- The decision is influenced by the number of competitors The more competitors, the more difficult to agree and more need to agree as well.
- Technical tradeoffs that have different appeal to the parties might make agreement impossible e.g. Sony with Toshiba on DVDs didn't agree (technological difference)

Standards wars can be socially undesirable

- Proprietary standards lead to entrenched monopolies
- Adoption and industry growth are delayed
- Risk of being locked in a low-quality standard which just happened to come out sooner
- Local firms may lose the standards war to foreign ones (de iure standards are non-tariff trade barriers)

Standards are sticked (locked-in), hard to get out of it. e.g. AAA battery v1.5 or keyboard (qwer)

Many standards: consumers are confused. Policy makers have huge role on standardization. e.g. standardization of car recharging stations because of CO2 emission

Regulator's dilemmas

- Whether to intervene, and on what grounds
- Finding the right balance in the timing for freezing the standard (e.g., de facto V2V vs. arising C-V2X for connected cars)

Fighting a standards war requires specific strategies

EU agreed on GSM (common standard) not only the advantage of having general communication but also benefited all the operating companies, like Nokia, Ericson... Legal Ground (EU): Giving same standard to all the companies to use. Sometimes hard: Having USB-c and not lightening (Apple). It will prevent Apple from future improvements.

Penetration pricing: Usually price goes down in time (Price skimming). Reason 1: Cost goes down. Reason 2(fundamental): Price discrimination: it means that I am able to practice different prices on different people and extract full amount of money. Price skimming doesn't work in the case of standards, instead you have to do penetration pricing which means give it away for free to gain market share and win the standards war then eventually come at pricing. e.g. Microsoft: you aren't allowed to copy but didn't enforce by any software or law. Basically it was for free as people were not buying. When they beat Apple, they started pricing first on businesses. They dealt with tax authorities of different companies to avoid illegal use of softwares. Then License keys to avoid copying.

Dominant designs and standards

Licensing to competitors: Intel gave license to Japanese company to produce microprocessor for them as they didn't have the capacity. After they got able to produce more, they stopped giving license to them.

- Products that are (or may be) associated to standards have peculiar competitive factors
  - Achieving critical mass as fast as possible
    - Accelerating entry
    - Spending lots of money on advertising
    - Penetration pricing (Microsoft, freemium services)
    - Boosting imitative / reciprocal diffusion effects (smartphone app stores)
    - Licencing to competitors (Intel, Open Source)
    - Gaining support from players that are closer to customers (Sony and Blockbuster) Sony made Blockbuster to use only blue ray and sell

Imitative: Bring your friend and get discount. reciprocal: driving adoption in one side will drive adoption in other side. e.g. allowing people to develop Apps. Windows vs Mac. Windows allowed people. or IOS (more closed) vs android (open) from perspective of standard wars.

  - Arising expectations (Microsoft with handheld PCs and smartphones)

If everybody believes you will win, you will win. e.g. handheld PCs of Microsoft killed palm devices.

  - Declaring irreversible commitments (Sony with Blue Ray)

Burning the boats at the beach strategy: You send signals that we are not afraid.

  - Supporting the availability of complementary goods (Microsoft with applications)
  - Exploiting the *lock-in* phenomenon
  - Supporting “competitive migrations” (Microsoft Excel)

Help people to get out from pervious standard towards yours.
e.g. Microsoft helped users of Lotus 1-2-3 recover all the data, files, macros in Excel.