

BIEM

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BLAB

HANDOUTS

TECHNOLOGY AND INNOVATION MANAGEMENT -CLASS SPECIFIC 31 & 34-

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This handout is written by students with no intention of replacing university materials.

It is a useful tool for studying the subject, but does not guarantee preparation as exhaustive and complete as the material recommended by the University.



1 – Introduction & ground rules

What does **innovation** mean to you?

- **doing of new things** / doing of things that are already being done in a **new way**
- new products, new production processes and new organizational setups
- creation of a **new product-market-technology-organization-combination**
- results of a creative process → new means-end combination that is **introduced to the market** or the **operations of a firm for the first time**

“making profits and gaining competitive advantage” ⇒ cost: fast fashion, pollution, media control

Why do companies innovate?

- **Create value** (for customer, for the company, for the society)
- **Maintain their competitive advantage** (that is unfortunately temporary)
- **Growth** (or survive in a competitive environment)

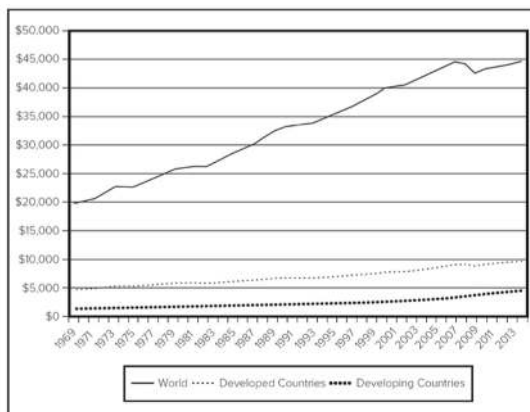
...and achieve progress through (creative) problem-solving

The impact of technological innovation on society

FIGURE 1.2

Gross Domestic Product per Capita, 1969–2014 (in Real 2010 US\$ Billions)

Source: USDA, Economic Research Service, International Macroeconomic Database (<http://www.ers.usda.gov>, accessed August 17, 2015)



Gross domestic product (GDP) = total annual output, measured by final purchase price

The historic rate of economic growth in GDP could not be accounted for entirely by growth in **labor** and **capital inputs**.

The residual growth component not explained capture technological change (**Solow's residual**, 1981)

Why do **firms** care about innovation?

Technological innovation is an important driver of competitive success in many industries

- ↳ Many firms earn over 1/3 of sales on products developed within last 5 years
 - **Product innovations** help firms project margins by offering new, differentiated features
 - **Process innovations** help make manufacturing more efficient

≠ context and ≠ competitive environment ⇒ need for innovation ⇒ firms have to innovate to grow (and survive)

Importance of Technological Innovation

Advances in information technology have enabled faster innovation

- e.g. CAD/CAM systems enable rapid design and shorter production runs

Importance of innovation and advances in information technology have lead to:

- Shorter product life cycles (more rapid product obsolescence)

- More rapid new product introductions
- Greater market segmentation

Characteristics of iconic products

- **Immediate recognizability:** a unique design or distinctive details that make the product identifiable at first glance
 - e.g., the Coca-Cola contour bottle or the Vespa Piaggio
- **Symbolic value:** represents something beyond its practical function, such as style, status, or an ideology
 - e.g., Rolex as a symbol of success
- **Emotional bond:** users often associate the product with specific memories or emotions
 - e.g., Polaroid as a symbol of nostalgia
- **Timelessness:** the design often requires no substantial changes to remain relevant
 - e.g., the Volkswagen Beetle or the Eames Lounge Chair

Impact on Society

Innovation enables a wider range of goods and services to be delivered to people worldwide

- More efficient food production, improved medical technologies, better transportation, etc.
- Increases GDP by making labor and capital more effective and efficient
- However, may result in negative externalities
 - ↪ ethical problems of AI

Why do you think so many innovation projects fail to generate an economic return?

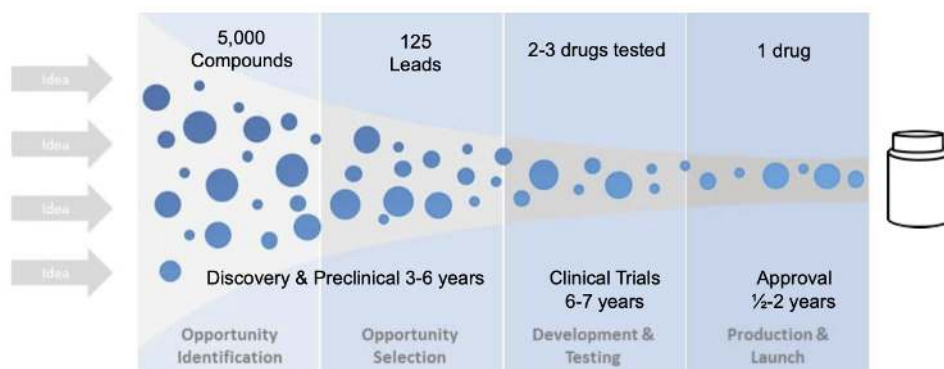
- 1999 – Cosmopolitan Yogurt
- 2015 – Amazon’s Fire Phone
- 2016 – Samsung’s Galaxy Note 7
- 2019 – Airpower
- 2015 – Google Glass
- 2023 – Meta’s Ray-Ban smart glasses

The Importance of Strategy

Successful innovation requires carefully crafted strategies and implementation processes.

Innovation funnel: Most innovative ideas do not become successful new products.

- e.g. The New Product Development Funnel in Pharmaceuticals:



Source: Adapted from Shilling, 2017

2 – Sources of innovation

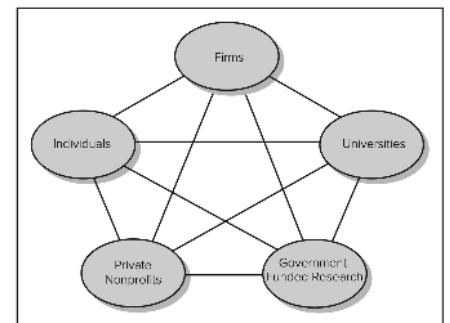
- Innovation can arise from many ≠ sources →
- Individuals
 - Universities
 - Government laboratories
 - Private R&D laboratories
 - Profit or non profit organizations
 - Incubators
 - Network of innovators

(Individual) creativity

1. Individual innovators

- Creativity is the ability to produce **ideas**
- Individual creativity is a function of:
 - Intellectual abilities
 - Knowledge
 - Style of thinking
 - Personality (e.g. confidence in own capabilities)
 - Motivation (e.g. rely on intrinsic motivation)
 - Environment (e.g. support and rewards for creative ideas)
- Each plays a role in generating, supporting, or commercializing new ideas ⇒ Most impactful innovations result from collaboration or integration across these sources

↳ sources of innovation as a system:



Creative thinking style

- **Creativity** = ability to produce novel and useful ideas → most creative individuals can discriminate between important problems and unimportant ones
- It is influenced by:
 - **intellectual ability**
 - **knowledge level**
 - **personality** (especially "openness to experience")
 - ↳ The personality traits include:
 - **self-efficacy**
 - **tolerance for ambiguity**
 - willingness to **overcome obstacles**
 - take reasonable **risks**
 - **intrinsic motivation**
 - **motivation**
 - **environment**
- Often driven by personal need, vision, or curiosity → individuals are more likely to be creative if they work on things they are genuinely interested in and enjoy

The inventor

Most successful inventors possess the following traits:

- **not specialized solely in the field in which they invent** → bringing ≠ perspectives to each
- **curious** and more **interested in problems than solutions**

- they **question the assumptions made** in previous work in the field
- often have the sense that **all knowledge is unified**
- **generalists** by nature

Innovation by users

- <https://www.ikeahackers.net/>
- quirky.com

Lead users in collaborative innovation

Lead users = individuals / organizations that experience needs ahead of the general market and often develop innovative solutions to address them before commercial products exist.

- ↳ typically more engaged, technically skilled
- ↳ motivated to solve problems due to their strong unmet needs.

Why are they so important in Collaborative Innovation?

- **Early identification of market trends:** lead users provide insights into emerging needs, helping companies anticipate future market demands.
- **Higher innovation potential:** they often develop advanced solutions that can serve as a foundation for commercial innovations.
- **Reduced development risks:** their feedback helps refine products before large-scale investments are made.
- **Faster time-to-market:** engaging with lead users accelerates product development by leveraging their expertise and prototyping efforts.
- **Stronger market fit:** solutions co-developed with lead users are more likely to succeed, as they align with real and pressing needs.

Organizational creativity

It is a function of:

- Creativity of individuals within the organization
- Social processes and contextual factors that shape how those individuals interact and behave

Methods of encouraging organizational creativity:

- Idea collection systems
- Creativity training programs
- Culture that encourages creativity (and accepts failures...)

Example: Google

An organizational structure that nurture creativity:

- **20% Time:** All Google engineers are encouraged to spend 20% of their time working on their own projects.
- **Recognition Awards:** Managers were given discretion to award employees with “recognition awards” to celebrate their innovative ideas.
- **Google Founders’ Awards:** Teams doing outstanding work could be awarded substantial stock grants.
- **Adsense Ideas Contest:** Each quarter, the Adsense online sales and operations teams reviewed 100 to 200 submissions from employees around the world, and selected finalists to present their ideas at the quarterly contest.
- **Innovation Reviews:** Formal meetings where managers product ideas originated in their divisions directly to founders.

2. Firms

R&D by firms

- **Research** refers to both:
 - **Basic research (explorative research)** aims at increasing understanding of a topic or field without an immediate commercial application in mind.
 - ↳ This research advances in scientific knowledge, which may (or may not) turn out to have long term commercial implications. (*Exploration*)
 - **Applied research (exploitative research)** aims at increasing understanding of a topic or field to meet a specific need.
 - ↳ This research has specific commercial objectives.
- **Development** refers to activities that apply knowledge to produce useful devices, materials, or processes. (*Exploitation*)

Firm Linkages with external players

- **Customers, Suppliers, Competitors, and Complementors**
- **Universities:** many universities have established technology transfer offices
- **Government-Funded Research:** Governments of many countries actively invest in research through their own laboratories, the formation of science parks and incubators,
 - Internal R&D helps to develop **absorptive capacity**, that enables companies to better exploit and combine information obtained from external players.
 - Absorptive capacity = “a firm's ability to recognize the value of new information assimilate it, and apply it to commercial ends”

3. Collaborative Networks

- The most powerful innovations often stem from **ecosystems**.
- Think: universities + startups + investors + customers + suppliers.
 - Example: Silicon Valley's dense, interactive innovation network.

Examples

- Area Science Park
- MIND Milano Innovation District
- Cambridge Science Park

4. Government Institutions

- Fund research, support high-risk early stages + sometimes provide direct subsidies or grants.
- Examples:
 - The parts of the smartphone that make it smart—GPS, touch screens, the Internet—were advanced by the **Defense Department**.
 - Tesla's battery technologies and solar panels came out of a grant from the **U.S. Department of Energy**.
 - Many innovative new drugs have come out of **National Institutes of Health (NIH) research**.

5. Technology clusters

- = Regional clusters of firms that have a connection to a common technology, and may engage in buyer, supplier, and complementary relationships, as well as research collaboration
- Proximity facilitates knowledge exchange.

- Cluster of firms can attract other firms to area.
 - Supplier and distributor markets grow to service the cluster.
 - Cluster of firms may make local labor pool more valuable by giving them experience.
 - Cluster can lead to infrastructure improvements (e.g., better roads, utilities, schools, etc.)
- ⇒ Clusters favour **agglomeration economies**, i.e. the benefits firms reap by locating in close geographical proximity to each other.

Summary Insight

The **most successful innovation strategies** blend internal capabilities with **external sources** of knowledge and creativity.

Firms should:

- Encourage **employee creativity**.
- Build relationships with universities, users, and governments → **collaborative innovation**
- Develop **absorptive capacity**: the ability to recognize, assimilate, and apply external knowledge.

3 – Types and patterns of innovation

How can we classify innovations?

There are several dimensions according to which innovation may be classified.

↳ Most used categories:

Object of the innovation	Product innovation vs. process innovation
Degree of novelty	Radical innovation vs. incremental innovation
«Focus» of the innovation	Architectural innovation vs. component innovation
Type of competence generated	Competence-enhancing innovation vs. competence-destroying innovation

⚠ Innovations often fall into multiple categories at once

Product vs. Process

A **product innovation** is embodied in the *output* of an organization.

It is the implementation of a good or service that is either new or an improved version of previous goods or services

Process innovations are innovations in the way a company produces or delivers goods/services

It is the implementation of a new or improved business method (this includes production, delivery, or marketing,...).
It aims to increase the effectiveness or efficiency of an existing process

Why does that distinction matter?

- ✓ Product innovations are usually more visible and based on more codified knowledge
- ✓ Implications for imitation and appropriability

Radical innovation vs. Incremental innovation

Radicalness of an innovation = the degree to which it is new and different from previously existing products and processes

Radical innovation (or breakthrough innovation): much new and different from prior products and processes.

- ↳ usually technology-pushed, based on future scenarios planning
- ↳ more time to be developed (and higher investments)
- ↳ e.g. *Exoskeleton*

Incremental innovation: relatively minor change from existing products and processes.

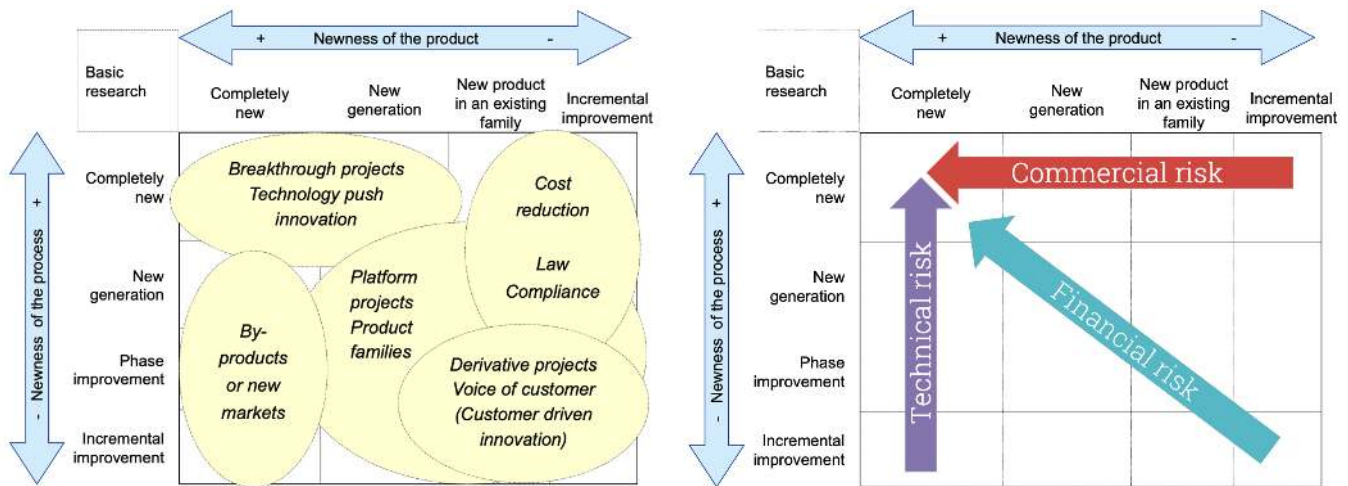
- ↳ most dominant form of innovation today (lower commercial, technical and financial risk, and shorter payback period)



N.B. Radicalness is a relative concept

- e.g. *A digital camera was competence-destroying and radical for Kodak, but incremental for Sony.*

Categories of projects depending on their degree of novelty



Project Classification

Basic R&D

- Advanced projects with scientific objectives, rather than commercial returns.
- Often originates from collaborations with research institutes, universities, and external partners.

Breakthrough

- Radical changes in product or production process technologies (e.g., compact disk).
- Typically lead to completely new products or markets.
- Customers cannot usually give feedback in advance.
- Project duration is normally > 1 year.

Platform

- Creation of a new generation of a product line.
- The product includes new functionalities or technologies and significant production process improvements.
- Time to market is usually ≤ 1 year
- e.g. *Humidifier*

Derivatives

- Incremental improvements to existing products or production processes.
- Focus is either on customer experience (e.g., added functions) or cost reduction.
- Limited organizational involvement and short development time.

Cost Reduction / Law Compliance (Maintenance/Support)

- Involves major technical changes and risk.
- Aims to produce similar products at lower cost or ensure compliance with new regulations.
- Main goals: cost efficiency and legal conformity.

Byproduct / New Markets (Enhancement)

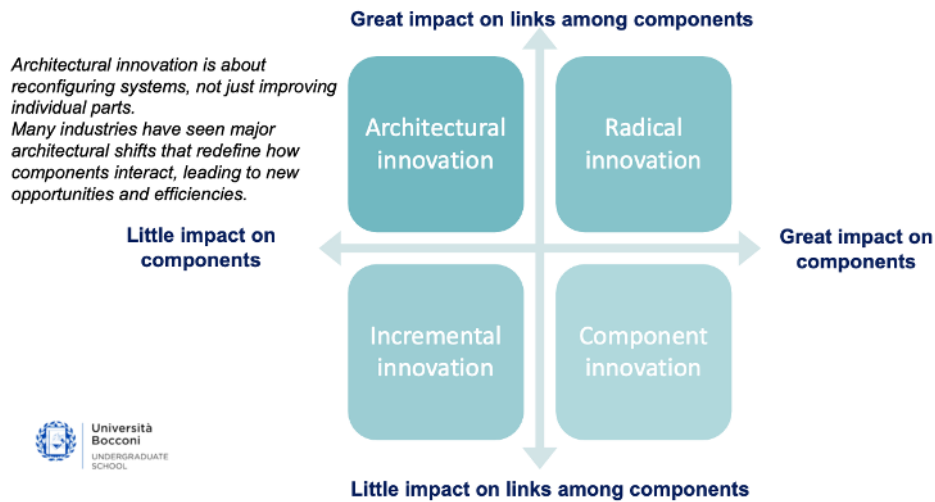
- Projects aimed at entering new markets with marginal changes in the product or process.
- Often involves adapting/exporting existing products to new regions or customer groups.
- e.g. *New markets: babybel, wood pellets; New geographical markets: CocaCola; Glocalization: McDonalds; New target customers: Gillette (Venus); New application: Telepass*

Architectural innovation vs. Component innovation

An **architectural innovation** changes the overall design of the system or the way components interact, often altering the system's logic.

Most architectural innovations require changes in the underlying components also.

A **component innovation** (or modular innovation) modifies one or more components of a product system without changing the overall product configuration.



Examples

❖ Architectural innovation: **Healthcare – AI & Telemedicine**

- Traditional healthcare relies on in-person doctor visits and hospital-centric models.
- Telemedicine and AI diagnostics **change the interaction between patients, doctors, and diagnostic systems.**
- AI radiology (e.g., Google DeepMind's AI for cancer detection) replaces the traditional hospital-based reading workflow with distributed, AI-assisted diagnostics.
- ✅ **Architectural shift:** Patients and healthcare professionals now interact in a decentralized way, enabled by AI and telemedicine.
- ❌ **Not just component innovation:** A better MRI scanner would be component innovation, but redefining healthcare workflows via AI and remote diagnostics is architectural.

❖ Architectural innovation: **Automotive – EV Skateboard Architecture**

- Traditional cars had a chassis designed around an internal combustion engine (ICE), transmission, and drivetrain.
- Tesla and other EV makers **restructured the vehicle by placing the battery pack at the bottom (skateboard design)**, removing the transmission, and integrating motors directly into axles.
- **This change altered the vehicle's fundamental structure**, affecting weight distribution, aerodynamics, and interior design.
- ✅ **Architectural shift:** Battery packs are now structural elements; no need for a front engine compartment, allowing new vehicle forms.
- ❌ **Not just component innovation:** The change is not just about swapping an engine for a battery—it redefines the whole vehicle architecture.

❖ Component innovation: **Automotive – Solid-State Batteries**

- Traditional lithium-ion batteries in electric vehicles (EVs) have liquid electrolytes.

- **Solid-state batteries replace liquid electrolytes with solid electrolytes**, making them safer and more energy-dense.
 - The overall car architecture (skateboard platform, drivetrain, charging system) remains the same.
 - **Impact:** Longer range, faster charging, improved safety.
- ✓ **Component Innovation:** A better battery does not change the way other vehicle parts interact.

Competence-enhancing vs. Competence-destroying innovation

Competence-enhancing innovations build on the firm's existing knowledge base
(e.g., Intel's evolution from 386 to Pentium)

Competence-destroying innovations renders a firm's existing competences obsolete
(e.g., slide rules replaced by calculators)

→ an innovation can be both, e.g. digital photography for Sony and Kodak

Summary Insight

Project Category	Innovation Type	Typical Pattern	Associated Risks
Basic Research	Radical, Exploratory	Often competence-destroying or competence-creating (e.g., biotechnology, quantum computing)	Very high uncertainty, long time horizon, low immediate ROI; risk of technological dead ends
Breakthrough Projects	Radical, Architectural	Often competence-enhancing if building on prior tech; may also be competence-destroying for some players	High R&D cost, risk of failure to scale or diffuse; may require systemic change (e.g., infrastructure)
Platform Projects	Architectural or Radical	Establish a core system from which derivative innovations can be launched	Risk of poor market fit or lock-in to a weak design; may require large investment without guaranteed adoption
Derivative Projects	Incremental, Component	Usually competence-enhancing; improves existing systems or offerings	Low strategic differentiation; easy for competitors to imitate; risk of limited value to customer
Enhancement Projects	Incremental	Can be either process or product innovation, depending on focus	Risk of diminishing returns; may not significantly affect market perception or performance
Maintenance/ Support Projects	Incremental, Process	Mostly operational; improves stability, compliance, or cost-efficiency	Opportunity cost: resources not allocated to more innovative work; risk of falling behind on disruptive trends

4 – S-curves and diffusion of innovation

How do technologies evolve over time?

Technology trajectory = path of evolution followed by a technology through time



Models to predict it:

- Foster's Technology S-curve (1986) ⇒ explain supply-side
 - Abernathy & Utterback's Technology Cycle (1978) ⇒ explain supply-side
 - Anderson & Tushman's Technology Life Cycle Model (1990) ⇒ explain supply-side technological improvement
-
- Rogers' Diffusion S-Curve (1962) ⇒ explain demand-side adoption
 - Christensen's Disruptive innovation Model (1997) ⇒ explain demand-side adoption

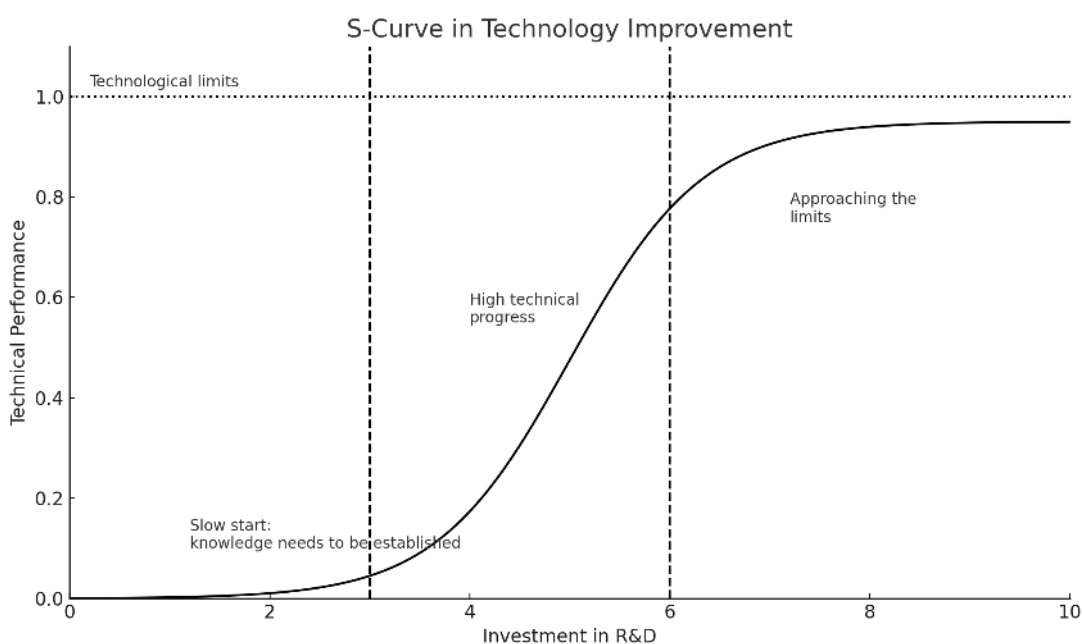
S-curves in Technology improvement (Richard Foster, 1986)

Both **technology improvement** and its **diffusion to the market** usually follow an **S-shaped curve**.

The curve illustrates 3 main stages:

1. **Early-stage, low R&D productivity:**
 - Knowledge is still being developed → progress is minimal
 - Need to experiment, lots of failures
2. **Mid stage, "Riding up" the S-curve:**
 - As understanding increases, performance improves quickly
 - Focusing on narrower and more well-defined technical challenges, organizational commitment and incentives, leveraging prior experience
3. **Late stage, Hitting natural limits:**
 - The technology approaches its **performance limits**, determined by broad technical choices (e.g. speed of sound, analog vs digital) → improvements slow down

This concept highlights the importance of **investing in R&D**, especially during the early phase to reach the growth stage:

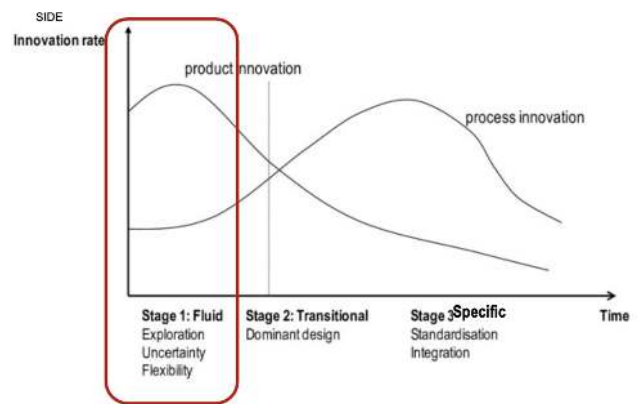


Technology Cycles: Model of Abernathy and Utterback (1975)

Phases:

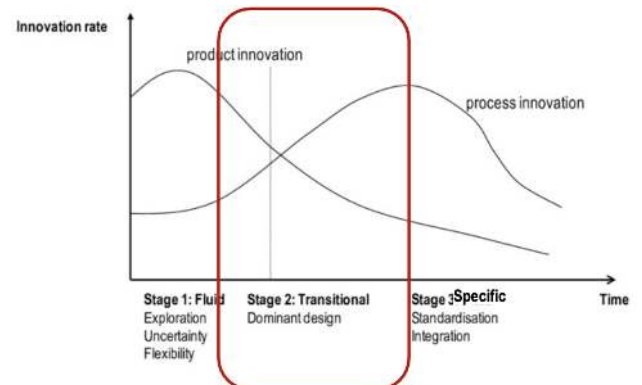
1. Fluid phase

- Considerable uncertainty about the technology and its market
- Firms experiment with ≠ product designs in this phase
- Characterized by:
 - Deep environmental uncertainty
 - Multiple technology solutions exist
 - Oriented towards **product innovation**, less to process innovation
 - **Testing** phase
 - **Small-scale** production plants and generalist equipment
 - **Flexible** and **inefficient** production processes
 - **Informal organizational control**



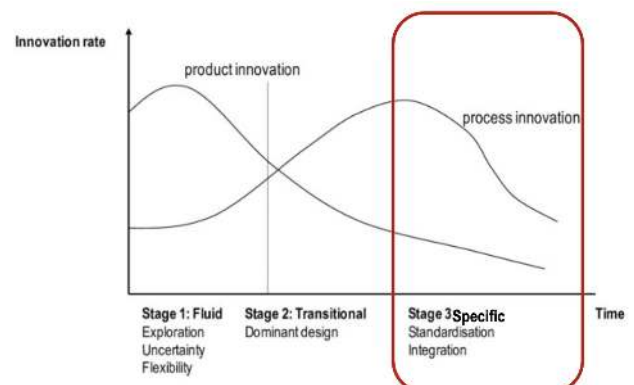
2. Transitional or ferment phase

- Dominant design emerges
- Characterized by:
 - The emergence of a dominant design
 - Reducing market and technology uncertainty
 - **Competition** on product variety
 - Innovation shifts to the **process**
 - Product **effectiveness** and process **efficiency** objectives
 - Tighter production processes and **more specialized** equipment
 - **Increase in plant production volumes**



3. Specific phase

- Firms focus on incremental improvements to the design and manufacturing efficiency
- Characterized by:
 - Predominantly incremental product innovations
 - **Efficiency-oriented process innovations**
 - **Large-scale** plants and **specialized** equipment
 - **Structured organizational control**



What is a dominant design?

- A dominant design emerges when a specific configuration or feature set becomes the **industry standard**.
- It marks a **convergence point**: most competitors align their products or technologies around it.
- Characterized by **stability** and **widespread adoption** → reduces market uncertainty

- Once established, **innovation tends to focus more on incremental improvements rather than radical changes to the basic design.**
- Creates **barriers to entry** for new competitors → new firms must conform to the established standards to remain competitive.
 - ↳ Value of technology increases through:
 - **Experience curves (learning curves)**
 - **Network externalities**

Case Study: Microsoft DOS as an Industry Standard

- Example of **network externalities**: growth feeds itself.
- Microsoft DOS illustrates how early adoption + developer support = dominant design.

... and Technical Standards

Regulatory Compliance

- Technical standards can be mandatory for regulatory compliance in areas like **safety, environmental, or market certification.**
- Compliance ensures access to certain markets and certification opportunities

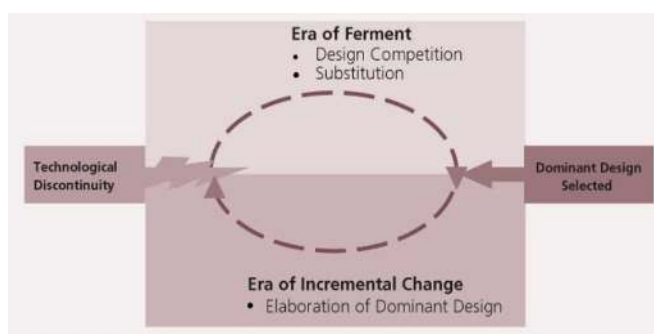
Examples:

- Communication protocols: *USB, Bluetooth, Wi-Fi*
- File formats: *JPEG (images), PDF (documents)*
- Quality management standards: *ISO 9001*

Key Characteristics of Technical Standards

1. **Compatibility and Interoperability**
 - Standards define common **protocols, formats, and interfaces.**
 - Ensure different products or systems work together.
 - Enable users to **mix and match components** from various manufacturers.
2. **Quality and Consistency**
 - Define **minimum quality and performance benchmarks.**
 - Ensure **safety, reliability, and efficiency.**
 - Promote consistency and reliability across the industry.
3. **Facilitation of Innovation**
 - Standards create a **framework** for consistency while still allowing **variation and improvement.**
 - Allow differentiation in **products/processes**, while ensuring **ecosystem compatibility.**

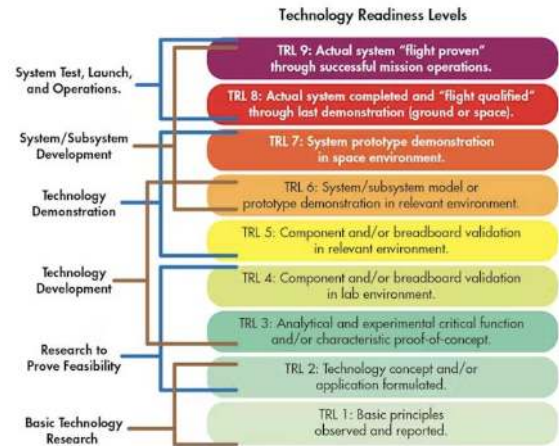
Technology Cycles: Model of Anderson and Tushman (1990)



⇒ Each discontinuity inaugurates a period of turbulence and uncertainty (era of ferment) until a dominant design is selected, ushering in an era of incremental change

Technology Readiness Level (TRL)

= framework used to assess the maturity of a specific technology or innovation, starting from the early stages of research to fully operational systems



Why are TRLs important?

TRL 9	Actual system demonstrated in operating environment: the technology is fully mature and successfully implemented in commercial or operational settings.
TRL 8	Actual system completed and qualified through testing and demonstration: the technology has been proven to work in its final form and under the intended conditions.
TRL 7	Demonstration of the system prototype in an operating environment: the prototype is demonstrated in the actual environment in which it is intended to operate.
TRL 6	Demonstration of the system or subsystem model in relevant environment: a prototype closer to the final product is developed and tested in an environment similar to the operational one.
TRL 5	Validation of components and/or the system in a relevant environment: the technology is tested in a simulated environment similar to the real one.
TRL 4	Validation of components and/or system in a laboratory environment: basic technology components are integrated to verify whether they work together.
TRL 3	Analytical and experimental proof of concept: active research and development is initiated, including laboratory studies to validate the concept.
TRL 2	Formulation of the technological concept and/or its application: practical applications are identified, but they are still speculative; There is no experimental evidence or detailed analysis.
TRL 1	Observation and reporting of the basic principles: we begin to translate scientific research into applied research and development. In this phase you have a theoretical understanding of the concept.

TRLs help companies and stakeholders **assess the risks, investments, and actions** required to bring a technology to market.

➤ Investment Decisions

- TRLs indicate when and where to allocate resources.
- **Early TRLs (1–3):** Require more **research funding**.
- **Later TRLs (7–9):** Need **investment for scalability or commercialization**.

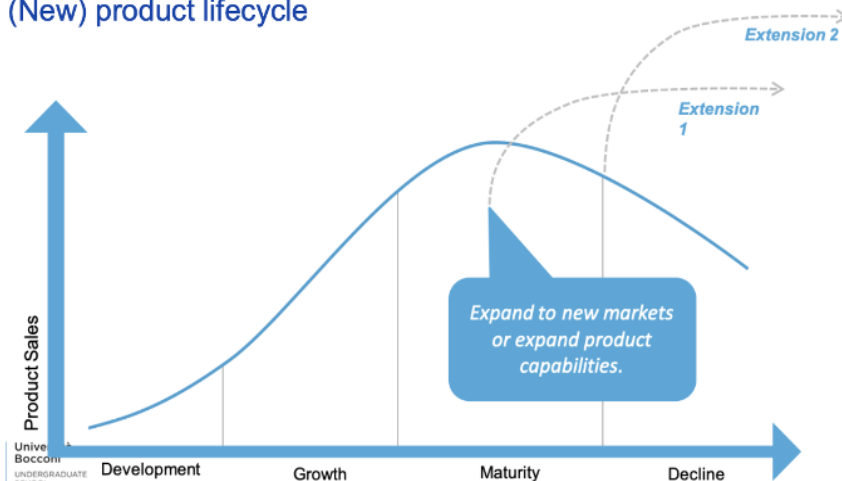
➤ Risk Management

- TRLs help evaluate the risk linked to a technology's development stage.
- **Lower TRL = higher uncertainty**, immature technology.
- **Higher TRL = lower risk**, more mature and proven technology.

➤ Communication with Partners & Stakeholders

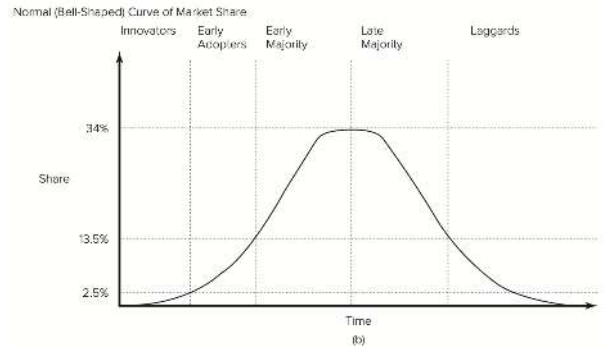
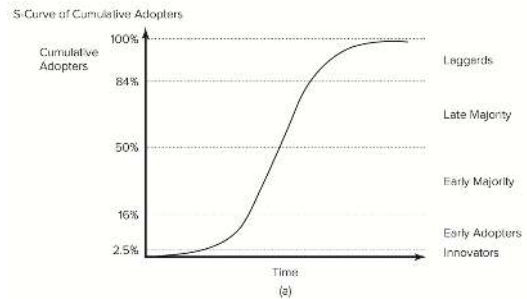
- TRLs provide a **standardized framework** to express technological maturity.
- Facilitates alignment with **partners, investors, and regulators**.

(New) product lifecycle



Diffusion of Innovation and adopter Categories (Everett M. Rogers)

- Focus on the **adoption rate of new technologies by users (market adoption)**, rather than performance improvement.
- **Diffusion** = process by which individuals and firms in a society adopt a new technology



S-Curves in Technology Diffusion

- Adoption is **initially slow** because the technology is unfamiliar.
- It **accelerates as technology becomes better understood**.
- Eventually market is saturated and **rate of new adoptions declines**.
- Technology diffusion tends to take far **longer than information diffusion** → A technology might be technically mature before the market widely adopts it.
- Technology may require acquiring complex **knowledge or experience**.
- Technology may require **complementary resources/products** to make it valuable (e.g., cameras not valuable without film)

Elements that impact the adoption of a product

Product characteristics		Customer characteristics (adopters categories)	
Value	Superior performance characteristics	Pioneers	<ul style="list-style-type: none"> ● First 2.5% to adopt an innovation ● adventurous, comfortable with a high degree of complexity and uncertainty ● access to substantial financial resources
Compatibility	Changes required for adoption (i.e. DVORAK keyboard), and in reference to any complementary products	Initial adopters	<ul style="list-style-type: none"> ● Next 13.5% to adopt the innovation ● well integrated and great potential for opinion leadership ● excellent “missionaries” for new products or processes
Complexity	Learning effort in using	Anticipatory majority	<ul style="list-style-type: none"> ● Next 34% ● adopt innovations slightly before average ● not opinion leaders, but they interact frequently with their peers

Provability	Reduces pre-purchase “stress” because it allows you to evaluate the characteristics of the product before buying it	Late majority	<ul style="list-style-type: none"> • Next 34% • skeptical – may not adopt the innovation until they feel pressure • scarce resources
Observability	How explicit and observable the difference is with previous models	Laggards	<ul style="list-style-type: none"> • Last 16% • base their decisions primarily on past experience + no opinion leadership • highly skeptical – must feel certain that will not fail prior to adopting

Why does it take so long for a technology to get diffused across the economy?

- Poor performance (value perceived)
- Uncertainty (complexity, observability, provability...)
- Human skills (competences)
- Complementary innovations

Technology S-Curves: Improvement and diffusion

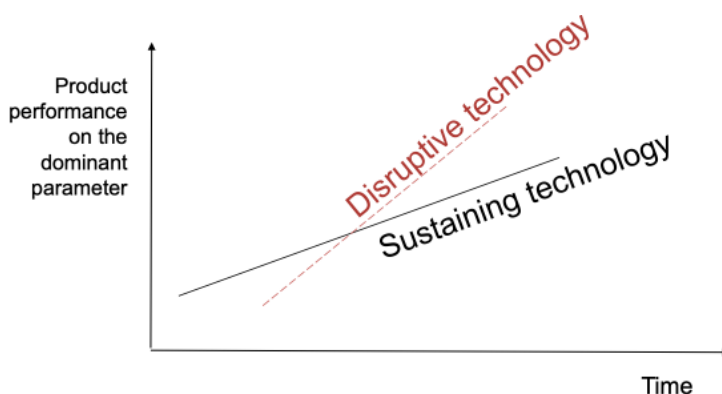
S-curves of diffusion are in part a function of s-curves in technology improvement

- ↳ learning curve leads to price drops, which accelerate diffusion

The effect of discontinuous technology

- **Discontinuous technology** = breakthrough that resets the S-curve
 - ↳ fulfills a similar market needs by means of an entirely new knowledge base (e.g., from analog to digital cameras)
- Firms may be reluctant to adopt new technology
 - Firms that jump **too early** face technical and market risk.
 - Firms that jump **too late** risk being disrupted.

Sustaining technologies and disruptive technologies



“Disruptive technology” = technology (or product) that initially has a niche market, but which steadily improves over time to **outperform existing technologies** and meet the needs of broader customers

Technologies improvement and market needs: the “segment zero” **Clayton Christensen** (The Innovator’s Dilemma, 1997)

- ↳ Invest in new (potentially disruptive) technology or continue to develop and improve existing technology?

“Segment Zero” = lowest segment of the market — the least demanding customers, who care more about **affordability, simplicity, or accessibility** than high performance.

Technologies often improve faster than customer requirements demand

- ↳ This enables low-end technologies to eventually meet the needs of the mass market.

FIGURE 3.8
Trajectories of Technology Improvement and Customer Requirements

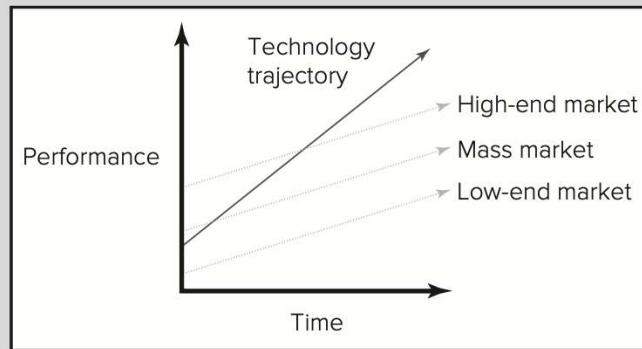
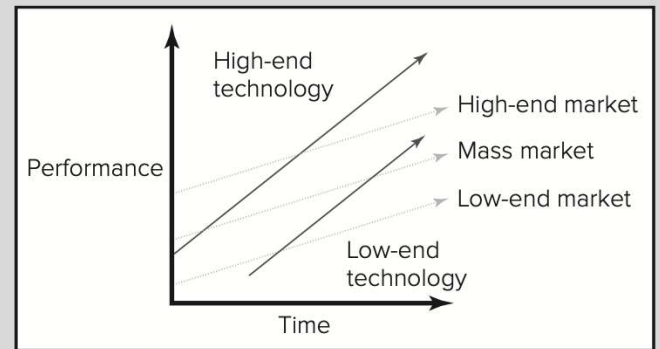


FIGURE 3.9
Low-End Technology’s Trajectory Intersects Mass Market Trajectory



Technology S-curves as a prescriptive tool

- Managers use investment and performance data to **map S-curves** and understand a technology's progress.
- However, **S-curves are limited** for making future predictions.

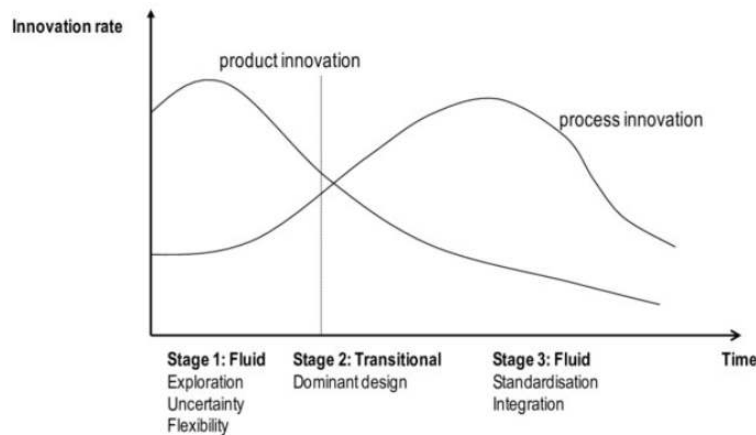
Why it’s hard to use S-curves as a prescriptive tool:

- **Future limits are unknown** and can change due to market shifts or new technologies.
- **Data is hard to collect.**
- **Requires expert knowledge** across different fields.
- **Risk of blind spots**, especially when disruptive technologies emerge.

5 – Standards, network effects and platforms

Dominant design

Definition: a single product or process architecture that dominates a product category – usually $\geq 50\%$ of the mkt. It is a “*de facto standard*”, meaning that while it may not be officially enforced or acknowledged, it has become a standard for the industry



📌 Once dominant, most competitors shift to **incremental innovation** on that architecture.

Why is there strong pressure for industries to converge on a single dominant technology?

Increasing returns to adoption – Learning effects

Learning Effects = the more a technology is used → the more it is developed → the more effective and efficient it becomes

↪ **learning curve:** performance improves or cost drops with cumulative output.

Absorptive capacity = the ability of an organization to recognize, assimilate, and use new knowledge (internal or external)

↳ Increasing returns indicate that technology trajectories are characterized by *path dependency*

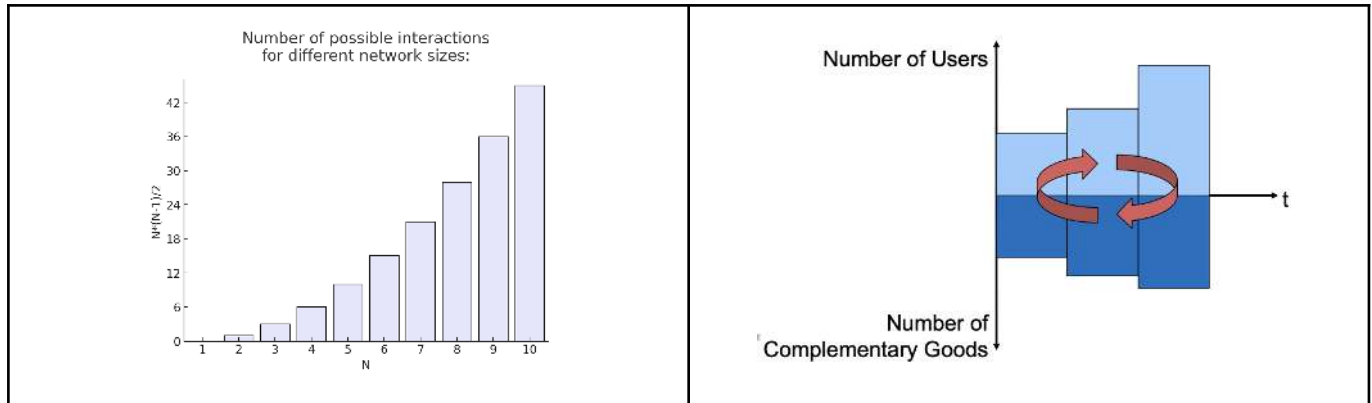
Increasing returns to adoption – Network externalities

Positive consumption externalities = when the value of a good to a user increases with the number of other users of the same or similar good

➤ Examples:

- Direct positive effect: socials – Whatsapp, WeChat, LinkedIn, Facebook
- Indirect network effects: PlayStation + Games , iPhone + AppStore

Direct positive effect	Indirect network effects
The utility derived from the consumption of a network good increases DIRECTLY with the <u>number of other people using the same or a compatible product</u>	Found in so-called system goods → where the utility derived from the consumption of a good DEPENDS ON the <u>availability of complementary goods</u> , which in turn depends on the <u>number of other users</u> .



Why are Dominant Designs selected?



- **Government Regulation:**
Sometimes the **consumer welfare benefits of having a single dominant design** ⇒ Authorities may impose a standard to increase consumer welfare.
 - Example: NTSC for tv in the US, GSM for mobile in EU.
- **Winner-Take-All Markets:**
With network effects, **markets tend to favor one dominant product** ⇒ situation in which a single company/product dominates the entire mkt, leaving little room for competitors.
 - Best product does not always win; network size matters.
- **Natural Monopolies:**
Firms supporting winning technologies earn huge rewards; others get excluded.
 - Examples – industries where the presence of economies of scale, high fixed costs, and network effects often result in natural monopolies:
 - *Utilities*
 - *Railway Networks*
 - *Telecommunications Infrastructure*
 - *Postal Services*
 - *Highways and Toll Roads*

Network effects and standards

- Network effects OFTEN require standards
 - ↳ **Standard** = a specification that allows for interoperability, i.e. a standard makes it possible for different components of a system to work together
 - Internet...
 - Telecommunications, Financial services...
 - Pipe fittings, automotive components, baby monitors...

- Controlling the standard might be very profitable

Dominant Design and Competition

“What is an abuse?”

Being dominant is not illegal – but abusing dominance is.

- ↳ **Abuse of dominance** includes:
 - Forcing buyers to purchase exclusively from the dominant company (**exclusive purchasing**)
 - Setting prices **below cost** to drive competitors out (**predatory pricing**)
 - **Refusing to supply** essential inputs needed by competitors (**input foreclosure**)
 - **Charging excessive prices**

Source: [EU Competition Policy](#)

Technology value: multiple dimensions of value

In many increasing return industries, the value of a technology is strongly influenced by:

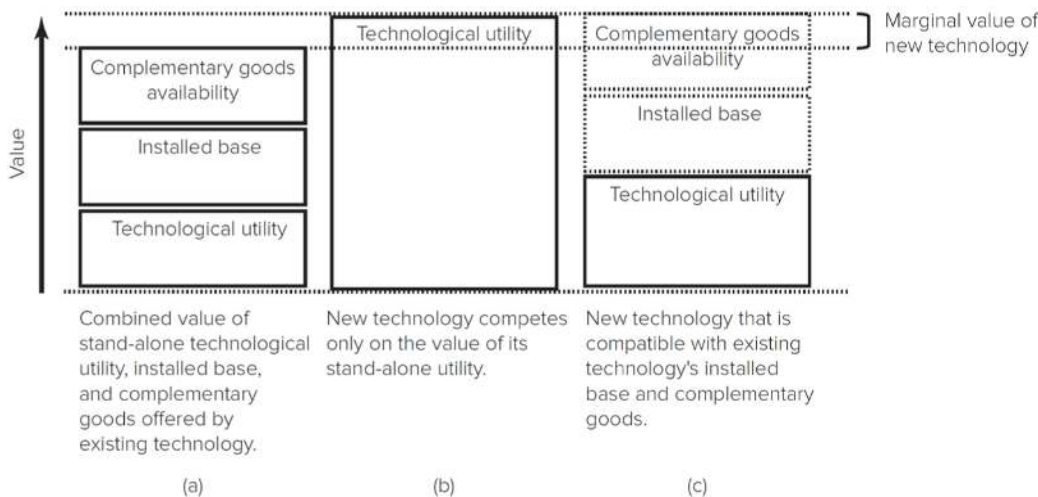
Technology’s Standalone Value

- The functions the technology enables customers to perform
- Aesthetic qualities
- Ease of use, etc.
- A “Buyer Utility Map” * → useful for identifying elements of a technology’s stand-alone value

Network Externality Value (direct and indirect)

- The size of the technology’s installed base
 - ↳ *The larger the installed base, the stronger the network effects.*
- The availability of complementary goods

Overall Value: sum of different components



Smart strategy: new technology is made **compatible** with the old one’s ecosystem (e.g. software, accessories)

So it benefits from:

- old installed base,
- existing complementary goods,
- + its own technological utility ⇒ the **marginal value** it adds is just the improvement in tech performance

*Buyer Utility Map

- Helps to understand where value is being created (or lost) for customers at every stage of the buyer experience and various dimensions of utility

- Helps companies identify potential gaps or opportunities for innovation by showing where existing products underperform or where new products can create unique value.
- **Structure** → consists of a matrix with 2 axes:
 - **X-axis: The Buyer Experience Cycle** (stages of a customer’s interaction with the product or service)
 - **Y-axis: The Utility Levers** (different dimensions of value that a product can provide)
 - ↳ the typical one includes:
 - *Customer Productivity*: Does the product help the customer save time, effort, or money?
 - *Simplicity*: Is the product simple and intuitive to use?
 - *Convenience*: Is the product convenient to purchase, use, or maintain?
 - *Risk Reduction*: Does the product reduce risks, such as financial, operational, or health risks?
 - *Fun and Image*: Does the product provide emotional benefits, such as enjoyment or status?
 - *Environmental Friendliness*: Is the product environmentally friendly or sustainable?

The Buyer Experience Cycle

➤ It represents ≠ stages that a customer goes through when engaging with a product or service.

can be customized for your industry but typically include:

- **Purchase**: How easy it is for the buyer to find, evaluate, and buy the product.
- **Delivery**: How quickly and conveniently the product is delivered or accessed.
- **Use**: How easy it is to use the product and how well it performs its intended function.
- **Supplements**: The need for complementary products or services to use the main product.
- **Maintenance**: How easy it is to maintain, upgrade, or repair the product.
- **Disposal**: How easy and environmentally friendly it is to dispose of the product after its lifecycle.

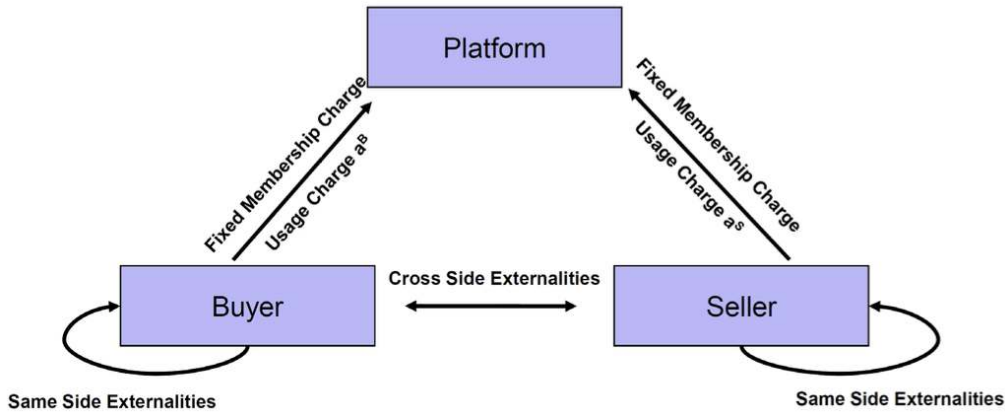
e.g. Buyer utility map for electric cars

	Purchase	Delivery	Use	Supplement	Maintenance	Disposal
Customer Productivity	Lower upfront cost if incentives are offered, but still higher than alternatives	Easy delivery through dealerships or online platforms	Reduced fuel cost compared to gasoline vehicles	Charging stations are needed for optimal use	Less frequent maintenance than gasoline vehicles	Battery recycling options are limited
Simplicity	Configurable options online, but can be complex	Standardized delivery	Easier to use, automatic gear shifting	Charging process may be confusing for new users	Simple to maintain with fewer moving parts	-
Convenience	Financing options available	Doorstep delivery	Long charging time, may cause inconvenience on long trips	Charging infrastructure needs improvement	Software updates are done automatically	Disposal services are unclear or limited
Risk Reduction	Upfront incentives reduce financial risk	Reliable delivery services	Lower risk of mechanical failure due to fewer moving parts	Charging delays might increase range anxiety	Battery replacement risk is high and costly	No clear method for battery disposal
Fun and Image	EVs are seen as trendy and environmentally responsible	Fast delivery increases excitement	Smooth and quiet driving experience	Charging stations in prime locations can be a status symbol	Owners may receive admiration for sustainability	-
Environmental Friendliness	Incentives promote eco-friendly choices	Minimal emissions during delivery	Zero emissions during use	Energy used for charging varies in cleanliness	Lower environmental impact due to fewer parts	Battery disposal remains an environmental challenge

From indirect network effects to two-sided markets

Two-sided / Multi-sided markets = mkts in which a **platform** enables interactions between separate groups and actively tries to increase installed bases on all sides of the mkt

- ↳ **Platform** = foundation product or technology upon which other firms can build complementary goods → wants **both** sides to grow

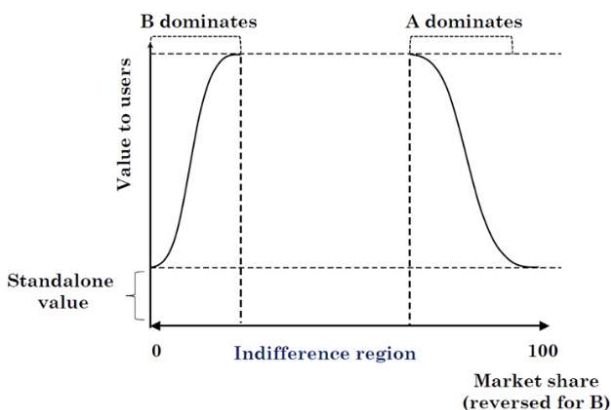


Same-side network effect	Cross-side network effect
Positive externality: Increasing the network on one side makes it more valuable for other users on this side (e.g. game consoles that support online gaming)	Positive externality: Users on one side of the market benefit from a large user base on the other side of the market (e.g. credit cards)
Negative externality: Users on the same side rival for the other side (e.g. career platforms)	Negative externality: One side would prefer only few users on the other side of the market. (e.g. TV advertising)

They are system markets which display **indirect network effects**.

Market	Platform	Side 1	Side 2
Software	OS	User	Application developer
Video games	Console	Player	Game developer
TV broadcasting	TV network	Viewer	Advertiser
Payment Systems	Credit card	Consumer	Seller
Social network	Facebook	User	Advertiser
Labor market	Linkedin	Professionals	Head hunters

Is dominance of a single technology unavoidable?



Not necessarily, different standards may co-exist.

- **Example of the video game industry:**
A bigger market share can boost network effects, but you do not need to dominate the market to get those benefits.

7 - Profiting from innovation: Collaboration Strategies

Technology plan

For each technology that the company aims to develop it has to identify:

- Product **innovation** (or technology innovation)
- **Lead time** (time of introduction to the market)
- **Mode of acquisition** (development and introduction)

Key points

- Firms must often choose between performing innovation alone or in collab
- Collaboration can enable firms to achieve more → at a faster rate, at less cost and risk
 - ↳ BUT also entails sharing control and rewards → may risk partner misbehavior ⇒ trade-offs
- Decision influenced by:
 - Availability of capabilities
 - Protecting proprietary technologies
 - Controlling technology development and use
 - Building and renewing capabilities

Solo Development vs. Collaboration Strategies

Aspect	Solo Development	Collaboration
Capabilities & Resources	Full internal control if all capabilities exist; build internally if not available	Gain faster access to complementary assets via partners (e.g., tech, distribution, manufacturing)
Speed to Market	Slower if missing key skills; longer cycle time	Speeds up innovation by combining strengths and shortening development time
Control & IP Protection	Protect proprietary technologies; avoid knowledge leakage	Must manage risk of IP exposure ; requires clear contracts and trust
Strategic Autonomy	Full control over decisions and direction; aligns with independent firm cultures	Shared decision-making; more negotiation and coordination needed
Organizational Learning	Helps build internal capabilities and transfer skills to future projects	Enhances knowledge exchange and co-creation; potential for long-term capability growth
Asset Commitment & Flexibility	Higher fixed costs; more rigid structure	Less asset lock-in; more flexibility in volatile or fast-changing markets
Risk & Cost Sharing	Firm bears all risks and expenses alone	Costs and risks of uncertain, high-investment projects are shared
Standards & Ecosystems	Harder to shape market standards or ecosystems alone	Collaboration helps build coalitions around shared standards and platform adoption

Context foresight: competitive and technological analysis

The context foresight is the result of:

External context driven analysis

- Identify new potential markets,
- Identify the evolution of existing markets,
- Identify future customer needs,
- Identify the required technological skills to make the applications able to satisfy customer needs,
- Mapping external competences

Internal context driven analysis

- Map existing (core) competences / technological skills and their existing and possible applications

Types of collaborative arrangements

Strategic Alliances = formal or informal agreements between two or more organizations (or other entities) to cooperate in some way

Model proposed by *Doz and Hamel* (1998) → 2 key dimensions:

1. combining **complementary capabilities or transferring capabilities**
2. focusing on **individual alliances or managing a network of alliances**
 - The model helps companies map out their alliance strategies depending on:
 - their goals,
 - the nature of the capabilities they need,
 - the structure they envision for their alliances (single partner vs. network)

Combining complementary capabilities

- Companies enter into alliances **to combine their distinct strengths to create value**
 - ↳ Each firm contributes resources, technologies, or expertise that the other lacks
- Goal: achieve synergy and jointly develop a competitive edge
- Typical in cases where partners have different but complementary assets

Example: **Renault-Nissan Alliance**

vs.

Transferring capabilities

- Focuses on **one firm leveraging** the expertise, technology, or processes of **another firm** and transferring them to its operations
- Idea: NOT to create smth new together, but to help one partner learn from the other and improve its own competitive position

Example: **Toyota and General Motors (NUMMI)**

Individual alliances

- A firm might form a standalone alliance with another company to achieve a **specific objective or address a particular need**
- These alliances are often **focused and time-bound**, with each company contributing to a distinct goal.

Example: **Starbucks and Barnes & Noble**

vs.

Network of alliances

- Portfolio of alliances → creating a **network of partnerships** that they can leverage simultaneously.
- This network approach allows firms to access a variety of skills, resources, or markets across multiple alliances, often leading to a **flexible and adaptive strategy**.

Examples: **Cisco Systems, Google's Android Ecosystem**

To sum up:

	Individual alliances	Network of alliances
Complementary capabilities	The focus is on leveraging synergies and shared resources to create competitive advantages within specific markets or segments .	The firm strategically manages its alliance portfolio to leverage synergies, scale efficiencies , and extend market reach across diverse markets or industries .
	<i>Tesla’s battery alliance with Panasonic</i>	<i>Google with its Android network</i>
Transferring capabilities	The goal is to access critical resources, knowledge , or expertise to enhance competitive positioning or fill gaps in capabilities.	The focus is on disseminating knowledge, expertise , or innovations widely to drive industry standards, establish ecosystems , or accelerate market adoption .
	<i>The NUMMI joint venture between GM and Toyota</i>	<i>Toyota’s supplier network</i>

Which are the reasons for an external collaboration?

Context foresight phase	Technology development phase	Technology introduction phase
<ul style="list-style-type: none"> ✓ Monitoring customer needs and mkt future trends ✓ Monitoring lead users and key customers (mkt knowledge acquisition) ✓ Monitoring suppliers ✓ Monitoring competitors ✓ Mkt opportunity analysis and new product ideas ✓ Technology scouting and monitoring of external technological resources (tech and R&D labs) 	<ul style="list-style-type: none"> ✓ Increasing of the company’s tech inn skills and its potential creativity ✓ Technological and scientific disciplines integration ✓ Increasing of the company’s R&D’s flexibility ✓ Improvement of the continuous innovation capability ✓ Reduction of the time to mkt ✓ Reduction (or at least sharing) of the new product technical risk 	<ul style="list-style-type: none"> ✓ Accessing to existing distribution channel ✓ Accessing to complementary assets/competencies/products for the innovation to be developed ✓ To easily commercialize the innovation in foreign countries of facilitate the introduction in new mkts ✓ Standard definition and setting (against other competitors)

Acquisition of technology from external sources for technology development: Make-Buy-Cooperate

New technologies can be “introduced” through:

- Internal development/resources use (**make**)
- Collaboration with external institutions (firms, labs, private, public, universities,...) (**collaborate**)
- Pure acquisition (**buy**) – Transfer of the technology to other companies (**sell**)

How to create innovation?

- Identify your **core competencies**:
 - Valuable

- Rare
- Imperfectly imitable
- Non-substitutable
- Also, understand **how to access complementary competencies**.

Managerial and Organizational Implications of External Technology Acquisition

When collaborating with external partners, analyze:

- Impact on firm (structure, assets, people)
- Time horizon
- Control over process (activities, people, information flow) and outputs (results)
- Startup time and costs
- Level of risk and of reversibility

Choosing a Mode of Collaboration

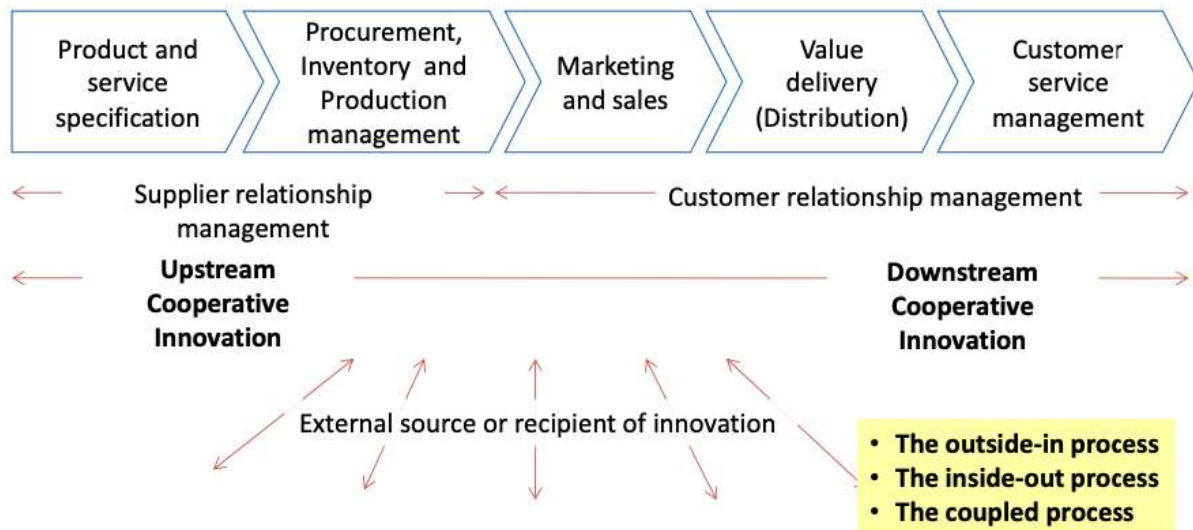
	Speed	Cost	Control	Potential for Leveraging Existing Competencies	Potential for Developing New Competencies	Potential for Accessing Other Firms' Competencies
Solo Internal Development	Low	High	High	Yes	Yes	No
Strategic Alliances	Varies	Varies	Low	Yes	Yes	Sometimes
Joint Ventures	Low	Shared	Shared	Yes	Yes	Yes
Licensing In	High	Medium	Low	Sometimes	Sometimes	Sometimes
Licensing Out	High	Low	Medium	Yes	No	Sometimes
Outsourcing	Medium/High	Medium	Medium	Sometimes	No	Yes
Collective Research Organizations	Low	Varies	Varies	Yes	Yes	Yes

Key factor to choose the most appropriate acquisition mode

Key factors <i>(if I want to...)</i>	Acquisition modes		
	Internal development (make)	Collaboration (cooperate)	Pure acquisition (buy)
Reduce the development time	X	XX	XXX
Increase the appropriability of the results	XXX	XX	X
Improve my learning process	XX	XXX	X
Reduce the development costs	X	XX	?
Minimize the technical risk	X	XX	XXX

Collaborative innovation

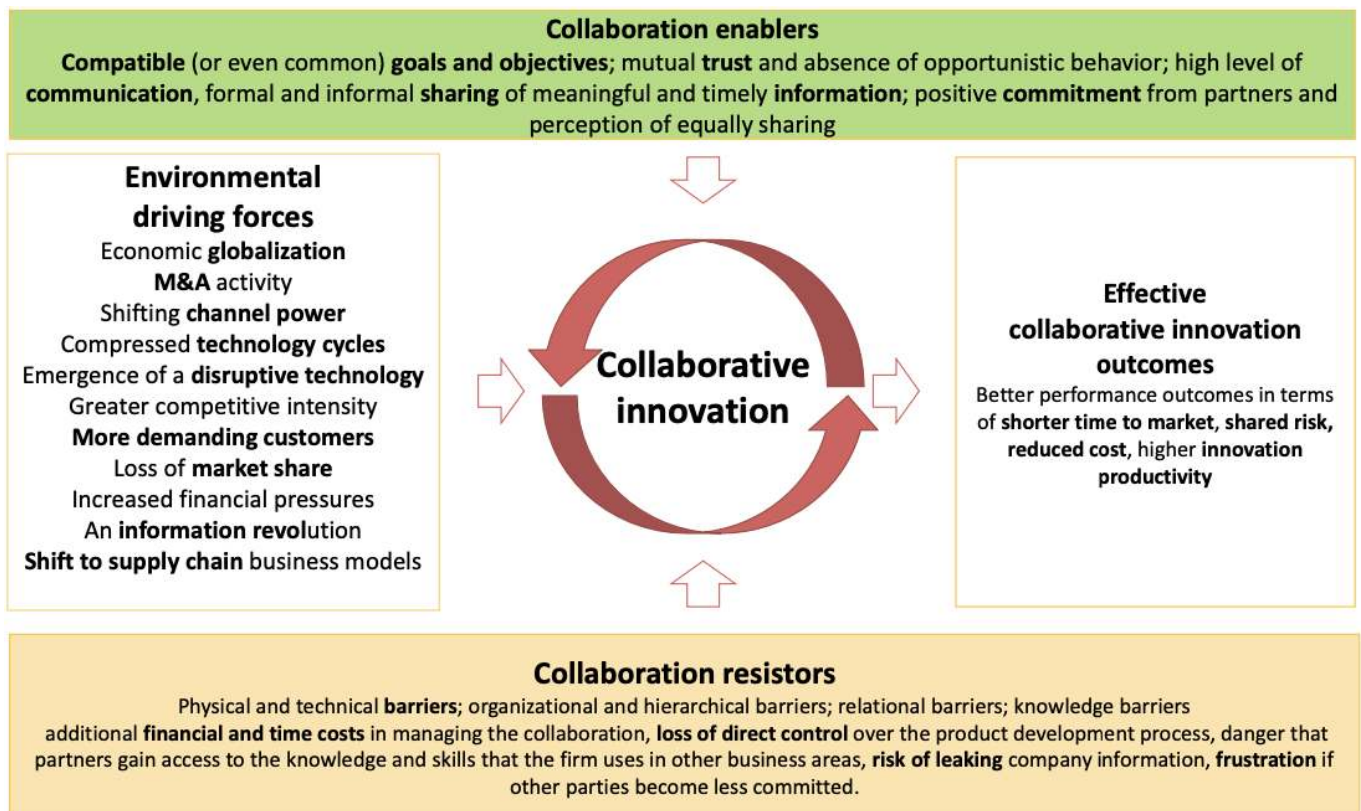
From dyadic relationships to networked collaboration



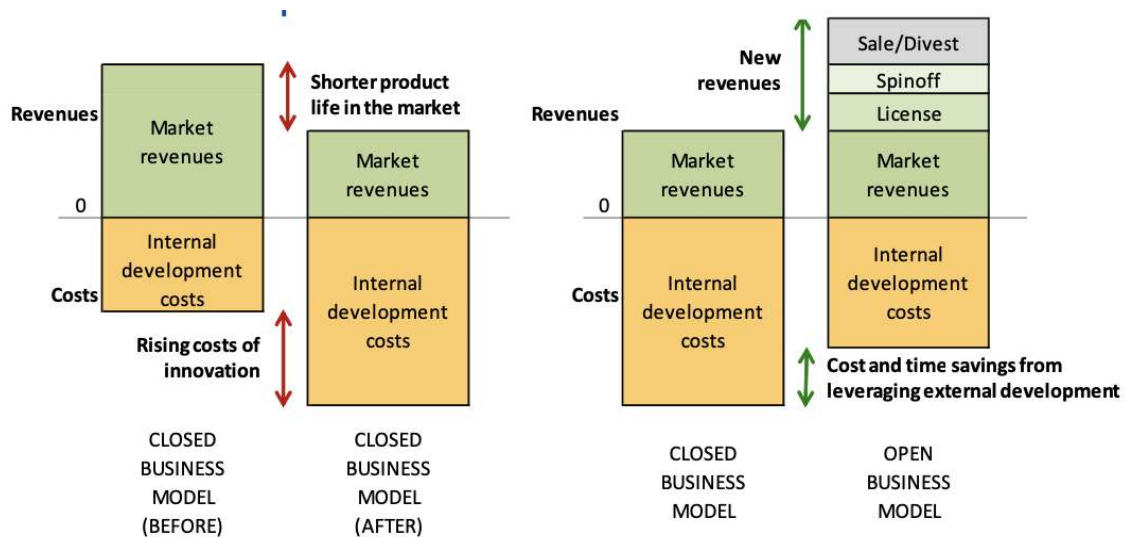
Open innovation paradigm

“... the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” (Chesbrough et al., 2006).

Drivers, enablers and resistors



“Closed” and “open” innovation business models



Choosing and Monitoring Partners

Key points for partner selection:

- **Resource fit:** *Do their resources match or complement the project's needs?*
- **Strategic fit:** *Are their goals and working style compatible?*
- **Impact on opportunities and threats:** *Will collaboration affect competition, suppliers, customers, or market threats?*
- **Impact on internal strengths and weaknesses:** *Will it strengthen the firm or fix weaknesses? Will it create a competitive advantage?*
- **Impact on strategic direction:** *Will it help the firm achieve its strategic goals?*

Partner monitoring and governance

Clear yet flexible monitoring and governance mechanisms

- Legally binding **contractual agreements** → ensure partners are aware of rights and obligations + provides legal remedies for violations
 - ↳ Contributions
 - ↳ Control
 - ↳ Proceeds distribution
 - ↳ Review/reporting
 - ↳ Termination
- **Shared equity ownership** help to align incentives and provide sense of ownership
- **Relational governance** = self-enforcing governance based on trust and reputation → built over time + can facilitate more extensive cooperation, sharing, and learning by partners

4 basic collaboration forms

Outsourcing: Buying services/products instead of making them

Licensing in / out: Selling or buying the right to use IP

Collective Research Organizations (Alliances): Firms collaborate on R&D

Joint Ventures: New legal entities, shared investment → merger, minority equity, consortium, acquisition

Commercialization strategies for technology start-ups

Gans and Stern (2003)'s framework:

- importance of choosing between

- > **cooperation** (working with incumbents)
- > **competition** (directly entering the product market)

based on the nature of IP protection and the availability of complementary assets

Cooperation

- Involves licensing technology or forming alliances with established firms to commercialize innovation
- More favorable when complementary assets are controlled by incumbents and excludability is strong
- A cooperation strategy often leads to less direct market competition and focuses on leveraging the market for ideas rather than competing in product markets.

Competition

- Involves start-ups directly entering the product market.
- More favourable when excludability is weak and start-ups aim to disrupt incumbents with innovative products

■ They consider 2 key dimensions:

1. **Excludability** = ability to prevent competitors from imitating the technology
2. **Control of complementary assets** = resources such as distribution networks or manufacturing capabilities, or brand reputation that are necessary for commercialization

Complementary asset control

Do incumbent's complementary assets contribute to the value proportion from the technology?

		Low	High		
Excludability <i>Can innovation by the start-up preclude effective development by the incumbent?</i>	Low	Attacker's Advantage Start-ups can enter the <u>market relatively easily</u> because there is no significant barrier in terms of assets like manufacturing or distribution. However, their <u>technological advantage is fleeting</u> because competitors can quickly imitate their innovation .		Reputation-Based Ideas Trading Incumbents control distribution and manufacturing, but the start-up's innovation is <u>vulnerable</u> to being copied. Thus, they face the risk of having their innovation expropriated if they disclose it to incumbents	
		Start-up Strategy - Key: speed and stealth. - They need to position their product or technology to exploit a "blind spot" of existing market leaders	Outcome - Success depends on ability to innovate and move quickly before established firms catch up - Long-term dominance is limited	Start-up Strategy - Must carefully select trusted incumbents with strong reputations for fairness in collaboration	Outcome - Can pursue cooperation with incumbents when they have reputational safeguards, but they must navigate the risk of disclosure carefully
	High	Greenfield Competition Start-ups have <u>strong IP protection</u> , allowing them to prevent competitors from copying their innovation easily . However, incumbents do not control critical complementary assets, so start-ups do not need incumbents' resources for commercialization		Ideas Factory Start-ups have <u>strong IP protection</u> , which allows them to prevent incumbents from easily imitating their innovation , but they need access to complementary assets controlled by incumbents to commercialize their products.	
		Start-up Strategy - Choose to compete directly or cooperate with incumbents - They have the	Outcome - Strong mkt power and can control their position → deciding whether to compete	Start-up Strategy - Start-ups often choose cooperation (e.g., licensing or partnerships with	Outcome - Model exemplified by industries like biotech, where start-ups partner

	power to dictate their commercialization strategy	or collaborate, depending on their goals and opportunities	incumbents). - Strong IP protection means they can safely share their ideas. - Incumbents are motivated to collaborate because they control key commercialization assets.	with large pharmaceutical companies to bring products to mkt - Startups reinforce the incumbent's mkt leadership by providing a continuous stream of innovations while avoiding direct competition
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Summary of the four strategies:

Complementary asset control

Do incumbent's complementary assets contribute to the value proportion from the technology?

		Low	High
Excludability Can innovation by the start-up preclude effective development by the incumbent?	Low	Strategic Alliance <ul style="list-style-type: none"> Lacks strong IP protection and does not control key commercialization assets – best option is <u>partnering with incumbents</u> to gain mkt access Cooperation strategy <ul style="list-style-type: none"> ➤ Example: Beyond meat → partnered with large good chains to scale 	Building a new market <ul style="list-style-type: none"> Lacks strong IP protection but controls key commercialization assets – must <u>innovate rapidly</u> and build a competitive brand before others Direct competition strategy <ul style="list-style-type: none"> ➤ Example: Netflix → scaled quickly and established itself as the dominant player before competitors could react
	High	Licensing (out) <ul style="list-style-type: none"> Strong IP protection but lacks key complementary assets – better off <u>licensing its technology to an established firm</u> rather than going to mkt itself Cooperation strategy <ul style="list-style-type: none"> ➤ Example: arm → instead of competing directly with Intel or AMD, it licensed its IP to Apple, Qualcomm, and Samsung 	Going It Alone <ul style="list-style-type: none"> Strong IP protection and controls the necessary assets for commercialization – does not rely on an incumbent, <u>can launch independently</u> Direct competition strategy <ul style="list-style-type: none"> ➤ Example: Tesla (early years) → competed directly with traditional automakers, NO licensing its technology

11 - Protecting innovation

Protect or not to protect?

- Firms must decide *whether* and *how* to protect their technological innovations
- **Protecting innovation** helps a firm keep control over it and appropriate the rents from it
- However, sometimes **NOT protecting** a technology can be an advantage for a firm – it may encourage others to support the technology and may become dominant

Appropriability = degree to which a firm is able to capture the rents from its innovation

- ↳ determined by how easily or quickly competitors can copy the innovation
- Some innovations are inherently difficult to copy (tacit, socially complex, etc.)
- Firms may also attempt to protect innovations through patents, trademarks, copyrights or trade secrets

Legal right	What for?	How?
Patents	New inventions	Application and examination
Copyright	Original creative artistic forms	Exists automatically
Trade marks	Distinctive identification of products or services	Use and/or registration
Registered designs	External appearance	Registration
Trade secrets	Valuable information not known to the public	reasonable efforts to keep secrets

IP protection: Patents

- **Patents** = rights granted by the govt that exclude others from producing, using, or selling an invention
 - ↳ must be *useful, novel, and not be obvious*
- **Utility patents** → protect new and useful processes, machines, manufactured items or combination of materials
- **Design patents** → protect original and ornamental designs for manufactured items
- **Plant patents** → protect distinct new varieties of plants

How to obtain a patent

1. Submit a patent application to a patent office
2. Application
 - describes the technical invention
 - defines the desired area of protection
3. The application is examined and approved (or rejected) by the patent office
 - application contains “claims”
4. Application is made public after 18 months

Patent laws around the world

- The patent process is **slow** → **2–5 years**, average **33 months** (in 2011).
- Each country has its own patent laws, but treaties exist to harmonize them

Paris Convention


- Foreigners can apply for the **same patent rights** as citizens.
- Grants a “**right of priority**”: if you apply in one country, you can apply in others (within a time limit) and keep the **same application date**.
- <https://www.wipo.int/treaties/en/ip/paris/>

Patent Cooperation Treaty (PCT)

- Apply once and **reserve patent rights in over 100 countries** for up to **2.5 years**.
- **Same filing date** applies in all member countries.
- Helps make patenting more **uniform** across borders.
- <https://www.wipo.int/pct/en>

Enforcement of patents

1. Infringement of patent
2. Preliminary injunctions: stop infringing activities
3. Claim of infringement is verified by trial
4. Punitive charges (damages)

 N.B. Patents are **national exclusion rights** ⇒ they only prevent others from making, using, offering for sale, selling or importing infringing products in the country where the patent was granted

Patent Strategies

We often assume inventors seek patents with the goal of making and commercializing the product themselves.

- However, inventors and firms may monetize patents in a range of ≠ ways, including
 - **Licensing** the technology to others.
 - **Selling** the patent rights to another firm.
- Some firms use patents just to block competitors or make money from lawsuits.
 - This is called **patent trolling** ↴

Patent Trolls

= person or company that buys patents just to **sue others** or **block competition**, without making or using the invention.

These are often **non-practicing entities** (NPEs) → They own patents but don't produce or develop any product or process associated with that patent.

- ↳ Not all NPEs are trolls — some are legit, like:
 - Universities
 - Research institutions
 - Tech transfer agencies
- ↳ Example: *In 2011, Innovatio threatened to sue 8,000 businesses in the US over Wi-Fi use. Many paid \$2,300–\$5,000 to settle, even without proof of infringement.*

Patent Thickets

= complex web of **overlapping patents** from ≠ companies or individuals, covering similar or related technologies

It creates a **difficult environment** for new products:

- High risk of **infringement**.

- **Hard to innovate** → barrier to innovation and competition, especially for smaller companies or new entrants in the market.

Companies use thickets to:

- **Protect innovations**
- **Block competitors** from copying or developing similar products
- **Discourage new entrants** who risk infringing existing patents or must invest in **costly licenses**

Example: Patent Thickets – Nortel Auction (2011)

- **Nortel** sold 6,000 patents related to wireless and networking tech
- A consortium (**Rockstar Bidco**) including **Apple, Microsoft, Sony, Ericsson, RIM** outbid **Google** with a **\$4.5B offer**
 - ↳ Their goal: gain leverage and protect their products from lawsuits
- **Google** lost the auction, so it bought **1,030 patents from IBM** instead
 - ↳ These weren't core to Google but gave them "retaliation power"
 - ↳ If sued, Google could countersue
- This is called **defensive patenting**: buying patents to avoid or fight back against aggressive litigation

13 – Trademarks, copyrights and trade secrets

Trademarks and Service Marks

- **Trademarks and Service Marks** = a word, phrase, symbol, design, or other indicator that identify the source of a product or service (e.g., Nike “swoosh” symbol)
- Help firms build and defend **brand equity**
- Rights to trademark are established in legitimate use of mark; do not require registration
 - ↳ However, marks must be registered before suit can be brought over use of the mark
- Registration can also be used to establish international rights over trademark
- Duration: do not expire as long as they are in use and renewed periodically

International Treaty for trademarks

2 treaties simplify registration of trademarks in multiple countries:

1. **Madrid Agreement Concerning the International Registration of Marks**
 2. **Madrid Protocol**
- Countries that adhere to either or both are in **Madrid Union** (85 members)

💡 Trademarks that have lost their value becoming common words: *Cellophane, Aspirina, Nylon, Freon, Yo-yo, Ketchup, Thermos, Teflon, Dynamite*

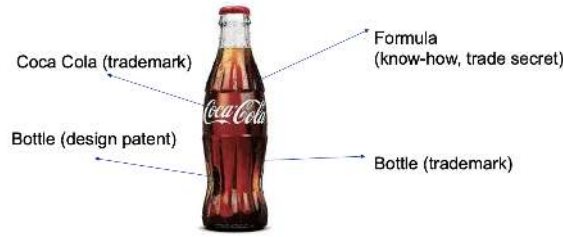
Copyright

- Protects an original creative, artistic or literary work → do NOT protect ideas, only **expressions** of them
- In the US: the authors of original works can obtain copyright protection
 - ↳ The rights are established by legitimate use of the work
 - ↳ This protection is available whether or not the work is published and prevents others from producing/distributing that work
- Duration: typically the life of the author + 70 years

Trade secret (Know-how)

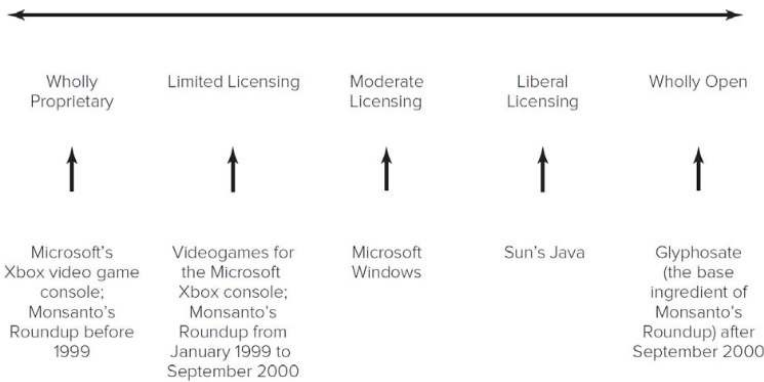
- **Trade secret** = valuable **confidential** information that gives a company a **competitive advantage** → unlike patents, trade secrets are not disclosed but are protected by keeping them secret (e.g. recipes, formulas, methods)
- Not registered — protection depends on **secrecy**.
- Used when:
 - Disclosing info (for a patent) would reduce competitive advantage.
 - The info gives a **long-term private economic benefit**.
- To qualify as a trade secret under the Uniform Trade Secret Act, the info must:
 1. **Not be generally known** or easy to discover legally.
 2. **Have economic value** from being secret.
 3. Be **protected through reasonable measures** (e.g. NDAs, limited access).

Example of different Intellectual property rights (IPR):



Wholly Proprietary Systems vs. Wholly Open Systems

	Wholly Proprietary Systems	Wholly Open Systems
Ownership	Owned by a single company	Not owned – open to everyone
Protection	Protected by patents, copyrights, secrecy, etc.	Not protected – no secrecy or patents
Access	Access limited or restricted	Freely accessible to anyone
Usage rights	Company controls how it's used or shared	Can be used, modified, and shared freely
Examples	Xbox console, Monsanto's Roundup (before 1999)	Glyphosate (after 2000), open-source software
Control level	High control	No or very low control



Most technologies are offered somewhere between wholly open and wholly proprietary and are protected by a range of control mechanisms – this range is exhibited by the **control continuum**.

To protect or not to protect?

Advantage of Protection	Advantage of Diffusion
<ul style="list-style-type: none"> ● great rent appropriability, ● greater incentives to invest in technological development, promotion and distribution ● to retain architectural control (i.e. ability to determine the structure and operation of 	<ul style="list-style-type: none"> ● encourages rapid adoption ● resulting in a large installed base ● stronger market for complementary goods

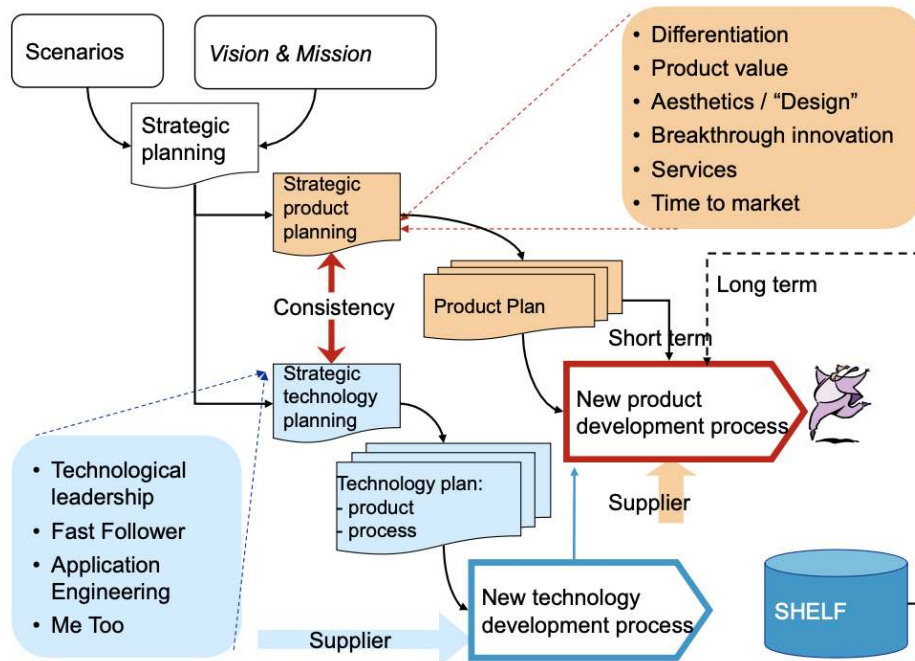
the technology and its compatibility with other goods and services)	• additional development efforts of other parties without additional cost to the original developer
---	--

Whether and to what degree a firm should protect its innovation depends on:

- **Production and marketing capabilities, and capital**
 - ↳ if unable to produce or market the technology (and complementary goods) at sufficient volume or quality, protecting the technology may hinder its adoption.
- **Industry opposition against sole source technology**
 - ↳ other industry members may jointly be able to exert enough pressure so that a firm will offer the technology with fewer restrictions.
- **Resources for internal development**
 - ↳ a firm lacking in sufficient resources to invest in the technology's functionality and ongoing improvements may not be able to compete in the market.
- **Control over fragmentation**
 - ↳ important when standardization and compatibility are important.
- **Incentives for architectural control**
 - ↳ especially high when the firm is a significant producer of complementary products.

15 – Selecting innovation projects

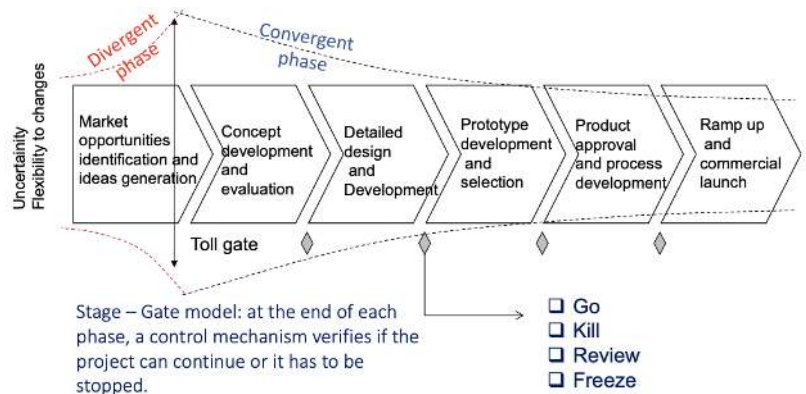
Company’s strategy and innovation strategy + The new product and technology planning



The New Product Development process *[see 21 - Managing the new product development]

The Stage - Gate process

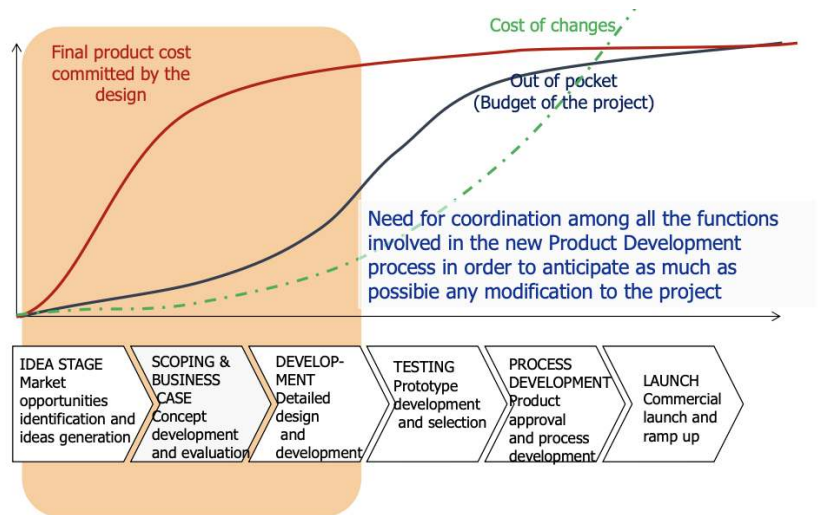
The NPD process consists of ≠ phases that we can ideally separate:



- ❖ **GO:** to the next stage, if it respects the criteria of selections of that particular gate
- ❖ **KILL:** the project has to be stopped, because it does not respect the criteria established by the company
- ❖ **REVIEW:** the project is interesting but does not satisfy all the criteria. → It needs to be refined and improved. → Then, it will be re-analyzed
- ❖ **FREEZE:** the project is interesting but it is too early to develop it (technology is not stable yet or the market is not yet prepared to accept it in terms of consumers habits or complementary products availability)

Technical life cycle cost of a project

- Cost of changes increases every time you pass in the next phase
- The early phases cost less than the later phases
- Cost decided in the early phases is 80-90% of the entire project budget

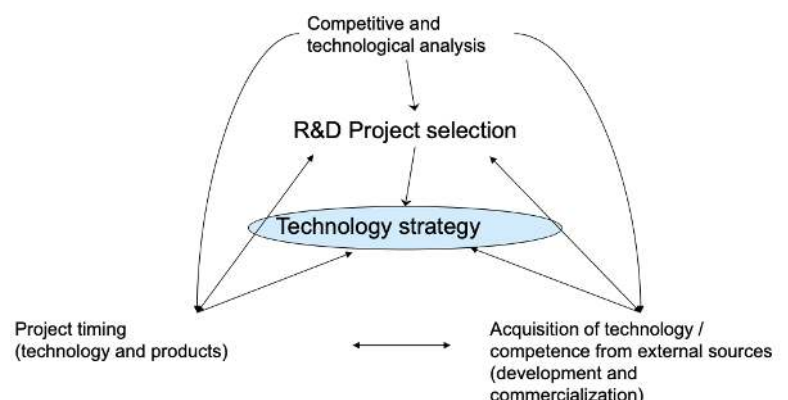


- Most firms set a fixed **R&D budget** (often a % of revenues).
- They evaluate potential projects to **rank** and **select** the best investments.
- The budget process is shaped by:
 - Past performance
 - Industry benchmarks
 - Strategic goals

Selection criteria: some examples (review)

Corporate objectives, strategy, policies and values	<ul style="list-style-type: none"> • Is it compatible with the company’s current strategy and long range plan? • Is it consistent with the corporate “image”? • Is it consistent with the corporate attitude to risk?....
Marketing criteria	<ul style="list-style-type: none"> • Does it meet a clearly defined market need? • Estimated total market size, market share, market life • Probability of commercial success • Effect upon current products portfolio (or brands)...
Research and development criteria	<ul style="list-style-type: none"> • Probability of technical success • Time and costs of technical development • Patent position • Effect upon other projects (synergies or conflicts)....
Production criteria	<ul style="list-style-type: none"> • Compatibility with existing capability/ processes or need for new processes/plants • Cost of manufacture and availability of raw material....
Financial Criteria	<ul style="list-style-type: none"> • Investments (manufacturing, marketing, distribution,...) • Expected margins, pay back period • Availability of resources in the time frame defined by the project, maximum negative cash flow....

Technology strategy formulation



R&D projects are intrinsically risky

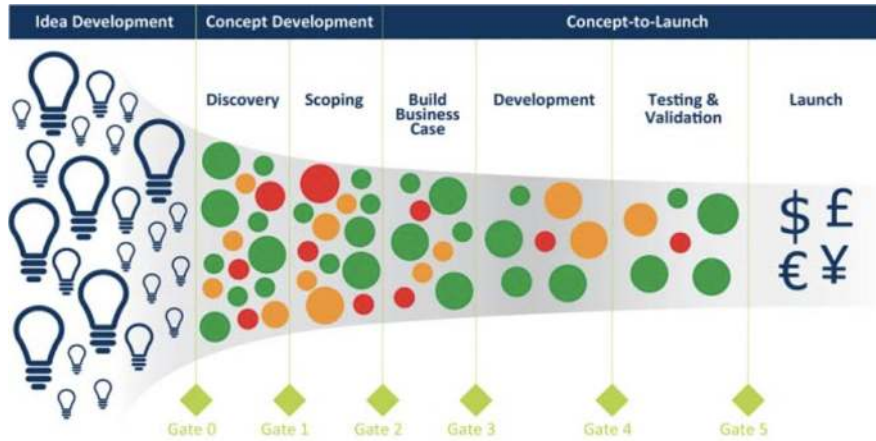
The risk of a technological project relates to:

- The probability that the project reveals to be not feasible technically – **technical risk**
- The probability that a technically successful project fails on the market – **commercial risk**

The probability that the project is not successful is therefore equal to: $1 - (P_t \cdot P_c)$

Where P_t = probability of technical success, P_c = probability of commercial success

Selection decisions



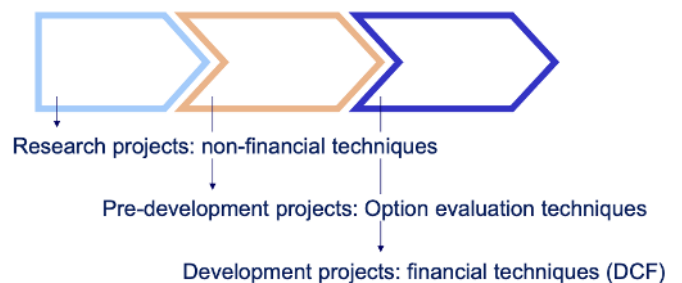
Idea selection is as important as idea generation → hard

		Actual Value (as confirmed by experiment)	
		positives	negatives
Predicted Value (predicted by the test)	positives	TP True Positive	FP False Positive Type 1 error = select an idea that does not succeed
	negatives	FN False Negative Type 2 error = do not select an idea that would have been successful	TN True Negative

R&D project evaluation techniques

Can be grouped into 3 different categories:

1. **Non financial techniques**
2. **Option-based techniques**
3. **Discounted Cash Flows (DCF) techniques**
(NPV, Profitability Index)



Each tool can be used as:

- ✓ **Acceptance criteria:** that evaluate if an investment is economically viable for the company
- ✓ **Ranking criteria:** that indicate the relative suitability of an investment among other possible alternatives.

Non-financial evaluation methods

3 main categories of non-financial methods used to evaluate R&D projects are:

1. Profile methods

- Each project is assigned a **qualitative judgment** (for example high, medium, low) which mirrors the **project performance of the project** against the set of criteria defined in advance.
- The **criteria** reflects the key factors determining the success or failure of a project.

Criterion	Expected performance		
	Low	Medium	High
Profitability			
Patentability			
Probability of commercial success			

2. Checklist

- Similar to the profile method
- A **set of criteria is fixed** and projects are evaluated against these criteria.
- The difference is that each project is assigned a **yes/no** or **0/1** evaluation according to the fact that the project is satisfactory against the criterion or not

Criterion	Expected performance	
	Project A	Project B
Profitability	0	1
Patentability	1	0
Probability of commercial success	0	1
Total	1	2

3. Scoring models

- The scoring models are based on the same principle of the previous 2 methods but add some other information about the **weight** of each considered criterion.
- They provide a weighted evaluation of each project, **depending on the (strategic) importance of the criteria**

Criterion	Weight (1-6)	Expected performance (1-6)	
		Project A	Project B
Profitability	6	1	5
Patentability	4	5	2
Probability of commercial success	5	3	5
Total		$1*6+5*4+3*5$ = 41	$5*6+2*4+5*5$ = 61


Qualitative methods: criteria to be considered

Role of customer	<ul style="list-style-type: none"> • Market • Use • Compatibility and ease of use • Distribution and pricing
-------------------------	--

Role of capabilities	<ul style="list-style-type: none"> Existing capabilities Competitors' capabilities Future capabilities
Project timing and costs	<ul style="list-style-type: none"> Timing Cost factors (now and future cost, learning curves, ...)

Q-sort analysis

1. Each card represents a potential project
2. Selection criteria are declared
3. Individuals sort their cards in rank order
4. Comparisons and debate
5. Consensus on the best projects

 The methodology is particularly useful when researchers wish to understand and describe the variety of **subjective** viewpoints on an issue → useful for early-stage or exploratory projects

Option based techniques

When dealing with *high-risk research projects*, traditional investment evaluation methods like Net Present Value (NPV) might not fully capture the flexibility managers have during the project.

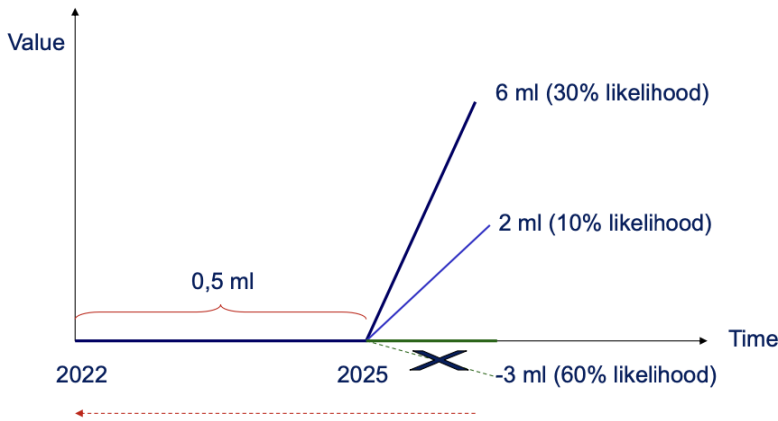
- ↳ This is where **real options** come into play.
 - = it is the **right**, but not the obligation, to undertake certain business decisions, such as delaying, expanding, or abandoning a project.
- "Real" option because **it applies to physical assets** (e.g., R&D projects, new product launches) rather than financial securities.
- In the context of an R&D project, it allows a company to:
 - **delay a project** until more information is available, uncertainty clears
 - **expand** the project if it shows promising results
 - **abandon** it if it turns out to be unprofitable → minimize the loss

The foreseen discounted cash flow

	2022	2025		
(Cash) Outflows	0,5 mln	4 mln		
(Cash) Inflows			<i>Likelihood</i>	Outcome
Hp1: Market is small		1 mln	0,6	Not worth it → you don't invest = you lose the option
Hp2: Market is promising, but is highly competitive		6 mln	0,1	Moderate profit
Hp3: Market is promising, and has low competition		10 mln	0,3	High profit

Discount rate: 15%

Investment evaluation with real option techniques



So:

➤ In **Hp1**, you walk away → your loss is only the 0.5 mln you spent in 2022.

➤ In **Hp2** or **Hp3**, you go ahead and invest 4 mln → and receive 6 (profit: 2 mln) or 10 mln (profit: 6 mln) in return.

Discounted Cash Flow techniques

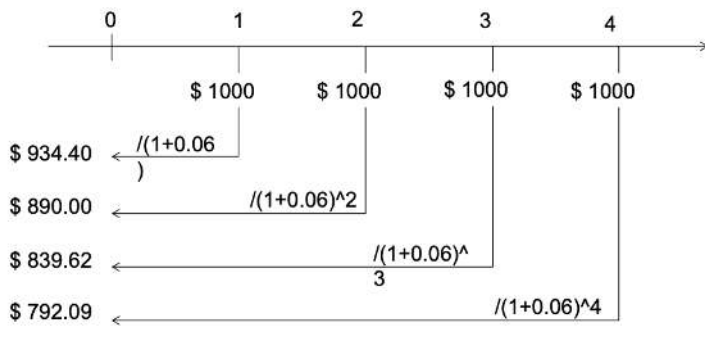
- Most common financial technique used for investment evaluation
- The variable calculated are stochastic, given that an R&D project involves risk (associating a probability of occurrence to each variable)

■ $NPV = \sum_t \frac{NCF(t)}{(1+i)^t}$ → **i = risk free rate (discount rate)** → difficult to calculate in practice

↳ **NCF = Net Cash Flow** generated by the project in year t (associated to the occurrence probability in order to consider the risk → obtained as:

$$[(Revenues - cash costs) * (1-t') + (Depreciation + Amortization) * t'] - Investment$$

where t' = the fiscal rate



\$ 3,465.11 Total present value at a discount rate of 6%

NPV: Criterion

If...	It means...	Then...
NPV > 0	the investment would add value to the firm	the project may be accepted , with an economic criterion
NPV < 0	the investment would subtract value from the firm	the project should be rejected
NPV = 0	the investment would neither gain nor lose value for the firm	we should be indifferent in the decision whether to accept or reject the project, from a pure monetary point of view.

NPV drivers

- **Incremental expected “other-than-financial cash-flows”** (so called “free cash-flows”, free of interests)
 - *Incremental*: only differences between investing / no investing matter. Opportunity costs should be included
 - *Expected*: because future cash-flows cannot usually be determined with certainty
- **Tax rate** reduces both inflows and outflows
- **Discount rate** has a major impact in NPV
- **Sunk costs** should not be addressed when computing NPV

Combined Approaches – qualitative & quantitative

- Many firms use a **hybrid** method, blending financial data with strategic judgment.
 - ↳ Firms must evaluate opportunities → not only by financial return
 - but also by strategic fit, customer value, and innovation potential
- Tools like **portfolio maps** (risk vs return) or **bubble charts** visualize project trade-offs.

A strong innovation portfolio should be **diversified** across:

- **Risk levels** (low-risk incremental vs high-risk radical)
- **Time horizons** (short-term improvements vs long-term platforms)
- **Project types** (basic research, platform, derivative, compliance)



This avoids over-investing in “safe” but unambitious projects, or only chasing risky breakthroughs

17 – Managing the R&D portfolio

The main steps to define the R&D project portfolio are:

1. Fixing the R&D budget

Setting of the R&D budget = results of the negotiations between top management and R&D managers.

- ↳ Top mgmt directly participates in the technology / innovation strategic planning process and defines the R&D projects that have to be developed

The R&D budget allocation can be based on:

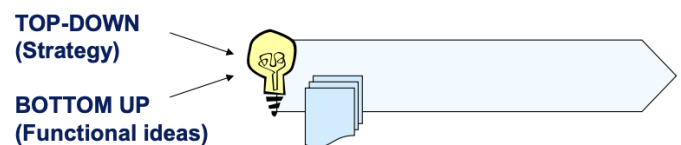
- the direct comparison with R&D expenses in other firms
- a fixed % on turnover
- a fixed % on profit
- the previous level of allocation
- the total cost of an agreed program

General principles for effective R&D budget allocation

- The R&D **investment level** has to be **consistent with the firm's long term objectives and plans**;
- The R&D activity requires **stability** to be fruitful (rapid decreases or increases generate difficulties);
- Large projects can explain **big cuts** or **grows** in R&D budgets (respectively if they are concluded or started)

2. R&D project definition

The generation of the R&D projects is the results of:



Scope

- = to describe the key characteristics of the projects that will be evaluated, defining:
 - the objectives
 - the information for the project feasibility evaluation:
 - its duration
 - the required resources (type and amount)
 - the expected results (outputs and outcomes)

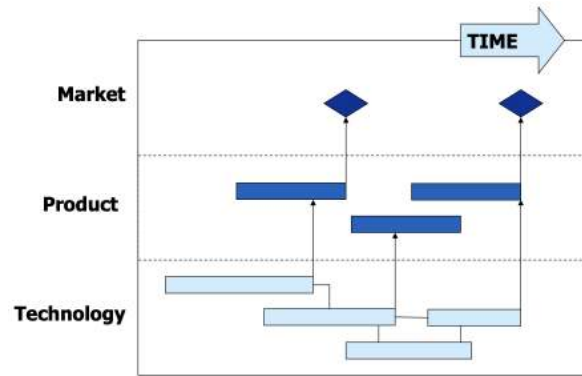
3. R&D project evaluation

Whatever techniques is used, the information that have to be considered are:

- The impact of the project **on the overall business** (including R&D and other functions)
- The impact that a project has **on other existing projects**
- The technical and commercial **risk** especially related to R&D projects
- **Costs** and expected results that can incur from the evaluation moment on (do not consider sunk costs)
- The **additional information** that can be gathered during the execution of a project (for the review of the ongoing projects)

4. R&D project selection

Technological road mapping (of selected projects):

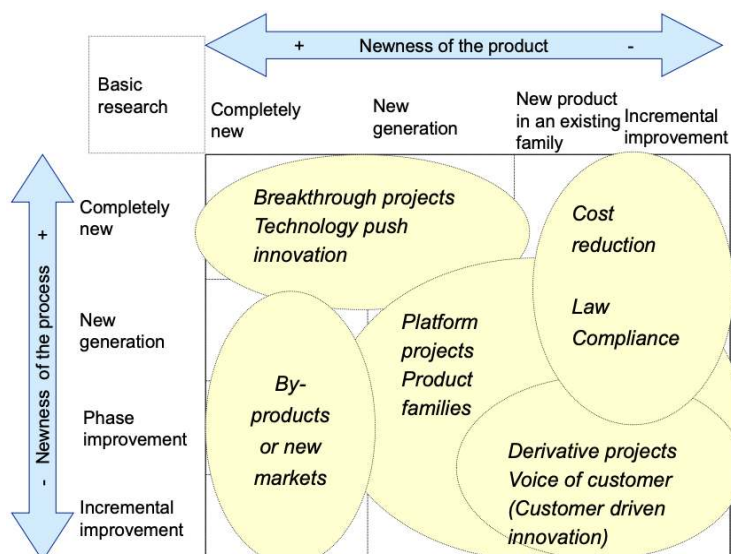


Project classification

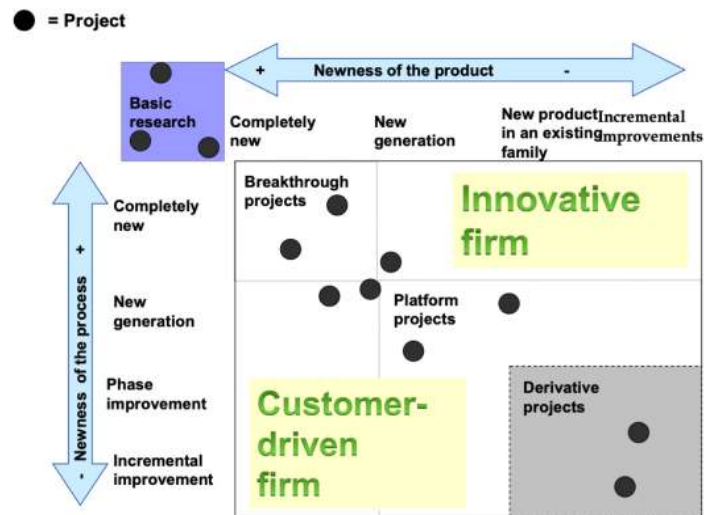
Type	Goal	Notes
Basic R&D	Scientific knowledge	Long-term, low commercial focus, often with universities
Breakthrough	New tech/product or market	Radical innovation, over 1 year, uncertain customer needs
Platform	New generation of product	Big improvement, ~1 year, better performance & features
Derivatives	Improve existing product/process	Add features or cut costs, short-term, limited scope
Cost Reduction / Compliance	Cut costs or meet regulations	Major process changes, riskier, same market
Byproduct / New Markets	Expand to new markets or use slight product tweaks	Adapt existing tech to new places/customers

Project mapping

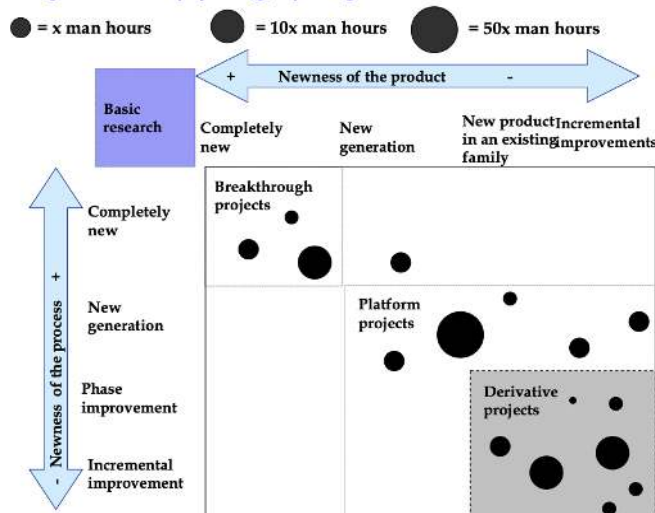
- Categories of projects from a strategic perspective



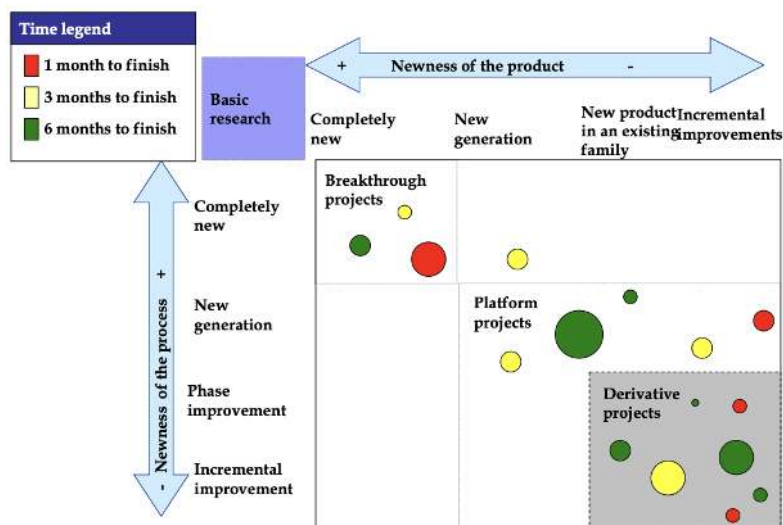
■ Projects



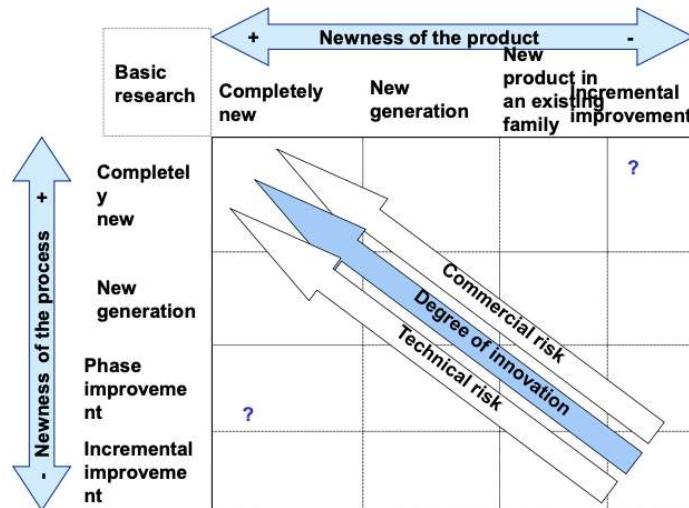
■ Projects and resources



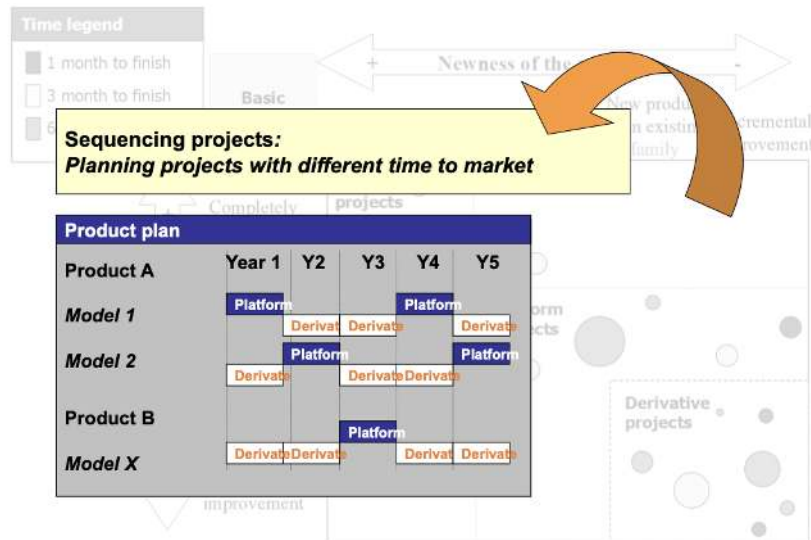
■ Projects, costs, time



■ **Determinants**

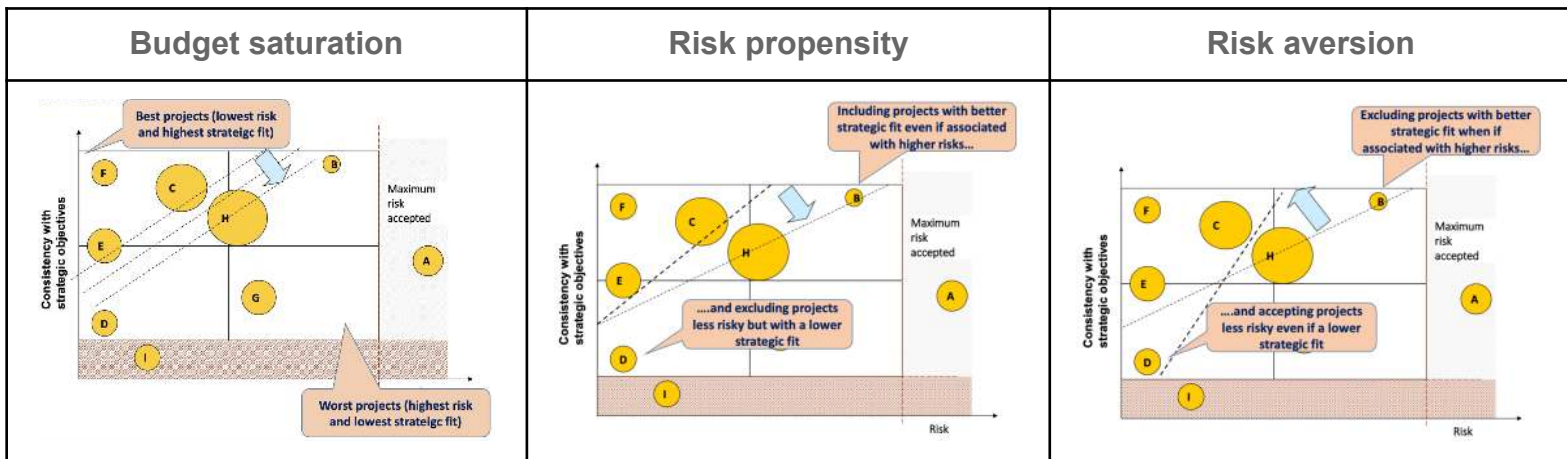


■ **Projects, costs, time**



Projects' selection process

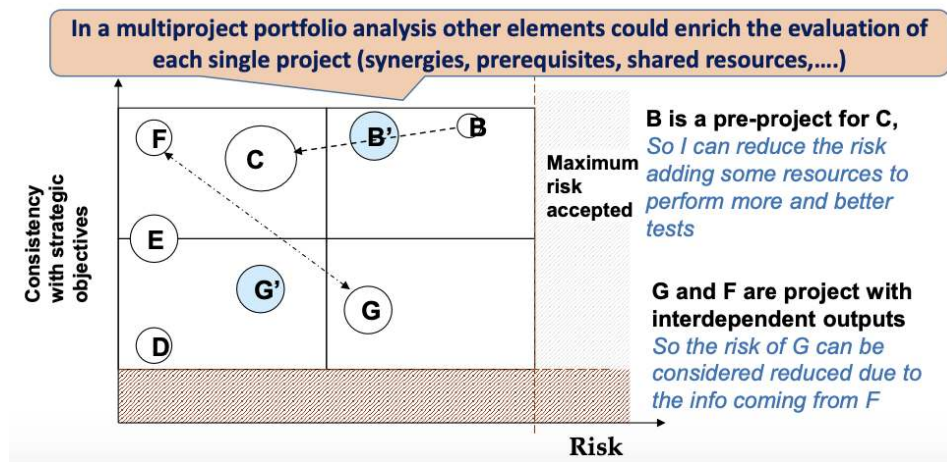
➤ **Strategic fit vs risk matrix**



5. R&D project portfolio analysis

The portfolio analysis allows to evaluate:

- The **projects interdependencies** (of time, outputs, used resources)
- The balance of investments along the timeline



19 – Organizing for innovation

Overview

- A firm's size and structure will impact its rate and likelihood of innovation.
- Some structures
 - may foster creativity and experimentation;
 - others may enhance efficiency and coherence across the firm's development activities.
 - There may also be structures that enable both simultaneously (**ambidexterity**).
- Some structural issues are even more significant for the multinational firm (**centralization** vs **decentralization** structural choices).

What is an organizational structure?

- = the formal system that outlines how activities are directed within a company in order to achieve its goals
 - ↳ It defines:
 - Roles and responsibilities
 - Reporting relationships (who reports to whom)
 - Communication flows
 - Coordination mechanisms between departments and teams

Innovativeness of a firm compared to its size and structural dimensions

"Smaller is better"

- High **managerial control** on R&D activities
- High **monitoring** and motivation of employees
- **Highest incentives** to innovation (clear authorship of the individual inventor)
- **Higher propensity to risk** (entrepreneur)
- Higher **flexibility**
- More **efficient** (R&D budget spent more carefully)

"Bigger is better"

- **Scale and learning effects**
- High **investment in R&D**
- Better developed **complementary** activities (marketing or financial planning)
- **Global** reach (to obtain information)
- **Better selection of projects**
- Possibility to take on large or **risky innovation** projects (aircrafts or pharmaceutical companies,...)

Many big firms have found ways of "feeling small"



Break overall firm into several subunits

Can utilize ≠ culture and controls in ≠ units

Structural dimensions of a firm

- **Formalization level**: the degree to which the firm utilizes **rules, procedures** and **written documentation** to structure the behavior of individuals or groups within the organization
- **Standardization**: the degree to which **activities** in a firm are performed **in a uniform manner** with predictable outcomes
- **Centralization**: the degree to which **decision-making authority** is kept at top level of firms → it can also refer to the **geographical location** of activities

... and their effect on innovation (and innovativeness)

Formalization level & standardization

Pro:

- Facilitate the standardization of firm activities
- Help to regulate employee behavior
- Can substitute possible managerial oversight
- It minimize variation

Cons:

- It may limit the employees creativity and experimentation for innovative ideas
- It can reduce the motivation to introduce something new

Mechanistic vs. Organic structures

Mechanistic structures	Organic structures
> High formalization and standardization <ul style="list-style-type: none"> ● Good for operational efficiency, reliability ● Minimizes variation → may stifle creativity 	> Low formalization and standardization; described as “free flowing” <ul style="list-style-type: none"> ● Encourages creativity and experimentation ● May yield low consistency and reliability in manufacturing
↘ ↙ The Ambidextrous Organization	
<ul style="list-style-type: none"> ● Some divisions (e.g. R&d, new product lines) may be small and organic ● Other divisions (e.g. manufacturing, mature product lines) may be larger and more mechanistic ● Can also alternate through ≠ structures over time 	

Ambidexterity

= a company’s ability to simultaneously manage two competing priorities:



Factors blocking innovation in large companies

- **Technical inertia:** not being able to change the core competencies in a dynamic way
- **Cognitive inertia:** «we’ve always have done in this way»; and «not invented here» (NIH) syndrome – not being able or intentionally resist to understand the new phenomena with ≠ perspectives (Xerox vs Canon)
- **Economical inertia:** focusing on short term innovation, less risky and reducing the possibility to cannibalize existing products (short term results oriented public companies)

How to profit from the benefit of small firms in large organizations?

- Break the overall firm into several smaller subunits → encouraging an entrepreneurial culture within these subunits
- Disaggregation (or “unbundling”) into networks of smaller, specialized, autonomous divisions or independent firms
- *Virtual organization, network organization, modular organization, ...*

Modularity and “Loosely-Coupled” Organizations

- **Modularity** = degree to which a system’s components can be separated and recombined.
 - ↳ Products may be modular at user level (e.g., Ikea shelving systems), manufacturing level (e.g., customizable PC or laptop)
 - ↳ A **standard interface** enables components to be combined easily
 - ↳ Modularity can enable many ≠ configurations to be achieved from a given set of components
 - ↳ Modular products can enable (though do not necessitate) the use of **modular organizations**
 - ↳ **“loosely coupled” organizational forms** → activities are not tightly integrated → they achieve coordination through adherence to shared objectives and standards.

Benefits

- More flexible configurations
- Ability to outsource and specialize

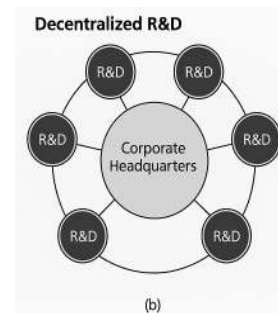
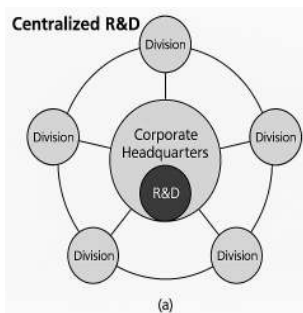
Limits

- Less effective when tight coordination is critical
- More room for conflicts if not well managed

- Example: *The Loosely-Coupled Production of Boeing’s 787 Dreamliner*
 - Boeing outsourced parts of the Dreamliner to ≠ global suppliers
 - **Boeing’s role:** acts as an **integrator**, assembling all outsourced modules into the final aircraft
 - Challenge: If tight coordination is needed, a loosely-coupled approach can be risky
 - So many suppliers ⇒ **coordination became very complex**
 - This caused **delays** in production.
 - Boeing considered **bringing work back in-house** (re-internalizing).
 - The PIC worked **24/7** to coordinate global operations across all time zones.

Centralization

= The degree to which decision-making authority is kept at top levels of the firm OR the degree to which activities are performed at a central location



Centralization

Decentralization

- when **economies of scale** are important
- need **communication** between research groups (and broader range of technological areas)
- when **long time scales** are involved (e.g. basic research)
- need for **functional integration**
- need for **specialist** staff or equipment (e.g. applied research)



Many firms use a **hybrid model**: central R&D for core tech, decentralized teams for market-specific adaptation.

Managing Innovation Across Borders

Centralization vs. decentralization is a particularly important issue for **multinational firms**.

- ↳ Foreign markets offer diverse resources, and have diverse needs.
- ↳ Innovation tailored to local markets might not be leveraged into other markets.
- ↳ Customization might make them poor fit for other markets.
- ↳ Divisions may be reluctant to share their innovations.
- ↳ Other divisions may have “not invented here” syndrome.

Strategies of multinational innovation

- **Center-for-global** – All R&D activities **centralized in a single hub**
 - Tight coordination
 - Economies of scale,
 - Avoids redundancy,
 - Develops core competencies,
 - Standardizes and implements innovations throughout firm.
- **Globally linked** – **Decentralized R&D labs** but each plays a **different role in firm’s strategy** and are **coordinated centrally**
 - Accesses diverse resources
 - Improve diffusion of innovation throughout firm and markets
 - May help develop core competencies
- **Locally leveraged** – **Each division does own R&D**, but firm attempts to **leverage most creative ideas across company**
 - Accesses diverse resources
 - Customizes products for local needs
 - Improve diffusion of innovation throughout firm and markets
- **Local-for-local** – Each division does **own R&D for local market**
 - Accesses diverse resources
 - Customizes products for local needs

Transnational approach

It combines benefits of both:

- **Global coordination** (e.g., shared platforms, unified vision)
- **Local responsiveness** (e.g., market-driven adaptations, local product tweaks)
- This model allows firms to leverage global knowledge while remaining agile in diverse markets.

It requires:

- **Reciprocal interdependence** among divisions
- Strong **integrating mechanisms** (e.g., personnel rotation, division-spanning teams, etc)
- A **balance** between local identity and global brand.

21 – Managing the new product development process

Objectives of New Product Development

An effective development process should achieve 3 core goals at the same time:

1. **Maximize fit with customer needs**
 - ↪ Does the product solve a real customer problem or create real value?
2. **Minimize development cycle time**
 - ↪ How fast can we get it to market? Time is critical for competitive advantage
3. **Control development costs**
 - ↪ Avoid runaway spending or investing too much in bad ideas

📌 Good development processes balance **speed, quality, cost, and market relevance.**

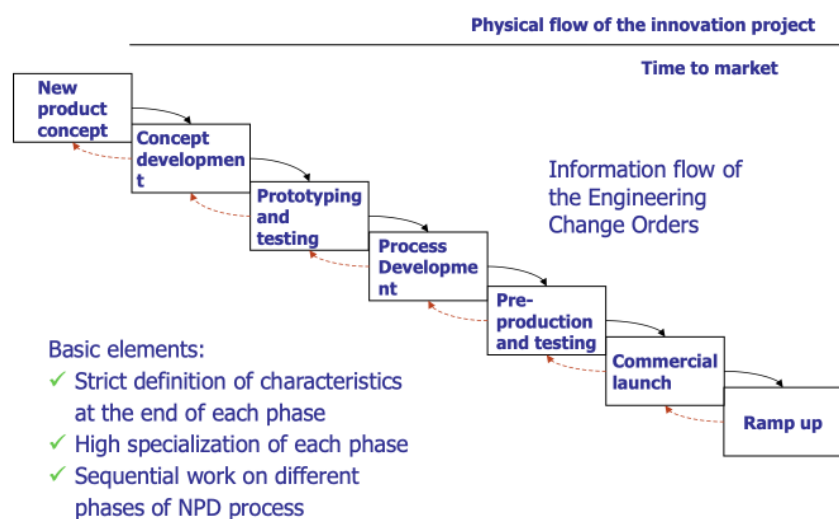
The organizational approaches of the new Product Development Process * [see 15 – Selecting innovation projects]

Classify in:

Sequential engineering approach

Each stage is carried out **separately**, and the next stage cannot start until the previous stage is finished

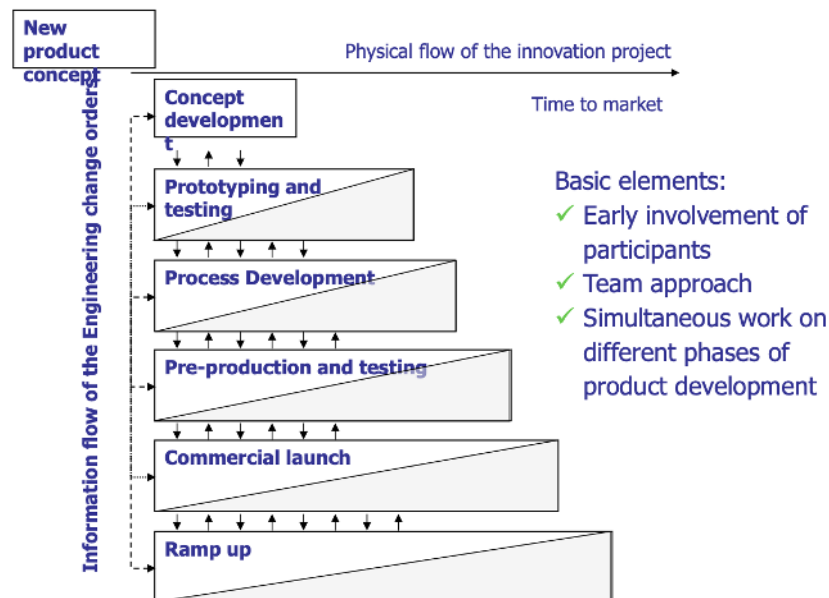
- ↳ Classic but slow, with risk of delays and last-minute problems.
- ↳ The information flow is only in one direction
- ↳ Main goal: reduce the degree of uncertainty at every phase



Concurrent Engineering approach

Can be overlapped because the execution of one phase does not imply that the previous one has to be completed

- ↳ Each activity is managed by a **cross functional team** that coordinate and control all the process
- ↳ Reduces rework, saves time, and surfaces problems earlier



ICT support in NPD process

e.g. *Italdesign Giugiaro Virtual Reality Center*

New product development process evolution thanks ICT:

- ↓ Time to Market
- ↓ costs of ≠ phases of NPD
- ↑ collaboration with supply chain actors (reciprocal exploitation of competence)
- ↑ interaction with customer (⇒ products/solutions more coherent with needs)

Customer and Supplier involvement in NPD

Customers are often best able to identify the maximum performance capabilities and minimum service requirements of new product

- ↳ *Crowdsourcing*, where people voluntarily contribute their ideas or effort
- ↳ Firms may also use beta testing to get customer input early in the development process
- ↳ **Lead users**
 - = Customers who face the same general needs of marketplace but experience them earlier than rest of mkt and benefit disproportionately from solutions
- e.g. *The Concurrent design facility (CDF) at esa*

Involving users and suppliers early:

- Helps clarify needs
- Improves design accuracy
- Reduces redesigns and waste
- Builds buy-in and alignment

22 – Tools supporting the new product development process

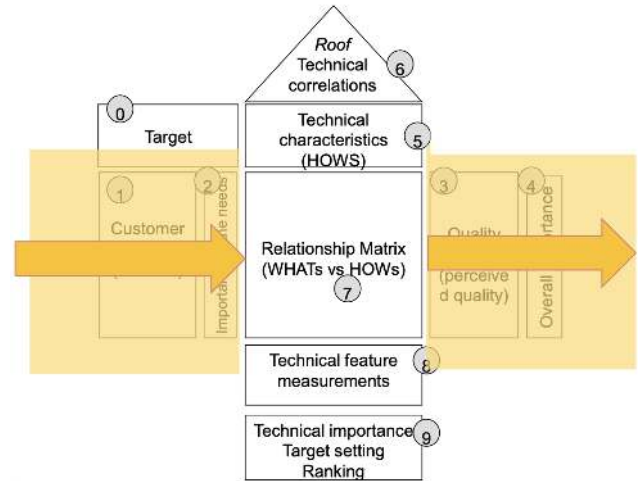
- Quality Function Deployment (QFD)
- Failure Mode and Effect Analysis (FMEA)
- Design for Manufacturing and Assembly (DFMA)

QFD: The house of quality

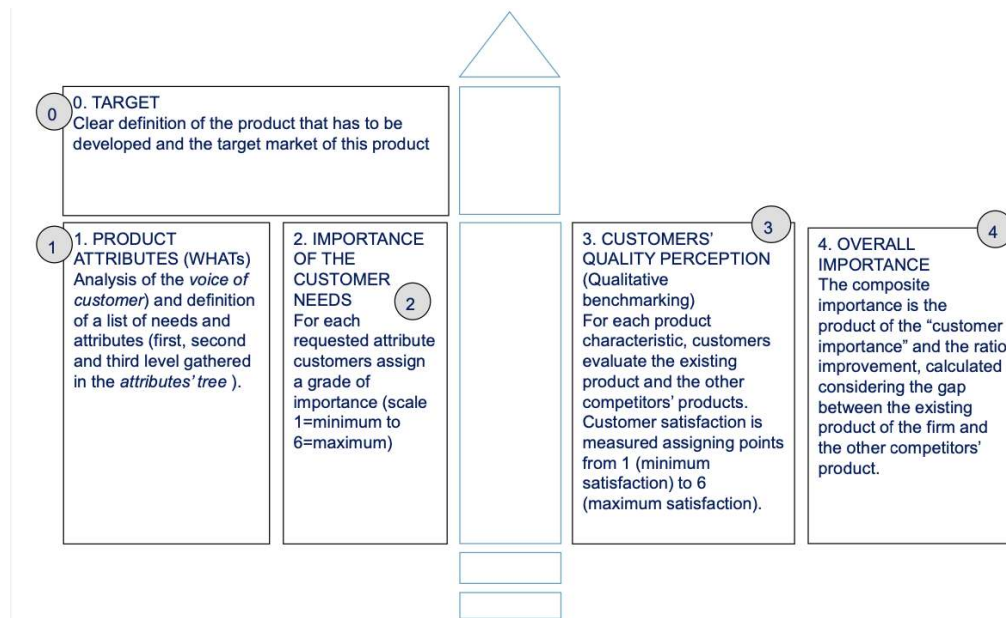
Objective: **translating the Voice of Customer** into technical specification, leveraging the competencies of the whole development team in a shared document, to take shared decisions

1. The house of quality **QUALITY PLANNING PROCESS**

- Planning the quality of the new product or services based on the Voice of Customer: **WHAT we have to develop to add VALUE** (functional characteristics and their importance)

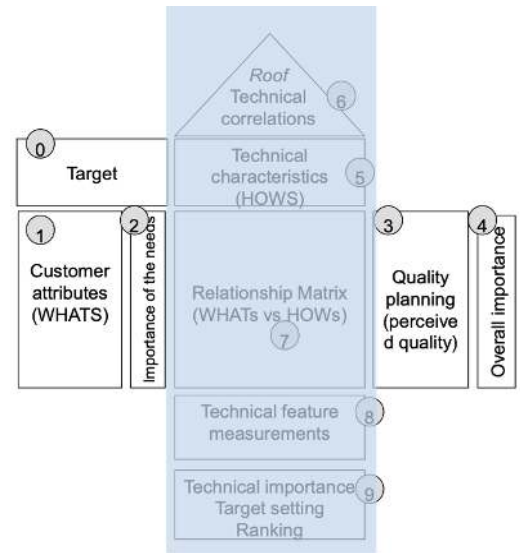


Understanding customer needs and planning product quality

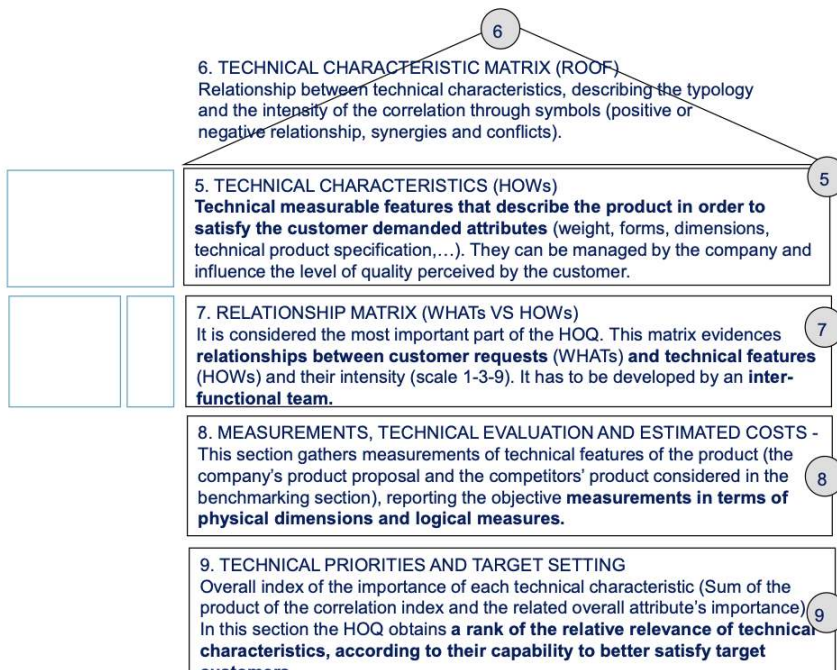


2. The house of quality **TECHNICAL DEVELOPMENT**

- **Transforms the needs (WHATs) in Technical solutions (HOWs) and prioritize them based on the Voice of Customer (thanks to the correlation matrix)**



Translating customer needs and product attributes into technical features



DFMA: Design for Manufacturing and Assembly

Design for manufacture (DFM) and design for assembly (DFA) developed from the very early stages to **lower costs** and **increase efficiency**

- Key principle: A product's cost is largely determined during the **design phase**, so smart design leads to lower production costs.
- Typically applied in **concurrent engineering**, where all phases of development (design, engineering, manufacturing) are considered together from the start.

DFMA can be structures into 2 ≠ parts:

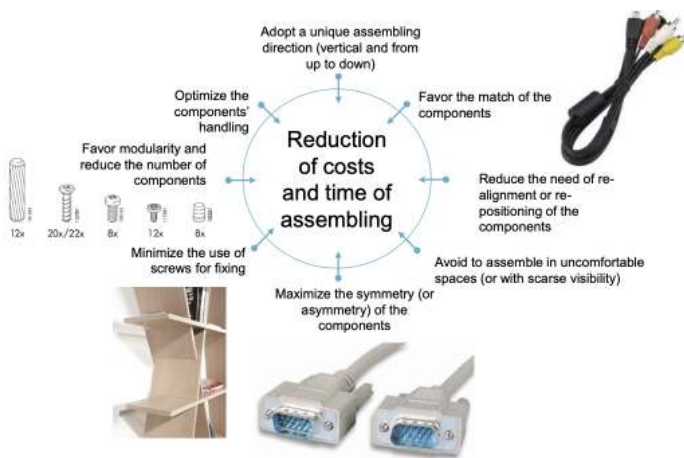
1. **Design for Assembly (DFA)** – for identifying parts that can be eliminated or combined, and for estimating assembly times and costs based on component characteristics

- Design for Manufacturing (DFM)** – focused on reducing the cost of product development, by minimising manufacture cost and time (reducing the n° of parts or using ≠ materials) and by avoiding needless design iteration

Design Rule	Impact on Performance
Minimize the number of parts	Simplifies assembly; ↓ direct labor; ↓ material handling and inventory costs; boosts product quality
Minimize the number of part numbers (use common parts across product family)	↓ material handling and inventory costs; improves economies of scale (increases volume through commonalty)
Eliminate adjustments	↓ assembly errors (↑ quality); allows for automation; ↑ capacity and throughput
Eliminate fasteners	Simplifies assembly (↑ quality); ↓ direct labor costs; ↓ squeaks and rattles; improves durability; allows for automation
Eliminate jigs and fixtures	↓ line changeover costs; ↓ required investment

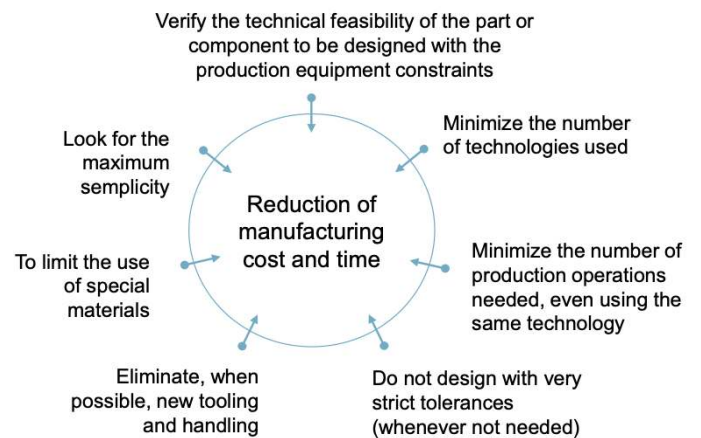
Design for Assembly (DFA)

To improve feasibility of the assembly sequences since the design, DFA consider the following guidelines:



Design for Manufacturing (DFM)

To improve technical feasibility considering the manufacturing constraints since the design phase, DFM consider the following guidelines:



Failure Mode and Effect Analysis (FMEA)

Method by which firms **identify potential failures** in a system, **classify** them according to their severity, and put a plan into place **to prevent** the failures from happening.

The severity of a risk is determined by:

$$\text{Impact on the project (time, cost or quality)} \times \text{likelihood of occurrence} \times \text{inability of controls to detect it}$$

N.	Task	Duration	Risk description	Impact T, C, Q (a)	Probability of occurrence (b)	Inability of controls to detect it (c)	Risk seriousness (a)*(b)*(c)
				2	5	3	30
						Risk level acceptance...*	
				4	4	1	16 **

*The "Risk level acceptance" is a threshold.

- If the risk seriousness score is **higher** than this threshold, the risk is **not acceptable** and needs action. → e.g. 16 **: “Continuous monitoring, extra budget allocation! Define the activities to prevent or to manage the risk (allocating more resources and/or checkpoint)”
- If the score is **below or equal to the threshold**, the risk is considered **acceptable** or manageable.

e.g.

	probability of occurrence	impact	inability of intercept the risk	risk seriousness	comments
activity A	2	5	2	= 20	more risky because the impact on the company is higher!
activity B	5	2	2	= 20	higher probability of occurrence, but lower impact

Risk Analysis: qualitative approach

Establish:

- Probability of occurrence
- Impact on:
 - time
 - cost
 - quality

	Probability						
	Very Low	Low	Med/Low	Medium	Med/High	High	Very High
Scale	1	2	3	4	5	6	7

	Impact						
	Negligible	+ 2% C, T, - Q	+ 10% C, T, - Q	+ 19% C, T, - Q	+ 29% C, T, - Q	+ 30% C, T, - Q	Failure
Scale	1	2	3	4	5	6	7

New product development metrics

Time	<ul style="list-style-type: none"> ● What was the average cycle time (time to market) for development projects? How did this cycle time vary for projects characterized as breakthrough, platform, or derivative? ● What percentage of development projects undertaken within the past 5 years met all or most of the deadlines set for the project?
Cost	<ul style="list-style-type: none"> ● What percentage of development projects undertaken within the past 5 years stayed within budget?
Quality	<ul style="list-style-type: none"> ● What percentage of development projects undertaken within the past 5 years resulted in a completed product?

23 – Managing the new product development process and teams

Introduction: Team

Innovation Team

- Skills of the members
 - ↳ diversity & complementarity
 - ↳ consensus
- Size (smaller groups are better?)
 - ↳ Group thinking?
 - ↳ Large groups → ⚠ coordination
 - ⚠ social loafing (free riding)
- Incentive & Rules

Definition

- = *a small number of people with complementary skills who are committed to a common purpose for which they hold themselves mutually accountable*

Critical factors for composing Innovative Teams

1. Group Size

- Optimal size of a group to balance creativity and efficiency
- Theoretical Foundation: Hackman (1987) suggests that smaller groups (5-7 members) are more effective for complex tasks requiring coordination
- Impact on Innovation:
 - Small groups foster better communication and faster decision-making
 - Larger group increase resource availability but risk fragmentation and coordination issues
- **Tailor group size to the project's complexity** → Teams should be **big enough to cover all key areas**, but small enough to stay agile.

2. Diversity of Skills

- Teams should mix:
 - **Functional backgrounds** (e.g., engineering + marketing)
 - **Experience levels**
 - **Cognitive styles** (creative thinkers + structured planners)
- Theoretical Foundation: Crossan et al. (1999) link diversity to increased organizational learning and innovation.
- Impact on Innovation:
 - Encourages diverse viewpoints, leading to more robust and innovative solutions
 - May create challenges in aligning goals and communication.
- **Foster an inclusive environment with training on collaboration. Balance technical and creative expertise**

Team composition/diversity:

- Diverse teams can lead to **exceptional success or failure** — outcomes are less predictable. This wide range in performance is due to 2 main factors:

Large number of members	Knowledge diversity of members
<p>Benefits:</p> <ul style="list-style-type: none"> • More people = more perspectives and ideas → leads to creative and breakthrough solutions • Cross-sharing of ideas helps innovation <p>Challenges:</p> <ul style="list-style-type: none"> • Bigger teams often struggle with logistics and communication • This can slow down decision-making or hurt team performance if not well managed 	<p>Benefits:</p> <ul style="list-style-type: none"> • Members with different expertise bring a larger pool of knowledge • These can be recombined to create novel and innovative results <p>Challenges:</p> <ul style="list-style-type: none"> • More diversity means higher chance of disagreement • Different goals, priorities, or work styles can cause conflicts • Managing this tension is key to unlocking the benefits of diversity

- Diverse teams also tend to exhibit **higher average performance** due to their ability to leverage complementary skills and collective intelligence over time.

More team experience:	Structured processes
<p>Improved communication: The more a diverse team works together, the better they get at communicating.</p> <ul style="list-style-type: none"> ➤ They develop shared habits and protocols that help reduce friction. <p>Enhanced synergy: Experienced teams are better at turning different perspectives into unified, effective strategies.</p> <ul style="list-style-type: none"> ➤ This boosts innovation and team performance. 	<p>Teams with clear roles and defined processes are:</p> <ul style="list-style-type: none"> • More able to use diversity constructively • Less likely to let diversity cause confusion or conflict <p>➤ Structure helps focus diversity into outcomes, improving average results without increasing chaos.</p>

Key Takeaways

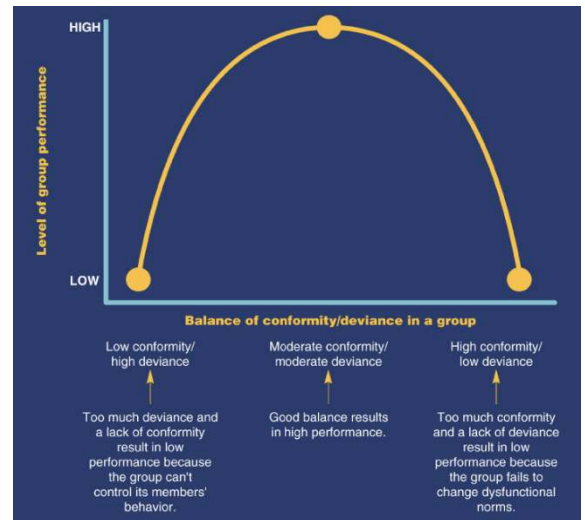
1. **Higher variance** in performance occurs because diversity can amplify both creative potential and conflicts ⇒ wider spread of outcomes
 2. **Higher mean performance arises** when teams develop processes and experience to effectively integrate diverse inputs ⇒ enhancing average outcomes over time
 3. **Individual outcomes tend to be more extreme**, as individuals are free from the constraints of compromise vs. **team outcomes are more moderated** and aligned
- This dynamic highlights the importance of team management in innovation
- To maximize the benefits of diversity, organizations should:
- Provide **training in conflict resolution**.
 - Establish **structured processes** for decision-making.
 - Foster a culture of **psychological safety to ensure all voices are heard**.

Team dynamics: balancing conformity and deviance

Critical role in shaping the performance and innovation potential of teams

↳ 2 contrasting behaviours are central to how teams function, adapt, and innovate:

1. **Conformity** = team members aligning their behaviors, attitudes, or decisions with established norms to maintain harmony and cohesion
 - ↳ **Overconformity** → *groupthink* = where dissenting opinions are suppressed, and the team makes suboptimal decisions
 - inhibits innovation and critical thinking when members fear challenging the status quo



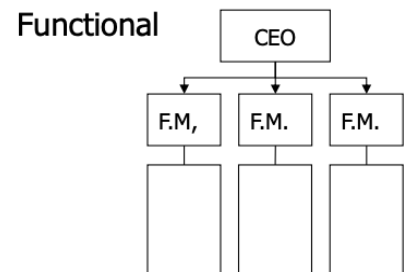
2. **Deviance** = team members challenge established norms by offering alternative ideas, questioning decisions, or behaving differently
 - ↳ Sparks creativity and innovation by introducing new perspective or ideas, challenges → improved methods, encourages adaptive learning within the team
 - ↳ **Negative deviance** can disrupt team harmony and creates interpersonal conflicts, and distracts the team from shared goals when it is perceived as non-constructive

Organizational structures of innovation projects

A. Functional

Team members are **grouped by their function** and project coordination happens through **functional manager**

- No cross-functional integration; team members remain within their own functional department
- No project manager
- Little commitment to the team



When to use:

- Projects are **small** or **short-term**
- **Specialized** expertise is required, and resources need to remain within functional departments
- **NO** need for frequent **cross-functional collaboration**

Advantages

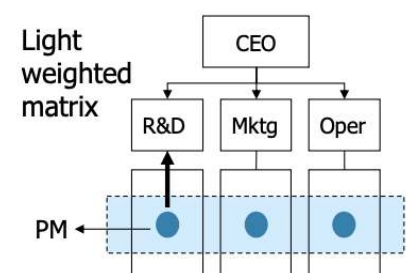
- Clear lines of authority within functions
- Efficient use of specialized expertise

Disadvantages

- Poor communication and coordination across functions
- Slow response to cross-functional issues

B. Light weighted matrix

Team members remain within their **own functional department**, **partially work on the project** and there's a coordination and integration role thanks to the introduction of a formal **Project Manager** (**NO hierarchical authority!**)

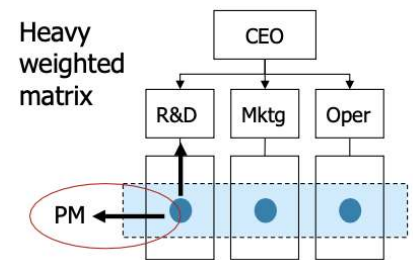


When to use: <ul style="list-style-type: none"> - Projects are not critical or resource-intensive - Functional expertise is more important than PM expertise - The organization wants to maintain functional control while supporting inter-department collaboration 	
Advantages <ul style="list-style-type: none"> • Minimal disruption to functional areas • Resources are shared efficiently across projects 	Disadvantages <ul style="list-style-type: none"> • Weaker authority for project managers ⇒ slower decision-making • Less project focus and team accountability

C. Heavy weighted matrix

Team members remain within their **own functional department**, **mainly work on the project**, and there's a coordination and integration role thanks to the **Project Manager** that has a **hierarchical authority on the team** (matrix organization)

- ↳ The PM has more authority than functional managers, leading to **stronger project focus**

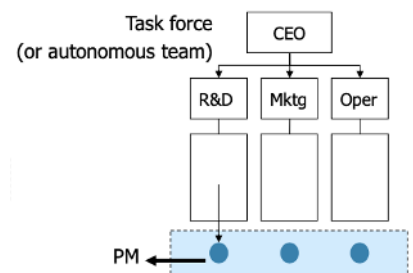


When to use: <ul style="list-style-type: none"> - Complex, high-priority projects that require significant resources - A need for strong project leadership and decision-making to meet critical deadlines 	
Advantages <ul style="list-style-type: none"> • Clear project ownership • Stronger commitment from team members and better coordination 	Disadvantages <ul style="list-style-type: none"> • Potential conflicts between PMs and FMs over resources • Higher demand for skilled project managers

D. Task force (or Autonomous team)

Team members work unusually **full time on the project** and **report to the Project Manager** that has **hierarchical authority** on the team (matrix organization)

- ↳ Very costly for the organization, but very effective for the commitment to the goal of the project



When to use: <ul style="list-style-type: none"> - Projects are critical, complex, or high-stakes - A strong focus and fast decision-making are required - The project cannot afford to share resources or face conflicts with functional priorities 	
Advantages <ul style="list-style-type: none"> • High commitment and accountability to the project • Faster decision-making due to dedicated resources 	Disadvantages <ul style="list-style-type: none"> • Expensive to maintain due to resource allocation • Re-integration of members back into functions can be challenging

Team Leadership & Administration

- **Team Leader** = crucial role in guiding the team's activities, ensuring alignment with project goals, and acting as a liaison between the team and senior mgmt

- ↳ Good innovation team leaders:
 - **technically credible** (respected by experts)
 - have **influence** and communication skills
 - facilitate collaboration and resolve conflict
 - align the team with **organizational strategy**
 - ↳ Leadership style may shift over time:
 - **Directive** early on (clear goals and structure)
 - **Facilitative** during ideation and refinement
 - **Coaching** near launch to overcome obstacles
- Many organizations now empower heavyweight, autonomous teams to develop a **project charter** and a **contract book** to enhance focus and commitment to the project
- **Project Charter** = defines the project's mission and sets specific, measurable goals, including a vision statement and rationale for the project's importance
 - **Contract Book** = negotiated by core team members and senior managers, detailing the plan to achieve the project's goals
 - ↳ This document estimates resources, development, schedule, and expected results
 - ⇒ tool for monitoring and evaluating the team's performance against set benchmarks and deadlines

Important roles in innovation teams

The project manager

- **Define** required resources and competences, goals and expectations, incentives
- Maintain focus
- Secure sponsorship and communication
- **Control execution**
- **Close the project** and transfer the knowledge

The project champion

= individual, often within the organization, who actively supports, advocates for, and promotes the project

They work to **secure buy-in**, **resources**, and **commitment** from:

- Persuades stakeholders and decision-makers to support the project
- Help navigate organizational barriers, including resource shortages or political opposition
- Bridges the gap between the project team and senior leadership, ensuring alignment with organizational goals

The project sponsor

= senior-level executive or manager who authorizes, funds, and oversees the project.

While the sponsor **provides strategic guidance** and **ensures alignment with organizational goals**, they typically do not handle the day-to-day promotion or advocacy that a champion does.

- Ensures the project aligns with the organization's objectives and strategic priorities
- Provides high-level decisions, especially during escalations or when conflicts arise
- Manages relationships with external stakeholders and ensures project buy-in at senior levels

The project anti-champion

= individual within or outside the organization who **actively or passively opposes the project** → a person who plays the role of the “devil's advocate”

- Challenges the project's assumptions, goals, or methods

- In some cases, the anti-champion highlights potential risks or weaknesses in the project, which can force the team to address critical issues proactively
- Represents an alternative perspective that may be valuable, even if their intentions seem to be obstructive

Project Communication Plan

1. **Identify communication objectives:** how to achieve awareness and involvement
2. Define **audiences** and **communication needs**
3. **Define per audience:** channels, key messages and frequency of communication
4. Identify **feedback channels**

Two types of Communications Plan:

- a. Regular or Ongoing Communication Plan
- b. One-time or Event-driven Communication Plan

A special type of team: Virtual teams

Virtual teams = teams in which members may be geographically distributed, but are still able to collaborate intensively via advanced information technologies

- Reduction of travel expenses
 - ↳ BUT difficulties in facilitating communication and collaboration (also informal interaction)
- Team members must be able to work independently and seek interaction (being comfortable with technologies and having strong interpersonal skills)
 - ↳ Daily updates (like Agile “stand-ups”)
 - ↳ Shared digital whiteboards, calendars
 - ↳ “*Dailies*” = team-wide check-ins for shared feedback, common in film/animation

FOR DOUBTS OR SUGGESTIONS ON THE HANDOUTS



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