Hands on Problem Solving

LUT Summer School
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Introduction

WHERE ARE WE NOW?

Outline

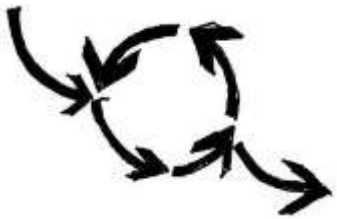
- Problem Framing
  - Network of Problems and Partial Solutions
  - Exploring the design space with the System Operator (multi-screen)

Outline

- Problem Framing
  - Network of Problems and Partial Solutions
  - Exploring the design space with the System Operator (multi-screen)

Problem Framing

- (Some) characteristics of design problems
  - ❖ **There is no definitive formulation of the problem**
  - – Temporary formulations are unstable and can change as more information becomes available
  - ❖ **Formulations of the problem are solution-dependent**
  - – The way the solution is conceived influences the way the problem is conceived
  - ❖ **Any problem formulation may embody inconsistencies**
  - – Many conflicts and inconsistencies emerge in the problem-solving process and have to be resolved in the solution

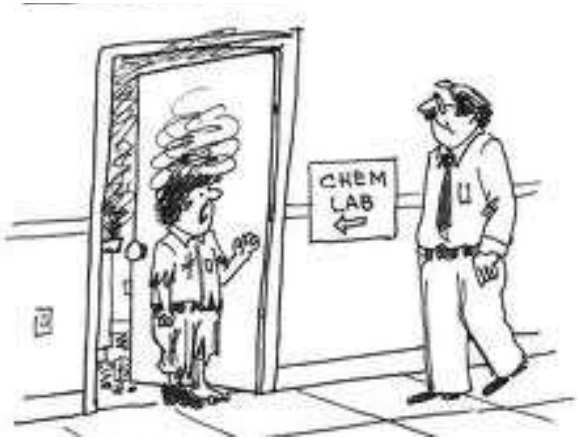


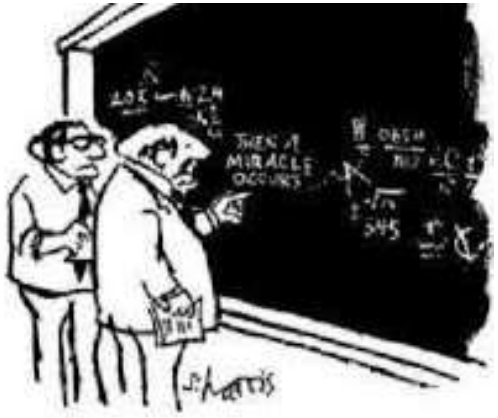
Source: Cross (2008)

Problem Framing

- (Some) characteristics of design problems (continued)
  - ❖ **Proposing solutions is a means of understanding the problem**
    - Many constraints and criteria emerge as a result of evaluating solution proposals
  - ❖ **There is no definitive solution to the problem**
    - Different solutions can be equally valid responses to the initial problem

What's the opposite of Eureka?



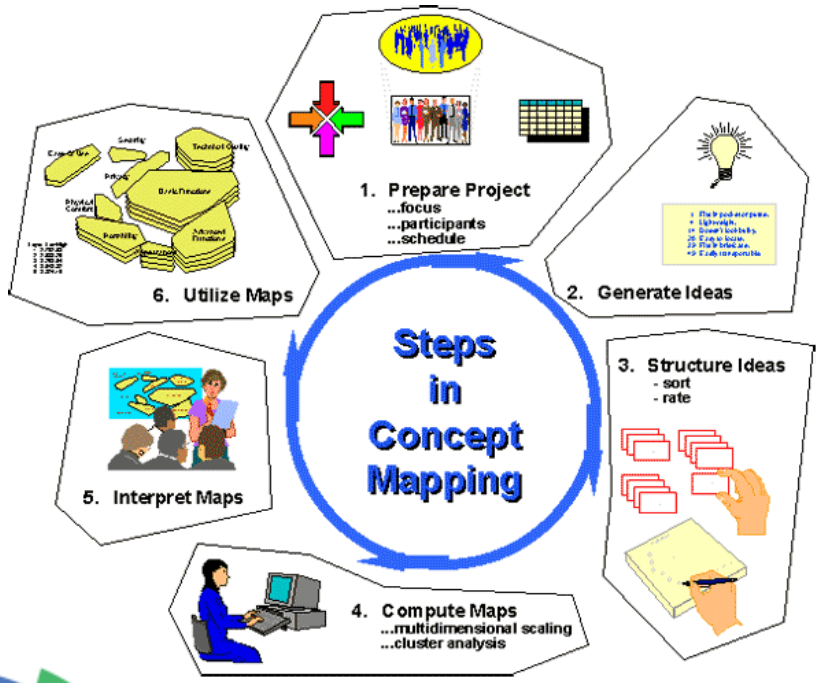


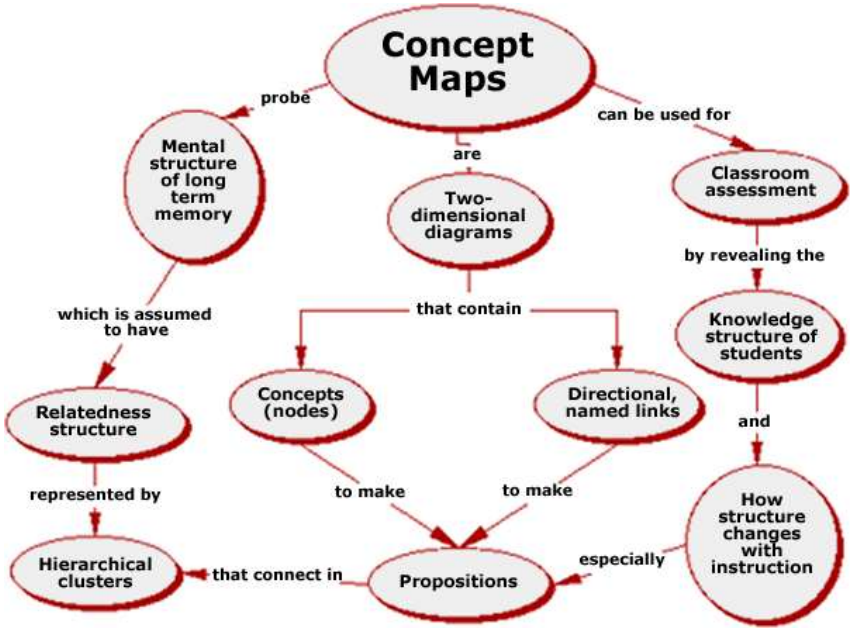
Source: Cross (2008)

Problem Framing

Conceptual Maps

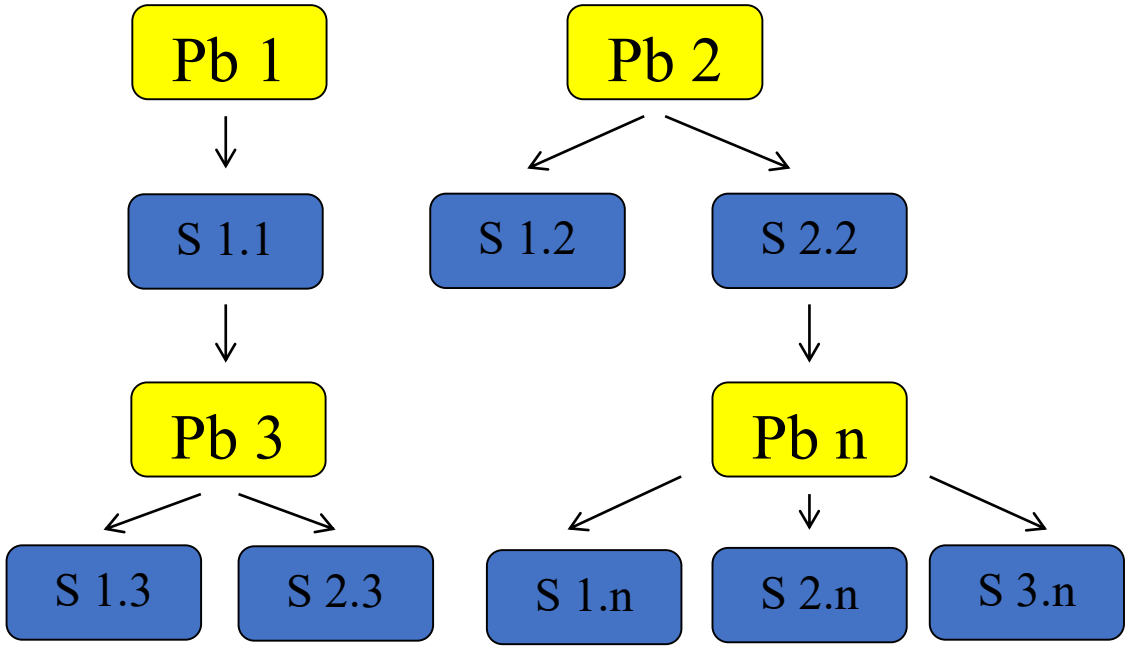
- Concept maps are graphical tools for organizing and representing knowledge
- A concept map is a 2-dimensional node-link representation that depicts the most important concepts and relationships





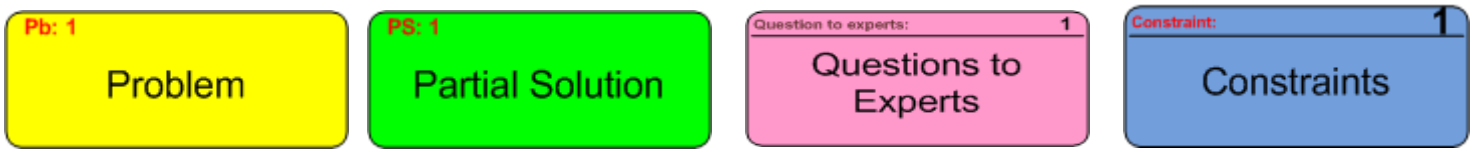
Problem Framing

- **Network of Problems and Partial Solutions:**



Problem Framing

- **Network of Problems and Partial Solutions:**
  - Nodes:
    - Problems (Pb)
    - Partial Solutions (PS)
    - Questions to Experts (QE)
    - Constraints (Cnstr)



Problem Framing

- **Network of Problems and Partial Solutions:**
  - Nodes:
    - Problems (Pb)
      - whatever we are not comfortable with
      - whatever objective we would like to achieve

    - Describe it with a statement about what we don't like:
      - How to… (Useful Function)?
      - Insufficient performance of a desired function
      - Undesired side effect of a design choice
      - Excessive consumption of a resource

Problem Framing

- **Network of Problems and Partial Solutions:**
  - Nodes:
    - Partial Solution (PS)
      - whatever we know that at least partially addresses a problem
      - whatever we suppose that at least might address a problem
      - whatever details a more specific way to implement a PS

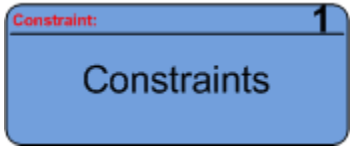
Problem Framing

- **Network of Problems and Partial Solutions:**
  - Nodes:
    - Questions to Experts (Information need)
      - Whatever info need emerges within the problem solving process

    - Typical sources of information:
      - Information Retrieval within the Company
        - » Other divisions/departments/colleagues
        - » Past experiences
      - Information Retrieval from Outside the Company
        - » Patents, Technical/Scientific Papers
        - » Customers, Market, Benchmarks

Problem Framing

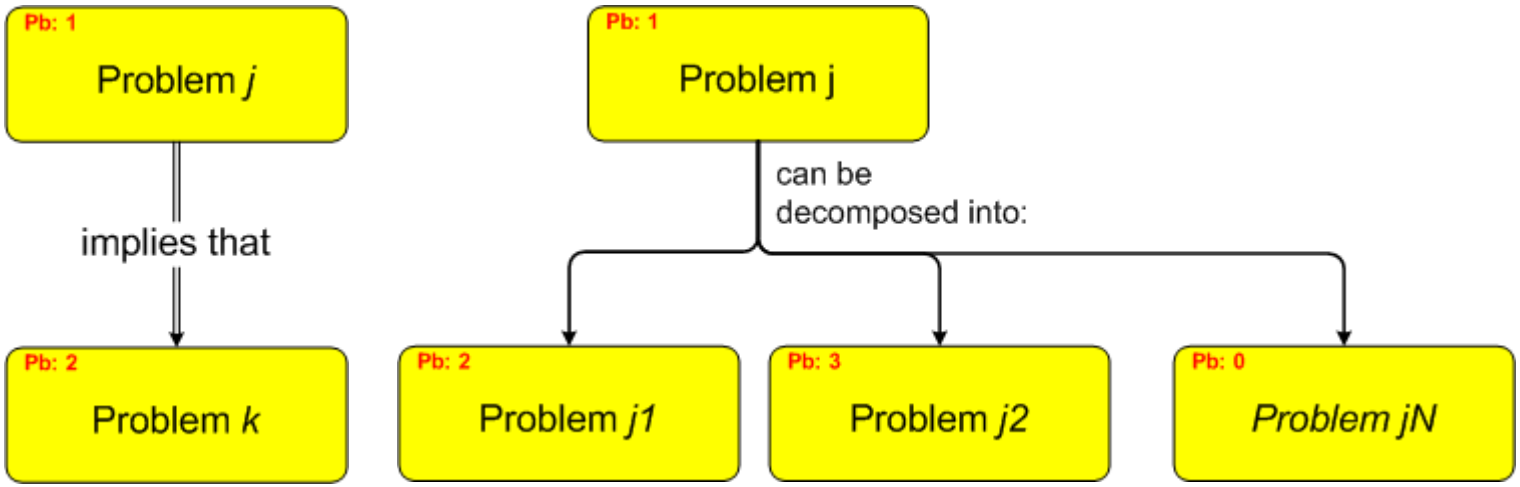
- **Network of Problems and Partial Solutions:**
  - Nodes:
    - Constraint
      - Whatever feature that cannot be modified to any extent, but should be taken into account
        - » Standards and rules
        - » Contract specifications
        - » Physical Laws



- Warning:
  Don't confuse problems with constraints!
  Double check if what you are describing as a constraint can be transformed into a further problem to address (e.g. through 5 Whys)

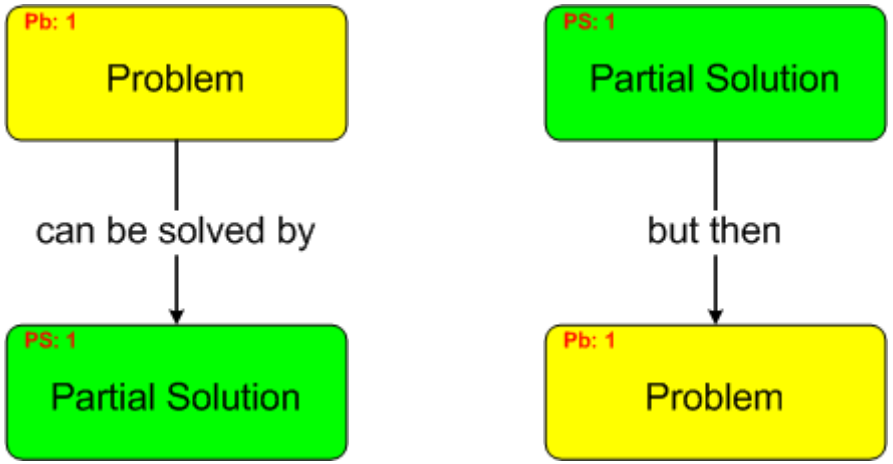
Problem Framing

- **Network of Problems and Partial Solutions:**
  - Links:
    - Pb ➔ Pb (cause-effect relationships, decompositions)



Problem Framing

- **Network of Problems and Partial Solutions:**
  - Links:
    - Pb ➔ PS
    - PS ➔ Pb



Problem Framing

❑ **Building a Network of Problems and Partial Solutions (excerpt from Tutorial 1, continued):**

NEED (TF)	STAKEHOLDER(s)	REQUIREMENT(S)
Wearable	-FITMI -RUNNERS	Lightweight: < 30g Easy to wear (max. 2 actions required)
Long battery life	-RUNNERS -FITMI	Max. 1 recharge/week with all tracking features in active mode

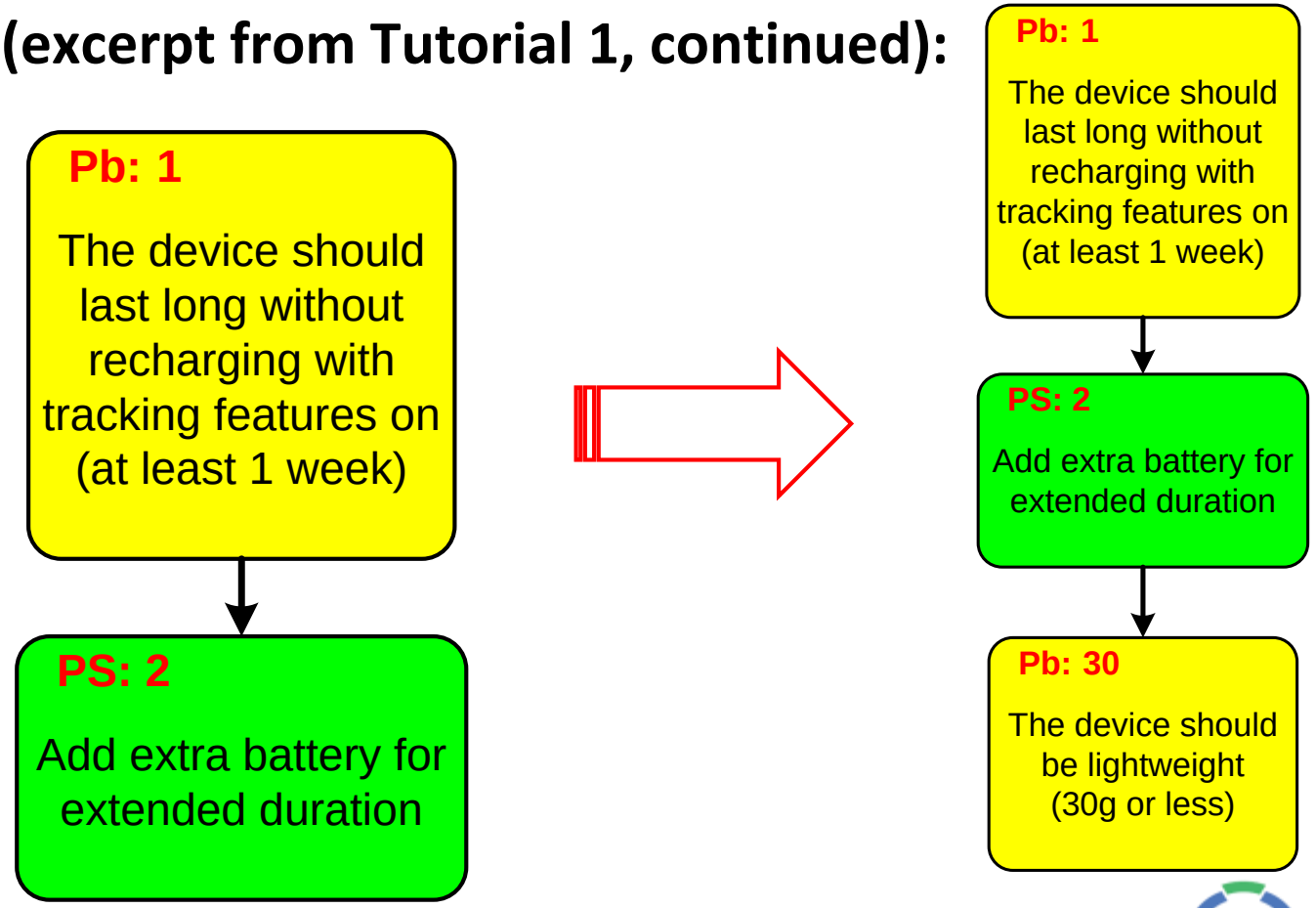
Pb: 30
The device should be lightweight (30g or less)

Pb: 2
The device should be easy to wear (less than 2 actions)

Pb: 1
The device should last long without recharging with tracking features on (at least 1 week)

Problem Framing

- **Building a Network of Problems and Partial Solutions (excerpt from Tutorial 1, continued):**



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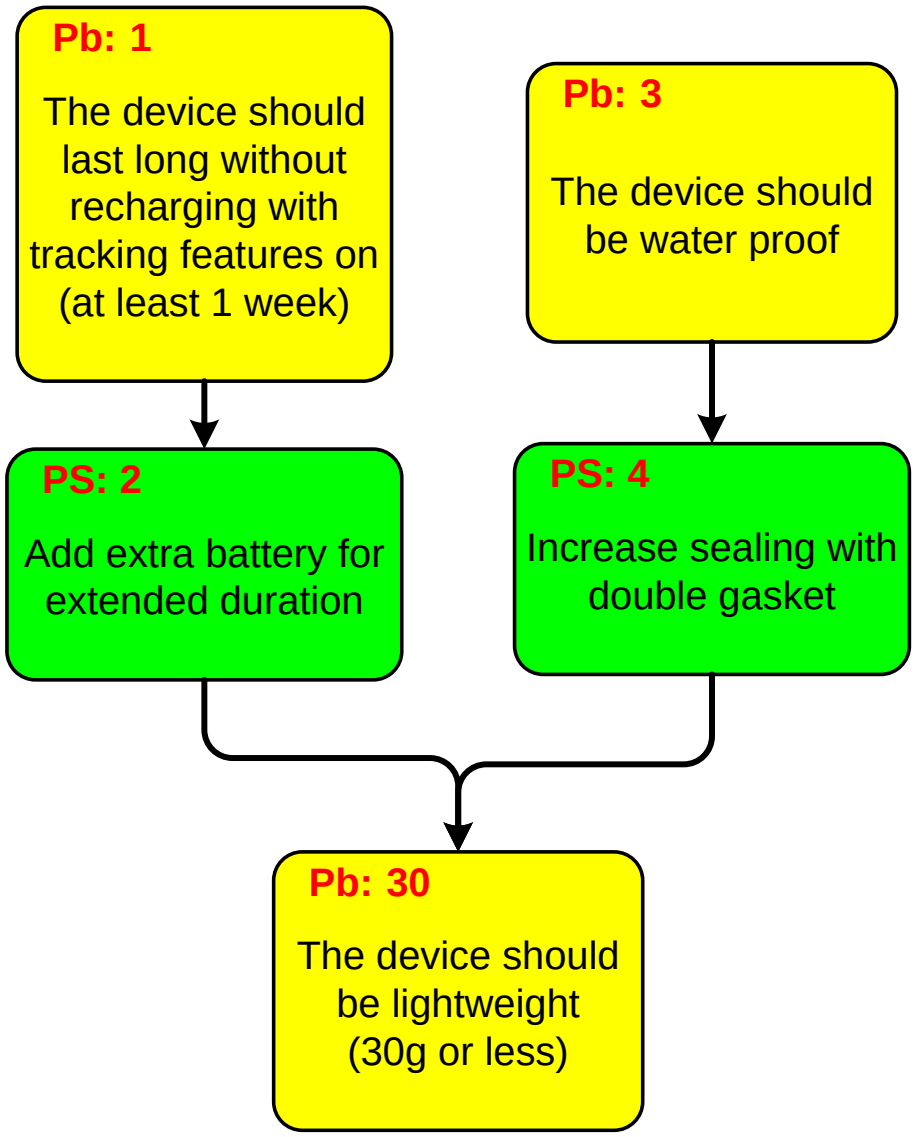

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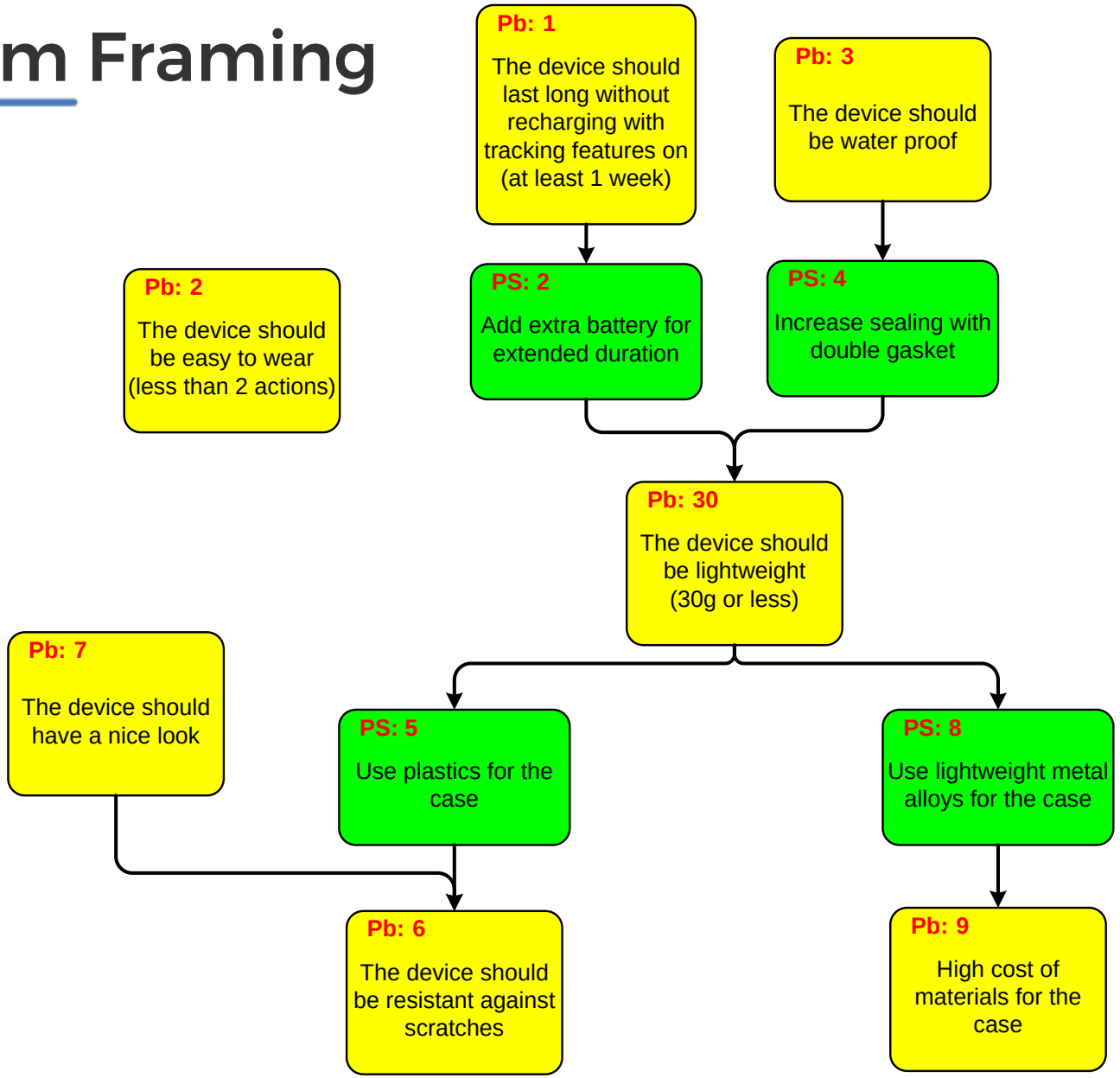

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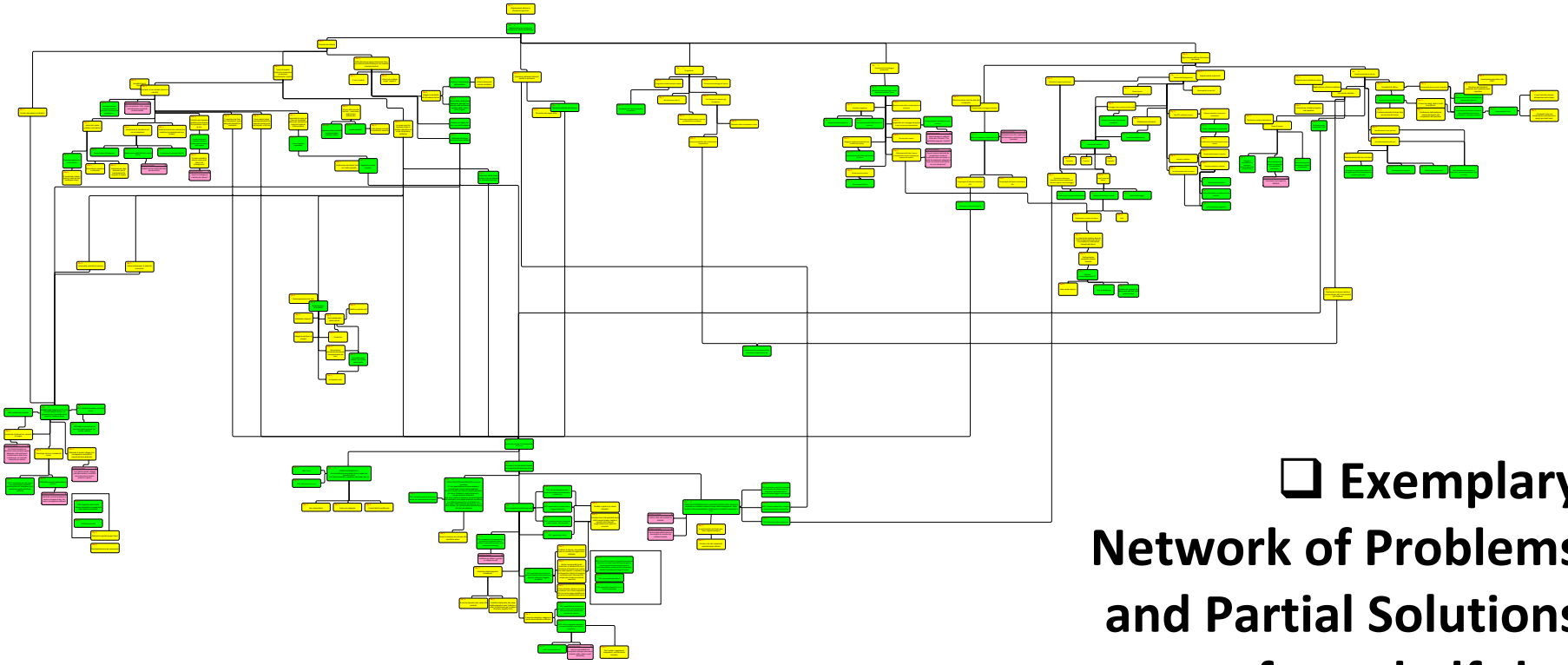
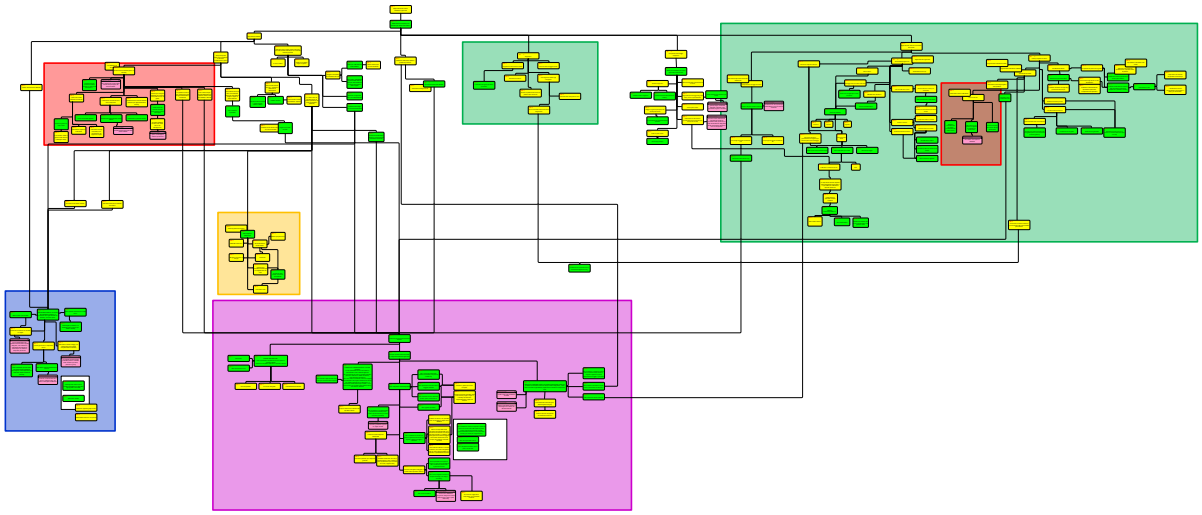
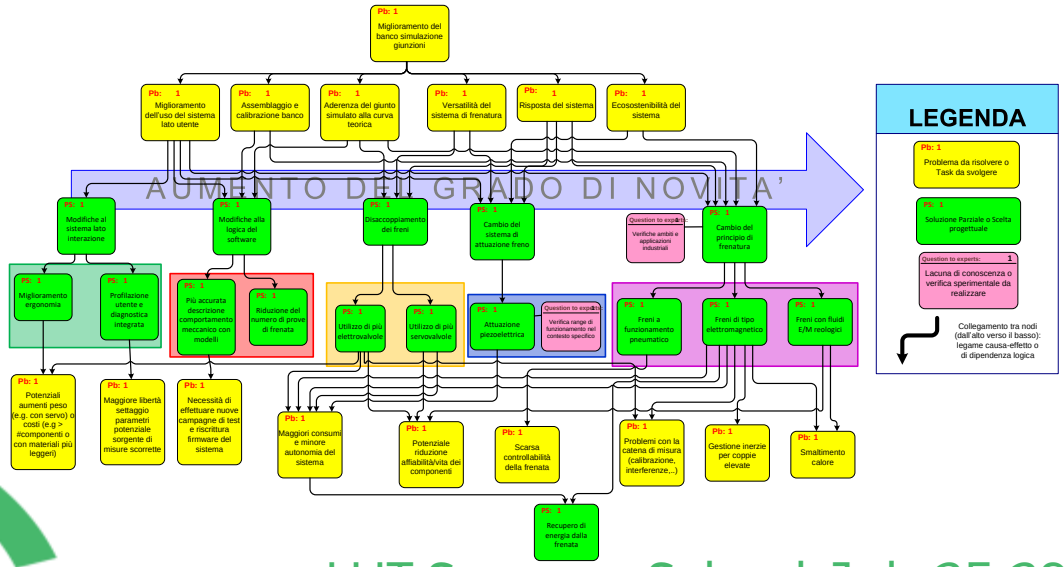


❑ **Exemplary Network of Problems and Partial Solutions after a half-day workshop in industry**

Problem Framing

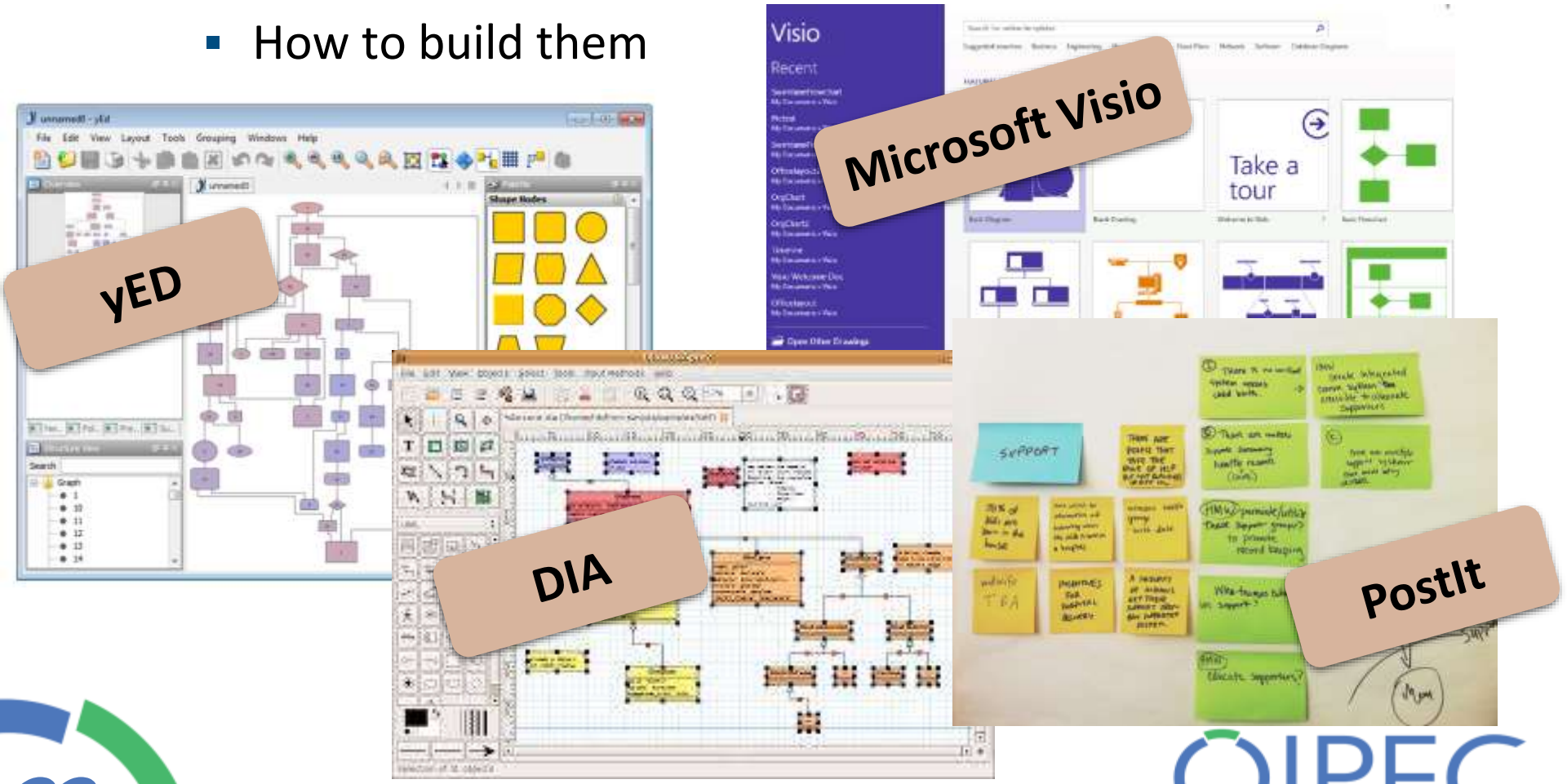




❑ **Exemplary Network of Problems and Partial Solutions after a half-day workshop in industry**

Problem Framing

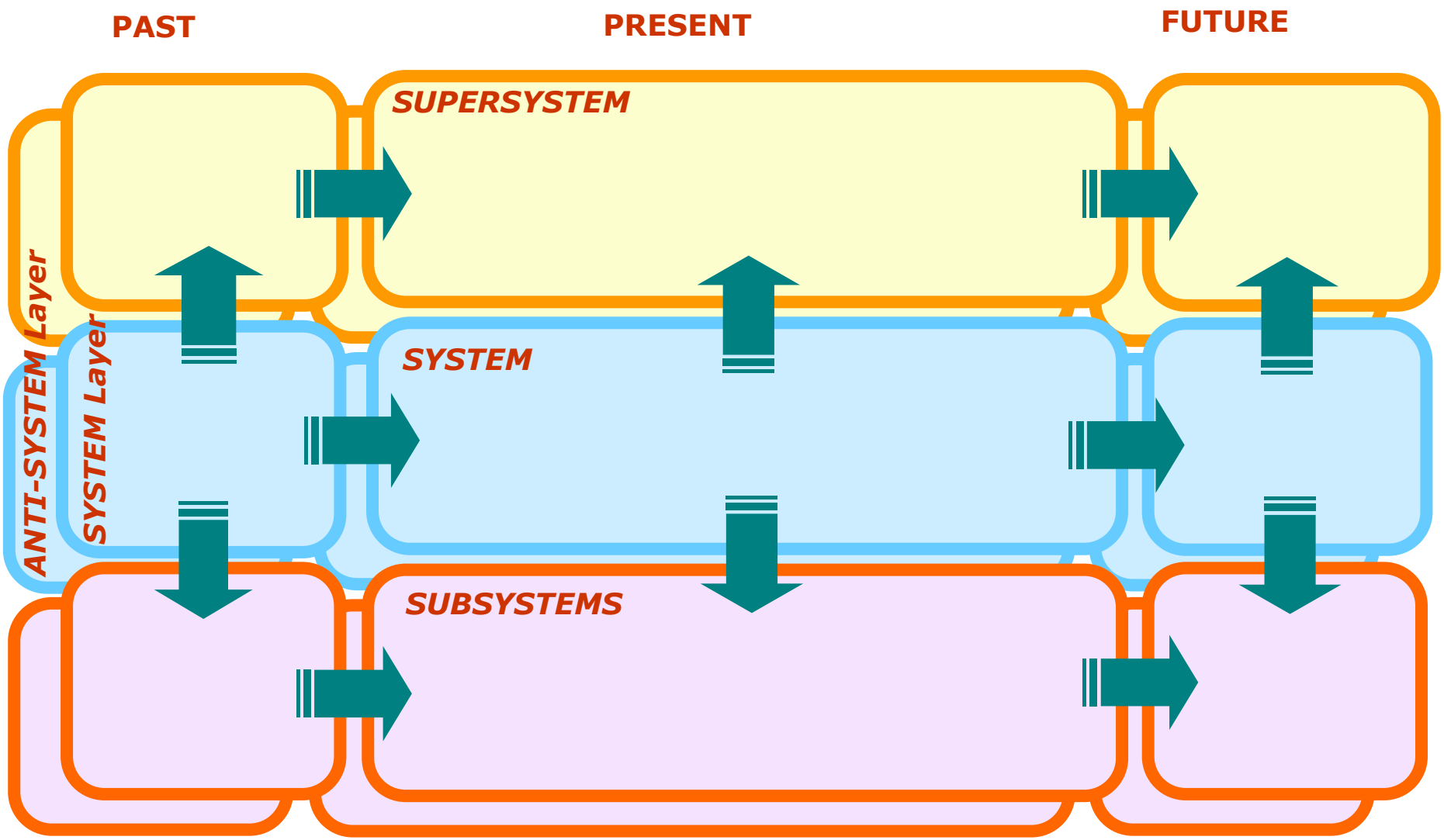
- **Network of Problems and Partial Solutions:**
  - How to build them



Outline

- Problem Framing
  - Network of Problems and Partial Solutions
  - Exploring the design space with the System Operator (multi-screen)

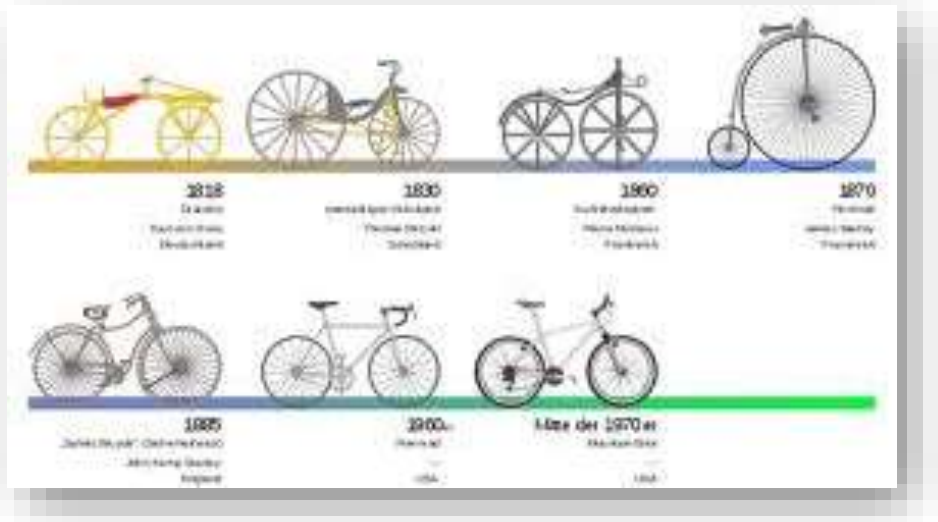
Exploring the Design Space



Exploring the Design Space

Different meanings of time

- Meaning #1: Technical Evolution (Historical Time)
  - What principle was used in the past to deliver the function of the system? How was the system like in the past?
  - What principle is currently used to deliver the function of the system? What is the current structure of the system?
  - What principles might be used in the future to deliver the same function? What is the ideal system?



Exploring the Design Space

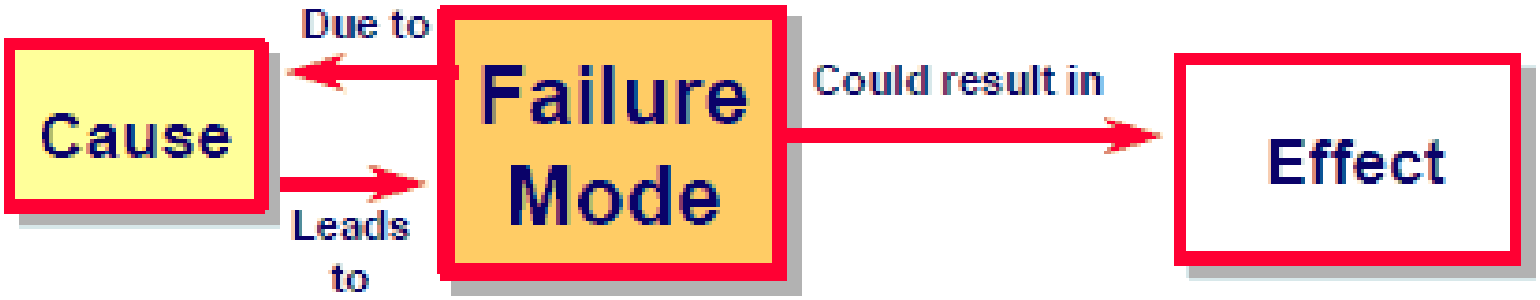
Different meanings of time

- Meaning #2: Phases of a Process
  - What phases precede the activity under analysis? What actions does the object of the function undergo before the current one?
  - Concurrent actions; simultaneous auxiliary functions
  - What phases will follow? What further actions will the object receive after?

Exploring the Design Space

Different meanings of time

- Meaning #3: Cause and Effect Chains
  - Root Cause: What event or situation did create the conditions for the appearance of our problem?
  - Failure Mode: What is the manner in which the failure of our system can occur?
  - Failure Effect: What are the undesired consequences of the failure?

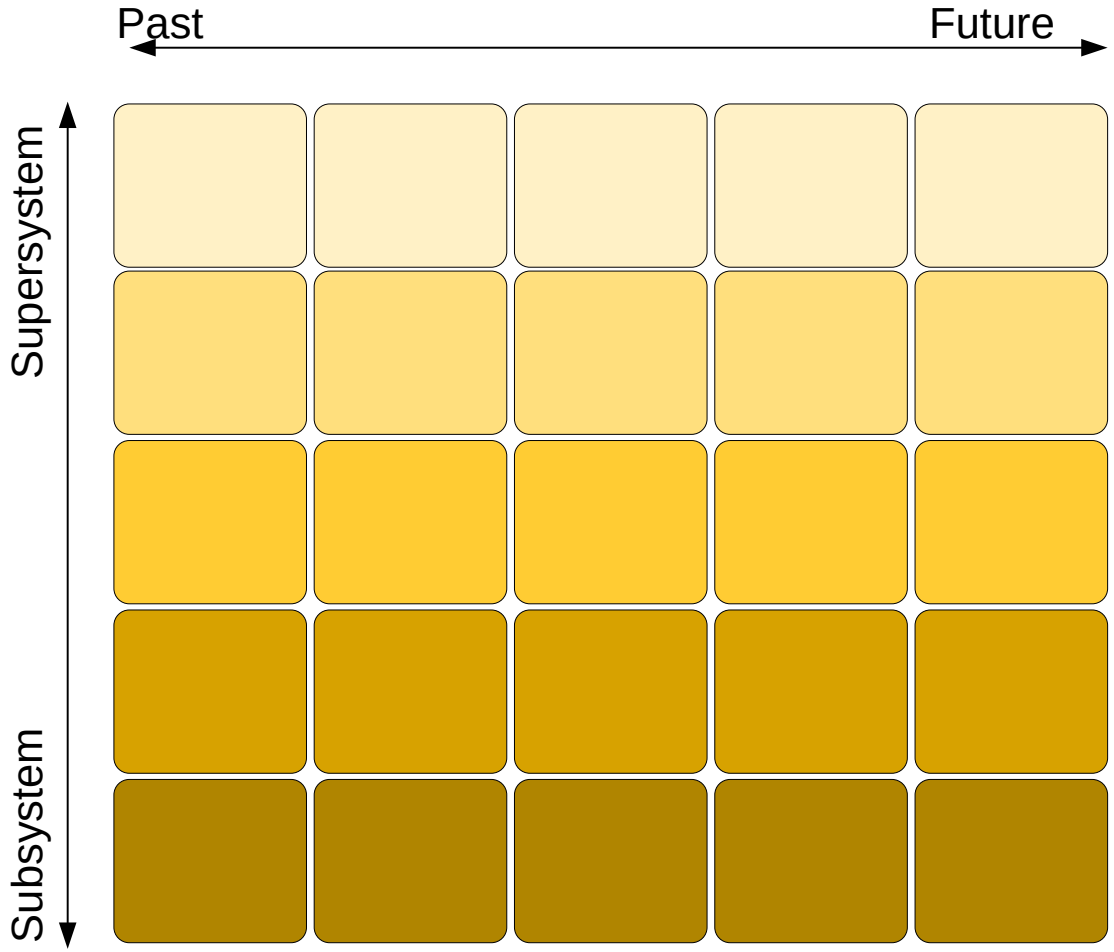


Exploring the Design Space

- The System operator can be used as a tool by itself with different functions within the problem solving process:
  - During the preliminary stages of the problem solving process, **while looking for roundabout problems** whose solution allows to obtain the same overall goal, a multi-screen view helps orienting the thought from cause prevention to effects compensation or mitigation, as well as a means to change the scale of the solution space in order to avoid psychological inertia.
  - **While looking for resources**, the System Operator helps focusing the attention on every relevant aspect of the system and its environment, by analyzing any time stage at any detail level with a systematic approach.

Exploring the Design Space

The «screens» are more than 9!!



Task for Today Afternoon Session

1. Revise and complete your stakeholder analysis; formulate a comprehensive design specification
2. Build your Network of Problems and Partial Solutions
   - Check coherence with the list of requirements you identified
   - Propose your first ideas to explore the design space and apply System Operator to enrich the map
   - Manage your time and competences properly!
3. Prepare the presentation of your partial results
   - Deliver a PPT to gaetano.cascini@polimi.it by 16:15
   - Put the names of your team-members in the first slide
   - At least 2 team members speaking
   - The presentation should last 7 minutes (or less)

Thank you

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