

Application of TRIZ tools in “Creative Problem solving and Engineering Design” Curriculum

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Structure of “Engineering Design” Curriculum

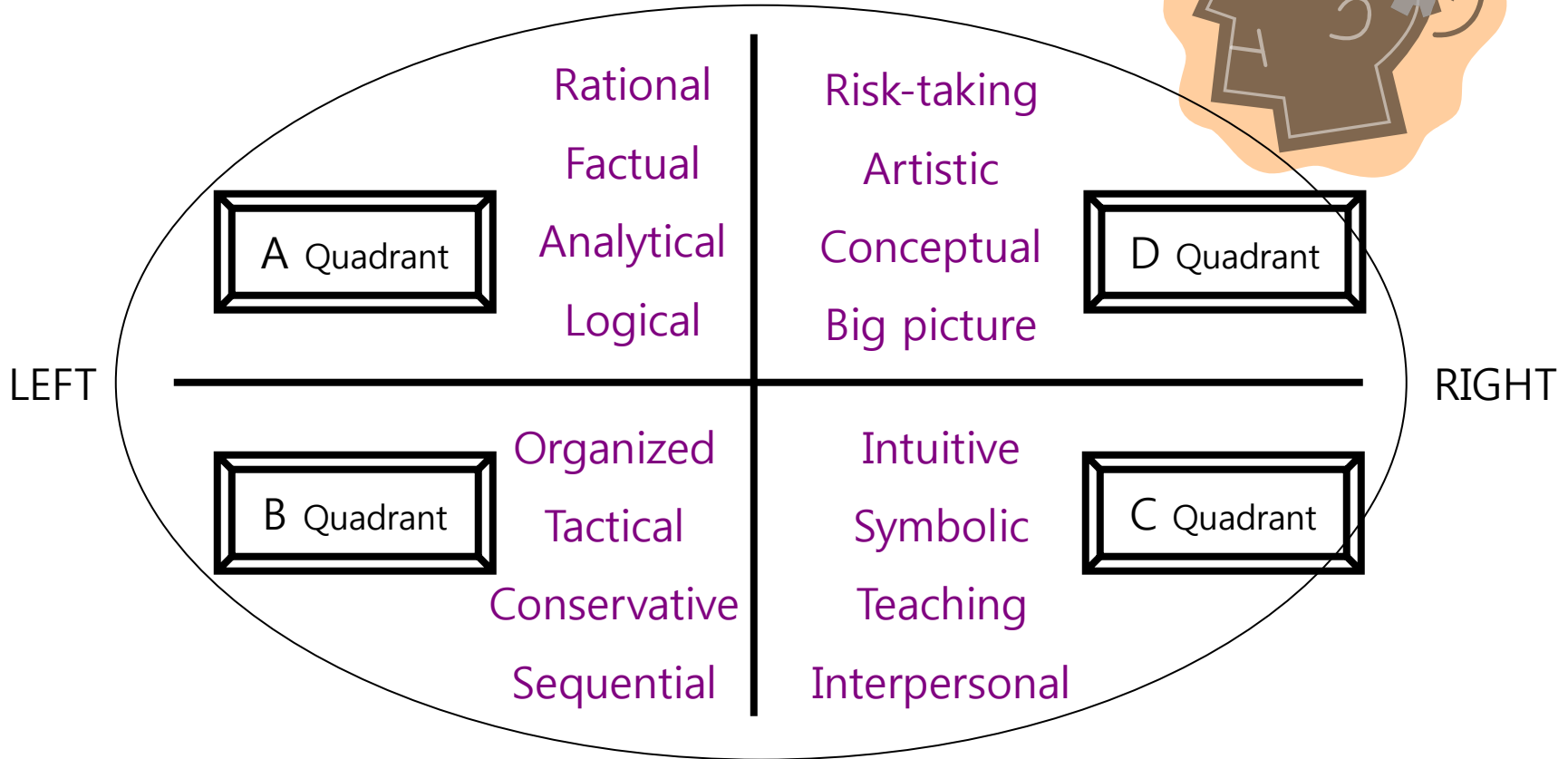
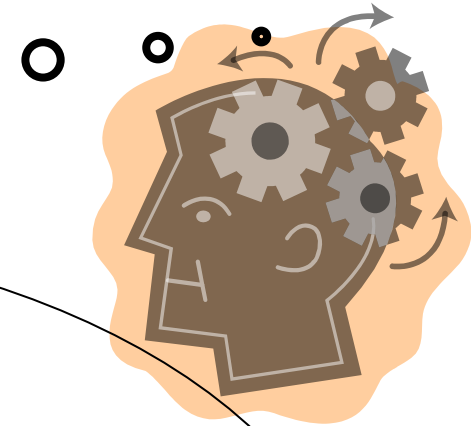
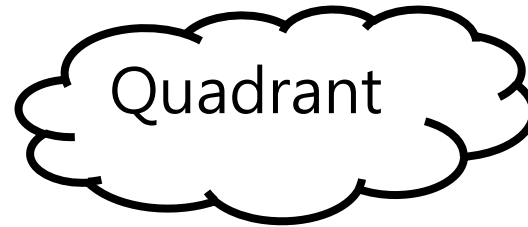
Part 1 : Team building

- ◇ Members role
- ◇ Team rule

Part 2 : Problem solving Process

- ◇ Task seeking
- ◇ **Identification of Problem**
- ◇ **Solution searching**
- ◇ Engineering Design
- ◇ Prototype making
- ◇ Presentation

Team Building_ By HBDI Propensity investigation



Team development_ Roles of team members



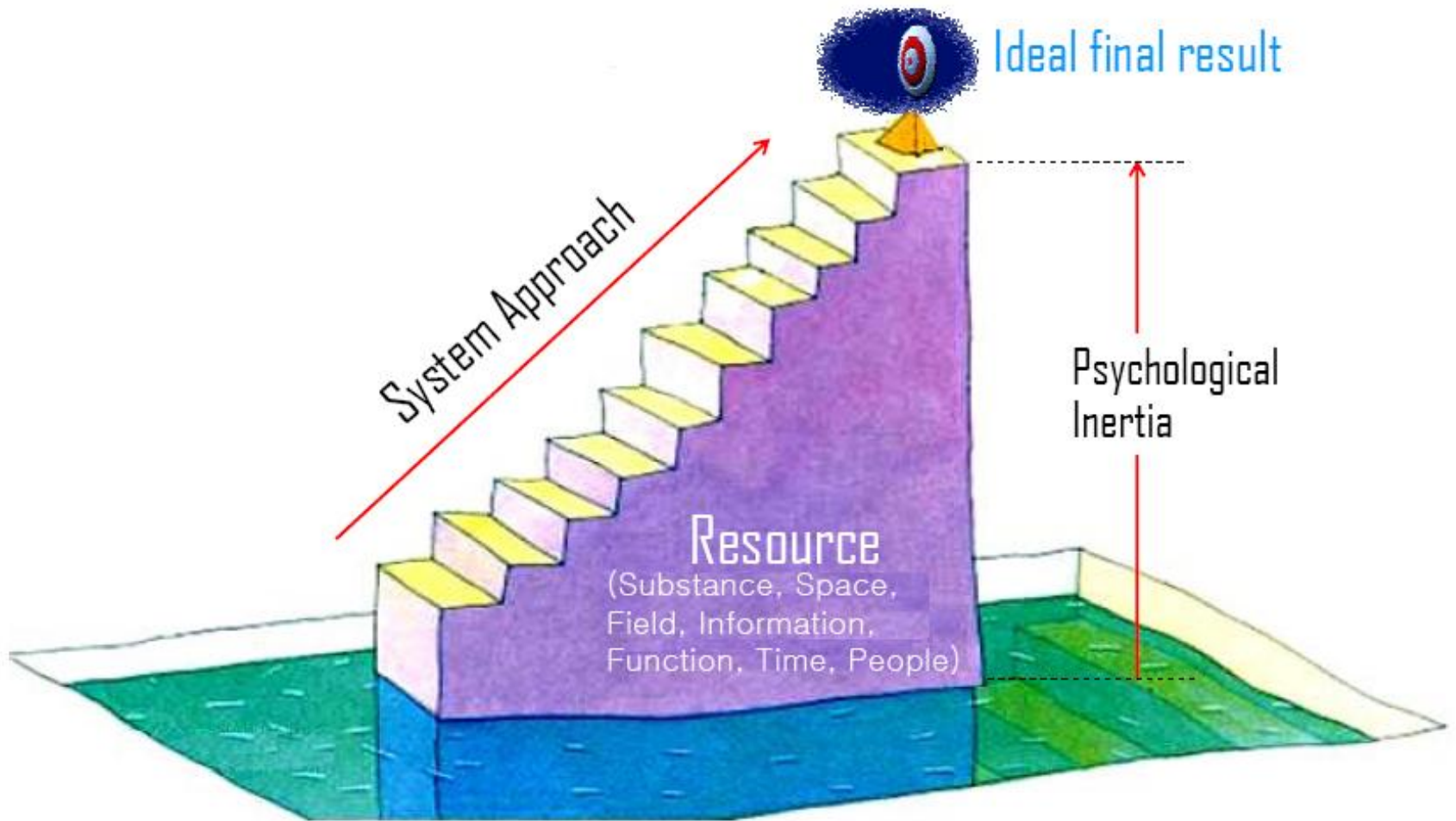
Team Members	
Recorder	Information seeker
Process observer	Information giver
Opinion seeker	Elaborator
Encourager	Orienter
Opinion giver	Evaluator
Coordinator	Energizer
Harmonizer	Procedural Technician
Gatekeeper	Process observer
Initiator	

Whether we like it or not, we are all in this together

TRIZ' Problem solving process

No	Step	TRIZ tools
1	Problem Description	Problematic situation expression by picture IFR Description
2	Problem Analysis	Function analysis, Main tool, object selection, Substance-field modeling, Resource analysis, 9 windows, STC operator, Small little people modeling, contradiction analysis
3	Idea generation	MATChEMIB, separation principle, Contradiction matrix, Substance-field, 9 windows , Scientific Effect
4	Creative evaluation/idea judgment	Evaluation Criteria(ideality, Contradiction' solving, Idle resource), Technical evolution law
5	Implementation	Engineering design start

Problem Solving Framework



Resource Analysis

Resource	Description
Substance	System and materials which composes an environment (circumference which relates with invention), the product, the additive, the waste and integral part, the price which is cheap, the material flowing, quality etc. of the material
Energy (Field)	Mechanical field (gravity inclusion), heat field, the chemical field, the electronic field, the acoustic field, the energy which to throw away from inside system, the energy which comes from an environment
Time	Operational order, operational time interval, arranging in a row control, advance control, partial preliminary operational etc.
Space	Empty space, different dimension, piles up, inserting, vertical arrangement
Function	All acts the system will be able to accomplish the function which is useful, use of adverse effect
Information	The material expelling, information which moves, change of condition and condition of the resources which is temporary

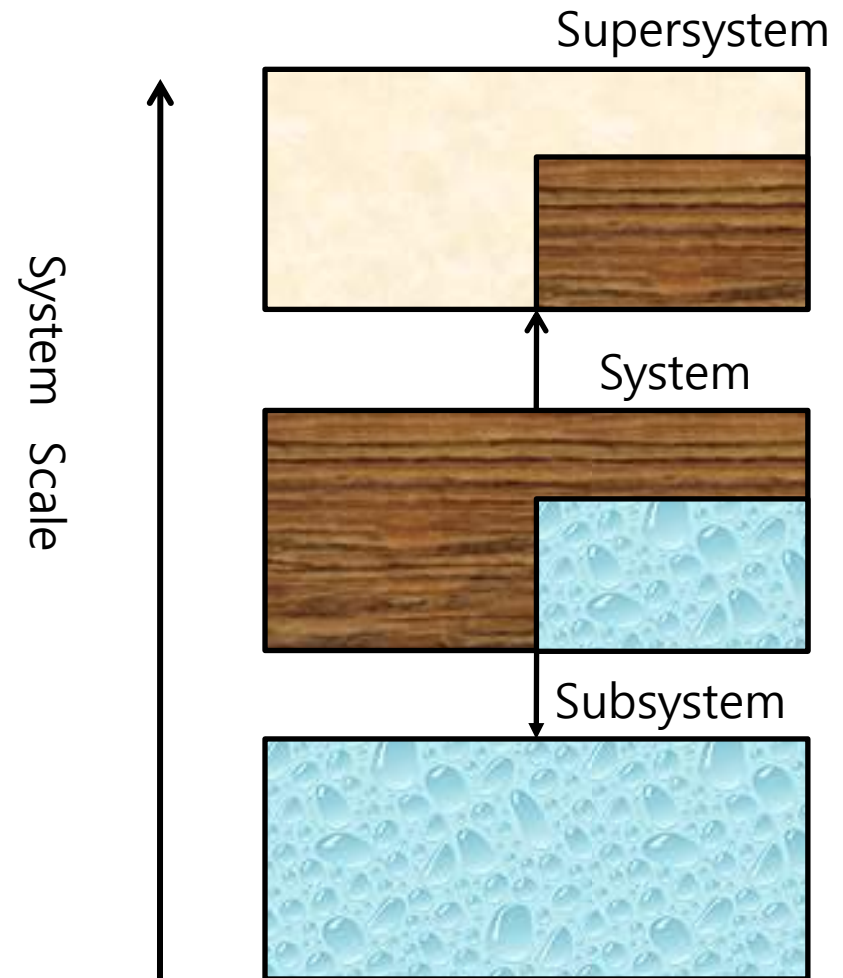
Criteria for Resource Analysis

Dividing the resources	Content
Resource type	Tangible : Material and information, person
	Intangible : field , time, space, function,
Resource location	System inside (tool and object) : Sub system
	System
	system outside (circumferential environment) : Super system
Available Resource	Readily available resources
	Derivative resources
	Differential resources

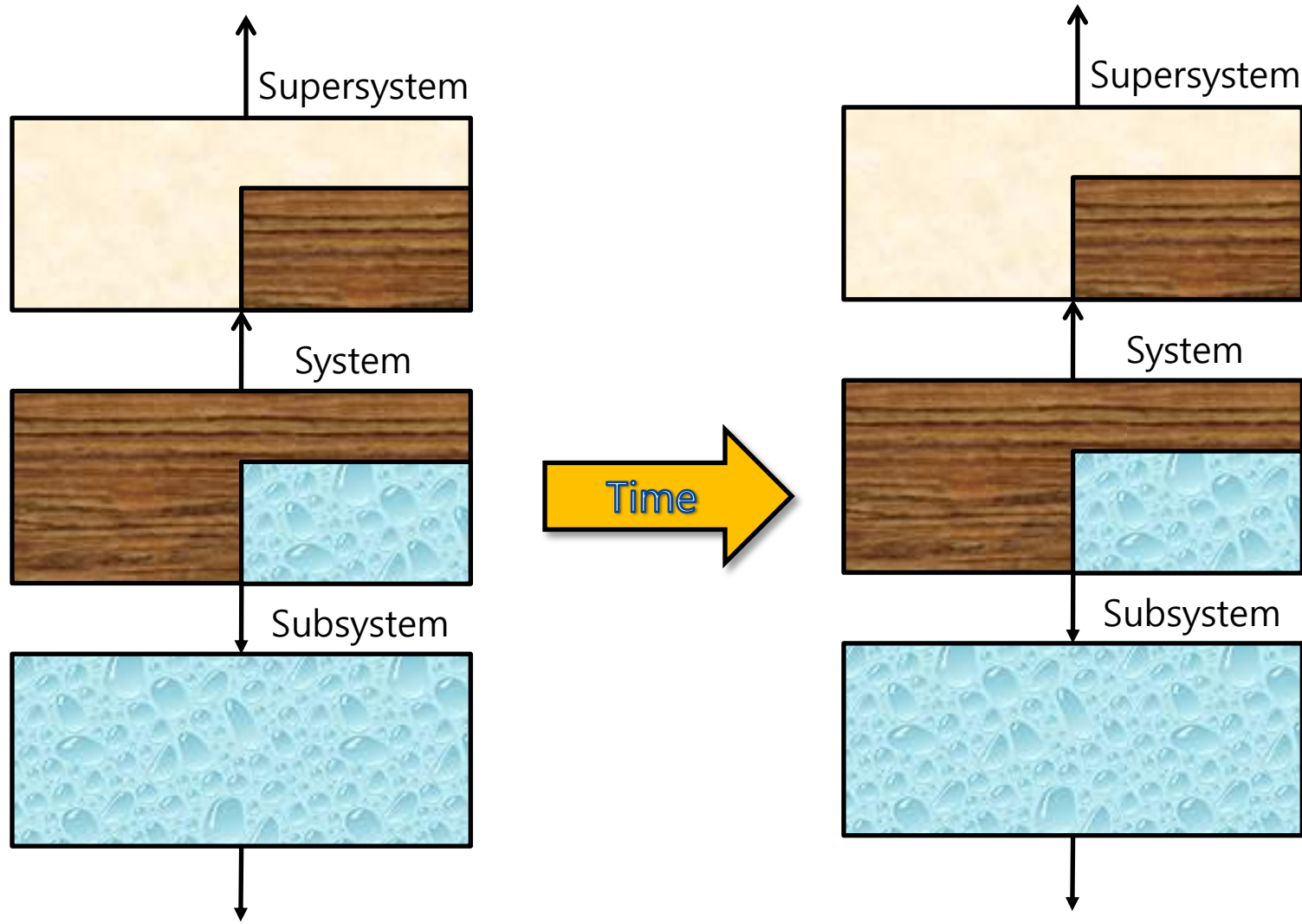
Understanding of System for Resource Analysis

Technical system exist not in isolation. Each one is part of a super system of which it forms a part reacting with other parts. But the systems themselves also consist of interacting parts and subsystems. The first indicator of talented thinking is the ability to shift from the system to the sub- and supersystem and for this three mental screen have to be at work.

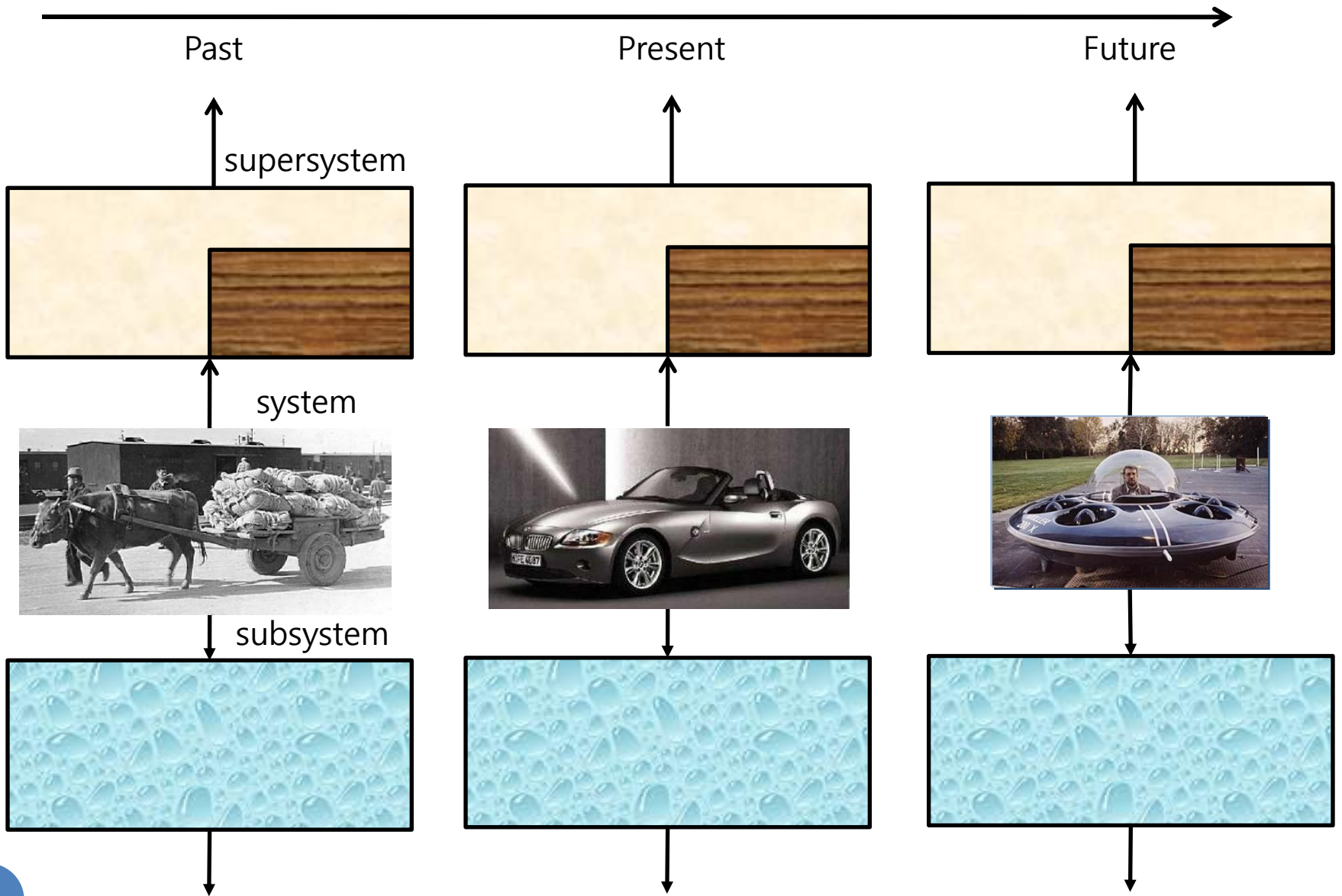
From "Creativity as an Exact Science"(G. S. Altshuller)



The technical system changes according to time.



Time Scale



Is the reason that engineer often not able to solve a problem ?

Restricted condition of the inside and the outside, and psychological inertial is caused by it

Talent thinking becomes the help which removes psychological inertia.

	past	present	future
supersystem			
system		Ours brain stays in usual here	
subsystem			

	past	present	future
supersystem	Actual problem and the solution can be to here	Actual problem and the solution can be to here	Actual problem and the solution can be to here
system	Actual problem and the solution can be to here		Actual problem and the solution can be to here
subsystem	Actual problem and the solution can be to here	Actual problem and the solution can be to here	Actual problem and the solution can be to here

Problem Analysis

1

Function Modeling

2

Substance-Field
Modeling

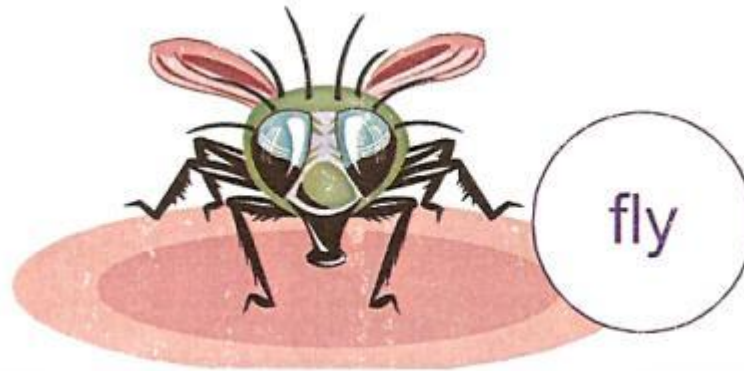
3

Small Little People

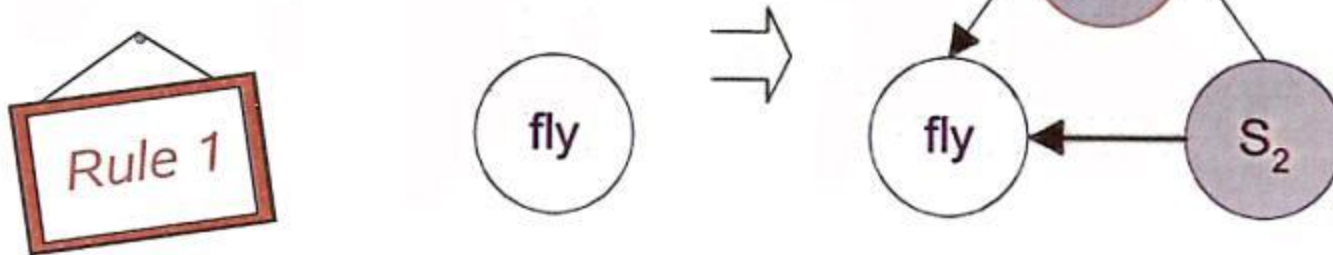
Modeling the situation : Fly

Step 1 :

Step 2 :



Step 3 :



Understanding of Field

M
A
T
C
E
M
I
B

Fields	Interactions Including
Mechanical	Gravitation, collisions, friction, direct contact
	Vibration, resonance, shocks, waves
	Gas/Fluid dynamics, wind, compression, vacuum
	Mechanical treatment and processing
Acoustic	Deformation, mixing, additives, explosion
	Sound, ultrasound, infrasound, cavitation
Thermal	Heating, cooling, insulation, thermal expansion
	Phase/state change, endo- exo-thermic reactions
	Fire, burning, heat radiation, convection
Chemical	Reactions, reactants, elements, compounds
	Catalysts, inhibitors, indicators (pH)
	Dissolving, crystallisation, polymerisation
	Odour, taste, change in colour, pH, etc.
Electric	Electrostatic charges, conductors, insulators
	Electric field, electric current
	Superconductivity, electrolysis, piezo-electrics
	Ionisation, electrical discharge, sparks
Magnetic	Magnetic field, forces and particles, induction
	Electromagnetic waves (X-ray, Microwaves, etc.)
	Optics, vision, colour/translucence change, image
Intermolecular	Subatomic (nano) particles, capillary, pores
	Nuclear reactions, radiation, fusion, emission, laser
Biological	Intermolecular interaction, surface effects, evaporation
	Microbes, bacteria, living organisms
	Plants, fungi, cells, enzymes

1. Mechanical field

- ◆ Gravitational force field
- ◆ Interaction or phenomenon by direct contact like shock
- ◆ vibration, resonance, shock and wave motion (the acoustic vibration exclusion)
- ◆ Gas and fluidal dynamics, winds, the phenomenon which relates with a pressure, a compression and a vacuum
- ◆ Mechanical control and process
- ◆ Variation, mixture and the additive (there is not reaction which is chemical), the interaction which is connected with insertion, extraction, removal and addition etc.
- ◆ Explosion (that changes the material with explosive means)

Idea Generation using substance-field

Step 4 :



What about a fly-swatter?



Sucking the fly in looks good!



Let us blow the fly away!



I will shoot it down!



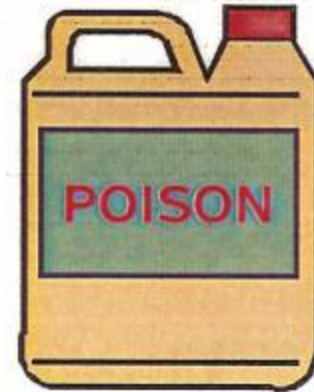
Let us glue it down!



I hate classics!



**I will get rid of you
pests!**



**And what about
this?**



**Heating or
freezing insects to
death is possible**



**Cover the insect
with a liquid able
to crystallise!**



We may fry a fly in a microwave!



Flies hate darkness and try to escape it



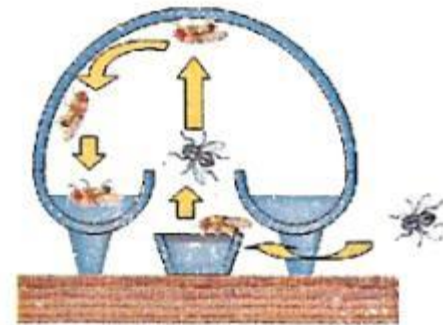
It's lunchtime!



A laser may be used too!



A genetically modified fly may not disturb humans...



We can successfully use fly behaviour!

Thinking outside the square



Good solution
ideas often hide
beyond the field
of our expertise

Evaluation criteria by IFR

Evaluation criteria	Comparison with known solution
1. Do the harmful features disappear?	
2. Are the useful feature retained? Will new benefits appear?	
3. Will new harmful features appear?	
4. Does the system becomes more complex?	
5. Is contradiction resolved?	
6. Are idle, easily available, earlier ignored resource used?	
7. Other criteria : Easy to train firefight to use?	

conclusion

- ◆ " In engineering design curriculum" the application of TRIZ tools is very effective in student project progress.
- ◆ 9 Windows deployment which connects in resources analysis are the tool which is useful from problem analysis step.
- ◆ Functional analysis and substance-field analysis are usefulness in idea generation, but understanding of field must precede.