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MMME 3049

Disruption and the Management of Innovation and New Technology

"What is innovation?"

"Why do it?"

Presented by Mike Walsh (Mar 2023)

Text: Martin Baumers and Mike Walsh

Today's objectives and learning outcomes

An introduction to the Management of Innovation

- What is innovation and why do it?
- The innovation process
- The cost of innovation
- Protecting innovation

What is innovation?

Innovation

An *innovation* is “an idea, practise or object that is perceived as new by an individual or other unit of adoption” (Rogers, 2003).

- Note two things here:

  → “perceived”, meaning subjectively new

  → “new” doesn’t just apply to knowledge. If a new product has been made from an old idea for the first time, that’s also an innovation

- “Newness” may be expressed in terms of knowledge, persuasion or decision to adopt.

What is the context of innovation

- Innovation and technology are important for change in the world
- In is part of an ongoing process in which old things are replaced by new things
- Sometimes associated with the process of “Creative Destruction” Schumpeter’s gale.
- Seen as part of a sequence of processes

Joseph Schumpeter
Economist
(1883 – 1950)

Disruptive innovation

- Unlike other innovations, disruptive innovations create new markets
- Unexpected source of value for buyers
- Destroys older markets → Schumpeter!
- Example: First cars were not disruptive innovations, because they were too expensive and unreliable to replace horse-drawn carriages

Clayton Christensen
Management Scholar
(born 1952)

→ **Henry Ford's Model T did this**

Exercise – Other disruptive innovations

Take five minutes with the people next to you to think of some other disruptive innovations.

The societal impact of technological innovation

Argued that technology regiments the things and people interacting with it.

Human interests become subordinate to the technological way of thinking and hence to the technology itself.

Technology makes use of people.

Martin Heidegger
Philosopher
(1889 – 1976)

The societal impact of technological innovation

Frame Knitting and Resistance to Change
The Luddites

Sabot

So, what is the motivation of innovation?

We look at it though the lens of the business. Businesses need to maintain a competitive position - other companies will be innovating in order to get ahead.

This means, for a business, goals might be:

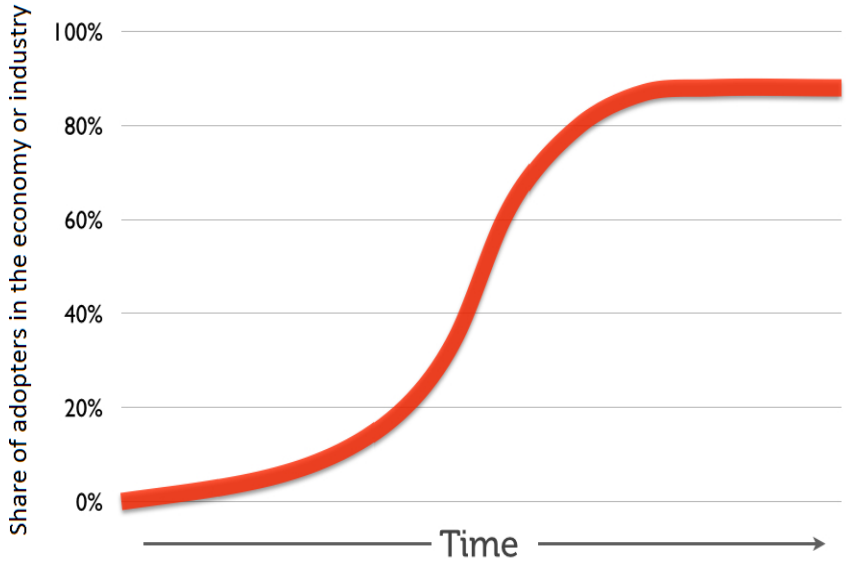
- To control costs through improved manufacturing
- To increase or update a product range
- To respond to technology changes

The innovation process and sources of innovations

How technologies and innovations spread

A general pattern is observed in the way technologies develop over time.

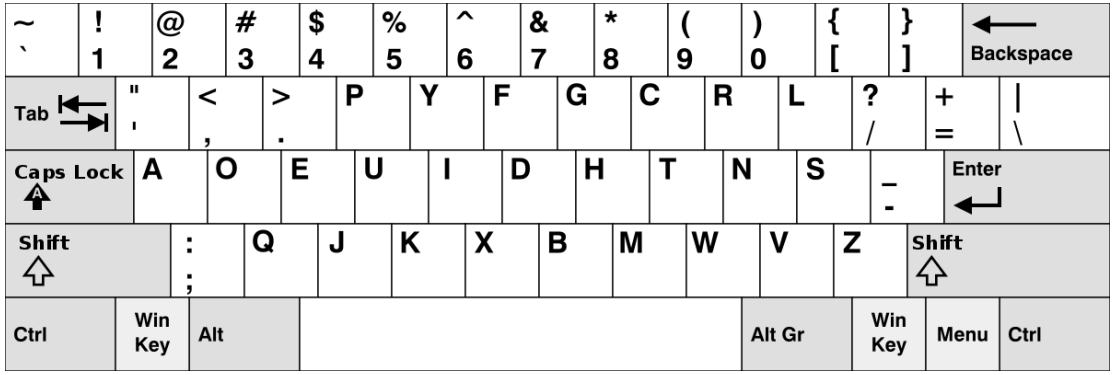
- Generaly follows an S-curve shape



- **But this doesn’t mean all innovations successfully spread**

Example: The Dvorak keyboard

Despite being superior to the conventional “QWERTY” keyboard layout in every respect, almost no-one uses the Dvorak keyboard.



- This is because the “QWERTY” keyboard was developed for typewriters and stopped better keyboard layouts from spreading…

Examples of the driving force behind products are:

- 3M notelets - driven by a technical discovery – a mistake?

- Dyson Vacuum cleaner - driven by desire to improve technology
- Airbus A380 airliner - driven by market need,
  as perceived in the mid 1990s!

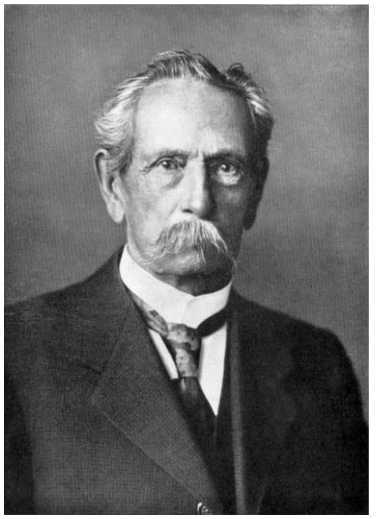
“Watching Brief” on technologies, examples:

- Steel companies looking at composites
- Sewing machine company looking at adhesives
- Software companies looking at hardware

Innovation need not on the basis of pure invention

For example, did Karl Benz invent the car?

- Carriage was in common use
- Steam propelled carriages were well known, if uncommon
- Otto cycle (four stroke) combustion engine was available
- This is known as “recombinant innovation”



Karl Benz
Engineer
(1844 – 1929)

Mercedes-Benz

The five phases of innovation from an industrial perspective

Innovation from an industrial perspective

In the industrial innovation process, we can identify five phases:

time ↓

Phase	Normally done by
1. Pure research	Universities
2. Basic research	Universities / Industry
3. Applied research	Industry / University
4. Product development	Industry
5. Product design	Industry

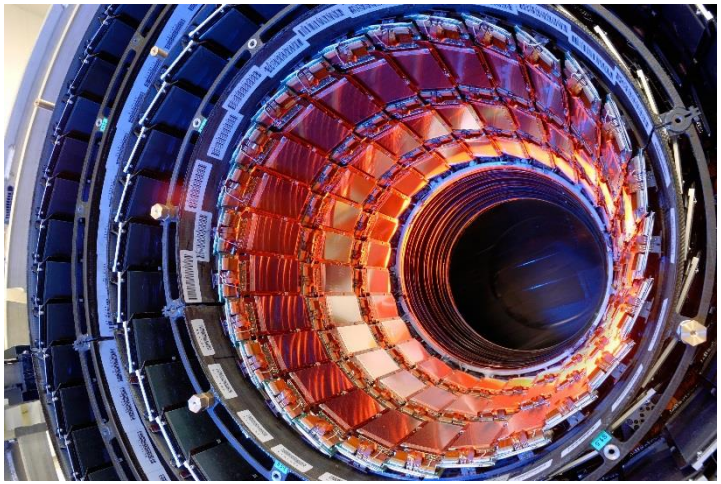


STAGE	MOTIVATION	WHERE	FUNDED
1. Pure research Eg. Particle physics	• Scientific interest • Curiosity • External stimulus • No immediate application • Little commercial consideration	• Universities	Government (research councils)
2. Basic research Eg. transistor	• Develop scientific theme • Market driven • Respond to competing technical challenge • This work will have direction but probably no business objective	• Universities • Possibly some industry	• Government • Govt./ industry collaboration
3. Applied research Eg. High temperature materials	• Market lead • Perceived need	• Industry • Possibly university collaboration	• Combination of government and industry
4. Product development Eg. Dyson vacuum cleaner	• Market lead • Perceived need • Specific commercial and technical objectives	• industry	• industry • possibly govt. aid
5. Product design	• Market lead • Perceived need • Specific commercial and technical objectives	• industry	• industry • possibly govt. aid

Pure Research

Example:

- No commercial element
- Adventurous, follows leads, hunches or curiosity
- Little or no concept of eventual application
- Ideas tend to be unrelated and there will be little flow or continuity
- Research ideas may well be dropped in favour of a new, more interesting avenue of research



Basic Research

- Recognition of commercial benefit
- Realistic objectives
- Technology and market input
- Emphasis on extending technology
- May well spawn other avenues of investigation

Examples:
EPSRC and H2020 funded research at Nottingham University

EPSRC
Pioneering research and skills

Applied research

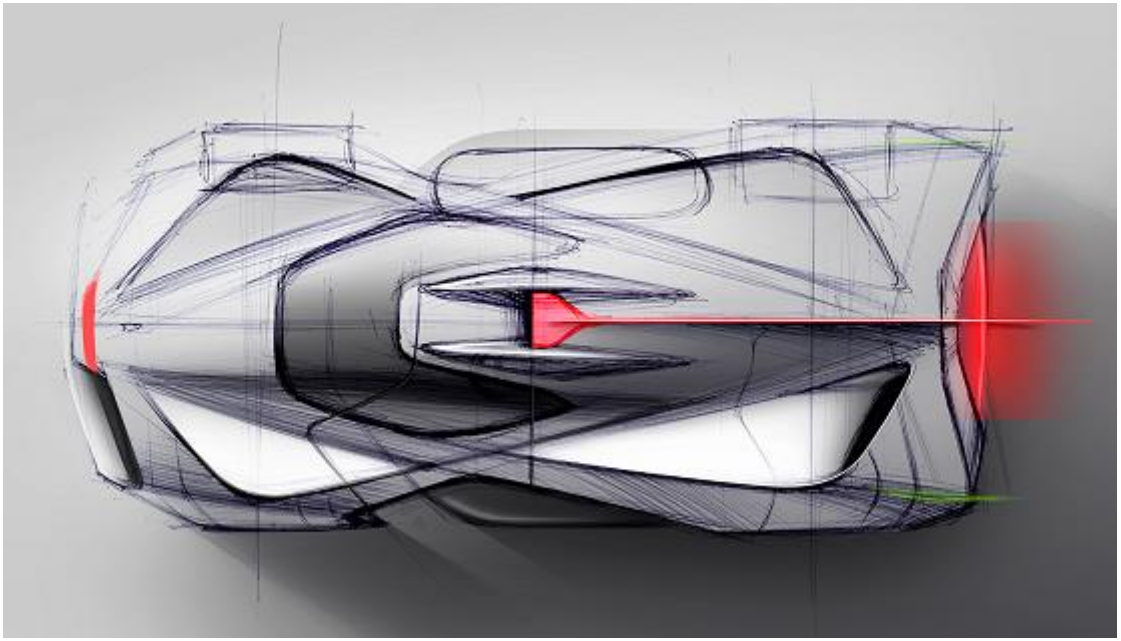
- Focussed work aimed at solving specific problems
- Aimed at extending the technological capability to match the needs of a new product or process
- Process ends with a working demonstration or simulation
- Includes implementation plan (i.e how to take it to market)
- Identifies any necessary supporting research product development and product design

Example:
Research at the Manufacturing Technology Centre in Coventry

mtc
Manufacturing Technology Centre

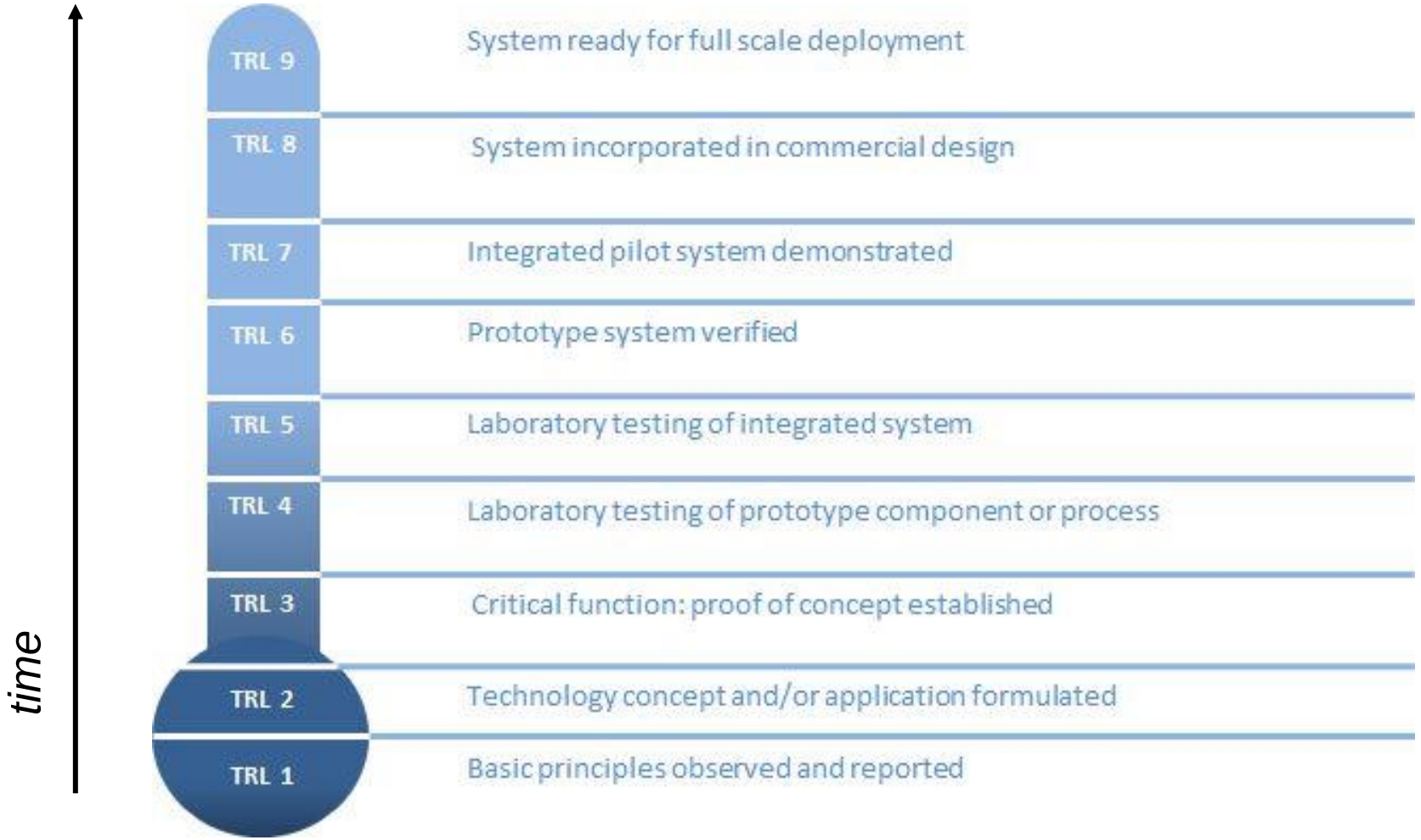
Product development and design

- Focussed on a specific product
- Will have hard objectives such as performance and cost
- Normally done by industry, either internally or externally



Example:
Development at design companies, such as Pininfarina

In engineering the relationship between time and development of Key Enabling Technologies (KETs) is often viewed in terms of "Technology Readiness Levels"

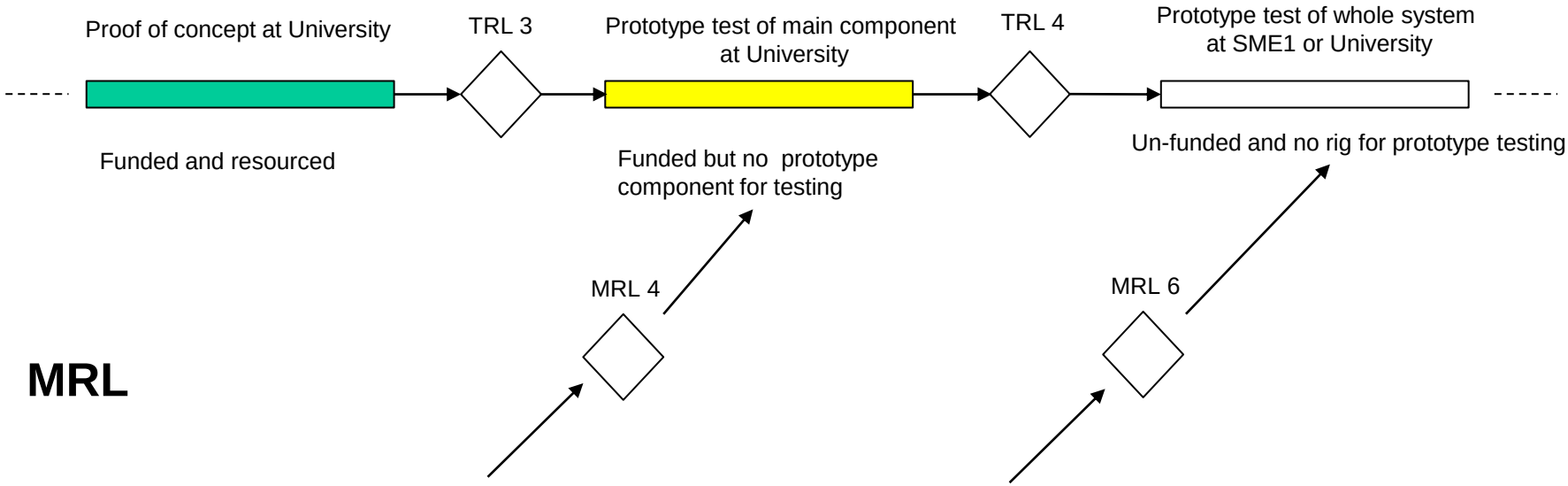


Technology Readiness Levels are sometimes used alone but are often used with Manufacturing Readiness Levels (MRL)

Phases	MRL	Definition
Operations and support	10	Full rate production demonstrated and lean production practices in place.
	9	Low rate production demonstrated. Capability in place to begin Full Rate Production.
Engineering and manufacturing development	8	Pilot line capability demonstrated. Ready to begin low rate production.
	7	Capability to produce systems, subsystems or components in a production representative environment.
Technology development	6	Capability to produce a prototype system or subsystem in a production relevant environment.
	5	Capability to produce prototype component in a production relevant environment
Material solutions analysis	4	Capability to produce the technology in a laboratory environment.
	3	Manufacturing proof of concept development.
	2	Manufacturing concepts identified.
	1	Basic manufacturing implications identified.

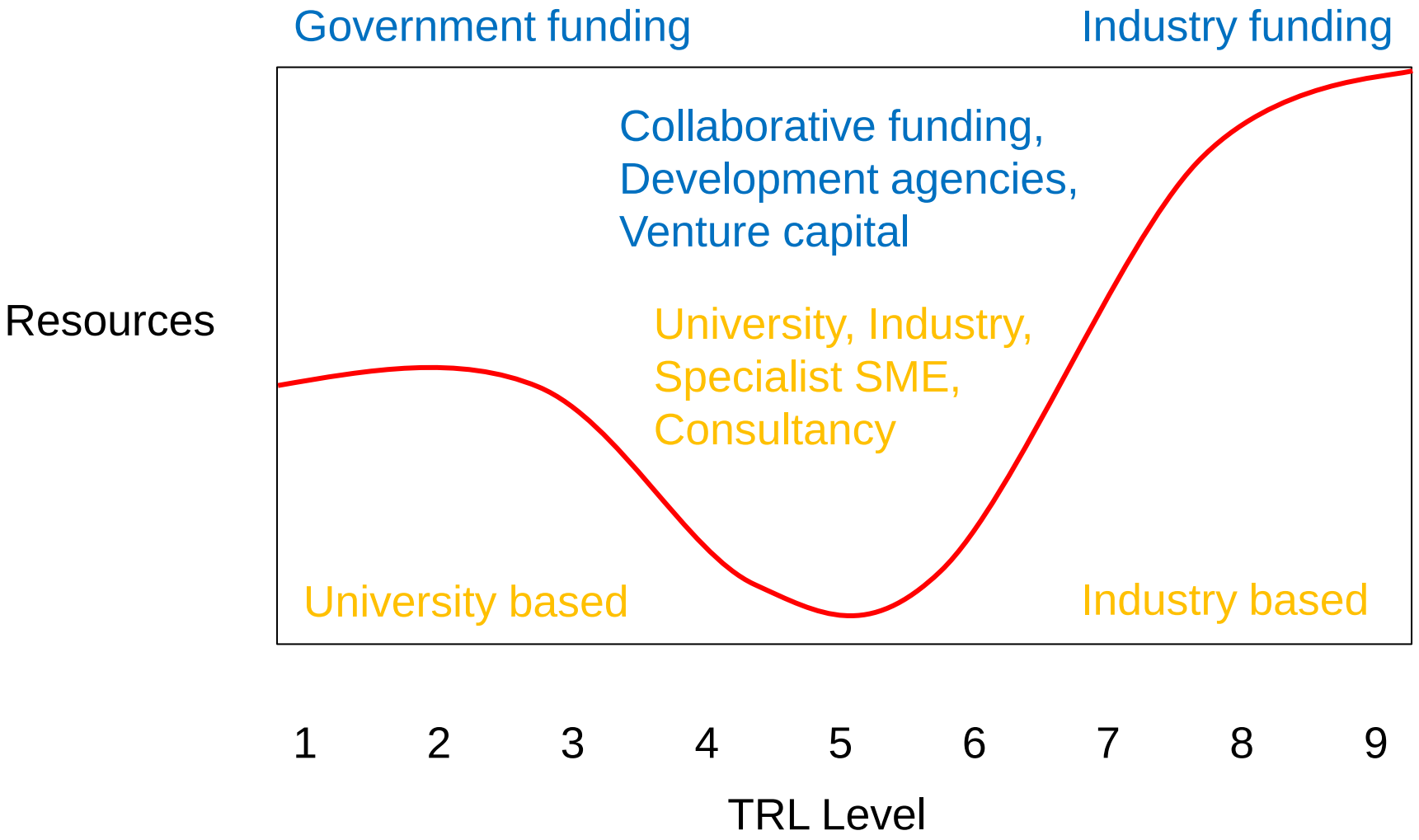
Technology Readiness Levels can be used in conjunction with a Technology Strategy Road Map. A road map is similar to a GANTT chart and TRLs are used in a similar fashion to milestones

TRL



Specialist software available

The ‘valley of death’ is an often observed feature during the development of an innovation. It is so called because a great many innovations do not progress beyond this point.



Summary

- Different levels of research
- Funding comes from different resources, success criteria are different

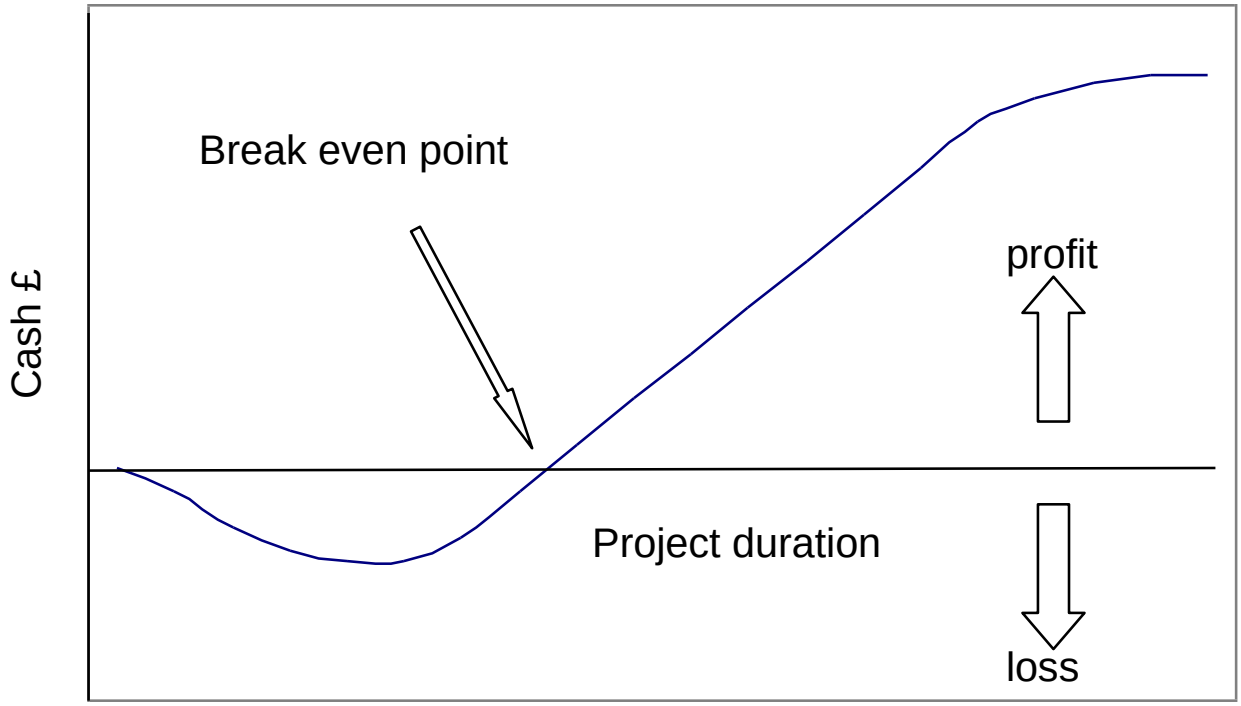
	BASIC RESEARCH	APPLIED RESEARCH	PROD DEV AND DESIGN
Clarity of objectives	low	medium	High
Probability of technical success	20%	50%	>90%
Relative cost	1	5 - 20	10 - 100
Optimum staff	Thinly spread over many interests	Focussed but versatile team	Highly focussed

The cost of innovation

Innovation comes at a cost

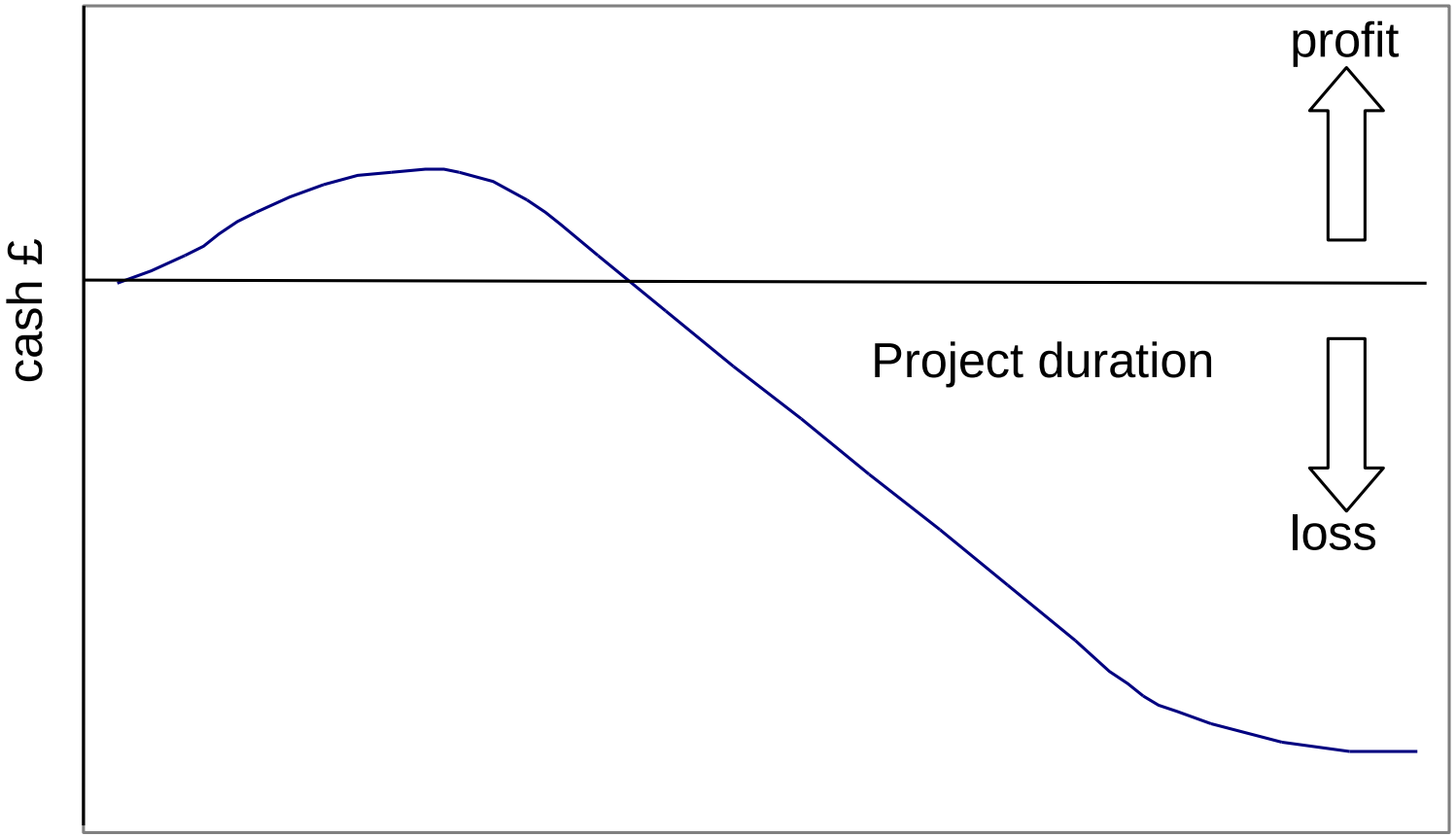
- The financial cost of innovation projects can be assessed like other projects

- Where the innovation is close to market, the returns to innovation can be assessed as a positive cash flow



The consequences of no innovation

- Non-innovation is generally seen to erode profitability in the long term

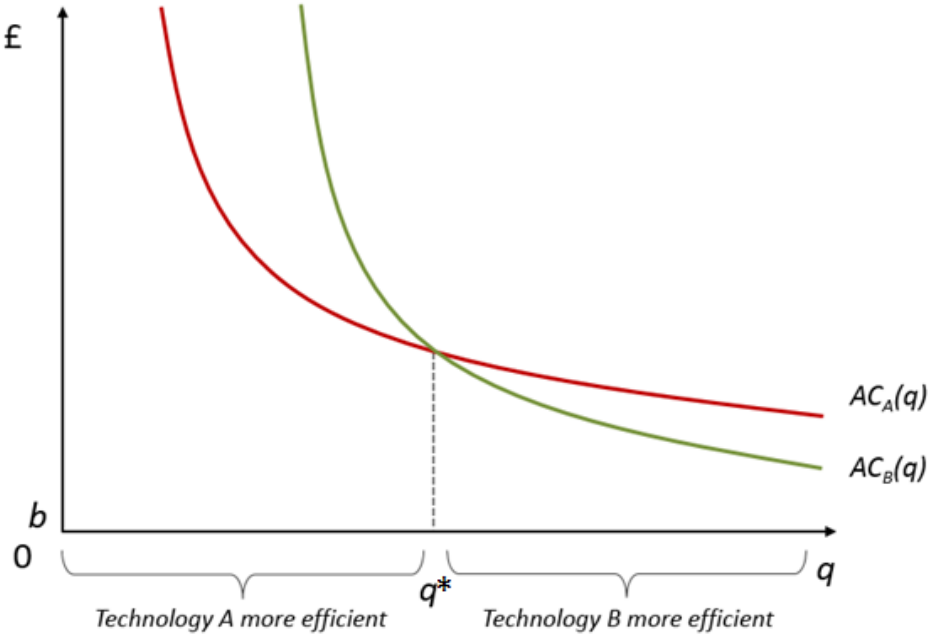


An average cost perspective on innovation

- Useful, for example in manufacturing
- Remember the concept of average cost (AC):

$$AC(q) = \frac{TC(q)}{q}$$

- This can be used to compare the average cost functions of a new technology and an old technology to identify breakeven



Effect of the level of activity on AC

- For new technologies it will be interesting to explore the impact on the AC at different levels of activity
- Can be used to justify the development of a new technology
- Can be investigated by calculating the marginal cost function, which is the derivative of the AC function
- In the linear case:

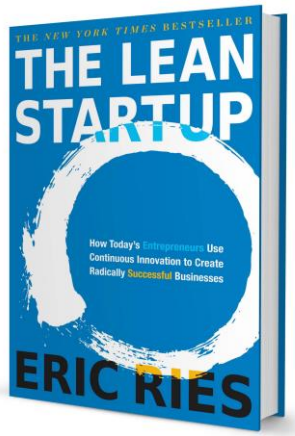
$$AC(q) = \frac{a + bq}{q} = aq^{-1} + b$$

$$AC'(q) = -\frac{a}{q^2} = -aq^{-2}$$

A modern approach to the commercial innovation process

Lean Startup

A new technique that has been very influential in the was businesses innovate is the “Lean Startup”, also known as “Customer Development”

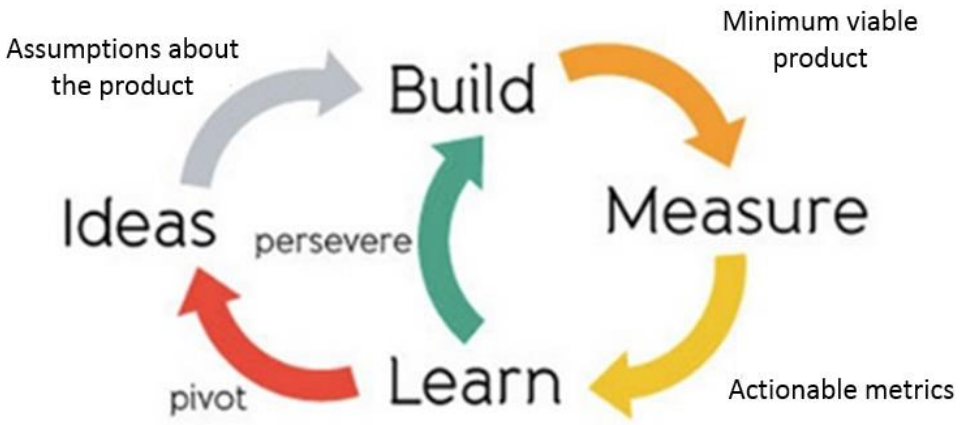


- We’ve seen that innovation is risky
- Lean Startup tries to de-risk this as far as possible
- Tries to obtain as much real customer data as early as possible
- Tries to avoid bringing to market fully developed products with big sunk costs
- Analogy: “Launching a rocket” vs “driving a car”

The Lean Startup process

This means frequently changing the products when new things have been learnt

- “Persevere or pivot” decisions faced in the innovation process



- In Lean Startup, the first product brought to market will not be fully developed

→ This is known as a “Minimum Viable Product”

Protecting innovation

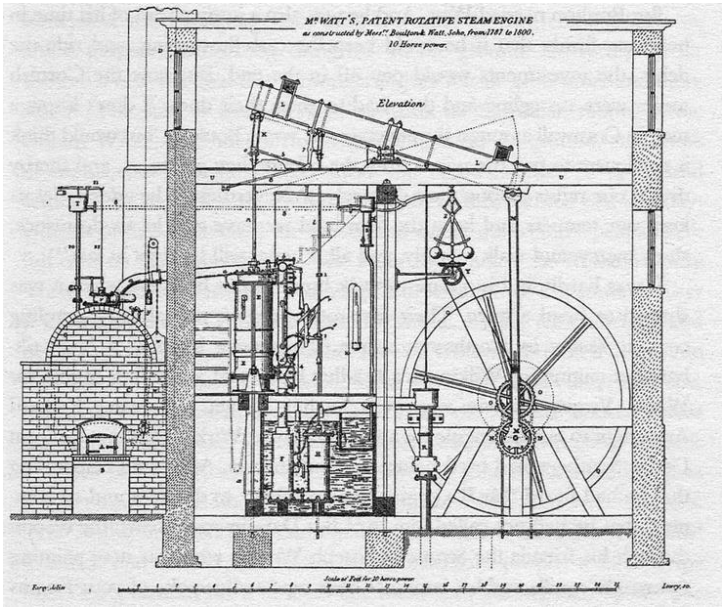
Intellectual Property (IP) rights can be used to protect specific innovations

IP rights are assigned to the creators of innovations by law and are designed to grant a monopoly over the invention.

- Designed to reward the innovator
- Normally IP is granted for limited amount of time
- Are very important for economic growth
- There are different types of IP which apply to different things

- **Note that the protection through IP doesn't mean that an innovation can't be stolen!**

Patents



To be patented, an invention must satisfy the following conditions:

- Be new and original.
- Involve an inventive step.
- Be capable of industrial application.
- Not be excluded. An invention cannot be patented if it is:
  - a discovery - Newton could not patent gravity
  - a scientific theory or mathematical method
  - an aesthetic creation such as a literary, dramatic or artistic work
  - a scheme or method for performing a mental act, playing a game or doing business
  - the presentation of information, or a computer programme

Patents – a word of warning

Patenting of ideas sounds like a great idea to obtain financial gain from an idea.

But be aware:

- The patenting process is expensive and can easily cost over £100,000 for patent with extensive geographic coverage
- A patent may not be granted after significant expenses
- The patenting process usually requires patent lawyers
- Sometimes defending a patent is so expensive that the owners of the IP will not decide to do so (e.g. universities)

Problems with Patenting

- Patent Disclosure – unintentional disclosure can invalidate a patent.
- Lack of Detail and Inaccurate Descriptions – this can have all sorts of unintended impacts.
- Patents Are Published! You cannot hide the details of your invention.

Protection of Patent IP in Collaborations

Competitors often wish to collaborate in the low TRLs of developing an innovation in order to reduce costs and maximise resources. In these instances it is very important to protect IP.

- Background knowledge/IP is relevant to a collaborative project that is supplied by the partners **at the start of the project**.
- Foreground knowledge/IP is produced within the collaborative project **during the project**'s duration.
- A Collaboration Agreement is normally drawn up at the start of the project listing all of the Background being provided by each partner and describing how the foreground will be distributed.

Registered Designs

To be eligible for registration, a design must:

- Be new at the date of registration. It must not have been previously published or disclosed in any way whatsoever.
- Be materially different and distinctive in shape pattern or ornament when compared with an earlier design.
- Be registered as a specific type of article, e.g. toy car, kettle, vacuum cleaner etc.

Registered Designs

Items that are excluded from registration include:

- Sculptures
- Wall plaques
- Printed matter such as book covers, dressmaking patterns and greeting cards.
  → In these cases other legal provisions exist for their protection.
- Designs concerned with how an article functions - such as a cutaway jet engine

Copyright

Regardless of patent or registration, any novel work is automatically covered by the laws of copyright.

- Literary works
- Dramatic, musical and artistic works
- Published editions
- Sound recordings
- Films
- Broadcasts
- Computer programs

Trade secrets

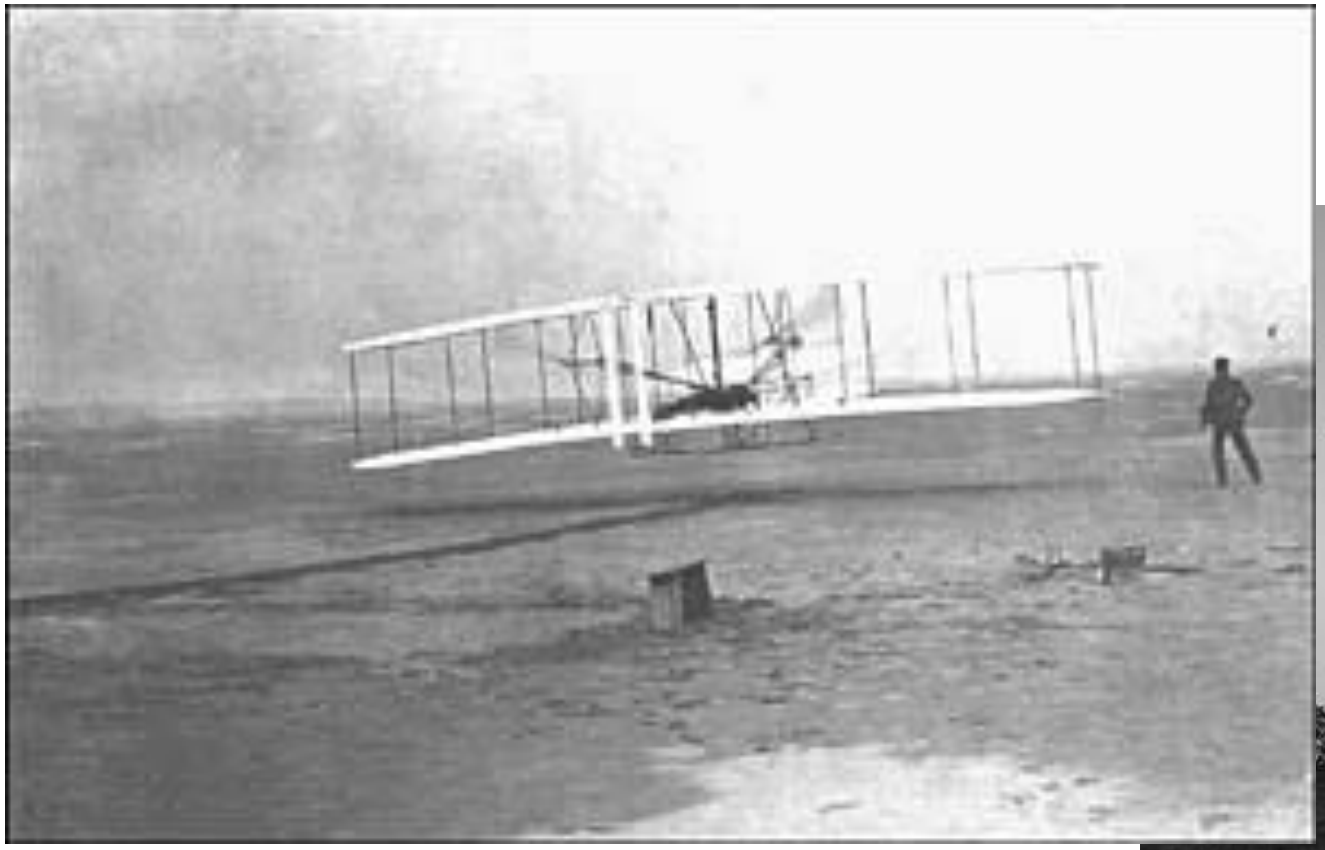
Intellectual property can be protected by keeping it secret providing a competitive advantage to the owner.

One way of ensuring that Trade Secrets are kept is through the use of non-disclosure agreements or contracts.

Exercise protect these innovations?

- A novel method of recovering waste heat from land fill?
- A photograph of a famous person?
- A recipe for mushy peas?
- Lego (when it first came out)?
- Plastic figurines based on the latest anime?
- An algorithm to predict the winner of the Eurovision Song Contest.
- Shoes of a particular colour?
- A published knitting pattern?

Some examples:



Wright brothers were unable to get a patent for the aeroplane, but did manage to patent their control system

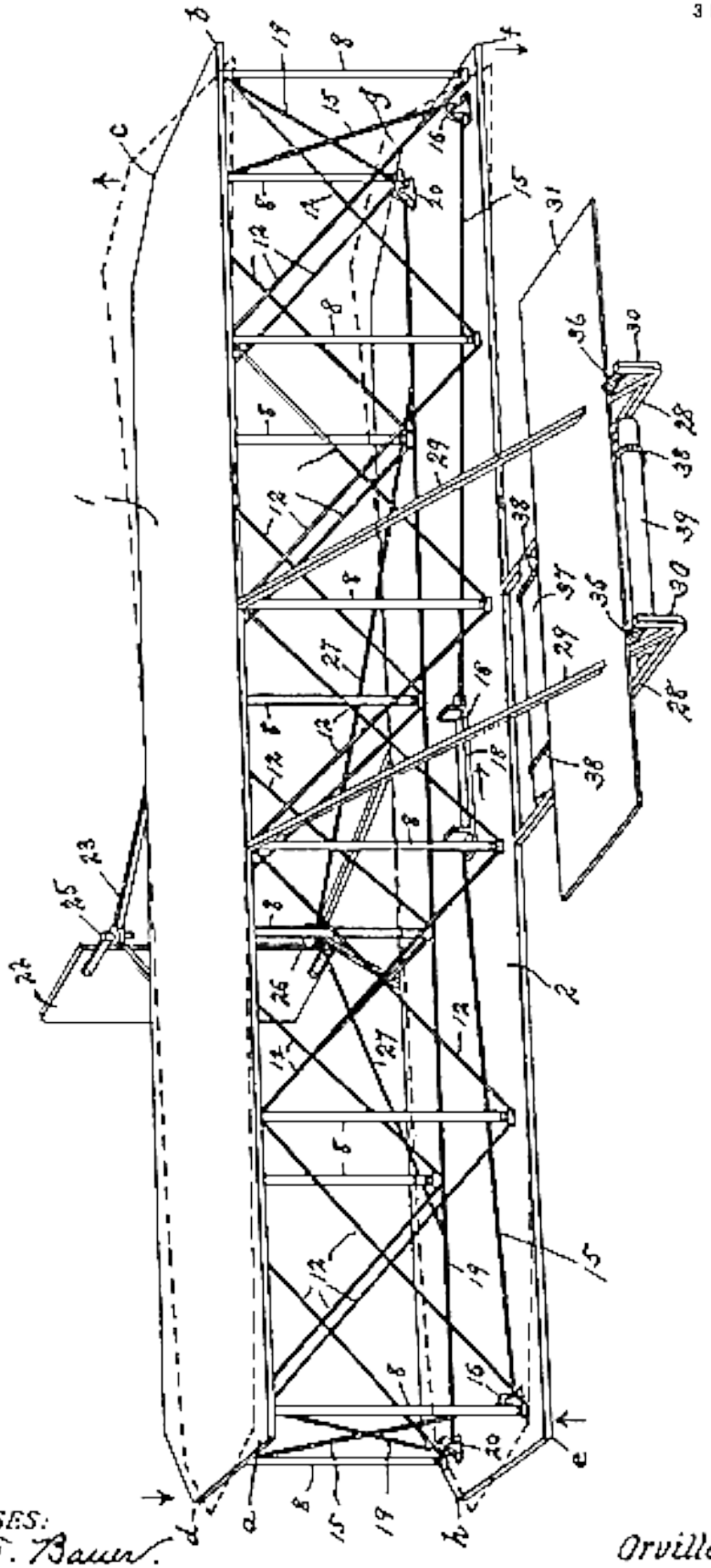


FIG. 1.

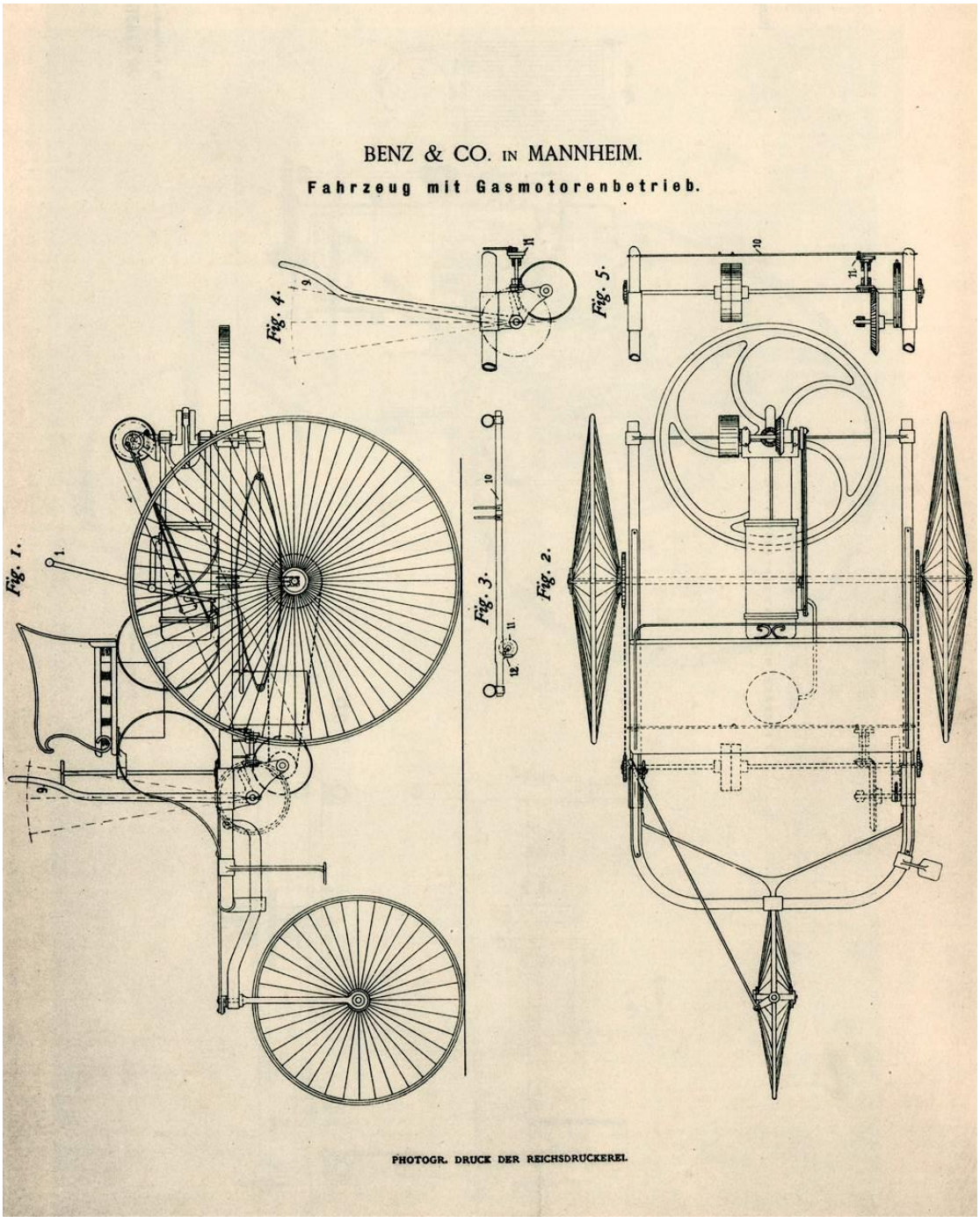
WITNESSES:
William F. Bauer.
Irvine Miller.

INVENTORS.
Orville Wright.
Wilbur Wright.
BY
H. A. Toulmin.
ATTORNEY.

Benz 1886 - Did get patent, not a motorised carriage but an integral design of motor car

BENZ & CO. IN MANNHEIM.

Fahrzeug mit Gasmotorenbetrieb.



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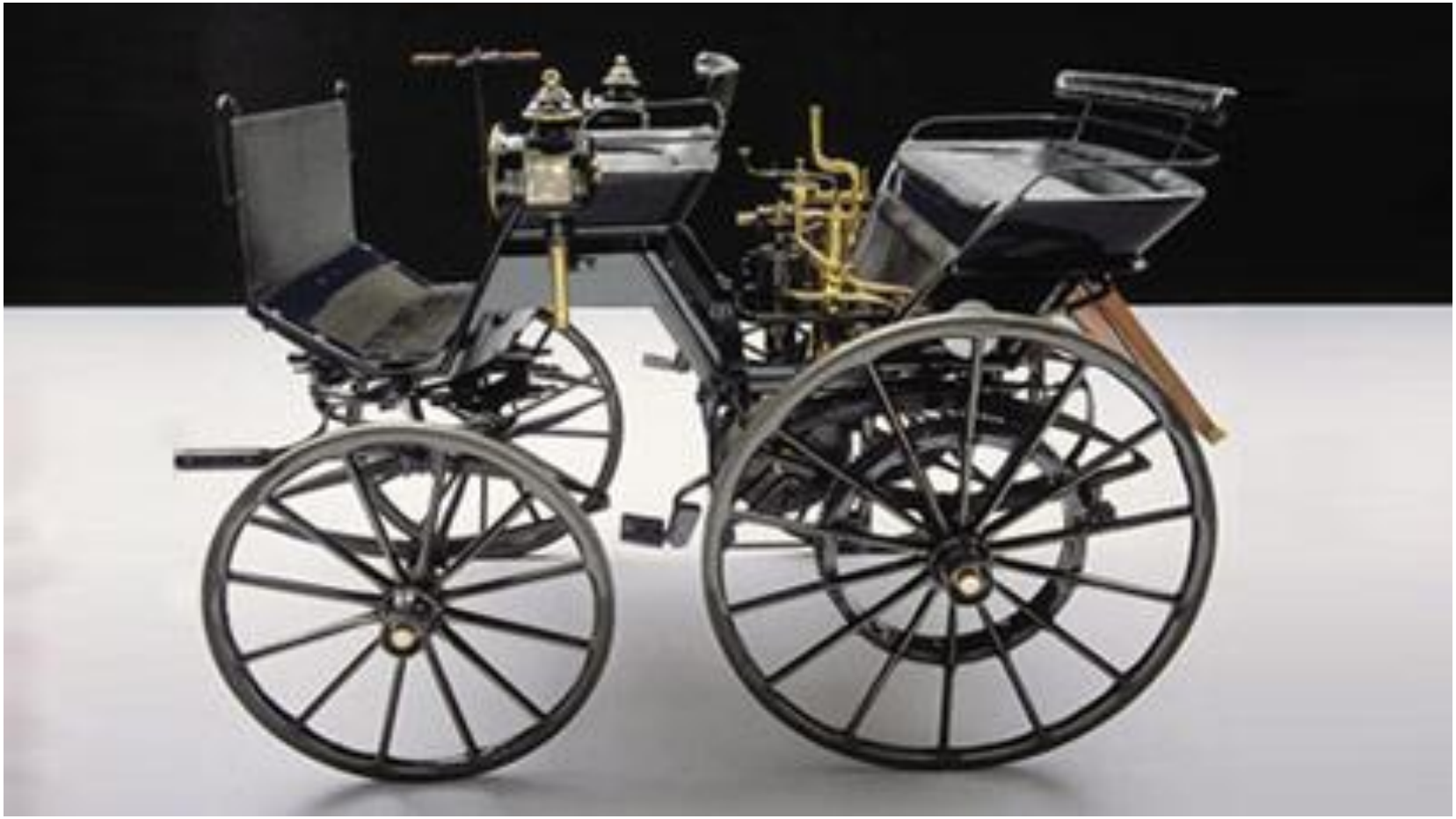


Daimler 1886, did not get patent as it was deemed a motorised carriage

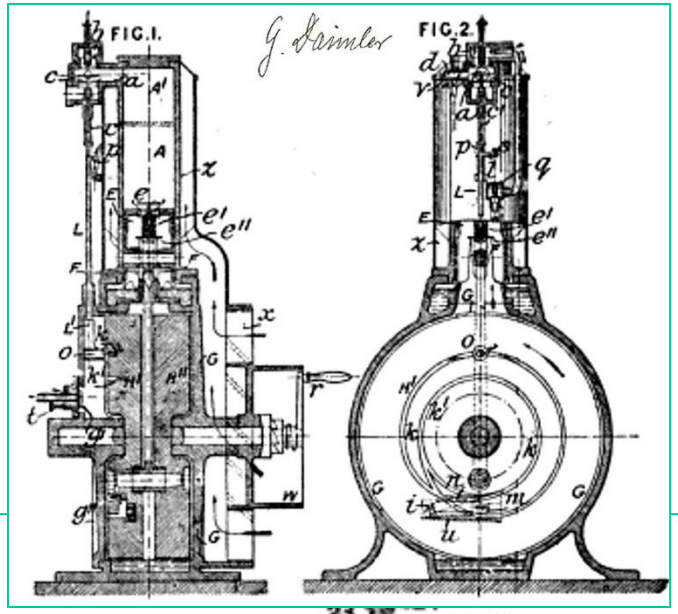


FIG. 1.
G. Daimler
FIG. 2.

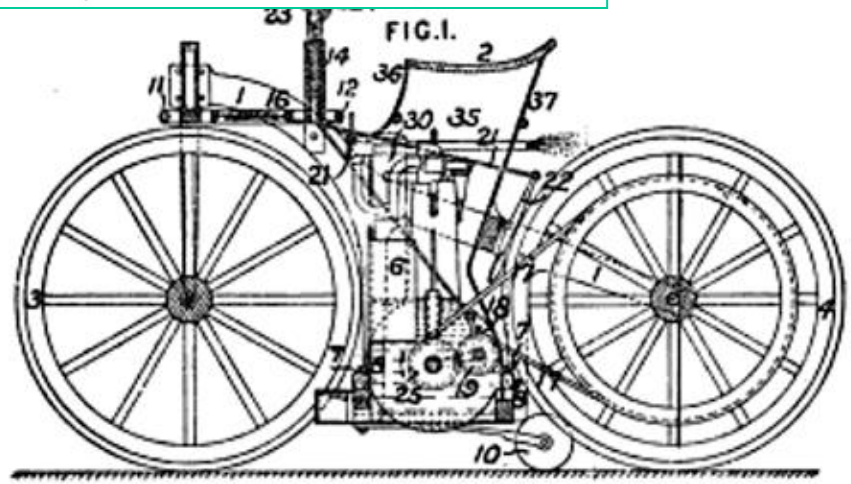
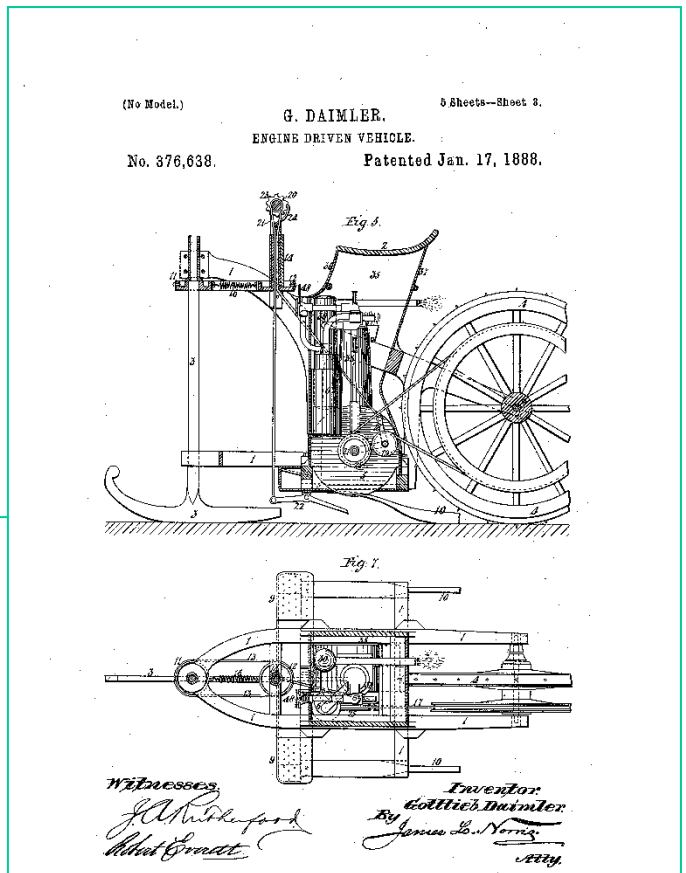


FIG. 1.


(No Model.)
5 Sheets—Sheet 3.
G. DAIMLER.
ENGINE DRIVEN VEHICLE.
No. 376,638.
Patented Jan. 17, 1888.
Fig. 5.
Fig. 7.
Witnesses.
Albert Everett
Inventor.
Gottlieb Daimler
By James L. Norris
Atty.

Learning outcomes

Have been introduced to the Management of Innovations

- We understand what the motivation for innovation is
- Understand the basis and phases of innovation
- Understand the cost of innovation projects
- Have been introduced to Lean Startup
- Able to name the main types of IP available to protect an innovation

Any questions?

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