SEEE
School of Electrical & Electronic Engineering

Introduction to Electronics and Telecommunication Engineering -

Chapter 1: What is Engineering?

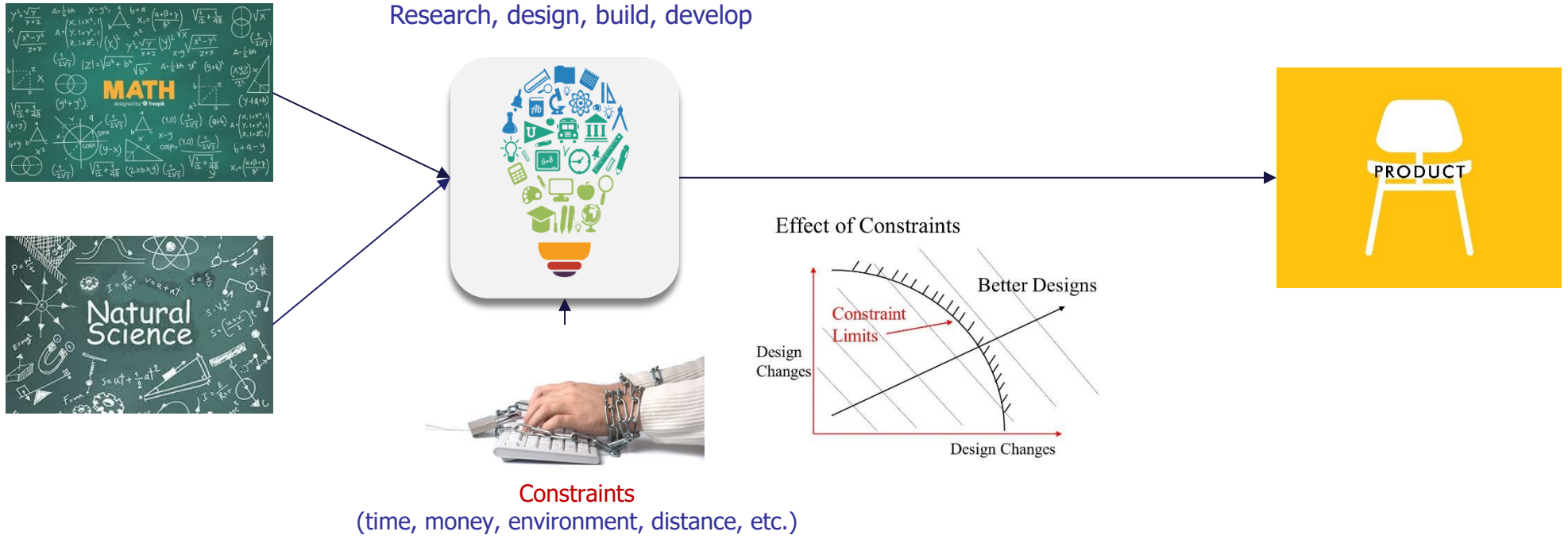
Contents

- What is engineering?
- Who is an engineer? What do engineers do?
- Engineering problem solving
- Types of engineers

What is engineering?

- Definition by The Accreditation Board for Engineering and Technology (ABET)
  - "The profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind"

→ Engineering is problem solving under certain constraints to build useful products/services



What is engineering?

Engineering /ˌen·dʒəˈnɪər·ɪŋ/ : **the study of using scientific principles to design and build machines, structures, and other things, including bridges, roads, vehicles, and buildings.**

=> Kỹ thuật: nghiên cứu sử dụng các nguyên lý khoa học để thiết kế và chế tạo máy móc, kết cấu và những thứ khác, bao gồm cầu, đường, xe cộ và tòa nhà.

The work of an engineer, for example, designing or building machines, electrical equipment, roads, etc. using scientific principles.

=> Công việc của một kỹ sư, ví dụ, thiết kế hoặc chế tạo máy móc, thiết bị điện, đường sá, v.v. bằng cách sử dụng các nguyên lý khoa học

Source: https://dictionary.cambridge.org/

What is engineering?

The future is built largely by engineers and designers with the talent and skill to take an idea and turn it into the products and services that enhance life for all of us.

https://www.engineering.com/

From Software Development to Software Engineering

By applying engineering principles and frameworks to development, software engineering focuses on reusing, refining and repeating what has already been developed in order to make it faster and more efficient. A transition from coding to maintaining and integrating large, complex systems is the future of software.

https://www.cognizant.com/

Engineering hay còn gọi là ngành kỹ thuật, đây là một ngành học đòi hỏi người học phải ứng dụng các kiến thức về khoa học, kinh tế, xã hội kết hợp với thực tiễn để thiết kế, xây dựng, duy trì các thiết bị, hệ thống, cấu trúc, máy móc, vật liệu và quá trình. Nó bao gồm việc vận dụng sự hiểu biết của người học để tạo ra mô hình, thay đổi quy mô một giải pháp hợp lý cho một vấn đề.

https://studylink.org/vn/engineering-nganh-ki-thuat-la-gi-.html

What is an engineer?

The work of an engineer, for example, designing or building machines, electrical equipment, roads, etc. using scientific principles => Công việc của một kỹ sư, ví dụ, thiết kế hoặc chế tạo máy móc, thiết bị điện, đường sá, v.v. bằng cách sử dụng các nguyên lý khoa học

Source: https://dictionary.cambridge.org/

một kỹ sư thường cần những nhân tố gì?

Một, đặc điểm mà nghề nào cũng cần như tâm huyết với nghề, sự sáng tạo,...

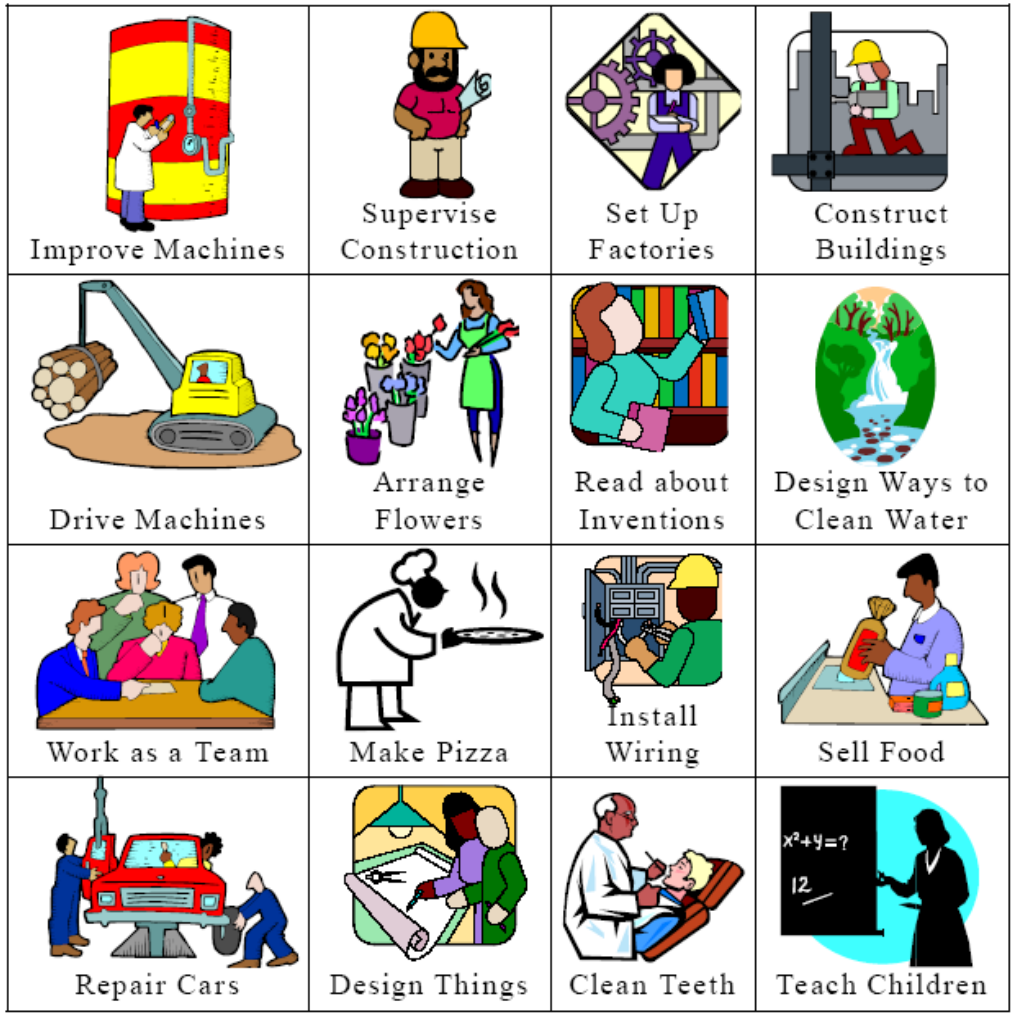
Hai, đặc điểm chuyên biệt cho ngành kỹ sư:

- Tư duy logic
- Có niềm yêu thích với khoa học, tính toán
- Khả năng lanh lẹ, thuần thục với các phép toán và con số

Source: https://studylink.org/vn/engineering-nganh-ki-thuat-la-gi-.html

Engineering Misconceptions

- What is an engineer?
  - What kind of work do engineers do?



Source: http://www.mos.org/eie/pdf/research/Pipeline_EiE_evaluation_0405_final.pdf

Engineering Misconception (*cont*…)

Plumber

Electrician

Carpenter

Auto mechanic

Train Operator

Building supervisor

Computer technician

Engineering Misconception (*cont*…)

Plumber

Electrician

Carpenter

Auto mechanic

Train Operator

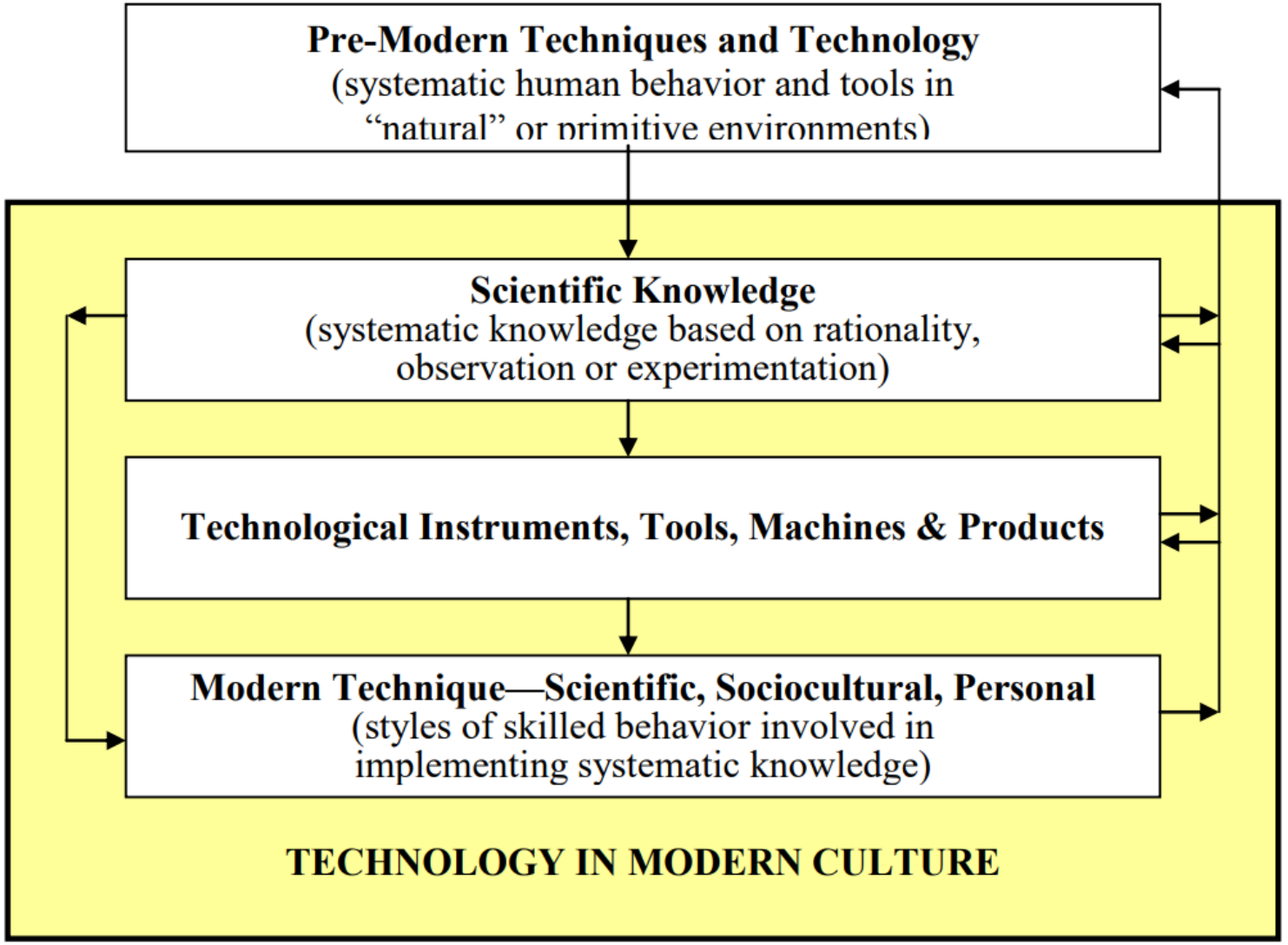
Building supervisor

Computer technician

Scientist – Engineer – Technologist – Technician/Artisan

- Scientist, engineer, technologist and technician play different roles in a technology team
- Science and scientist
  - Investigation, understanding, and discovery of nature, its composition, and its behavior (i.e., "laws of nature")
  - Ask why
  - Build to learn (experiments, tools etc.)
- Engineering and engineer
  - Manipulating the forces of nature to advance humanity
  - Ask how
  - Learn to build (products and services useful for humans)

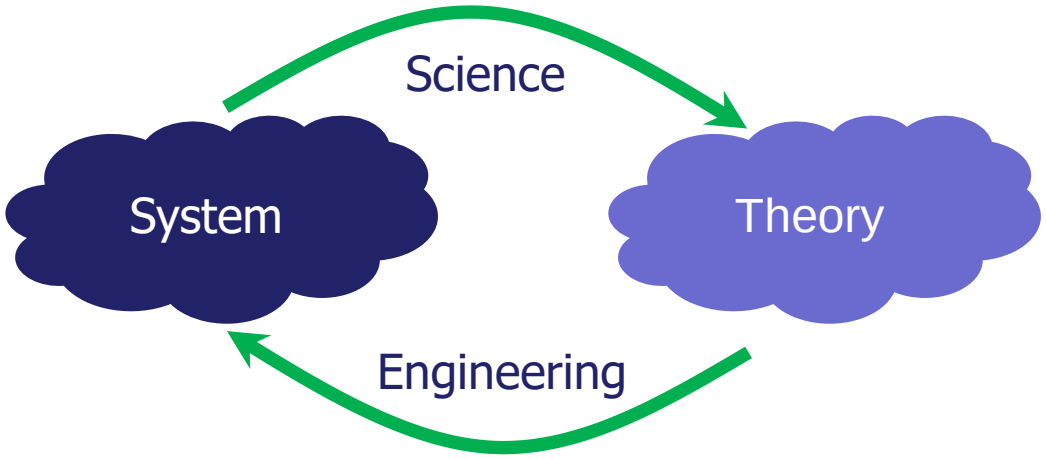
Scientist – Engineer – Technologist – Technician/Artisan

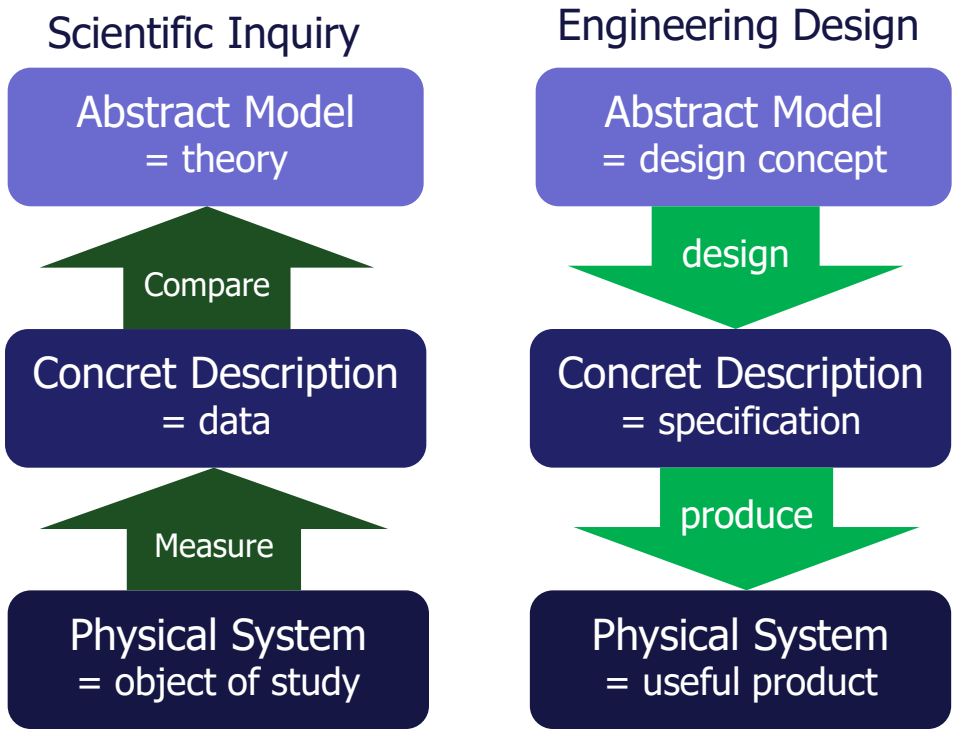


Source: http://tojet.net/articles/v11i2/11222.pdf

Scientist – Engineer – Technologist – Technician/Artisan (*cont*...)

Science vs. Engineering





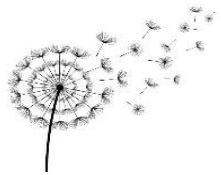
Scientist – Engineer – Technologist – Technician/Artisan (*cont*…)

- Technologist
  - Focusing on direct application of established engineering principles and processes
  - Less theory based
  - Technology is the outcome of engineering
- Technician/artisan
  - Skilled workers in a field of technology who is proficient in the relevant skill and technique, with a relatively practical understanding of the theoretical principles

Which of these are the examples of technology?


Shoes


Subway


Dandelion


Cellular

Oak tree


Bridge


Cup

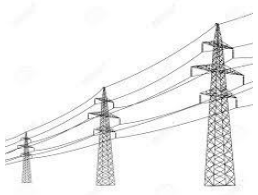

Factory


Bird


TV


Bandage


House


Power lines


Lightning

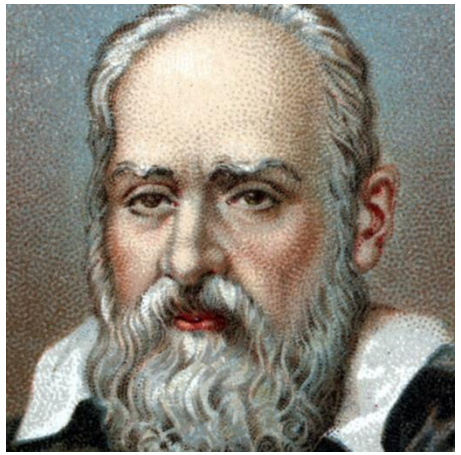

Bicycle


Book

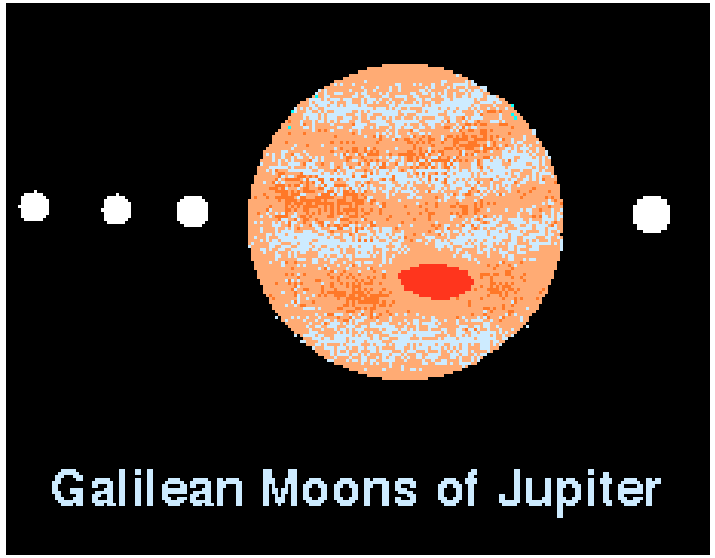
Technology is the product of transferring scientific knowledge to practical use

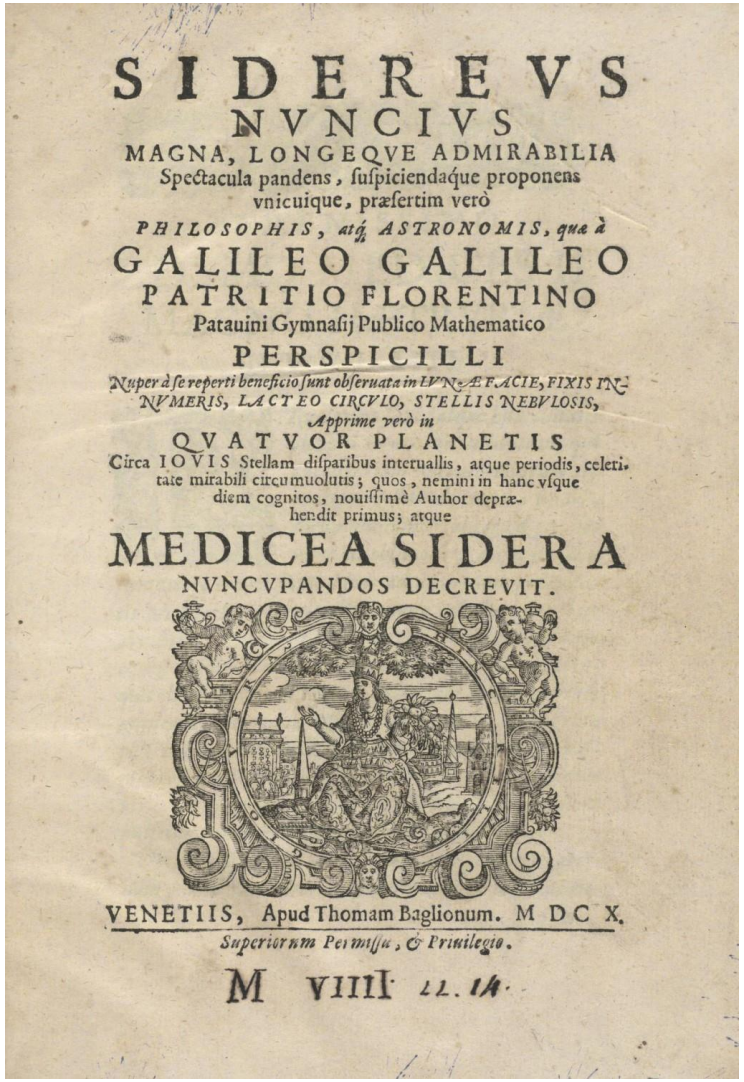
https://www.indeed.com/career-advice/finding-a-job/types-of-technology

Engineer vs. Scientist



Galileo Galilei
(1564-1642)





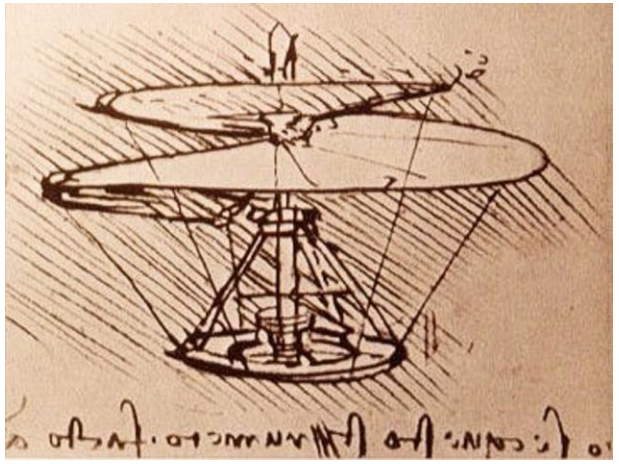
SIDEREVS
NVNCIVS
MAGNA, LONGEQVE ADMIRABILIA
Spectacula pandens, suspiciendaque proponens
vnicuique, præsertim verò
PHILOSOPHIS, atq; ASTRONOMIS, quæ à
GALILEO GALILEO
PATRITIO FLORENTINO
Patauini Gymnasij Publico Mathematico
PERSPICILLI
Nuper à se reperti beneficio sunt obseruata in LVNÆ FACIE, FIXIS IN-
NVMERIS, LACTEO CIRCVLO, STELLIS NEBVLOSIS,
Apprime verò in
QVATVOR PLANETIS
Circa IOVIS Stellam disparibus interuallis, atque periodis, celeri-
tate mirabili circumuolutis; quos, nemini in hanc vsque
diem cognitos, nouissimè Author depræ-
hendit primus; atque
MEDICEA SIDERA
NVNCVPANDOS DECREVIT.
VENETIIS, Apud Thomam Baglionum. M DC X.
Superiorum Permissu, & Priuilegio.
M VIIII ll. 14

The Starry Mesenger – Galieo's observations of the moon

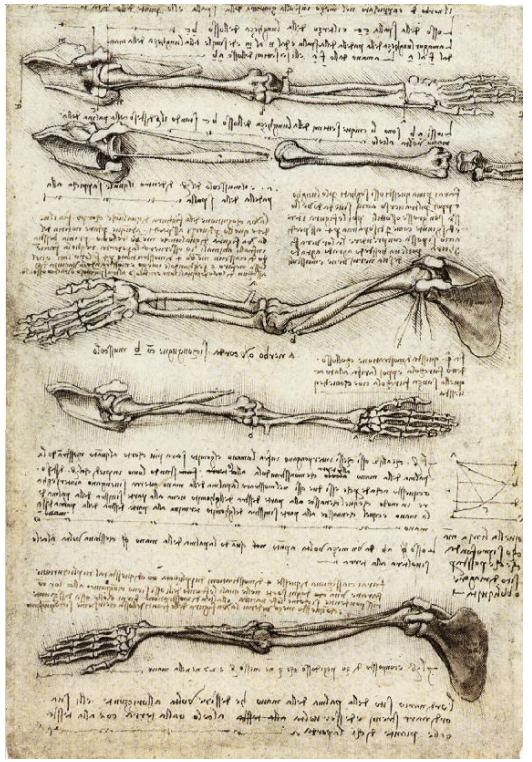
Engineer vs. Scientist (*cont*...)

Leonardo da Vinci (1452 - 1519)

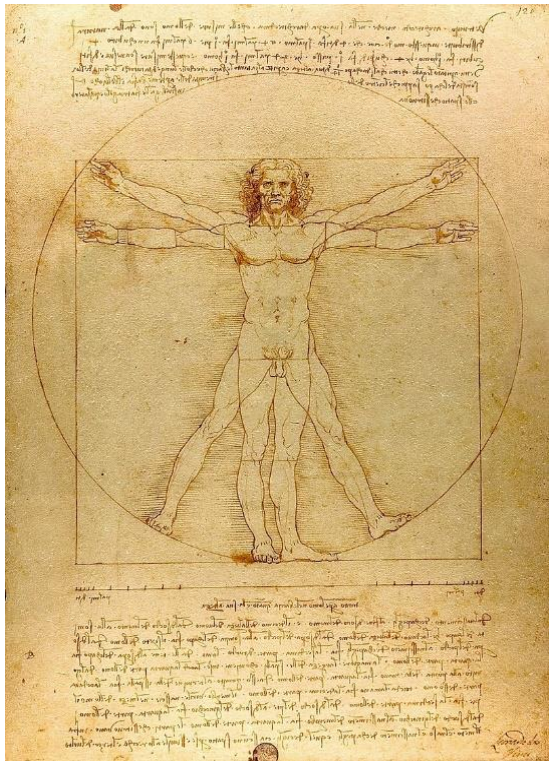
- wanted to fly, to paint, to make things



Helicopter



The study of arm's motion

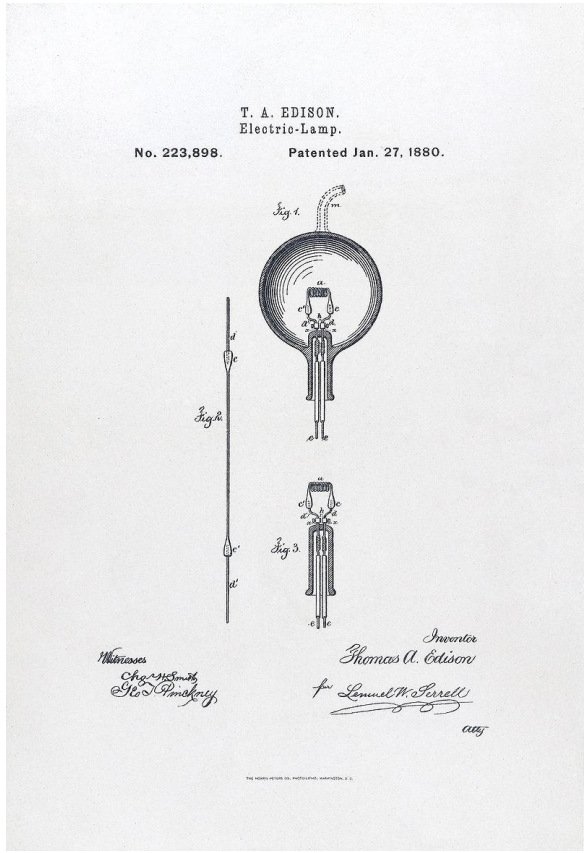


The Vitruvian Man
(or proportion of human body)

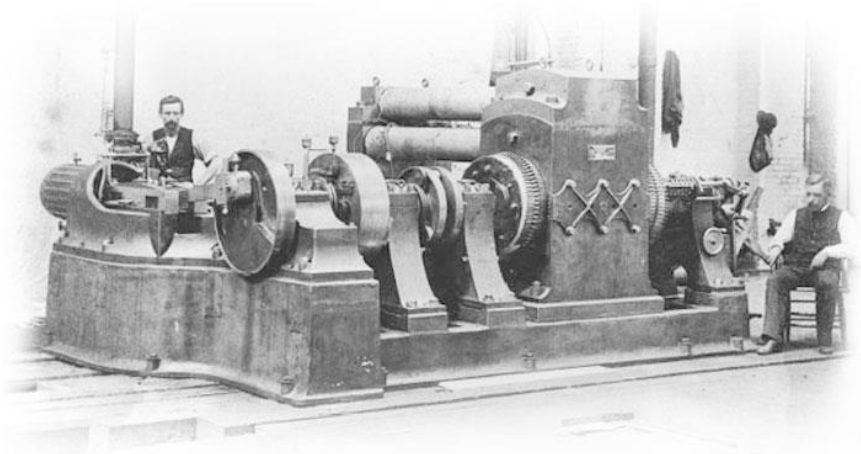
Engineer vs. Scientist (*cont*...)

Thomas Alva Edison
(1847 - 1931)

Phonograph (1899)

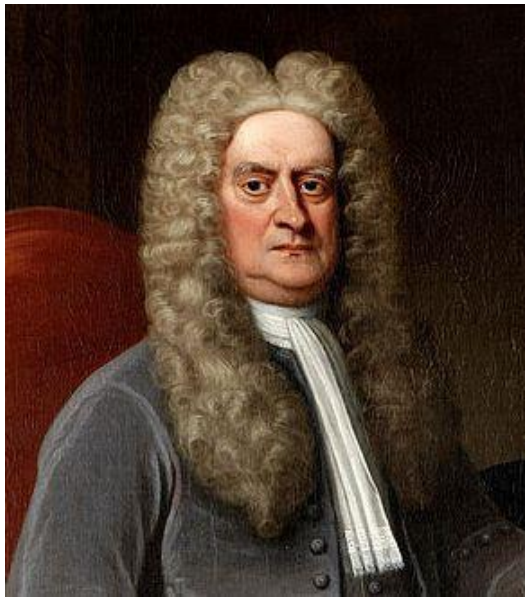


U.S. Patent#223898: Electric-Lamp.
January 27, 1880.

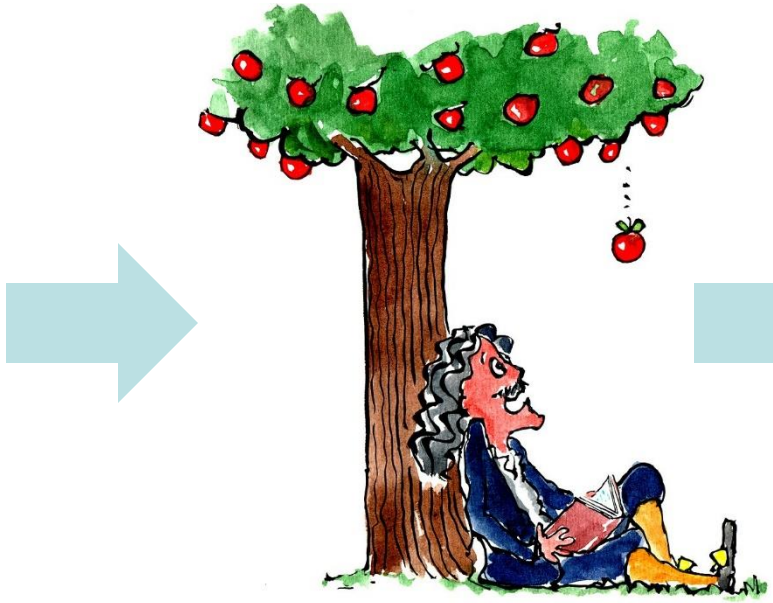


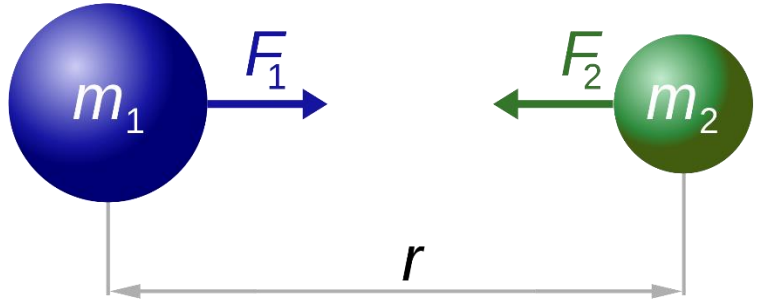
Edison's electric power station at 257 Pearl Street in New York City (1882)

Engineer vs. Scientist (*cont*...)



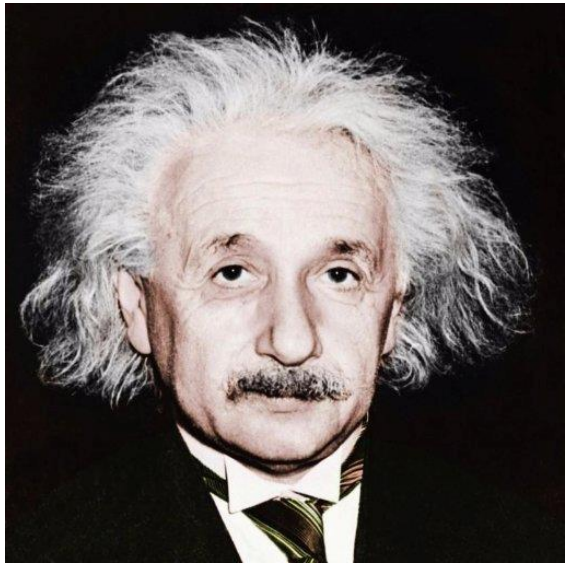
Sir Isaac Newton
(1642 - 1727)



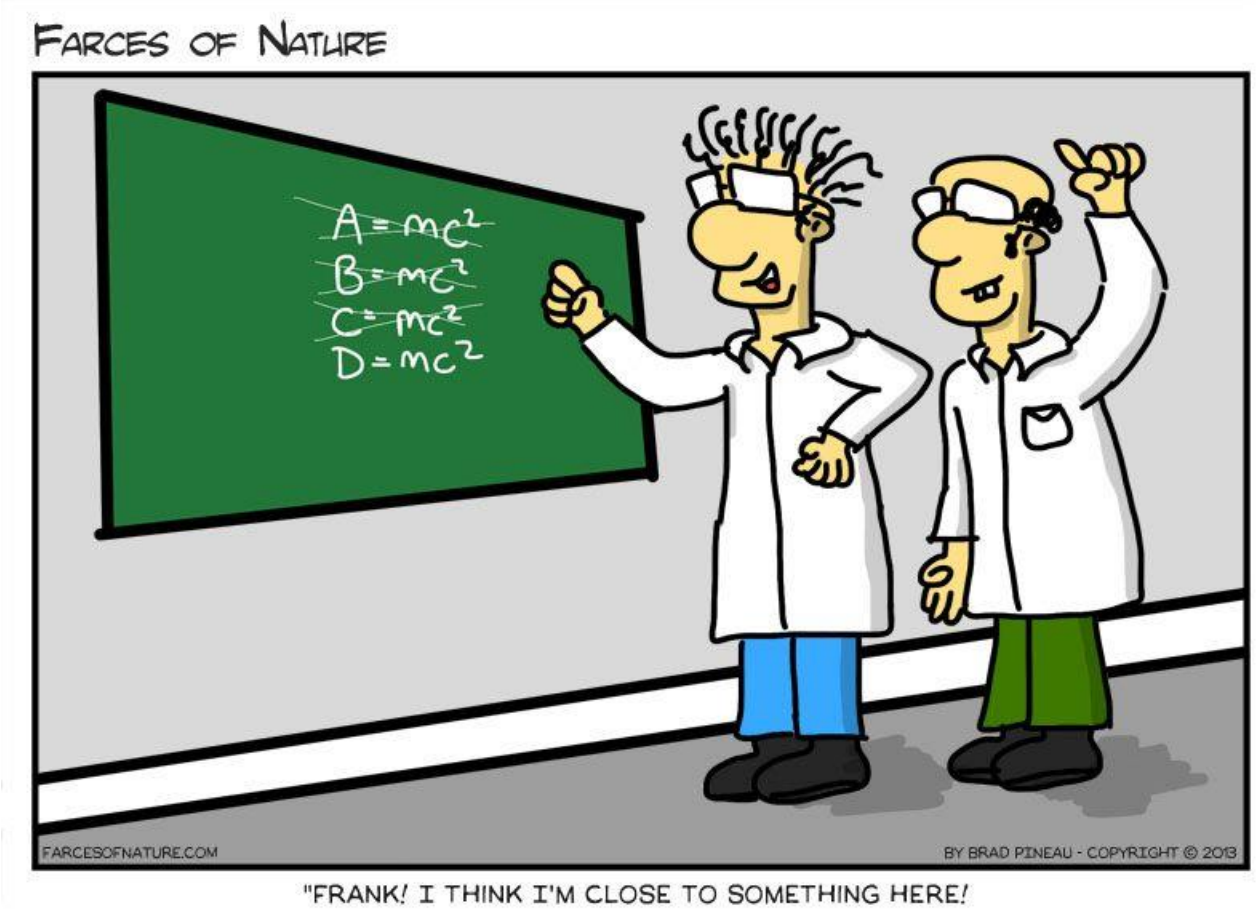


$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

Engineer vs. Scientist (*cont*...)

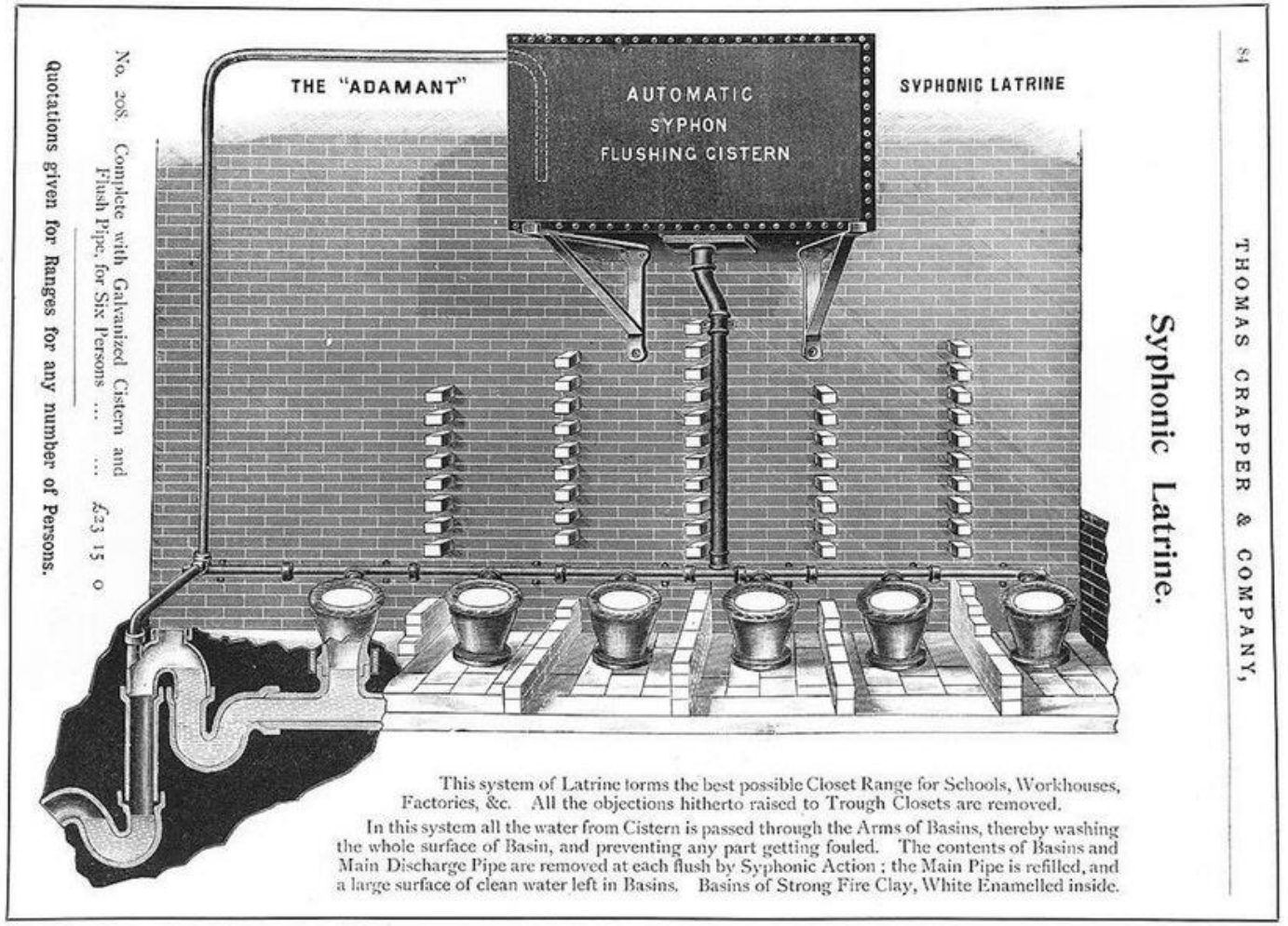


Albert Einstein
(1879 - 1955)



Engineer vs. Scientist (*cont*...)

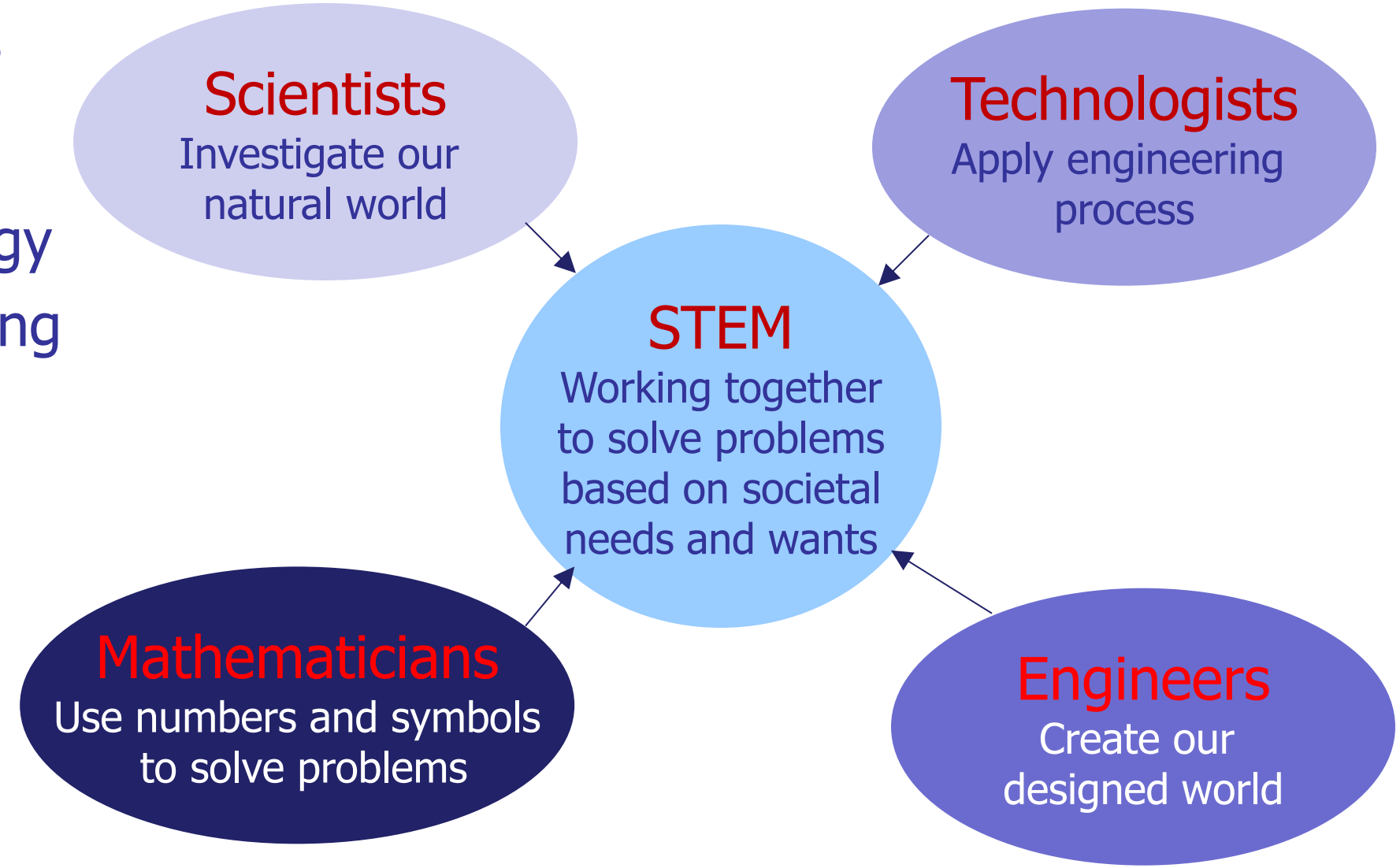
Sir Thomas Crapper
(1879 - 1955)



Crapper's toilet design (1902)

The Role of STEM in Engineering

- What is STEM?
  - **S** – Science
  - **T** – Technology
  - **E** – Engineering
  - **M** – Math



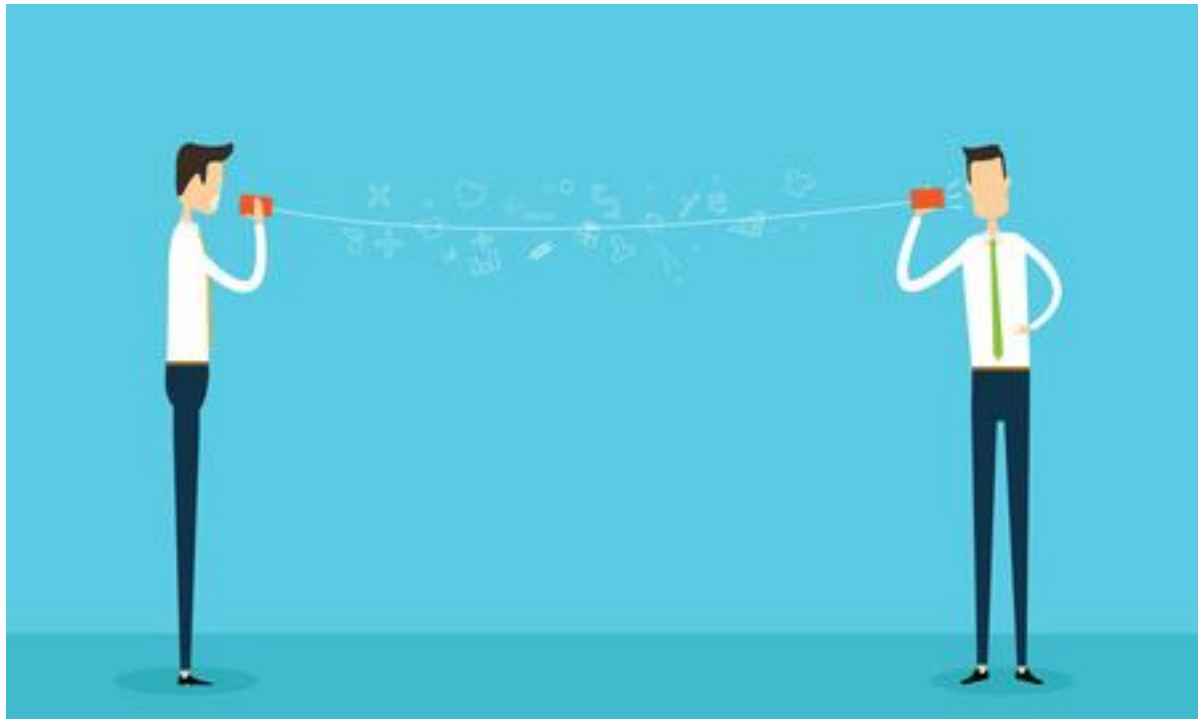
Problem Solving in Engineering

- Example:
  - Problem: design a system to transmit human voice in a distance
    - a) 10m
    - b) 100m
    - c) 30km

  → As an engineer, what should you do?

Problem Solving in Engineering (*cont*...)

- A) 10m
  - Is there any problem to transfer voice in a 10m free space environment?



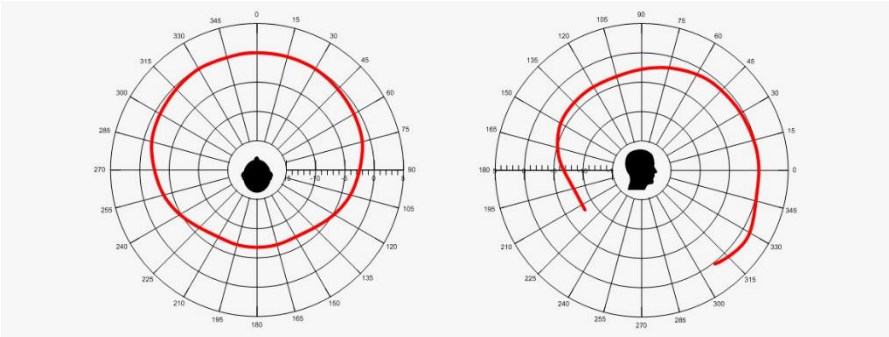
Problem Solving in Engineering (*cont*...)

- B) 100m
  - Problem:
    - ◇ Voice deteriorates significantly after 100m so that it is difficult to hear
  - Question:
    - ◇ Why voice deteriorates by distance?
    - ◇ Is this deterioration proportional to distance?
    - ◇ Which factors contribute to this deterioration?
      - E.g., distance, frequency, weather condition, terrain, etc.
    - ◇ How these factors contribute to this deterioration?
      - E.g., the energy of voice reduces by 2 after 50m; the energy of higher frequency can be transmitted 2 times farer etc.
    - ◇ Which factors contribute to the voice quality at the receiver?
      - E.g., noise level, etc.
    - ◇ How these factors contribute to the receiver's voice quality?
    - ◇ What is the minimum energy level of voice at the receiver that human can hear?

→ The more you ask, the more you understand the constraints and issues to be solved

Problem Solving in Engineering (*cont*...)

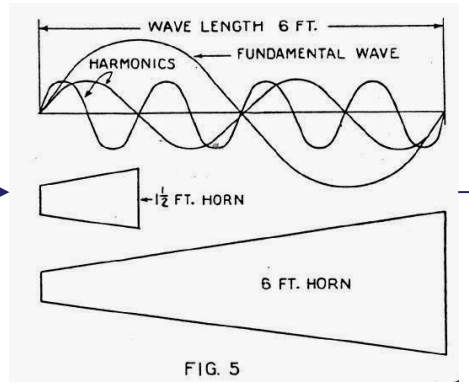
- B) 100m (*cont*...)
  - The next is to find solutions for these issues → system design
  - Then to implement the solutions in devices → system implementation



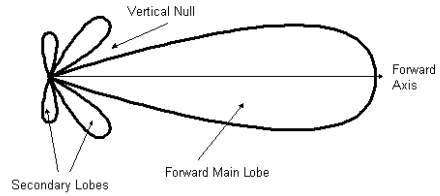
Sound pressure level (SPL) measurement

Understand the problem

Speaker design

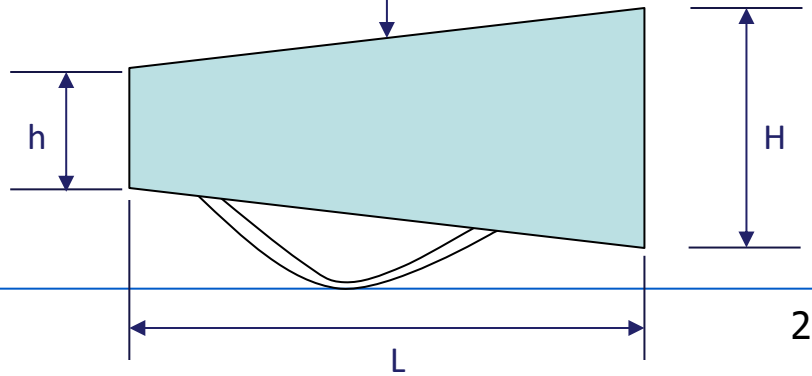


Speaker's directivity



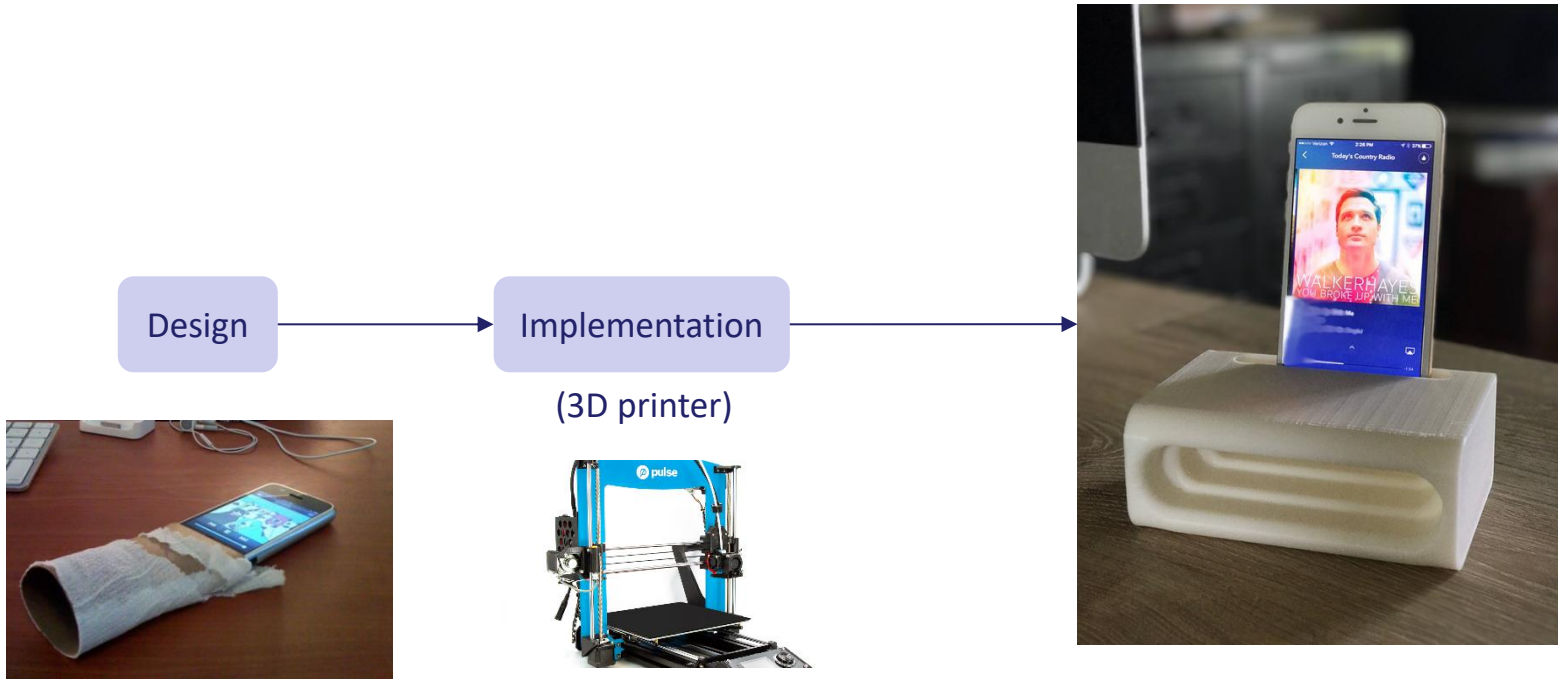
Design a system

System implementation



Problem Solving in Engineering (*cont*...)

- B) 100m
  - A slightly more advanced system

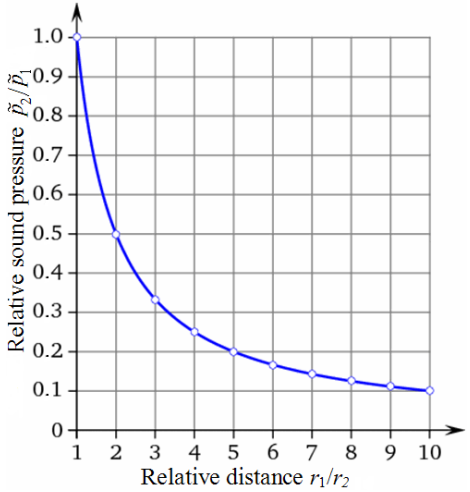


Problem Solving in Engineering (*cont*...)

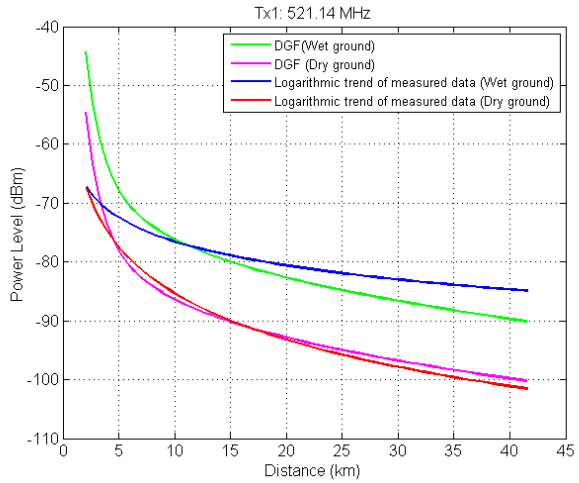
- C) 30km
  - Problem:
    - ◇Natural voice cannot be transmitted over a distance of 100km
  - Questions:
    - ◇ Why voice cannot be transmitted far?
    - ◇ Which medium is used? (e.g., air, copper cable)
    - ◇ Which signal is best suitable to a given environment?
    - ◇ What are the properties of these media when carrying signals? How do these media affect the quality of signal?
    - ◇ How to convert voice to that kind of signal?
    - ◇ How to recover voice at the receiver with best quality?

Problem Solving in Engineering (*cont*…)

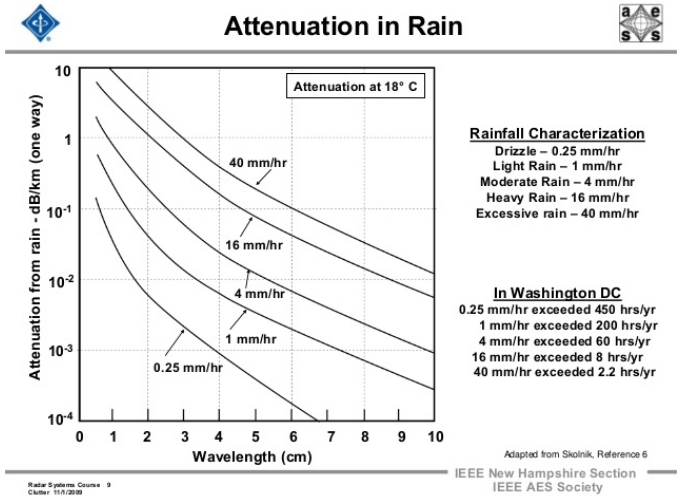
- C) 30km (*cont*…)



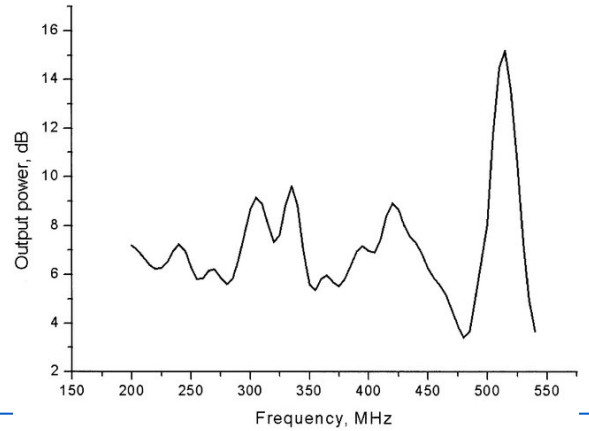
Voice attenuation in distance



Path loss for radio signals (~520MHz)



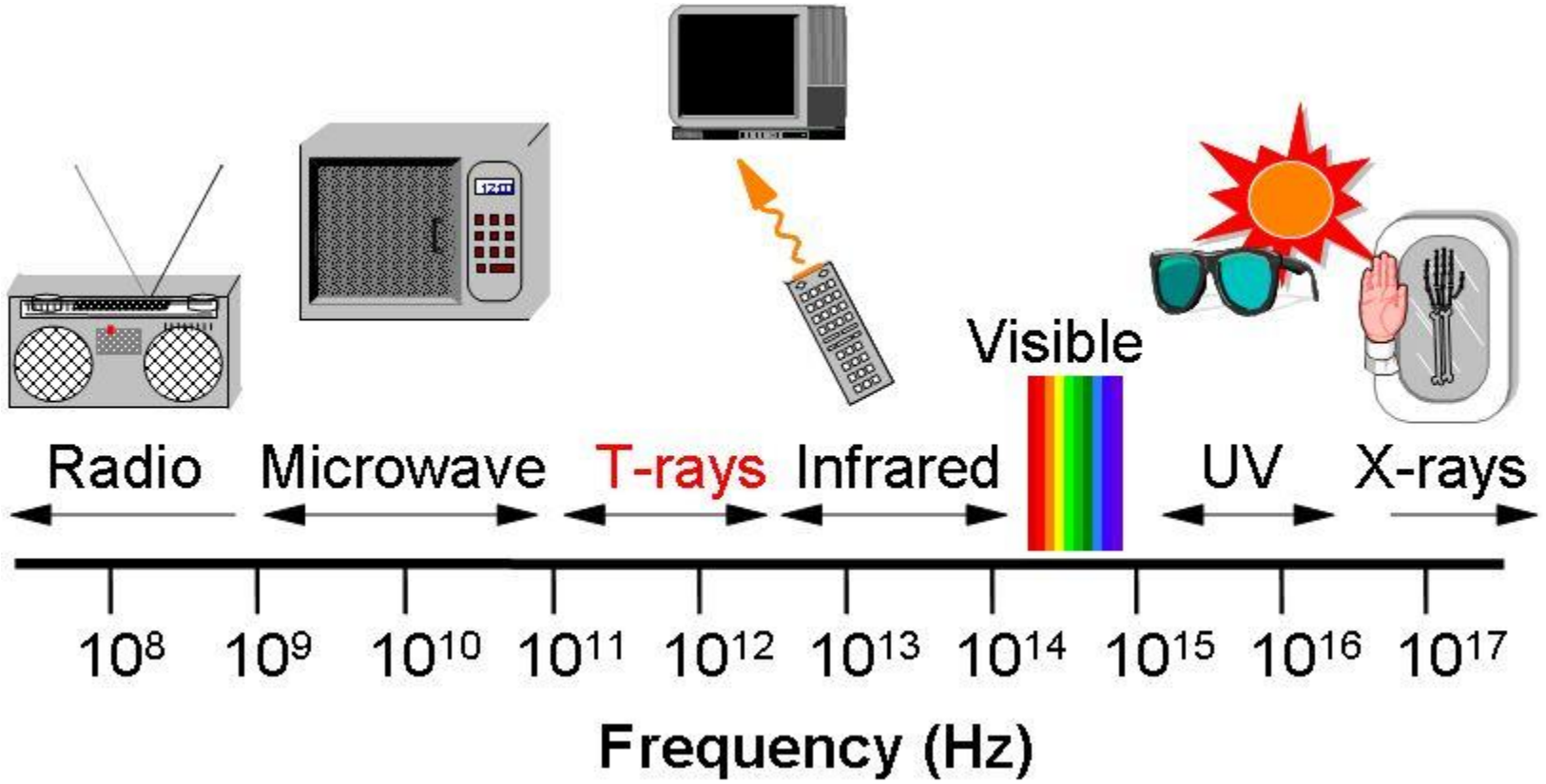
Attenuation under different weather conditions



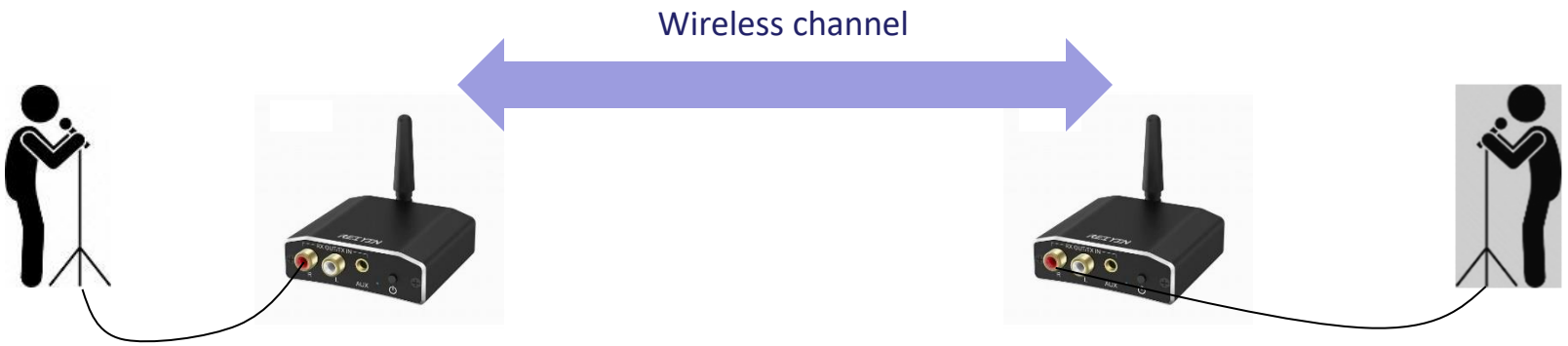
Frequency response

Problem Solving in Engineering (*cont*...)

- C) 30km (*cont*...)

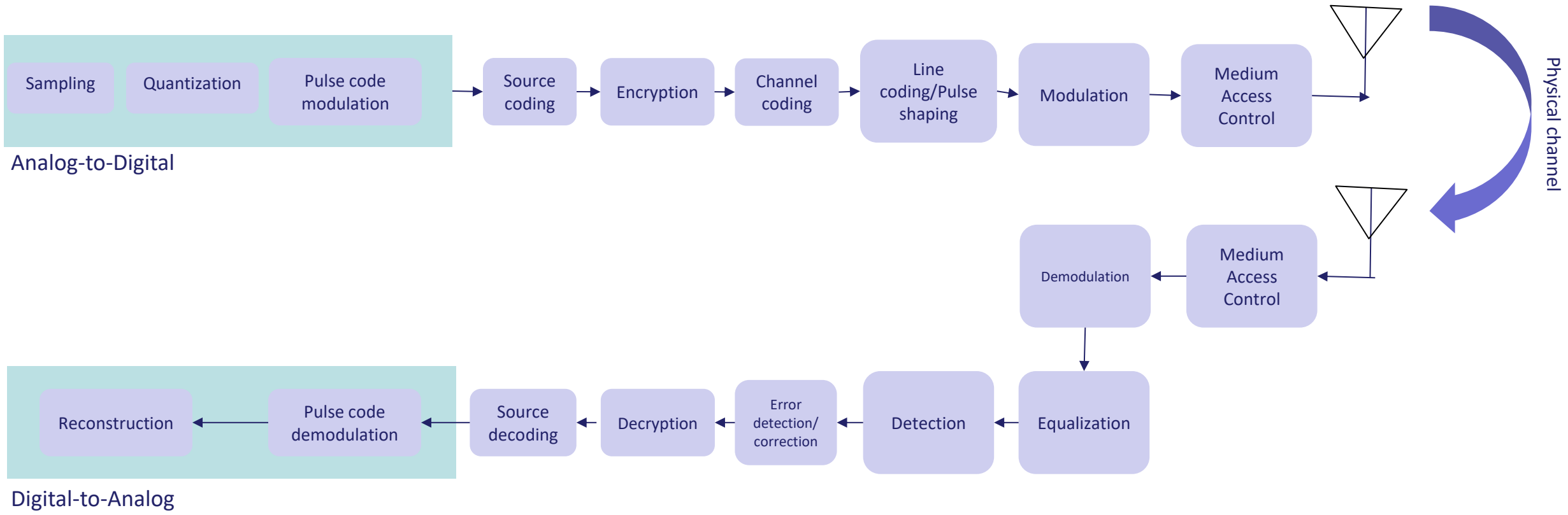


Problem Solving in Engineering (*cont*...)



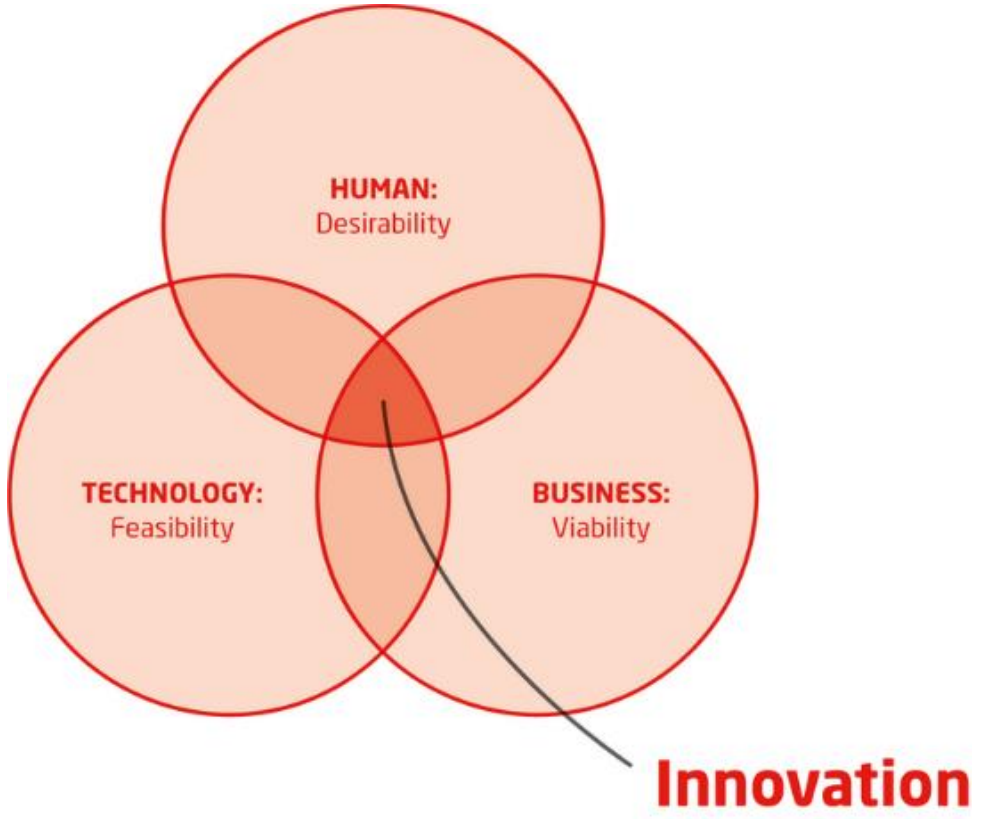
Problem Solving in Engineering (*cont*...)

- C) 30km (*cont*...)



Introduction to Design Thinking

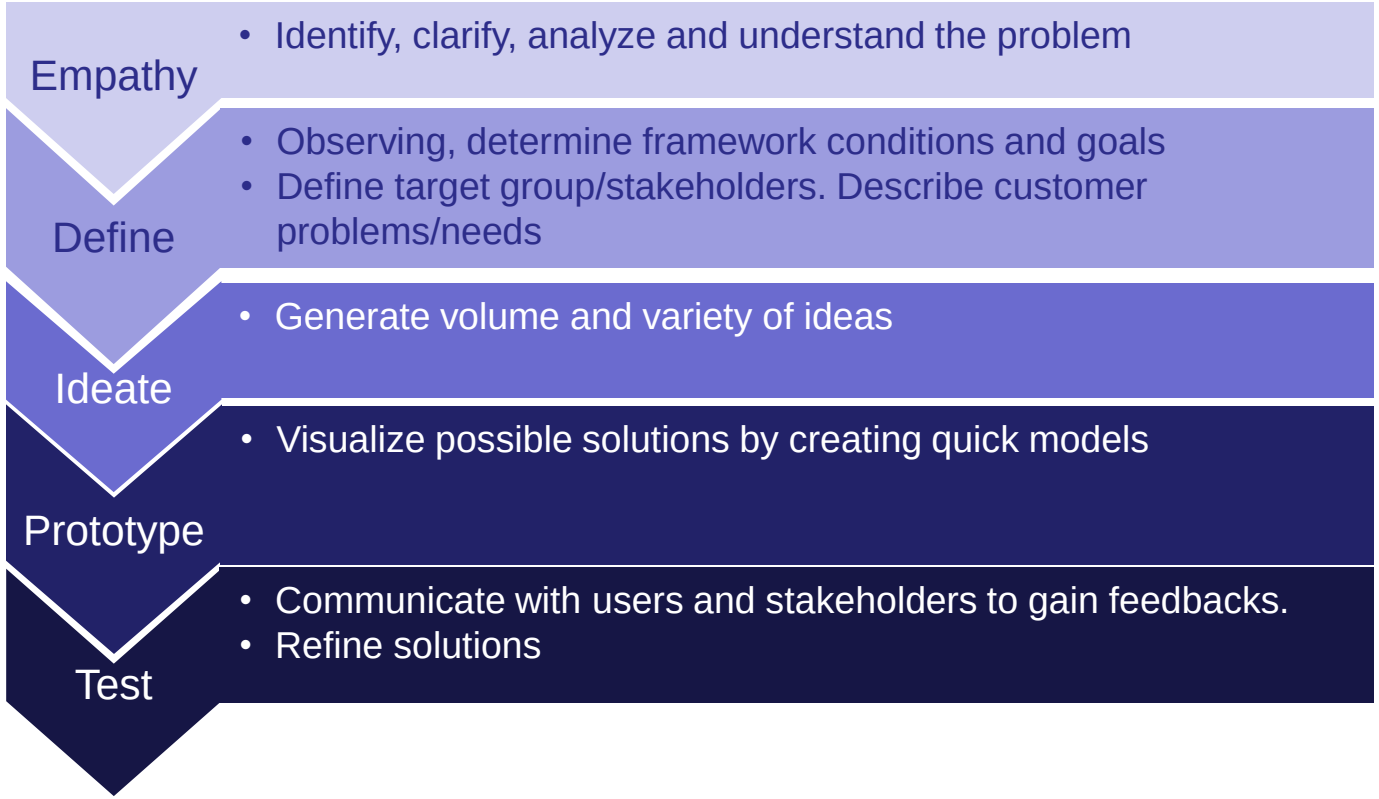
- What is design thinking?
  - Design thinking is a process for creative problem solving
    - ◇ A human-centered approach to problem solving
    - ◇ Help to get deep understanding of customer's unmet needs and wants
    - ◇ Encourage creative consideration of a wide array of innovative solutions
    - ◇ Mindset as a process



Introduction to Design Thinking (*cont*...)

- Human – desirability
  - What makes sense to people and for people?
- Business – viability
  - What is likely to become part of a sustainable business model?
- Technology – feasibility
  - What is functionally possible within the foreseeable future?

Process of Design Thinking



Empathy

- Who has the problem?
- Where does the problem occur?
- When did the problem start/occur?
- What is the problem? What do you know or don’t know about the problem?
- How can it be formulated differently?
- Why is it a problem?

Define

- Select and observe target group/stakeholders
  - Select customers/users with the same needs/problem
    - Who should be observed?
  - Observe the customer during his/her activities and the situation to better understand problem
    - Which behavior should be observed?
    - What is the specific need/problem to be solved?

Ideate

- Brainstorming
- Synectics*
- Evaluation of ideas
  - Selecting promising ideas

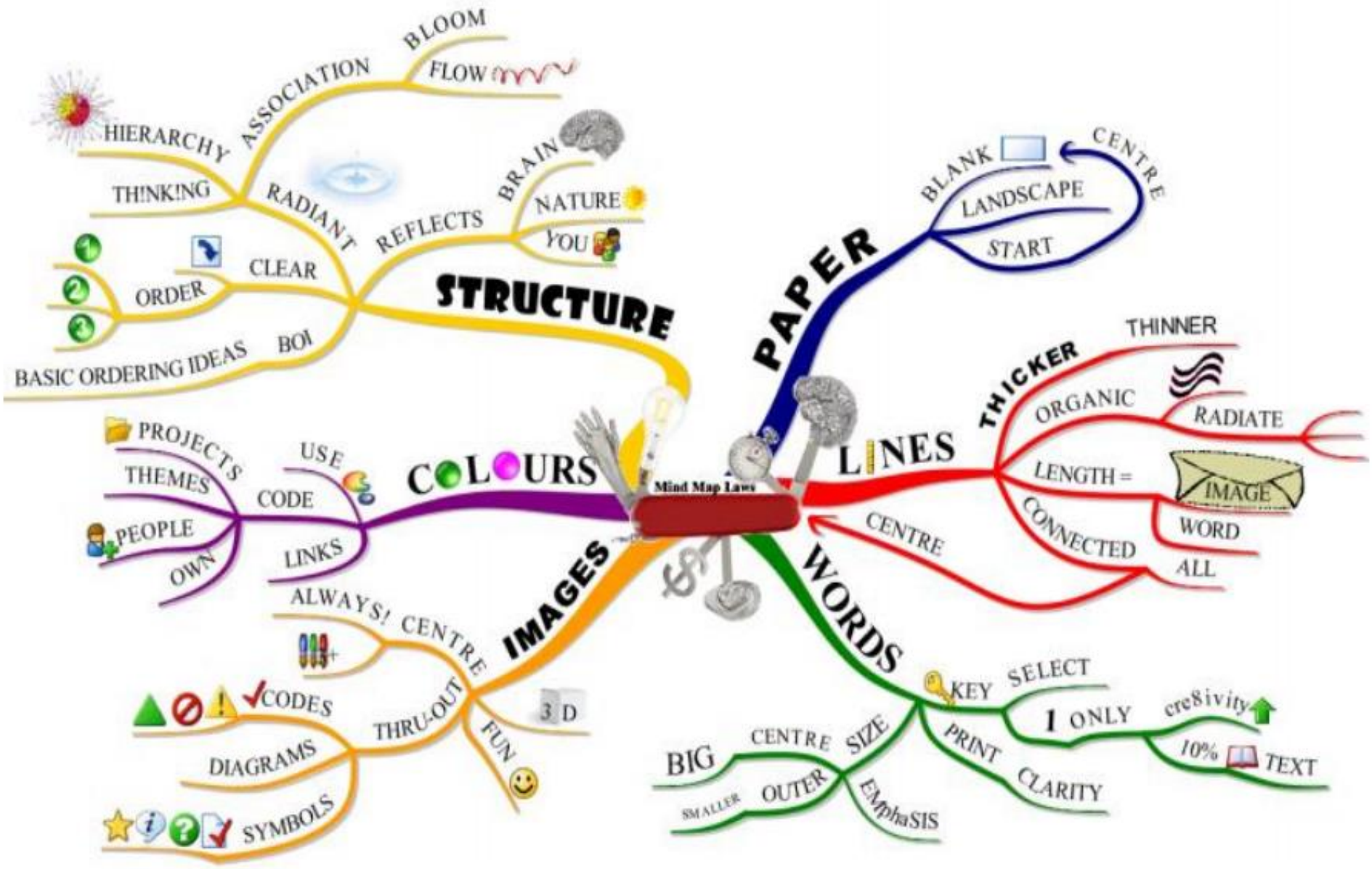
* *https://en.wikipedia.org/wiki/Synectics*

Prototype

- Ideas selected are expanded into design concept

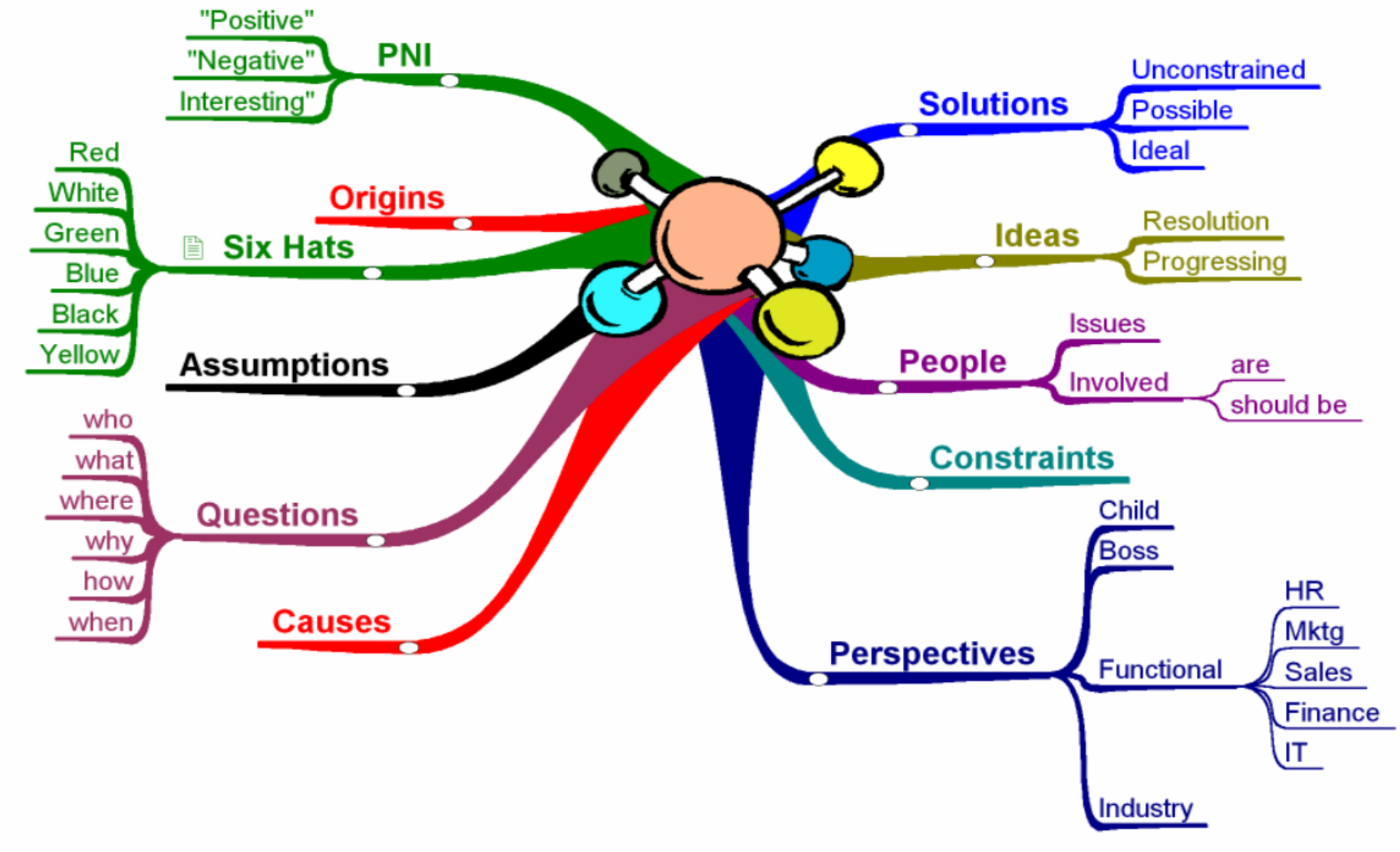
Test

- After creating a prototype, the testing of the prototype must be planned and organized with the concrete interaction with customers/users



General mind map illustration

https://iopscience.iop.org/article/10.1088/1757-899X/297/1/012054/pdf



General mind map illustration

Thank you!