Systems Thinking for Design

Session 2

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY,
DESIGN AND MANUFACTURING,
KANCHEEPURAM

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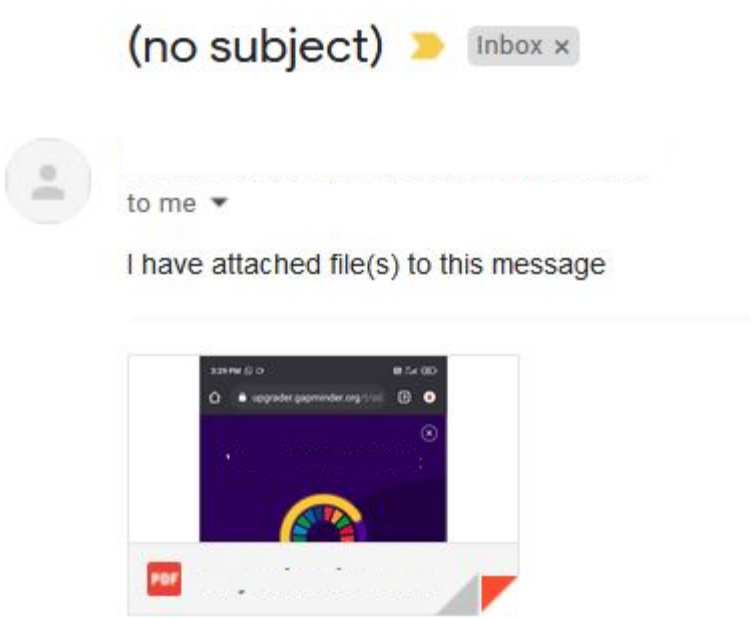
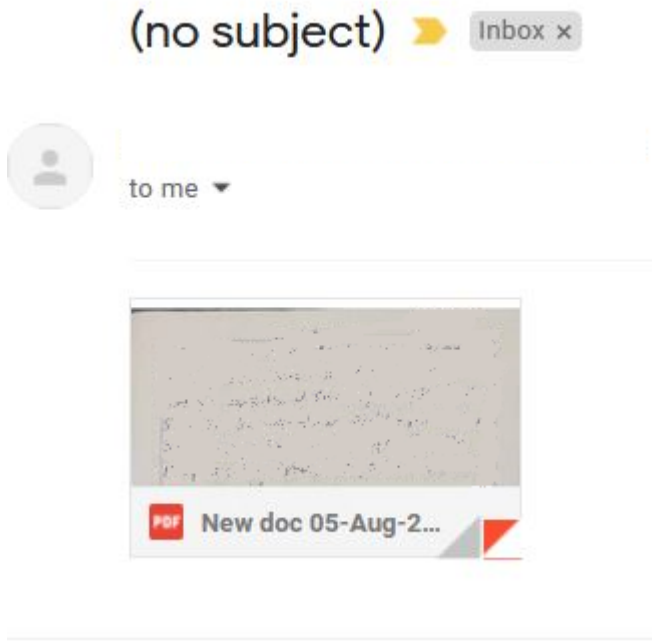
Recap of last session

1. IIITDM and its relevance
2. Gap between student's competencies and industry requirements
3. Global state of the art in engineering
4. Assignments

Understanding context





Sample mail from students

Recap: What do these terms mean to you? (10 min)

1. Science (Natural / Social)
2. Engineering
3. Technology
4. Innovation
5. Entrepreneurship
6. Management
7. Enterprise/Business/Company
8. Industry

Make-in-India

Startup India

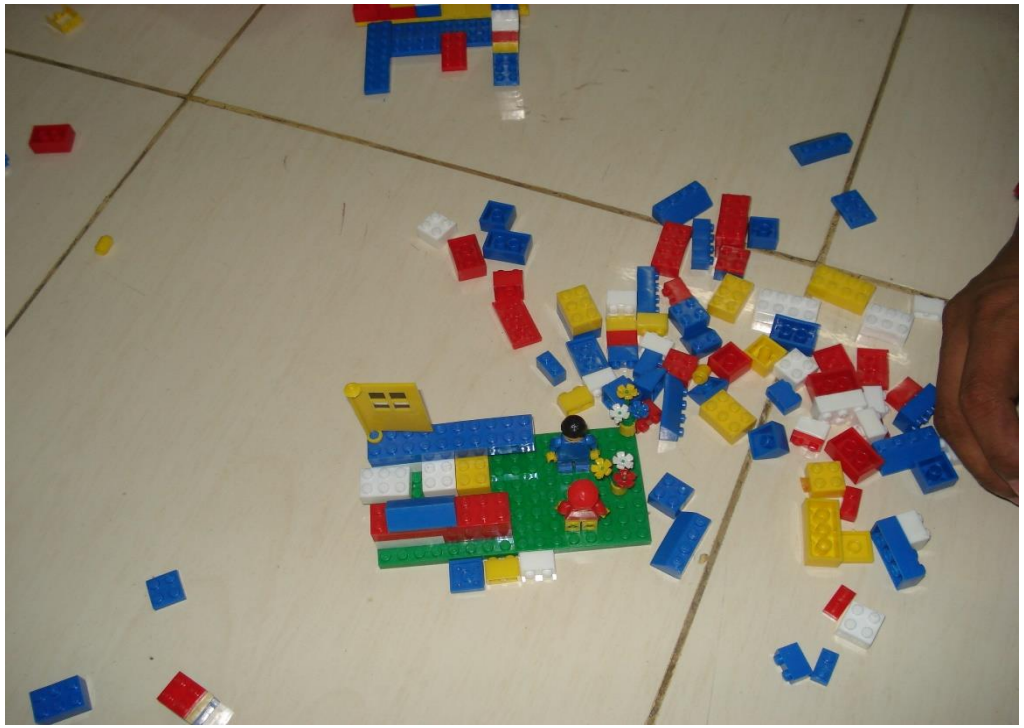
Skill India

IIITDM

9. Product
10. Industrial Design
11. Engineering Design
12. Prototype
13. Manufacturing
14. User
15. Customer
16. Market

Constraint: Should not exceed a page & should include all terms

Recap: What competencies did you develop in Year-1 & how?



Relook at your first year courses and depict using the skills you have acquired in the first year

My assumption: all of you remember the courses

Category	Course Name
BSC	Calculus
BSC	Engineering Electromagnetics
BEC	Electrical Circuits for Engineers
BEC	Problem Solving and Programming
BEC	Materials for Engineers
DSC	Foundation for Engineering and Product Design
BSC	Engineering Electromagnetics Practice
BEC	Problem Solving and Programming Practice
HSC	Effective Language and Communication Skills

Category	Course Name
BSC	Differential Equations
SEC	Science Elective 1
BEC	Engineering Graphics
ITC	Data Structures and Algorithms
DSC	Sociology of Design
ITC	Design and Manufacturing Lab
PCC	Discrete Structures for Computer Science
ITC	Data Structures and Algorithms Practice
HSC	NSO/NCC/SSG/NSS
HSC	Earth, Environment and Design

The answer that is most common will receive lowest marks

Session outline

- Kickstart Opportunity Identification
- Challenges in the Fuzzy Front End of NPD
- Need for inter-disciplinary concepts and approaches

Exercise 2.1: What do you want to work on? (20 min)

- Identify a few areas of interest individually
- List a couple of dimensions of each area
- Summarize top 10 factors/aspects of the problem you identified
- Work together as a team on the idea
- Add relevant class work to Google drive and maintain it for the rest of your stay at IIITDM

Lota – A study by Charles & Ray Eames

Link - https://youtu.be/BMC5gDv_Yos

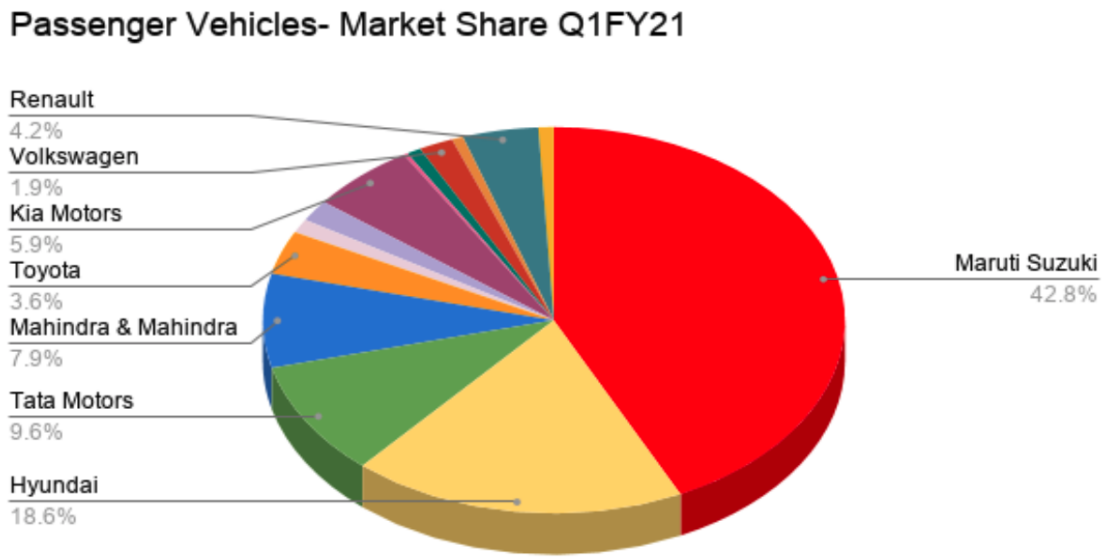
Think about the hidden cost

How much do you think the headlight of Maruti 800 would cost?

How to identify latent/unstated need?

What do you think is the reason for TATA motor's growth?

No	OEM Wholesales	Sep-20	Sep-19	Diff	% Growth
1	Maruti	1,47,912	1,10,454	37,458	33.91
2	Hyundai	50,313	40,705	9,608	23.60
3	Tata	21,200	8,097	13,103	161.83
4	Kia	18,676	7,754	10,922	140.86
5	Mahindra	14,857	14,333	524	3.66
6	Honda	10,199	9,301	898	9.65
7	Renault	8,805	8,345	460	5.51
8	Toyota	8,116	10,203	-2,087	-20.45
9	Ford	5,765	5,556	209	3.76
10	MG	2,537	2,608	-71	-2.72
11	VW	2,050	2,550	-500	-19.61
12	Skoda	1,312	1,233	79	6.41
13	Nissan	780	1,433	-653	-45.57
14	Jeep	554	603	-49	-8.13
-	Total	2,93,076	2,23,175	69,901	31.32



How to identify latent/unstated need?

1. Competitive price?
2. New design?
3. Aggressive marketing?
4. Nice features?

Image courtesy: https://www.globalncap.org

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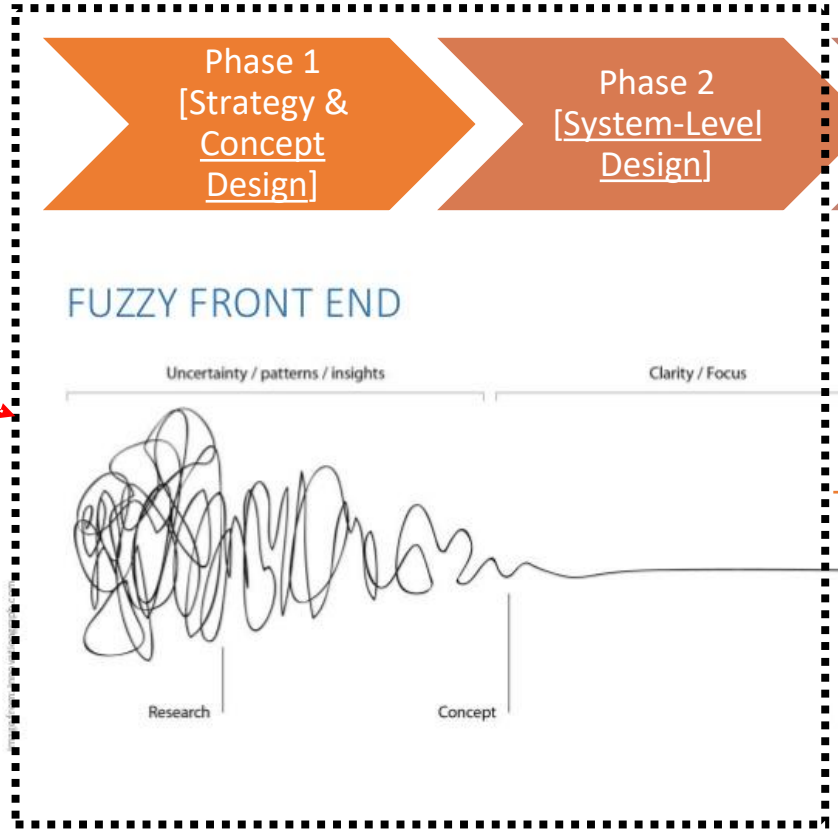
Fuzzy Front End (FFE) of NPD and Innovation

NPD = New Product Development

Phase 1 [Strategy & Concept Design] → Phase 2 [System-Level Design] → Phase 3 [Detailed Design & Prototype] → Phase 4 [Manufacture, Assembly, Test] → Phase 5 [Market Introduction & Penetration]

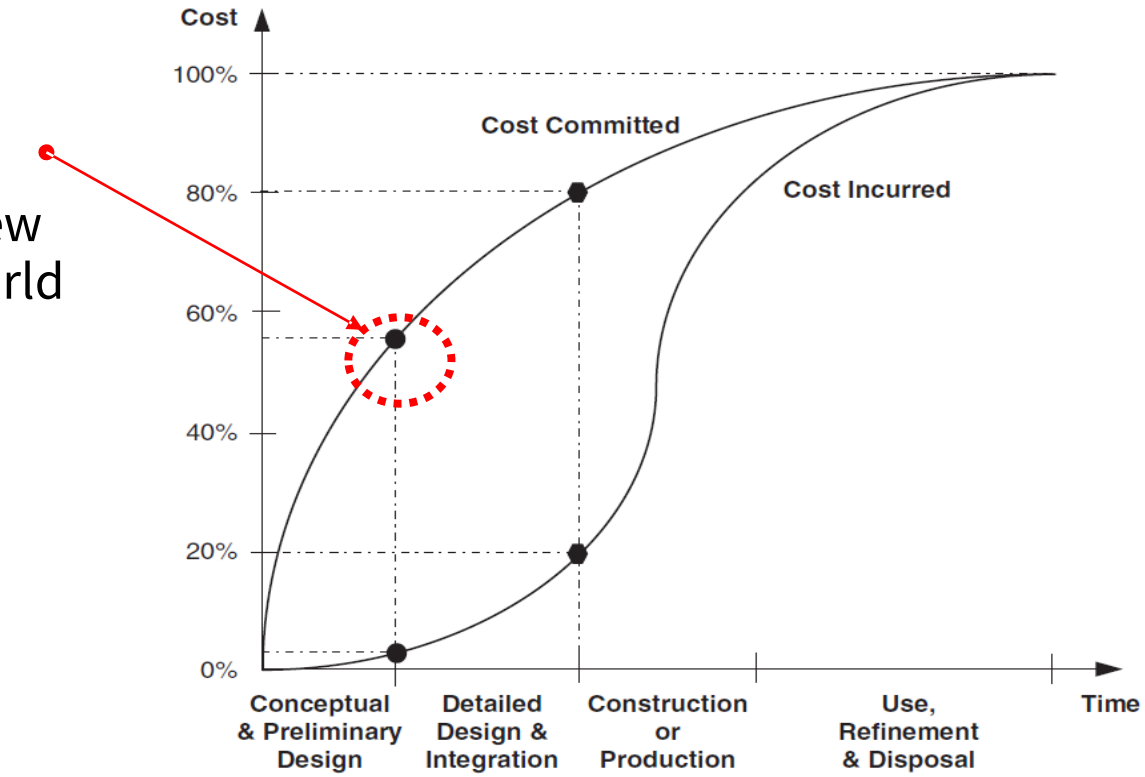


Why is this important?

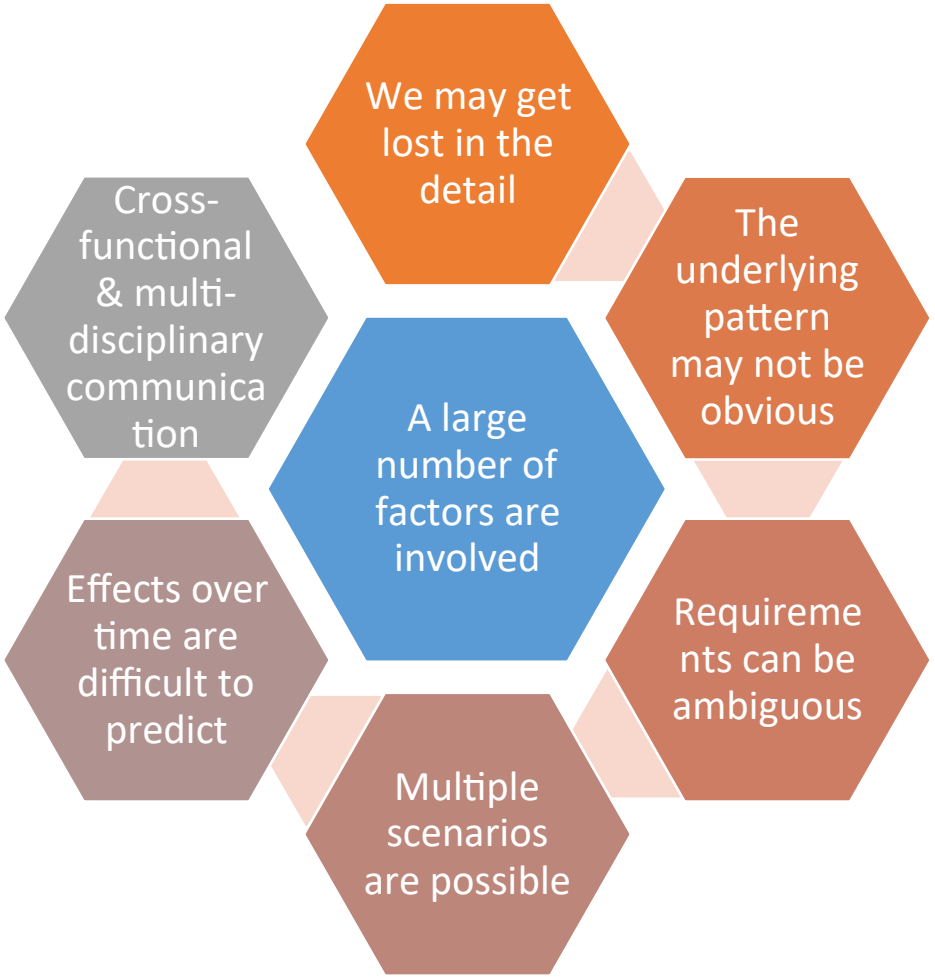
What are the challenges in this phase?

The importance of FFE

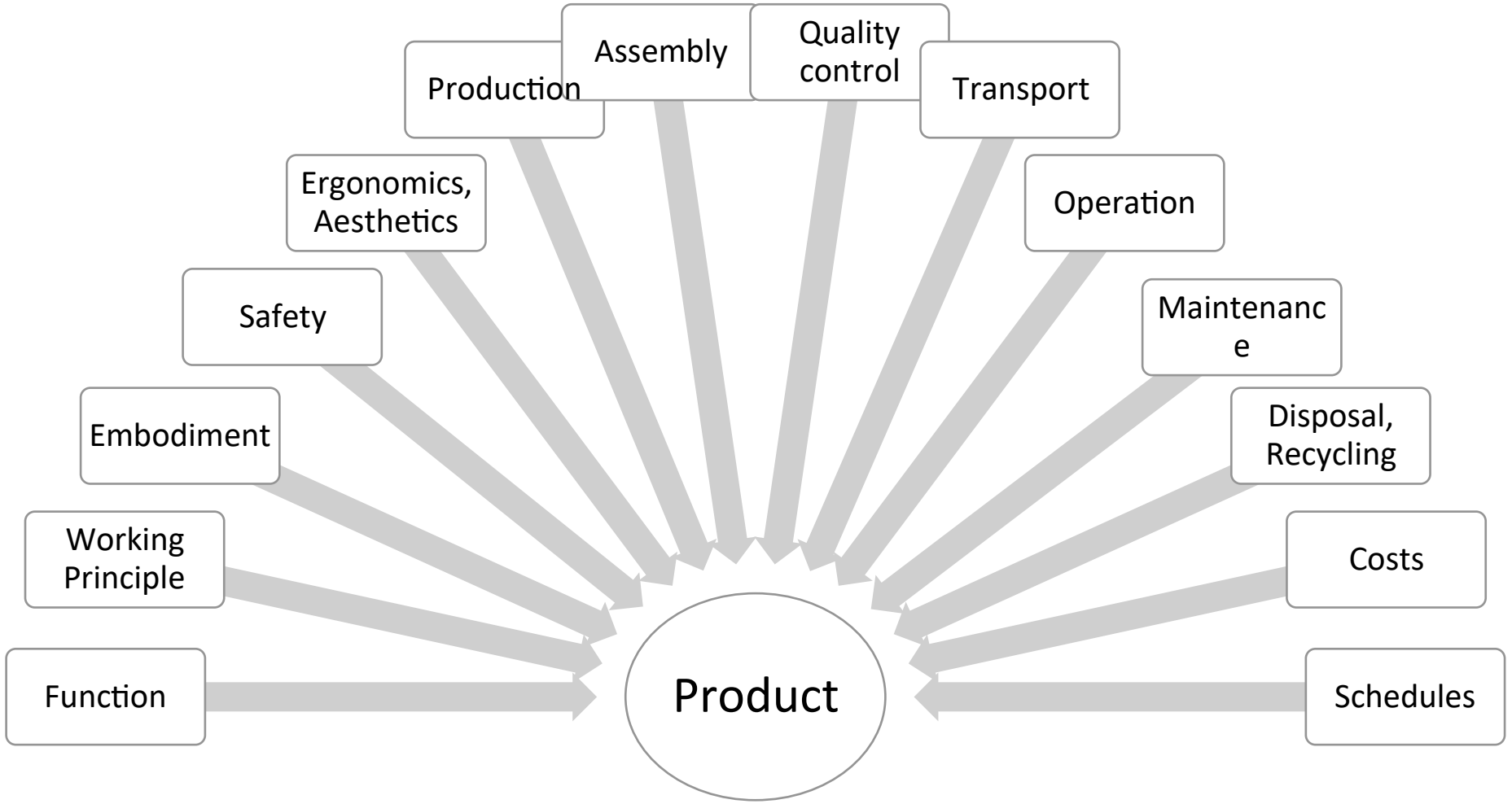
- About 60% of the product cost is committed when the concept design is selected (wrong choices can destroy the advantage)
- Opportunity to shape a market and create new sources of competitive advantage … (In a world of interdependence, competition can come from anywhere)
- Proliferation of technologies (digital), emergence of integrated product concepts (PSS, SCS, CPS) and regulatory issues like sustainability necessitates a deeper understanding of market and technology trends



Key Challenges in FFE



A variety of factors are involved in design



We could easily get lost in the detail

- Cna yuo raed tihs? Olny 55 plepoe out of 100 can.
- i cdnuolt blveiee taht I cluod aulaclty uesdnatnrdwaht I was rdanieg. The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it dseno't mtaetr in waht oerdr the ltteres in a wrod are, the olny iproamtnt tihng is taht the frsit and lsat ltteer be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it whotuit a pboerlm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Azanmig huh? yaeh and I awlyas tghuhot slpeling was ipmorantt!

The power of seeing the whole without knowing all the parts

The underlying pattern may not be obvious

CONCENTRATE ON THE FOUR DOTS IN THE MIDDLE OF THE PICTURE FOR ABOUT 30 SECONDS.

THEN CLOSE YOUR EYES AND TILT YOUR HEAD BACK.

KEEP THEM CLOSED. . YOU WILL SEE A CIRCLE OF LIGHT; CONTINUE LOOKING AT THE CIRCLE...

WHAT DO YOU SEE?

Seeing connections and patterns requires immersion in the problem context

The problem/requirement can be ambiguous

Set of Elements

	A		A	
WITH		OFFICE		IN
	I			MY
HANDLE		PROBLEM		COMPUTER

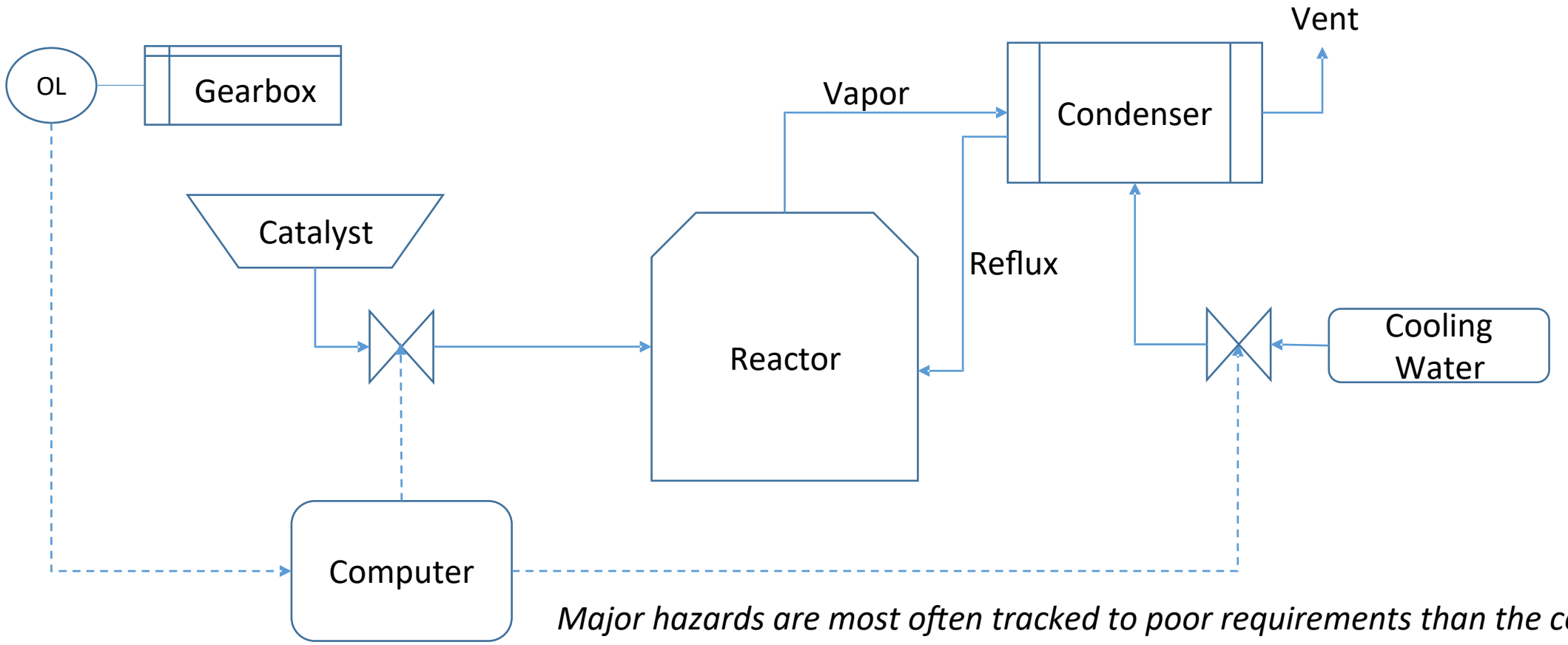
Different Meanings

- WITH A COMPUTER, I HANDLE A PROBLEM IN MY OFFICE
  - Using Computer to handle business problem
- WITH MY OFFICE, I HANDLE A PROBLEM IN A COMPUTER
  - Providing hardware services to clients
- IN MY OFFICE, I HANDLE A PROBLEM WITH A COMPUTER
  - Using computers for solving client problems

Source: Allen S. Lee (1999), Researching MIS

Each pattern suggests different requirements

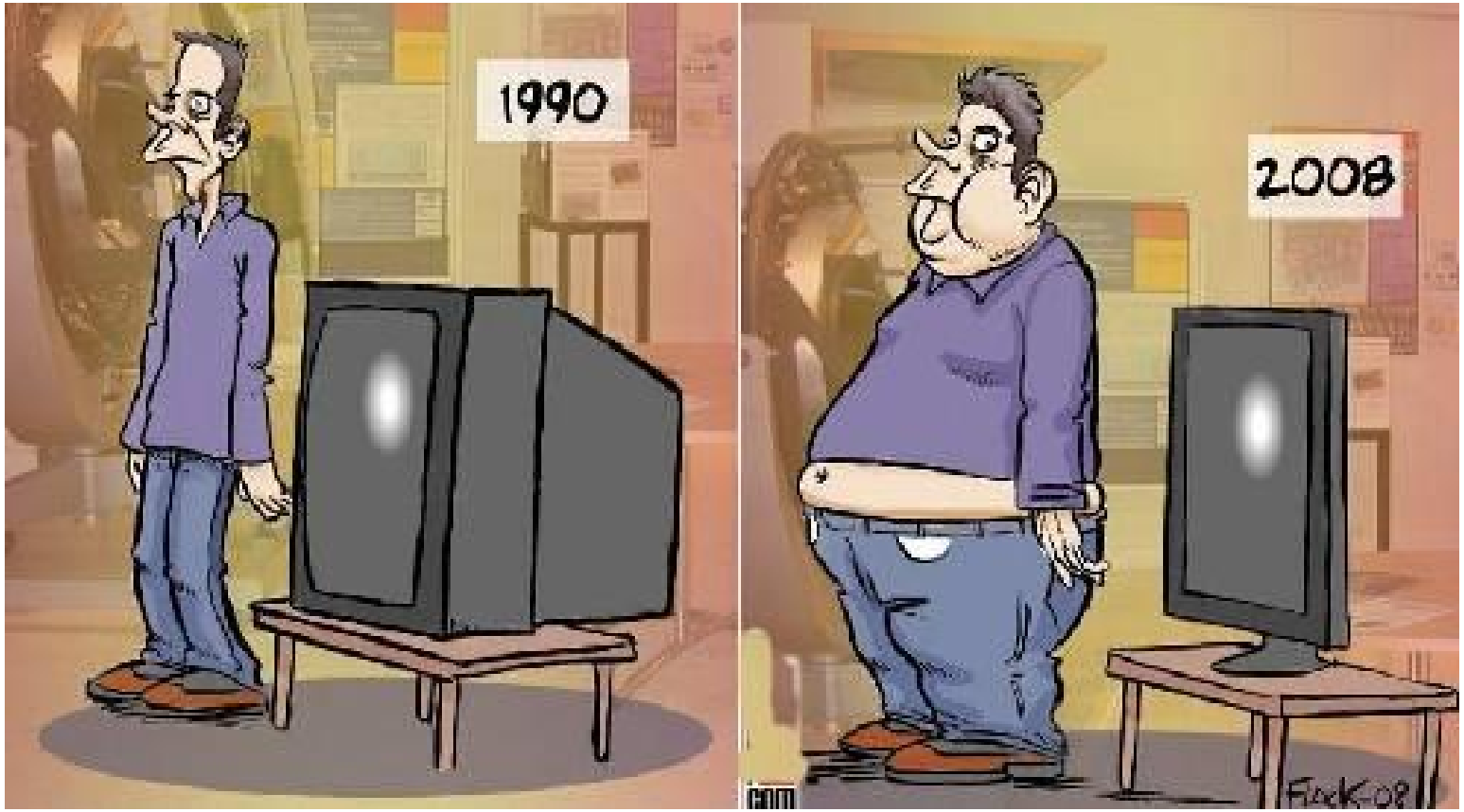
Scenarios may be difficult to visualize



Major hazards are most often tracked to poor requirements than the code

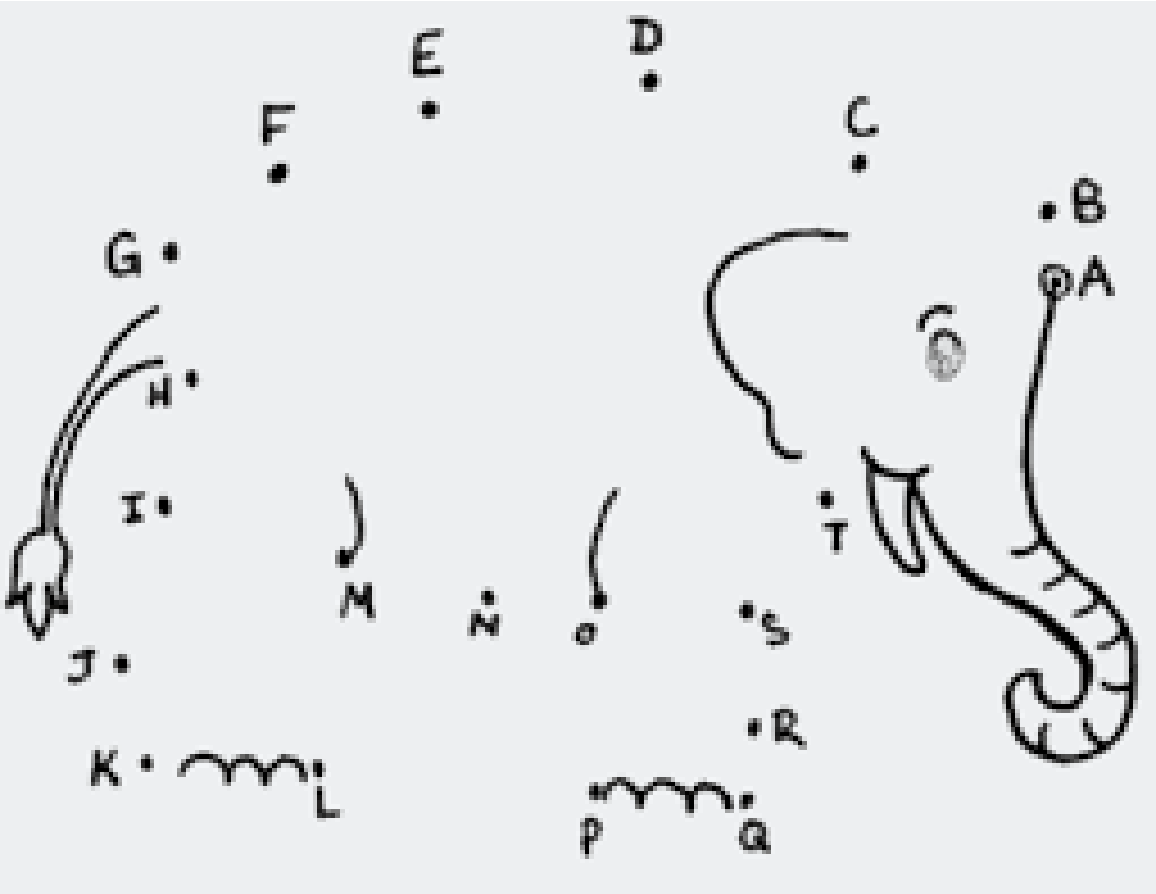
Becomes more problematic with increasing use of IoT

Effects over time may be difficult to predict



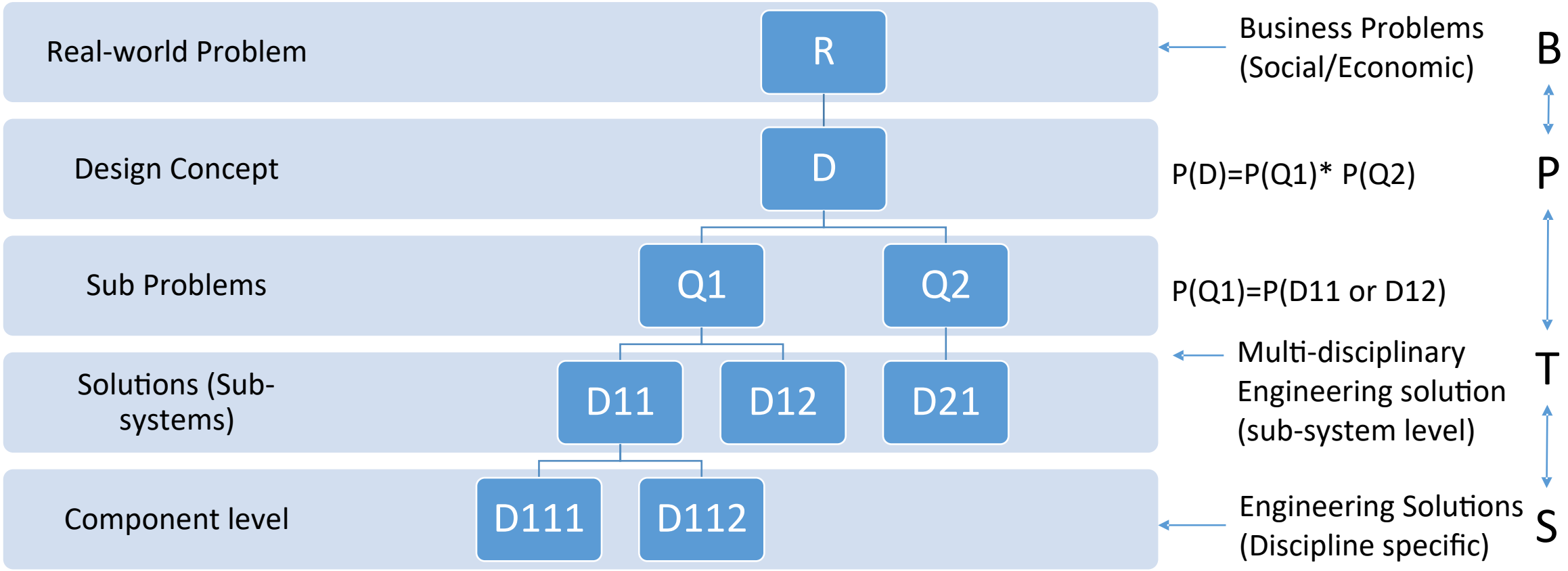
Did we change the TECHNOLOGY? OR It CHANGED us?

Exercise 2.2: Is there scope for taking a more holistic view of your problem/idea? (15 min)



Can you see the elephant in your opportunity/idea description or are you seeing the tail/trunk?

Are you able to see the difference between problem space & solution space?



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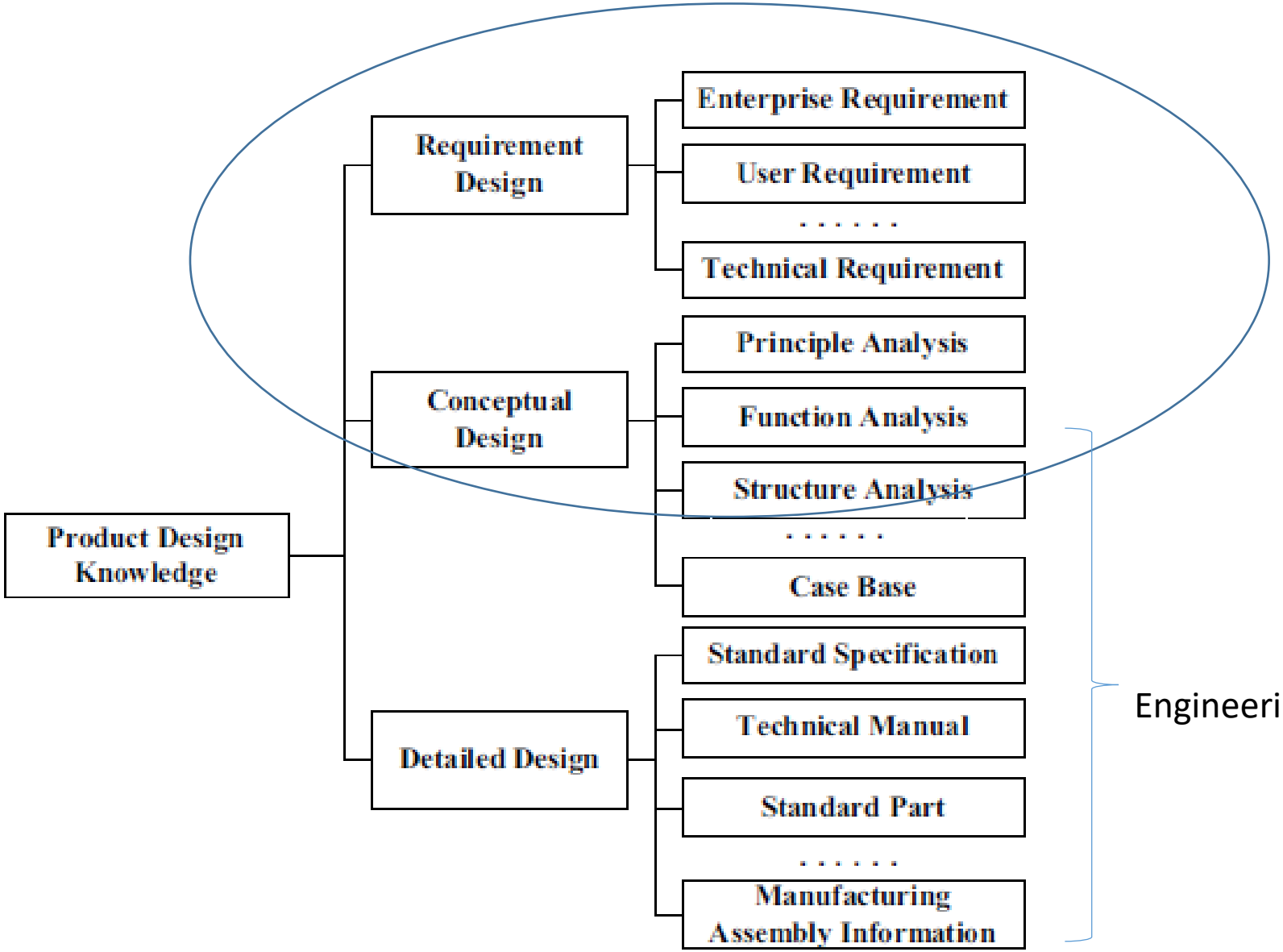
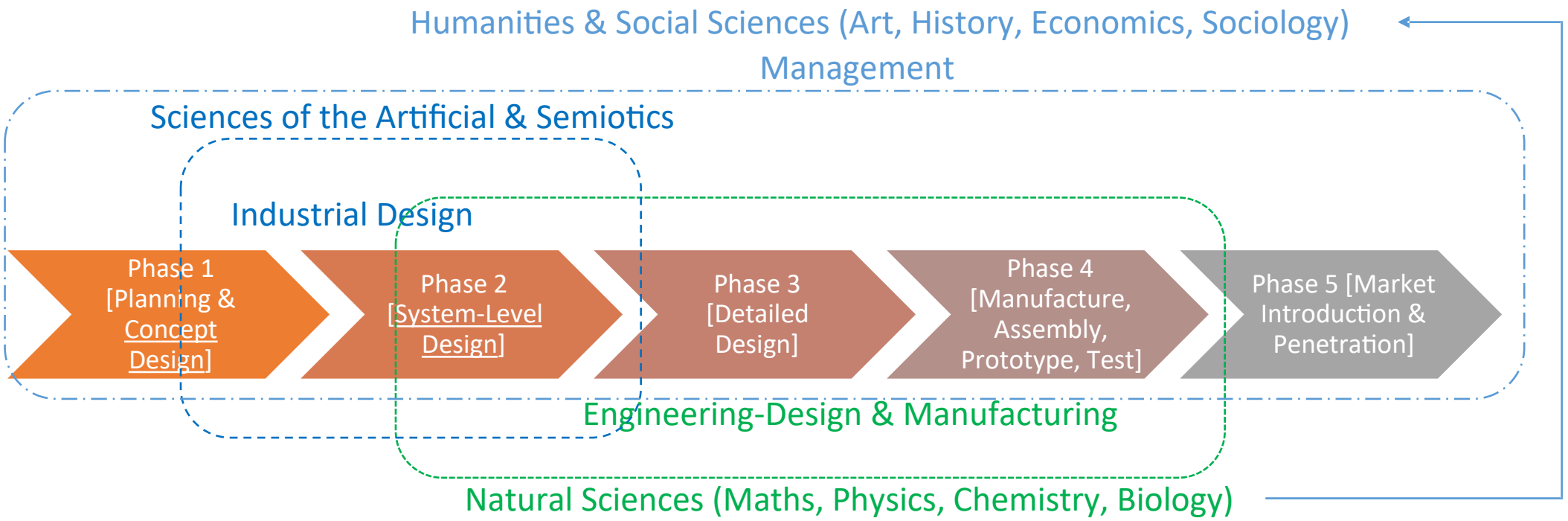
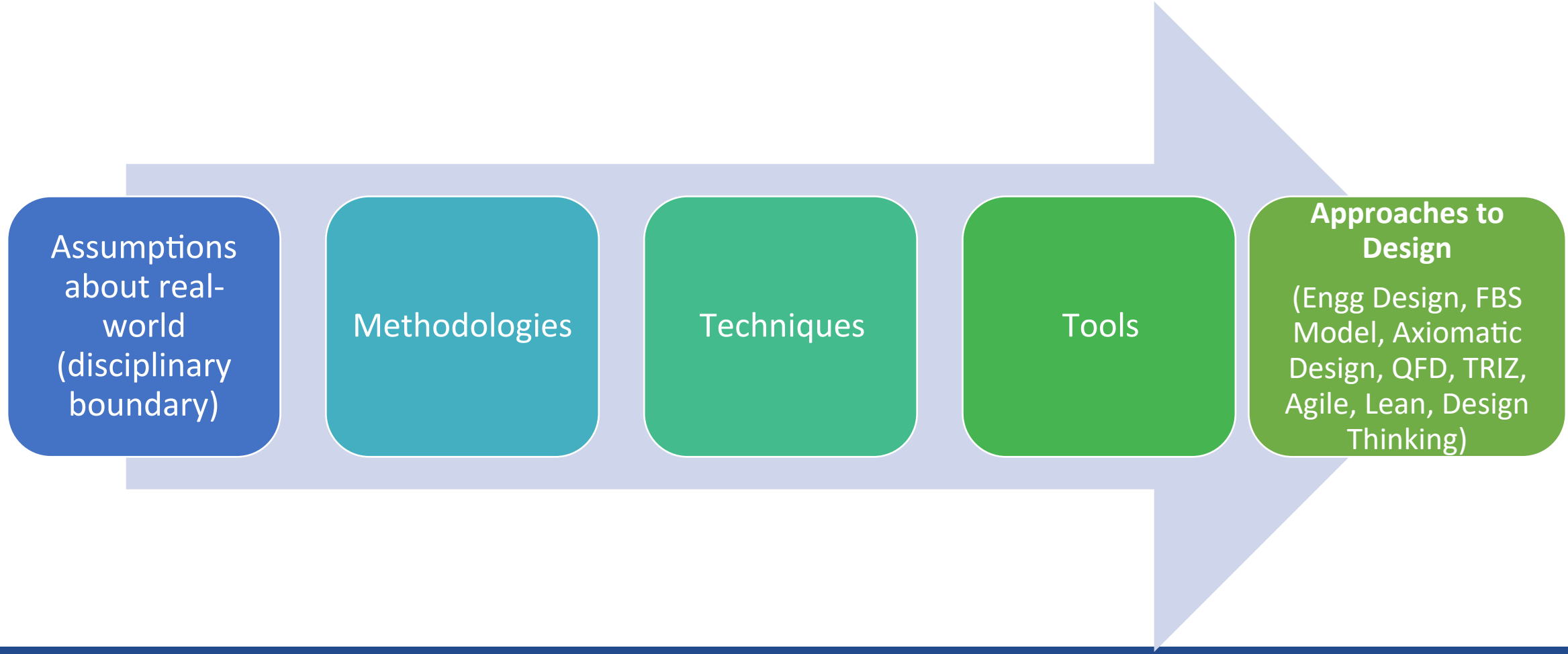

Product Design Knowledge
Requirement Design
Conceptual Design
Detailed Design
Enterprise Requirement
User Requirement
. . . . . .
Technical Requirement
Principle Analysis
Function Analysis
Structure Analysis
. . . . . .
Case Base
Standard Specification
Technical Manual
Standard Part
. . . . . .
Manufacturing Assembly Information
Engineering Design

Multi-disciplinary & cross-functional challenge

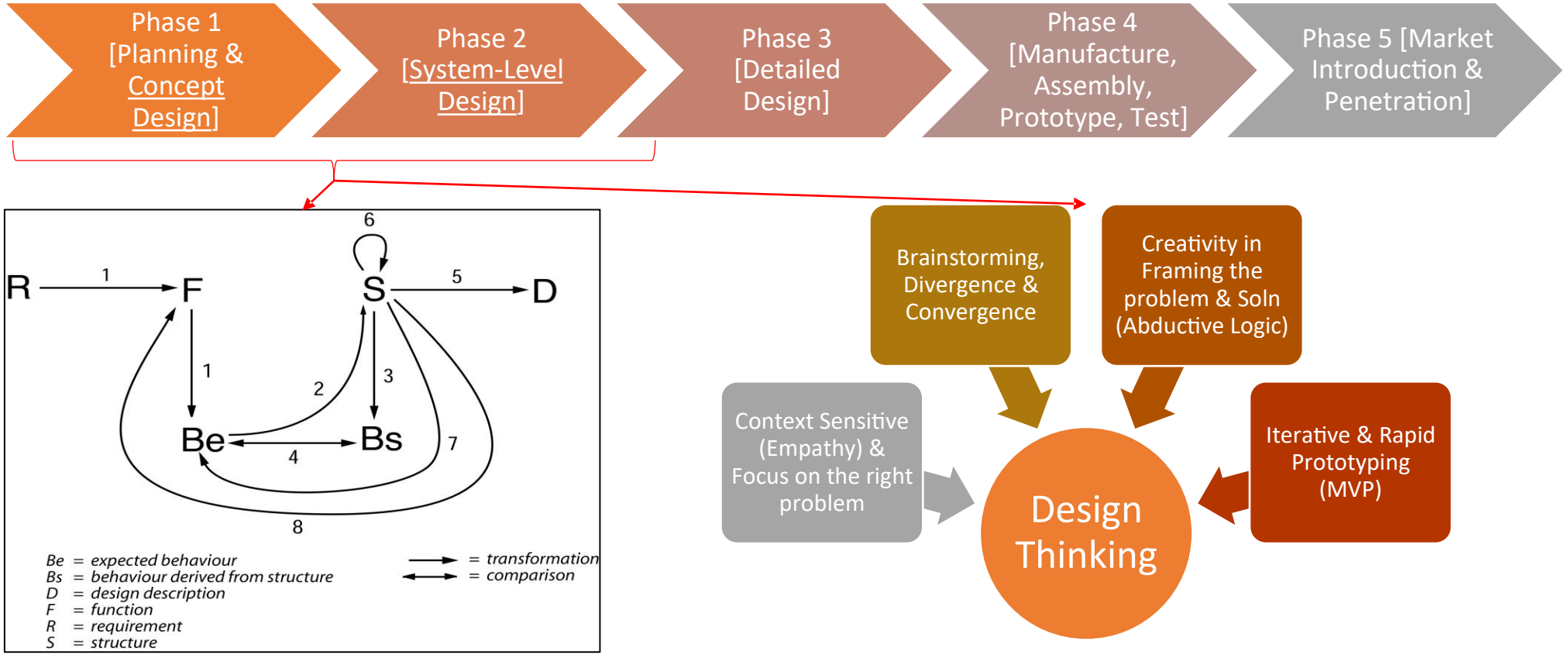


INCOMMENSURABILITY

Multiple disciplines = Multiple approaches



Popular Approaches to Product Design



FBS Framework

Design Thinking of Stanford University & IDEO

Approaches differ in their core assumptions

Real-world problem situations have

Ambiguity

Inter-dependency

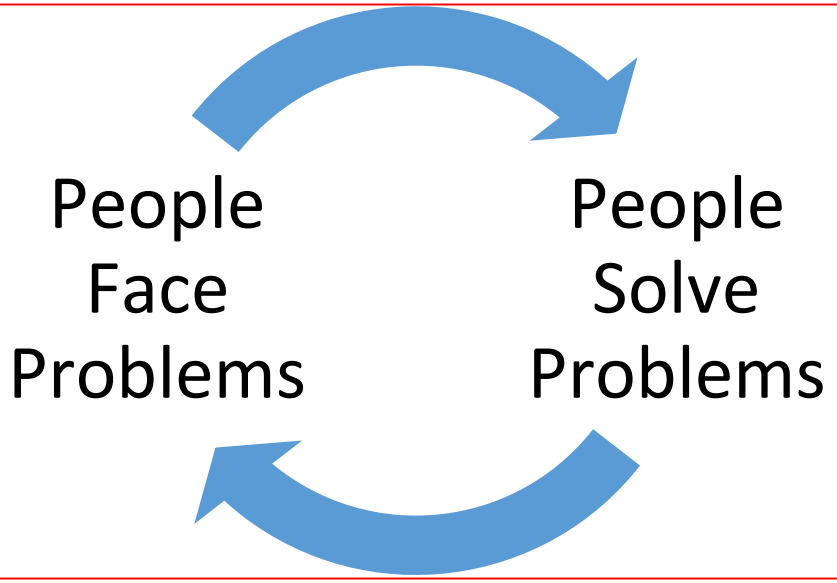
Uncertainty

Multi-disciplinarity

Systems Thinkers are more concerned about these issues because

How do we DESIGN solutions that are creative, efficient and economical?

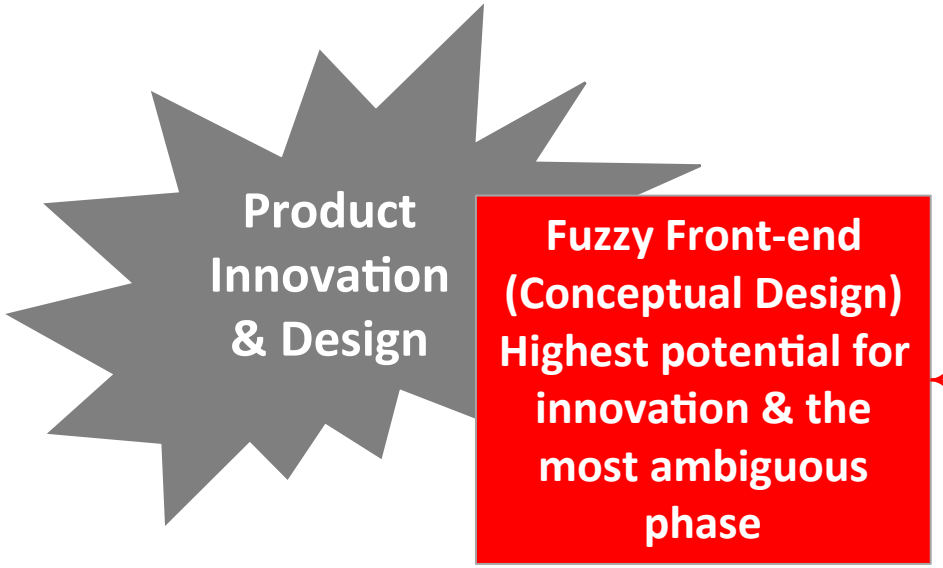
Engineers, Industrial Designers & Managers focus a lot on this



Far more emphasis on Discovery & Diagnosis coupled with iterative approach can help focus on the right Design Challenge

How do we ensure that the SOLUTION is effective, does not create new problems or worsen the original problem?

FFE & NPD needs a Holistic Approach

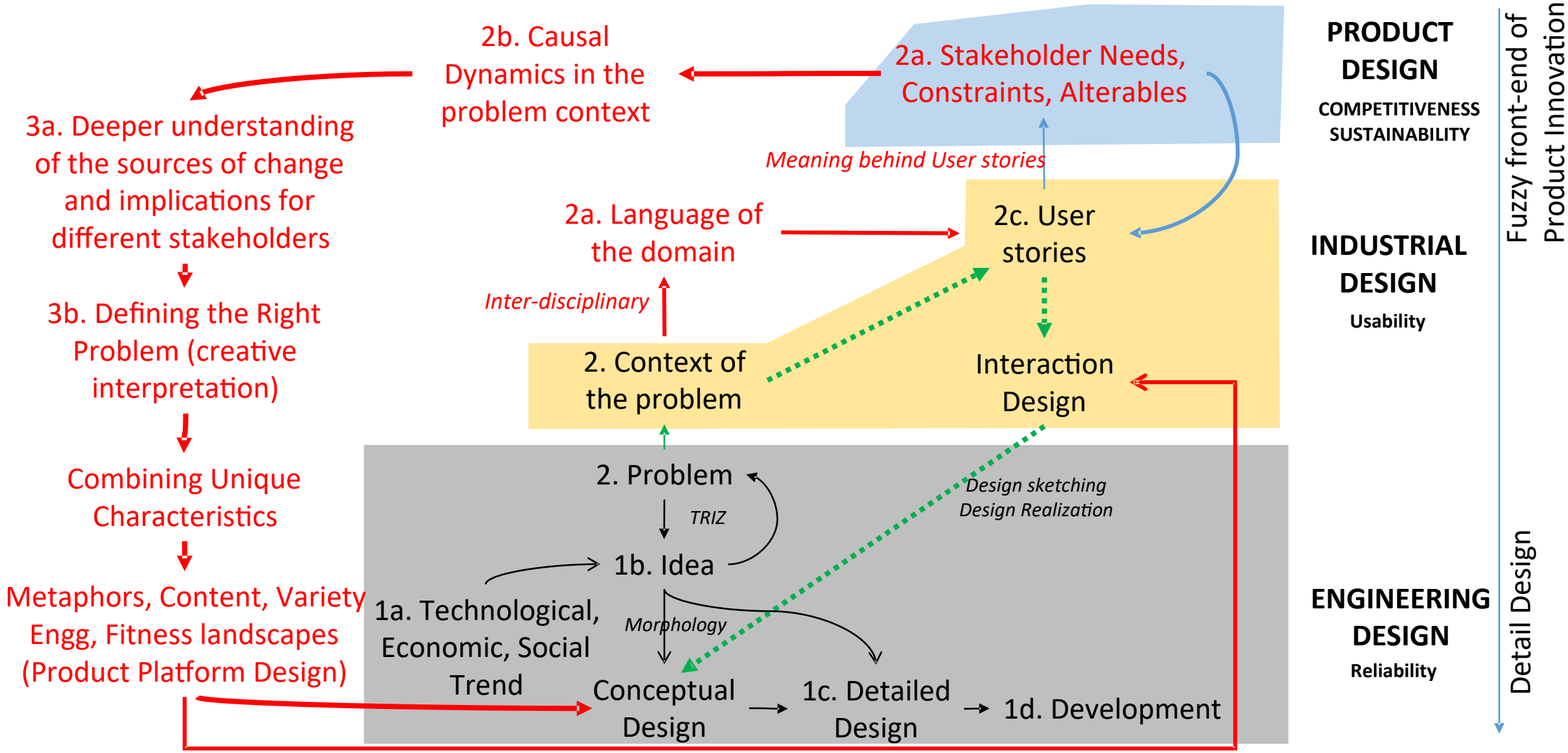


Fuzzy Front-end (Conceptual Design) Highest potential for innovation & the most ambiguous phase

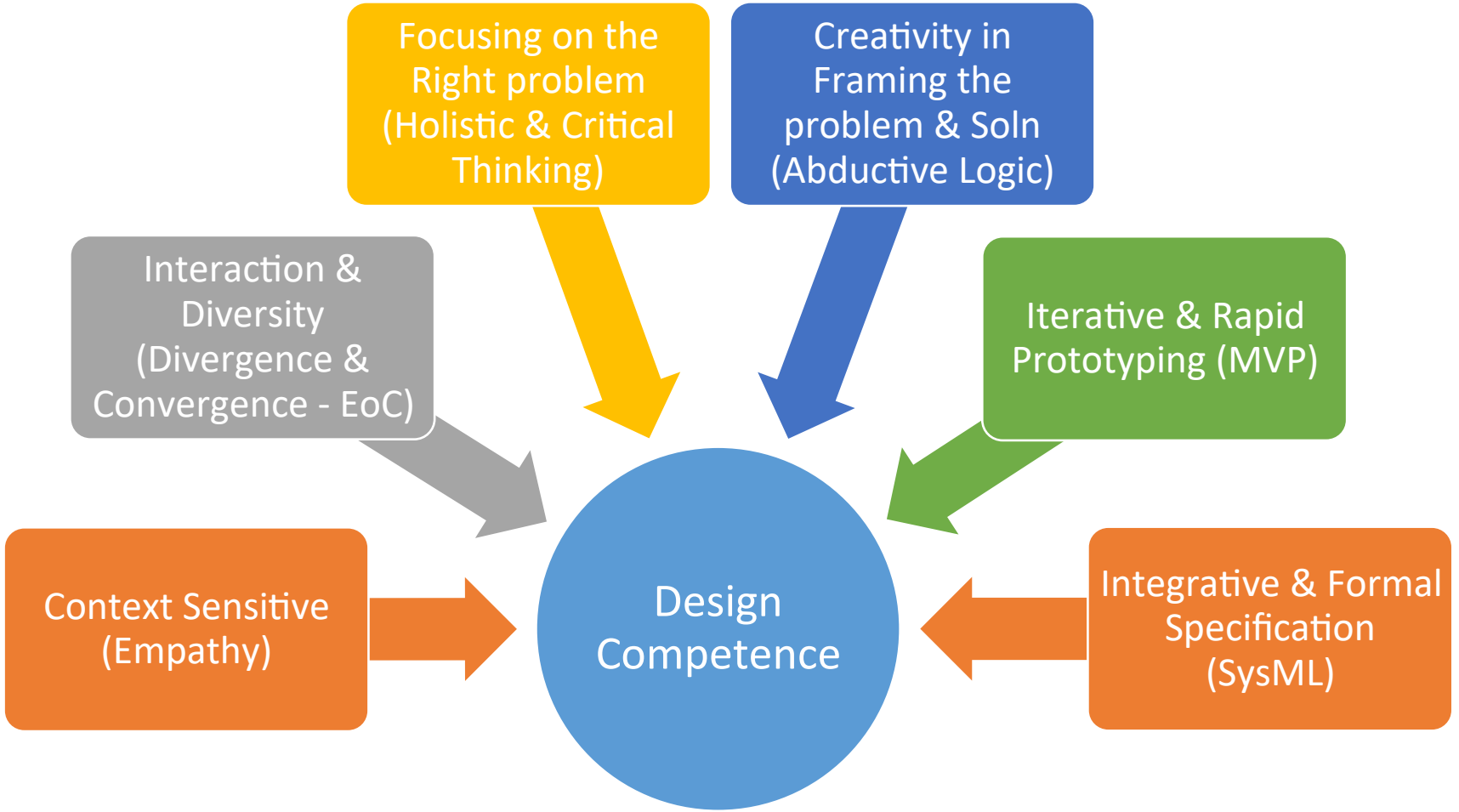
- Ambiguity
- Inter-dependency
- Inter-disciplinary
- Uncertainty

1. Diverse Perspectives & Interactive
2. Qualitative Modeling (Semi-mathematical & Pictorial)
3. Integrative theory / concepts
4. Iteration, Simulation, Physical models & Time to market

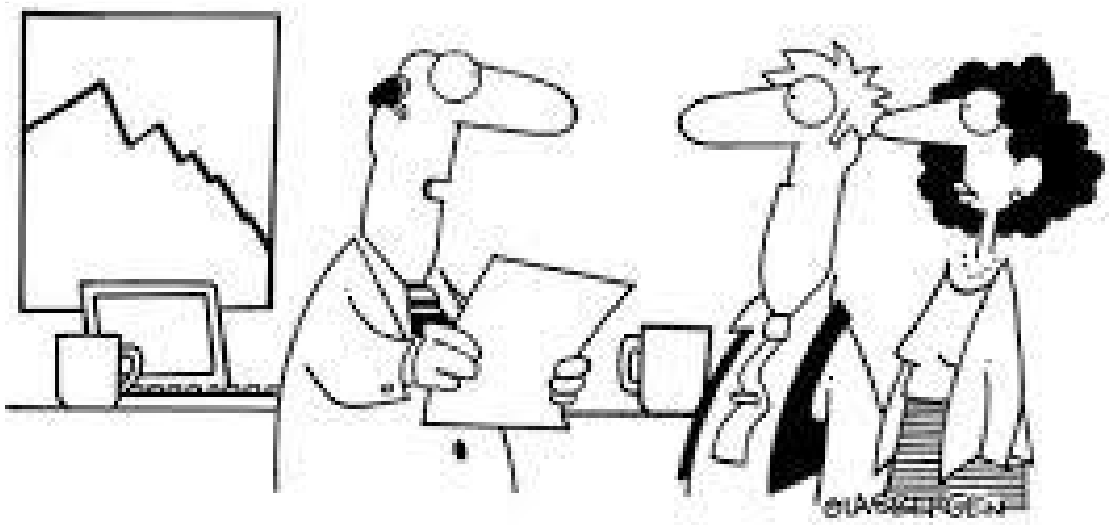
Systems Thinking helps in Holistic Design



Systems thinking enhances design competence



While approaches are useful in different ways, never forget that design is a social activity



"Thinking outside of the box didn't work.
Thinking inside of the box didn't work.
Maybe it's a defective box!"

Expert designers pay attention to the real issues without becoming prisoners of methods … Pay greater attention to collaborative problem solving

Welcome to the world of inter-disciplinary concepts

Reflect on today's session and post your comments