Korea TRIZ Conference

FOS and TESE in real project

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Create Solutions using “Analogy” in TRIZ

“Analogy” is the process of comparing one thing with another that has similar features.

Use “Analogy” to create solutions in one technical system by investigating other technical systems with similar features.

“Analogy” supports to generate “proven” solutions fast.

“Analogy” is used in TRIZ tools such as

Function Oriented Search,

Physical Contradiction,

Trends of Engineering System Evolution

and Harmful Machine Theory.

Contents

Function Oriented Search

Utilize global knowledge to achieve more effective innovation faster

There are proven technologies somewhere in the world that can address your key problems

The “Leading Area” is an industry or scientific field in which similar functions have high importance

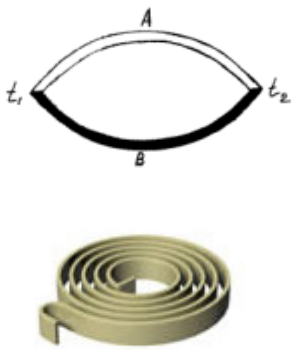
Generalize Functions to search in the “Leading Area”.

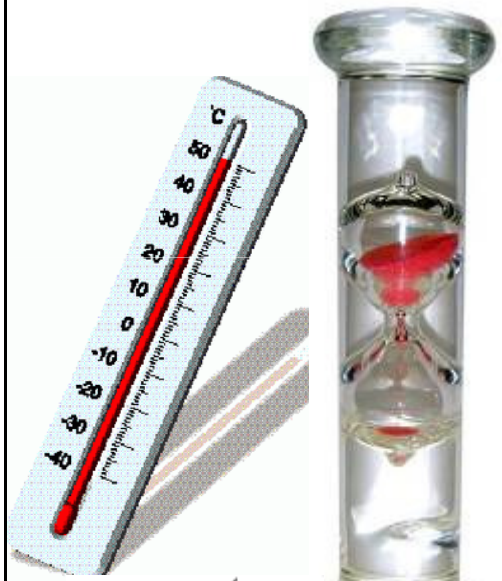
If solution from “Leading Area” is expensive, go to another Areas.

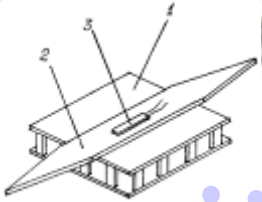
Function Oriented Search

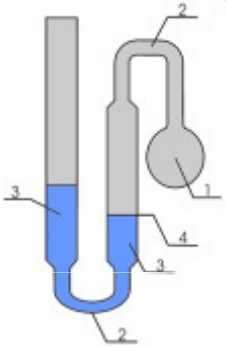
How Many Ways Can You Measure Temperature?

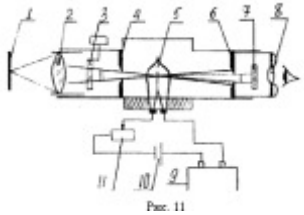
SOLID BODY	LIQUID	GAS	FIELD
• Bimetallic plate • Spiral • thermocouple • semiconductor thermometer of the resistance			• Termoelektricheskie thermometers. • The Device thermo-electrical thermometer • Standard and non-standard thermometers • The Electric thermometers of the resistance • The Types and designs TS • The Bridge schemes of the measurement of the resistance thermometer • The Balanced bridge • The Unbalanced bridge • The Automatic balanced bridges • The Measurement thermo-E way • The Automatic potentiomete • The Noncontact measureme • The Main notions and laws o • The Pyrometers of the partia • The Optical pyrometers • The Photoelectric pyrometer • The Pyrometers spectral rela • The Pyrometers of the total r











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http://www.fos.ru/fisika/12338_1.html

Function Oriented Search

◆ FOS Steps

Step 1: Define Main Function

Step 2: Define Root Function

Step 3: Search for Examples and Ideas

Step 4: Create Solutions

Function Oriented Search Example: *"Cosmetic Liquid"*

What is problems?

What is Disadvantages?

Step 1: Define Main Function

What is Main Function?

"Apply Cosmetic Liquid to Face"

Step 2: Define Root Function

- "Root function" is Abstract or Generalized Function of Main Function.
- "Root Function" must be expressed as "verb" + "noun"
- Function must explain "what to do or what to change?"
- There is a database to support defining Root Function.

Function Oriented Search Example: *"Cosmetic Device"*

RESOURCE / ACTION	SUBSTANCE	FIELD	INFORMATION
Transport (move)	1.1. Move substance Typical examples	2.1. Move field Typical examples	3.1. Move information Typical examples
Move or add	1.2. Add substance Typical examples	2.2. Add field Typical examples	3.2.Add information Typical examples
Extract Delete	1.3.Delete substance Typical examples	2.3.Delete field Typical examples	3.3.Delete information Typical examples
Hold (fix)	1.4.Hold substance Typical examples	2.4.Hold field Typical examples	3.4.Hold information Typical examples
Reflect (change direction)	1.5.Reflect substance Typical examples	2.5.Reflect field Typical examples	3.5.Reflect information Typical examples
Transform* (change of matter) * **warm/cool, hold up/accelerate**	1.6.Transform substance Typical examples	2.6.Transform field Typical examples	3.6.Transform information Typical examples

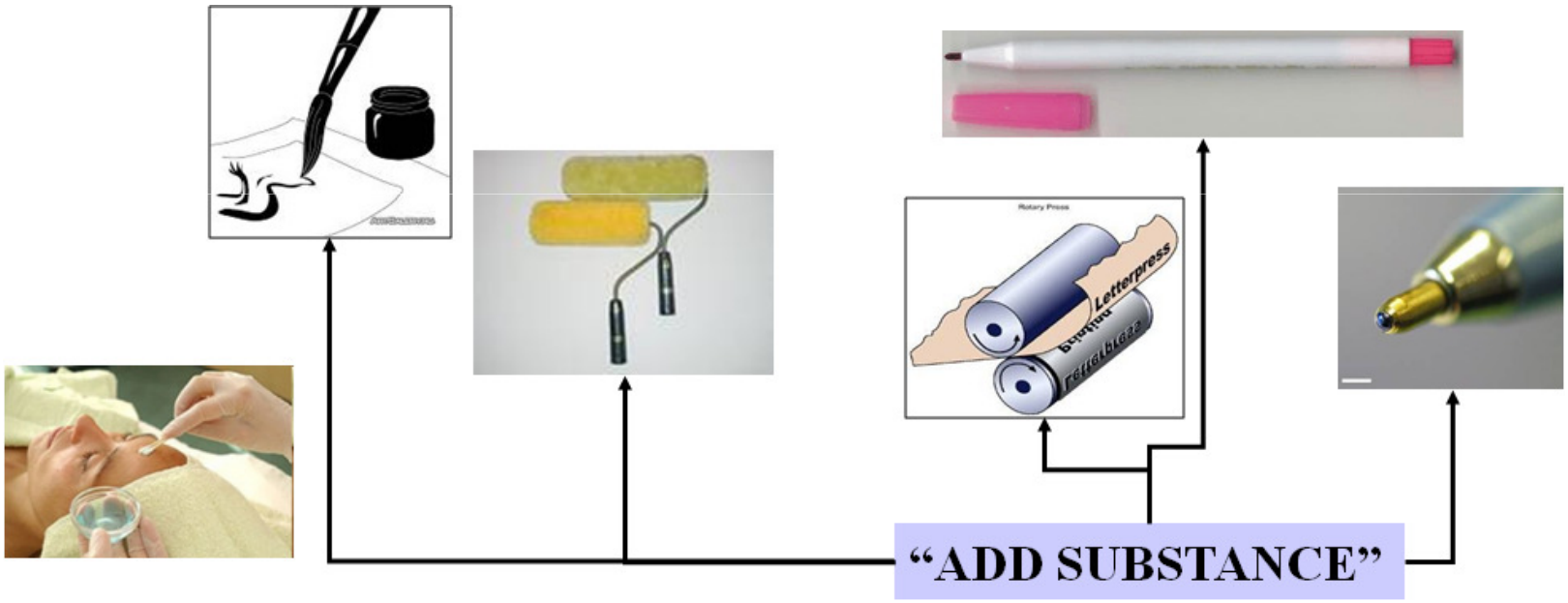
What is Root Function?

" Add Substance"

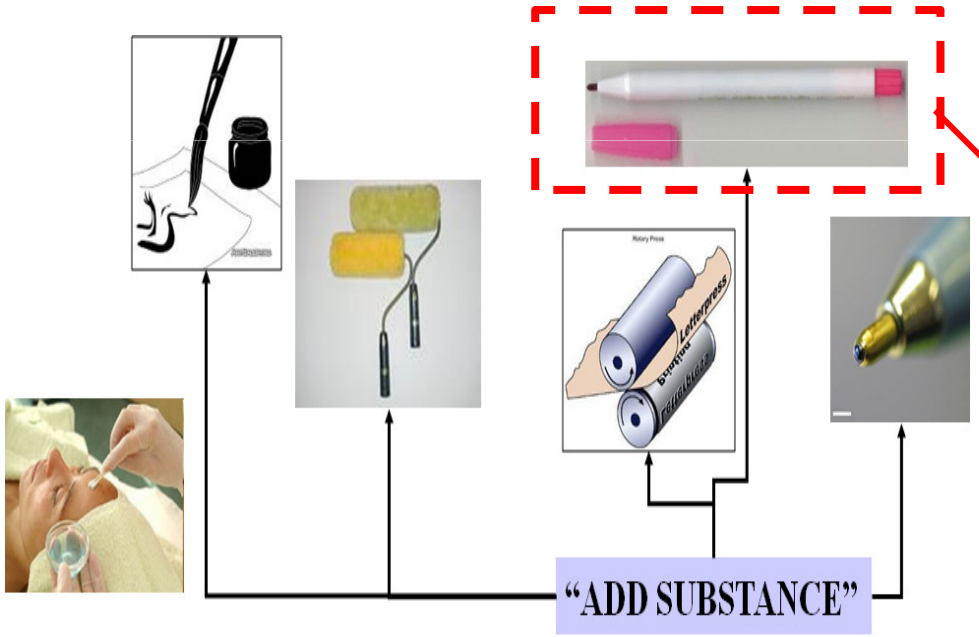
< Database of Root Function >

- Every Cell shows Typical Examples of "Root Function".

Step 3: Search for Examples and Ideas



Step 4: Create Solutions



Solution

Function Oriented Search Example: *"Cosmetic Device"*

- **Other Application with the same principle**

You can buy this device in Aero or Artware (USA).

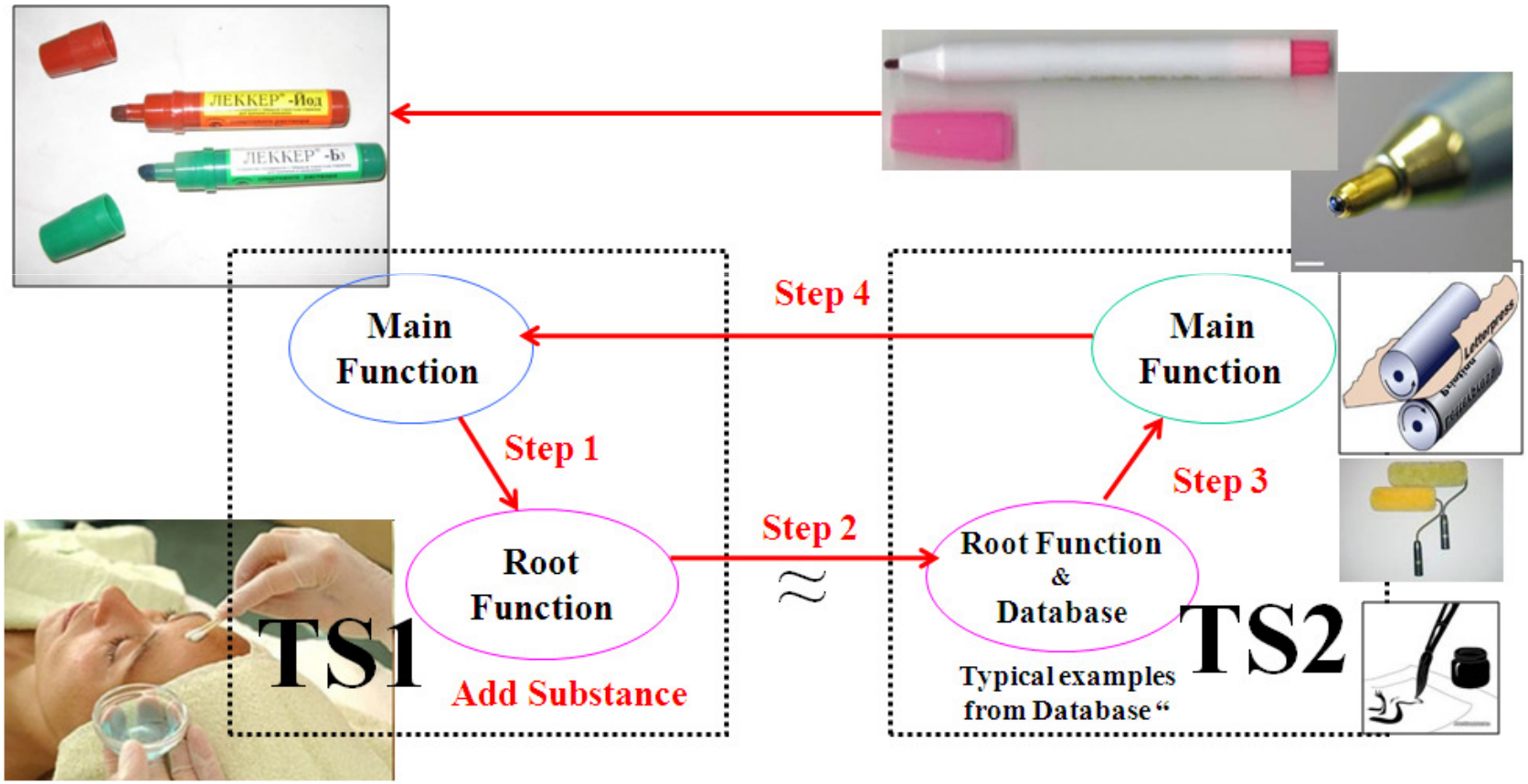
http://www.eco-artware.com/catalog/JR1-perfume.php

Function Oriented Search Example: *"Cosmetic Device"*

- **Other Application Idea with the same principle**

Function Oriented Search Example: *"Cosmetic Device"*

- **Summary**



*TS: Technical System

Contents

1. Create Solutions using Analogy in TRIZ
2. FOS (Function Oriented Search)
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3. Physical Contradiction
   - Example : "Wall Socket" & "Clothes Hanger"
4. TESE (Trends of Engineering System Evolution)
   - Example : "Business Card".
5. Harmful Machine Theory
   - Example : "Umbrella", & "Pen with Record"
6. FOS + TESE
   - Example : "Automated Labeling of Bottles"
7. Conclusions

Physical Contradiction

Physical contradiction is a model of inventive problem where opposite requirements are imposed on the same component of Technical System.

Example

- Cell Phone buttons should be small to provide for small phone body, but the buttons should be large to provide for convenient dialing.
- Computer password should be long to make its cracking more difficult, but it should be short to be easy to memorize.

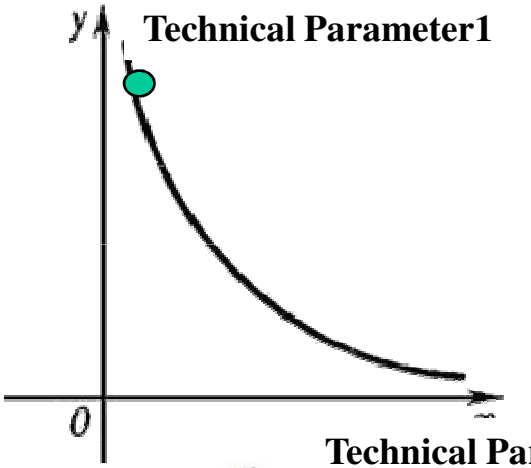
Physical Contradiction

Physical Contradiction

"keypad of the telephone"

Opposite Requirements to One Parameter

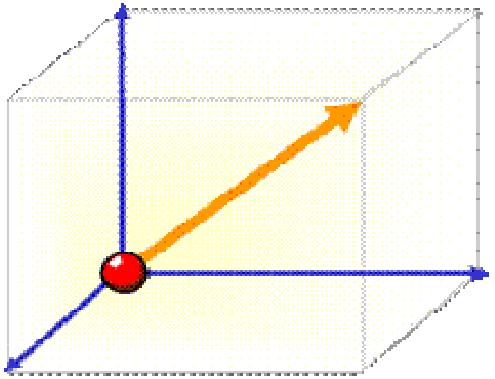
Technical Contradiction



Physical Contradiction

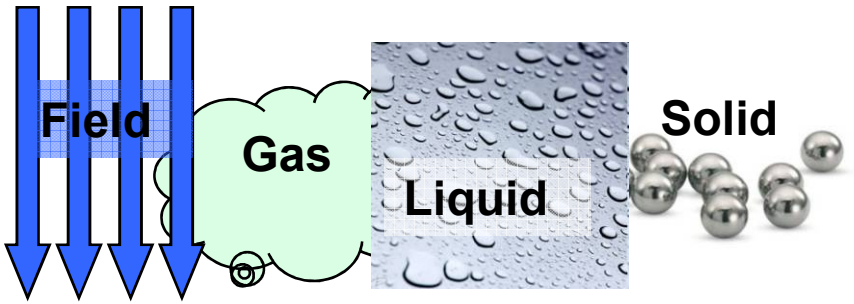
- **Separation: Typical Solutions for Physical Contradiction**

Time

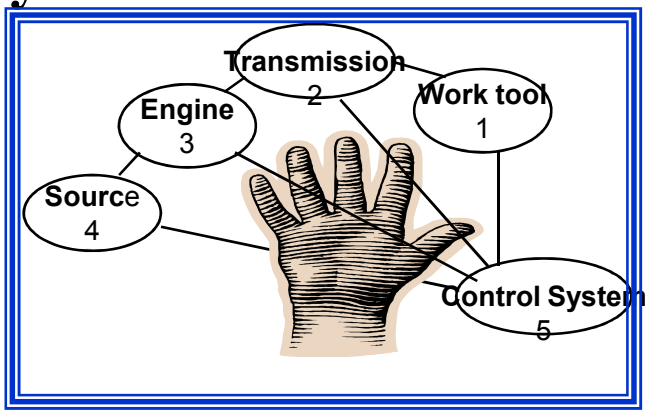


Space

Substance & Field (Materials)

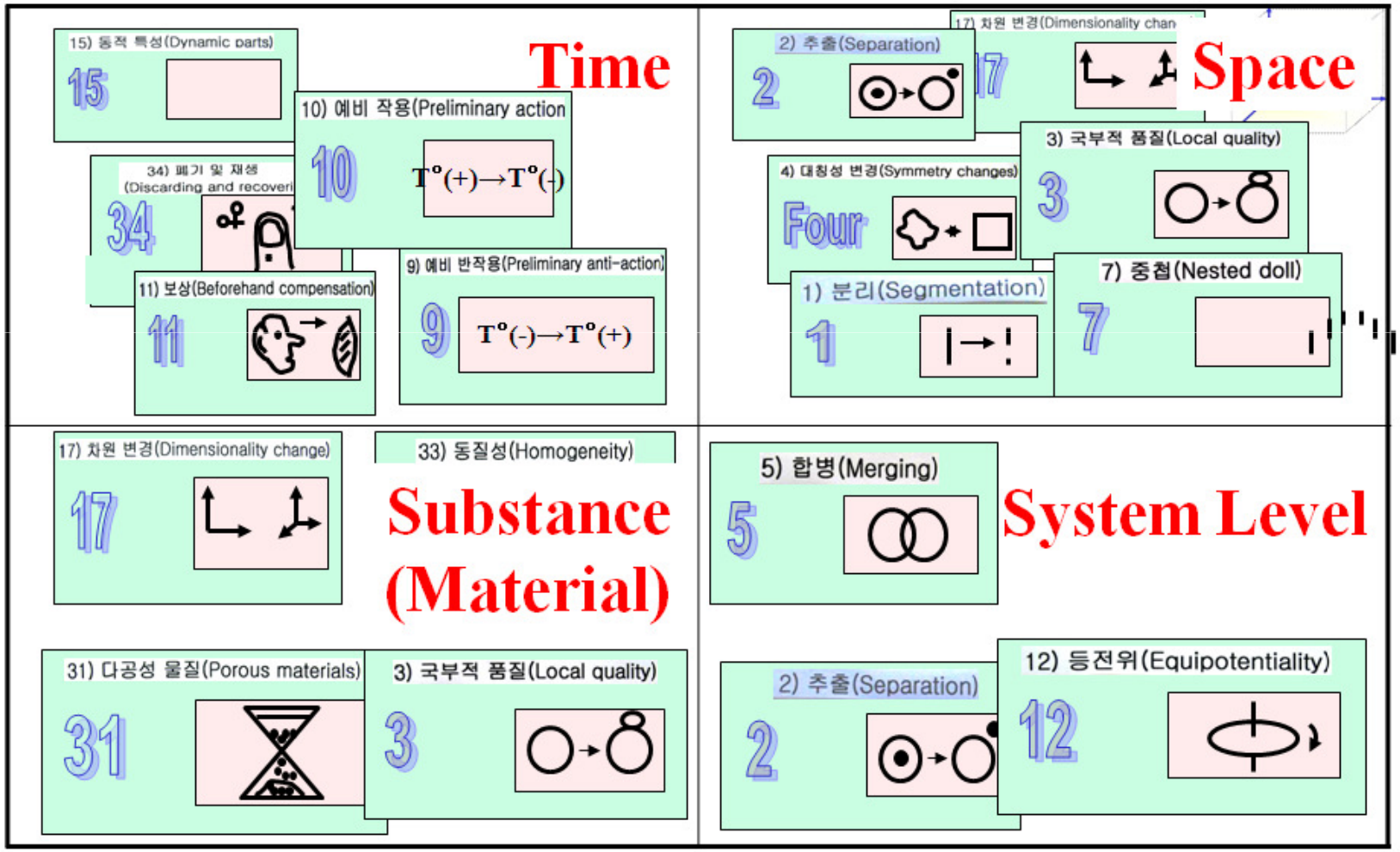


System Level



Physical Contradiction

- **Separation with 40 principles**



Physical Contradiction Example: *"Wall Socket"*

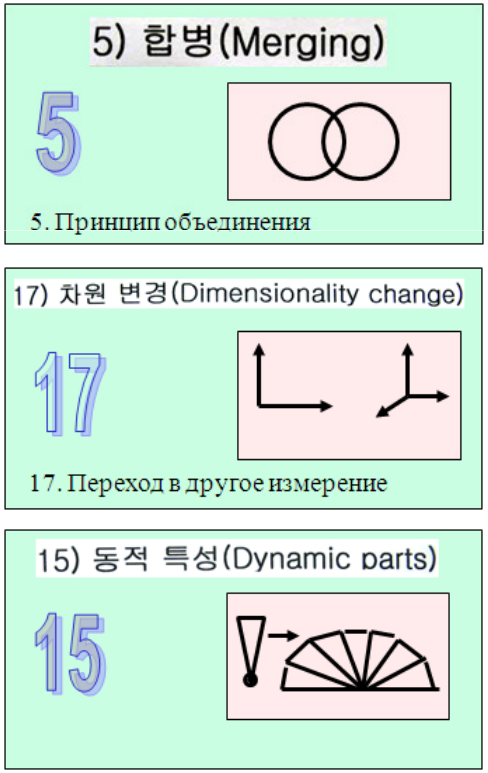
"Physical Contradiction?"

Wall sockets should be large
to insert many plugs, but
wall sockets should be small
to fit into small space

Physical Contradiction Example: *"Wall Socket"*

Solution in Time and Space: "Pop-Out Socket"

Principles Used for Solution



Before

After

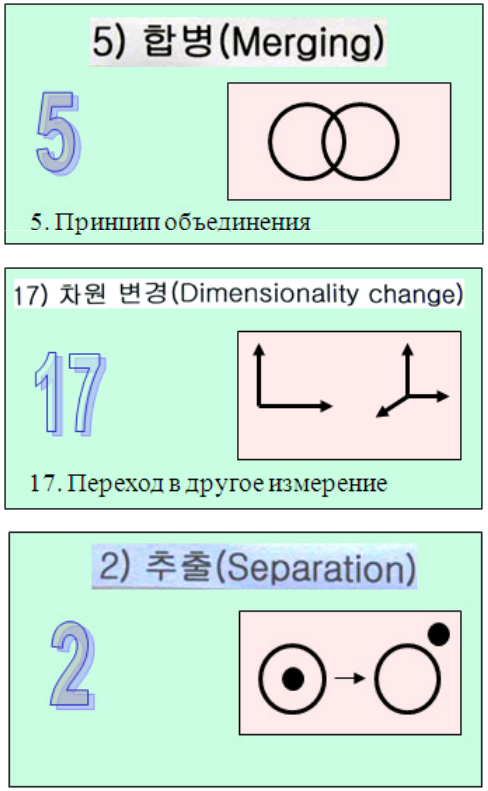
"Push to Pop Out"

- A Pop-Out Socket with five power splitters.
- Flat like a normal wall socket until you push to insert more plugs into the socket.

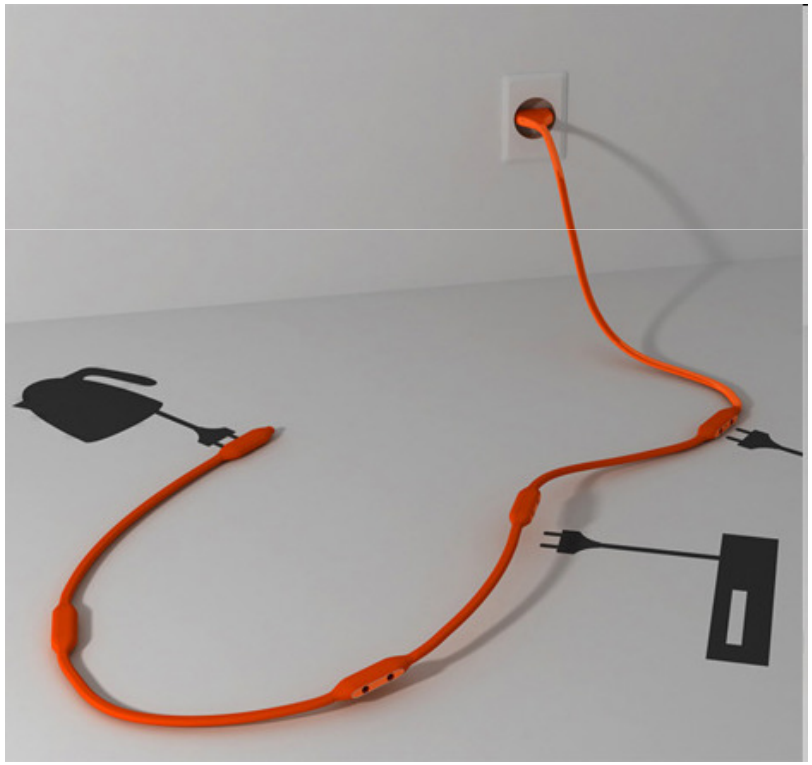
Physical Contradiction Example: *"Wall Socket"*

Solution in System Level and Substance

Principles Used for Solution



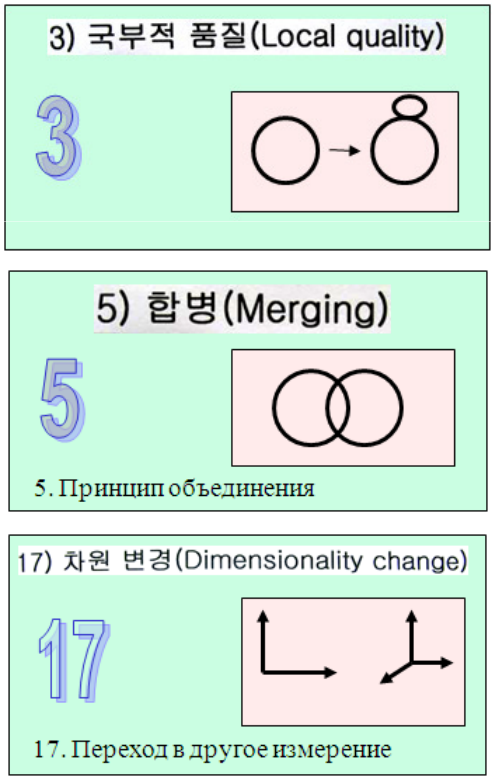
Solution



Physical Contradiction Example: *"Wall Socket"*

Solution in System Level and Space

Principles Used for Solution



Solution

Physical Contradiction Example: *"Clothes Hanger"*

"Physical Contradiction?"

- Clothes Hanger should be large to hang many clothes, but clothes hanger should be small to fit into small space

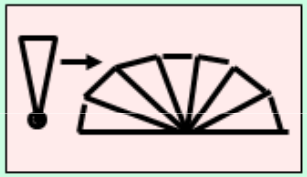
Physical Contradiction Example: *"Clothes Hanger"*

Solution in Time and Space

Principles Used for Solution

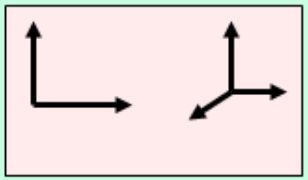
15) 동적 특성(Dynamic parts)

15



17) 차원 변경(Dimensionality change)

17



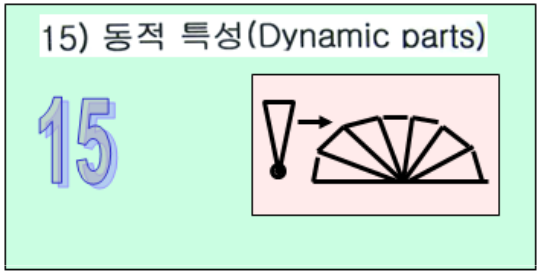
17. Переход в другое измерение

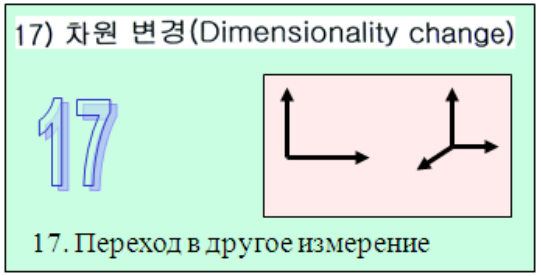
Solution

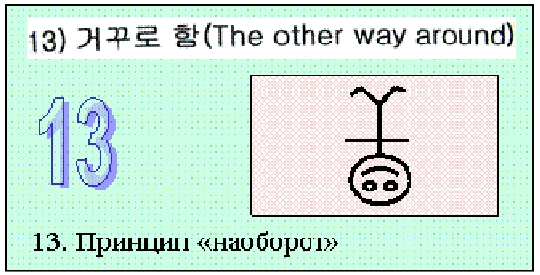
Physical Contradiction Example: *"Clothes Hanger"*

Solution in Time and Space

Principles Used for Solution





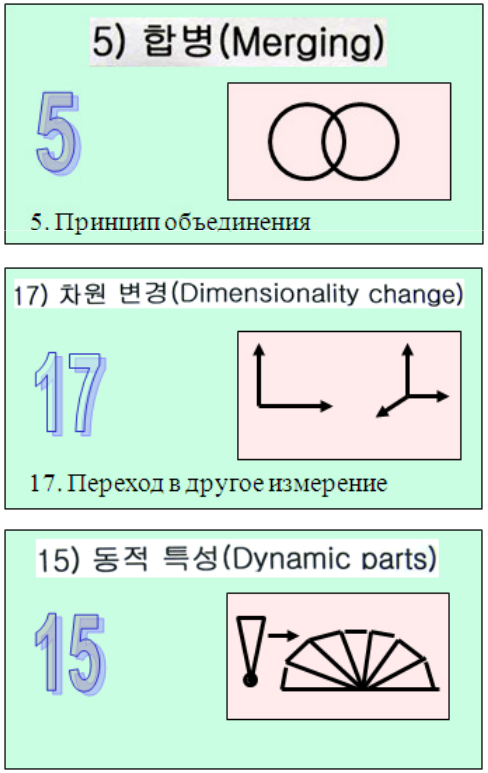


Solution

Physical Contradiction Example: *"Clothes Hanger"*

Solution in Time and Space

Principles Used for Solution



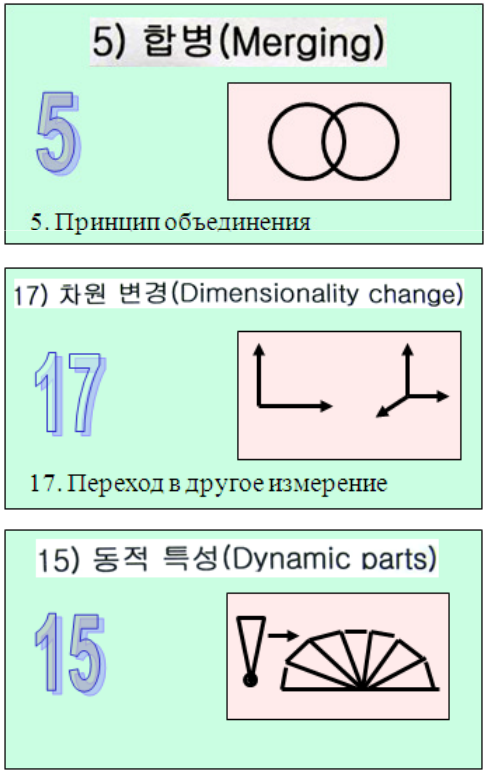
Solution

Similar PC and Similar Solution

Physical Contradiction Example: *"Clothes Hanger"*

Solution in Time and Space

Principles Used for Solution



Solution

Similar PC and Similar Solution

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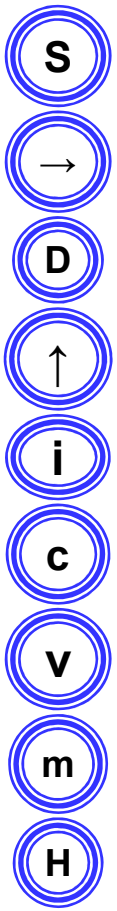
What is TESE (Trend of Engineering System Evolution)?

- The Trends of Engineering System Evolution are statistically reliable lines of evolution that describe natural transitions of systems from one state to another
- These lines of evolution are true and correct for all engineering systems or large groups of engineering systems
- TESE is a navigation system for development of technical systems

What is TESE (Trend of Engineering System Evolution)?



1. **S curve** (non linear development of TS as based model)
2. **Conductivity level - increase**
3. **Dynamicity level - increase**
4. **Transition to the Supersystem**
5. **Ideality level - increase**
6. **Completeness level - increase**
7. **Substance-Field level MATCHEM**
8. **Macro– Micro (transfer)**
9. **Harmonization and non harmonization**

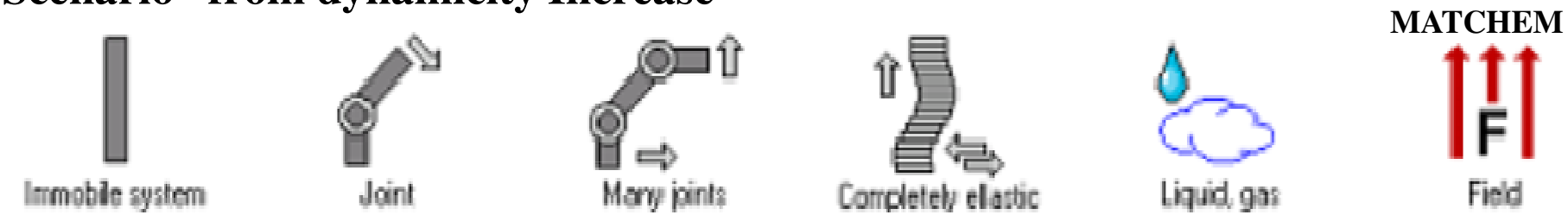
What is Line of development or "scenarios"?

- Every Trends of TESE have some "sub-trend" as mechanism and recommendations called "Line of development" or "scenarios"
- There are 22 different "scenarios" from TESE

Line of development or “scenarios”

- **TESE(Trend of Engineering System Evolution)**
  Dynamicity level – increase; As an Engineering System evolves, it and its components become more “dynamic.”

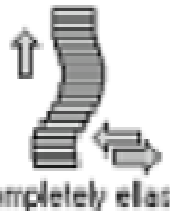
“Scenario” from dynamicity Increase



How can we use “scenarios” for analogy?

- If techincal systems(TS) follow similar scenario, they use similar solution
- If the scenario of TS1 and TS2 is similar, we can use technology from TS1 for TS2

Examples of “scenarios” from “increase of dynamicity”



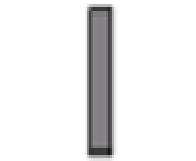
MATCHEM

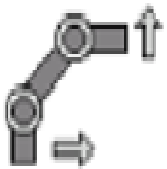
Mechanical field

Function of “Hold of Lamp”

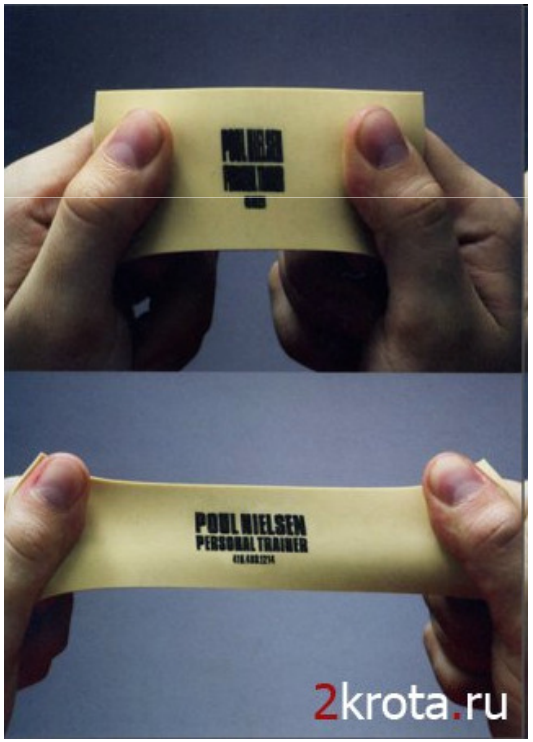
“Flare”

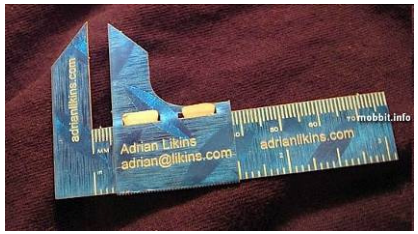
Invention of “business card” with TESE



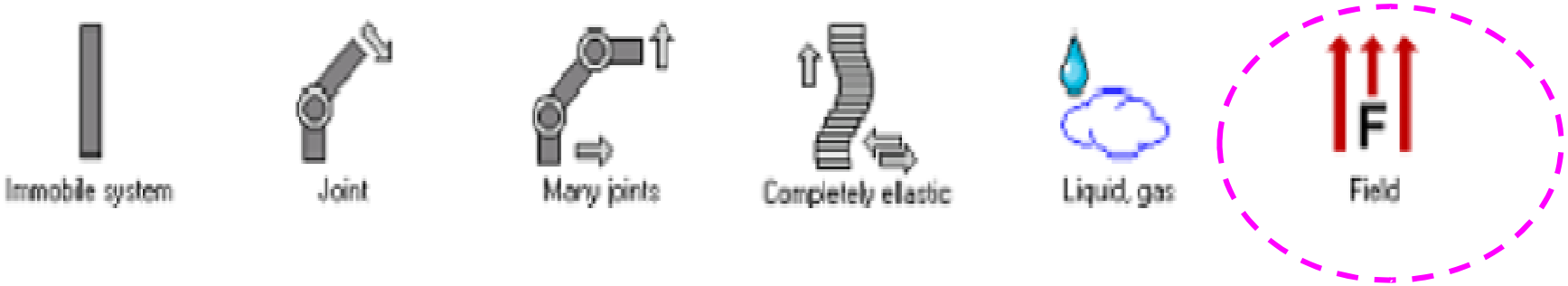


Divorce Attorney





Working idea for this seminar



We can create
business card with
TWO languages or TWO pictures

Picture 1- your name and company
Picture 2- your photo

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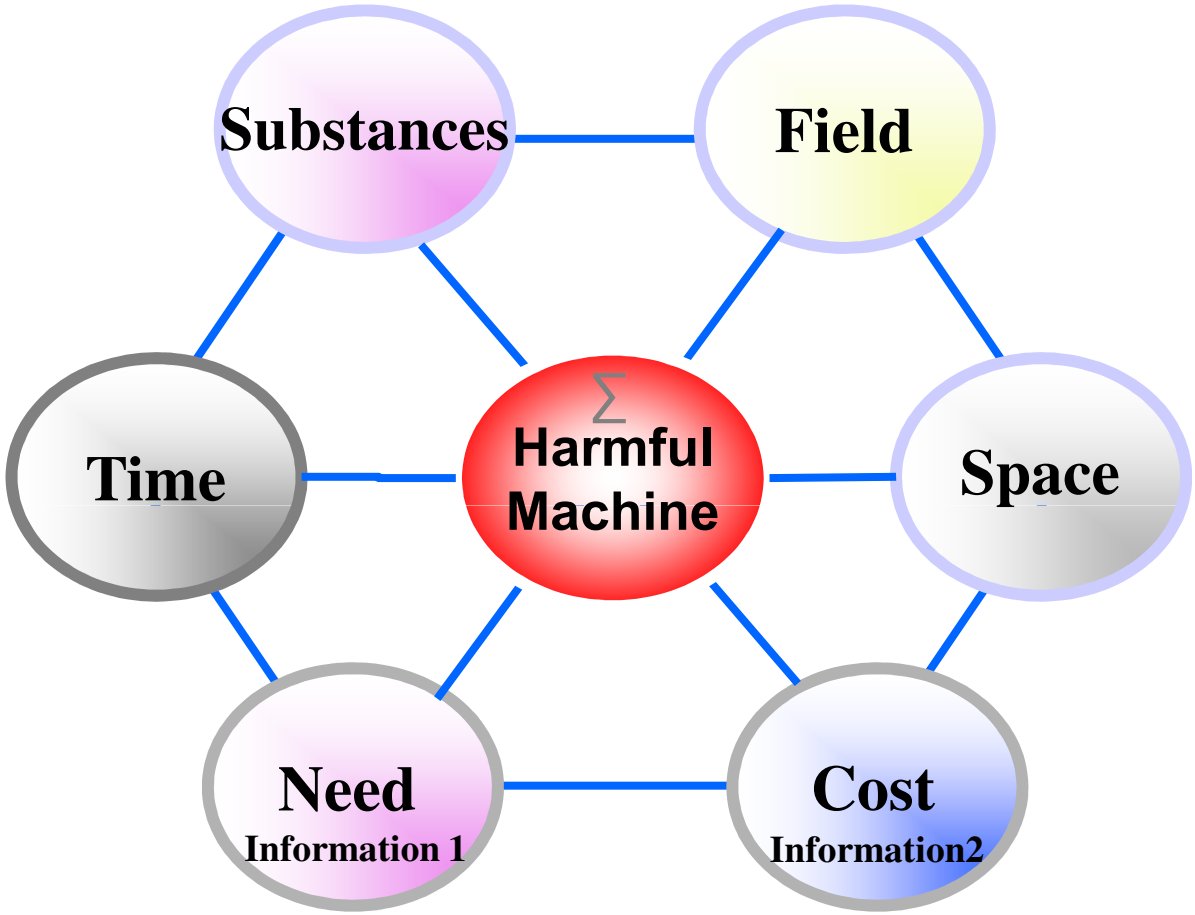
What is Harmful Machine?

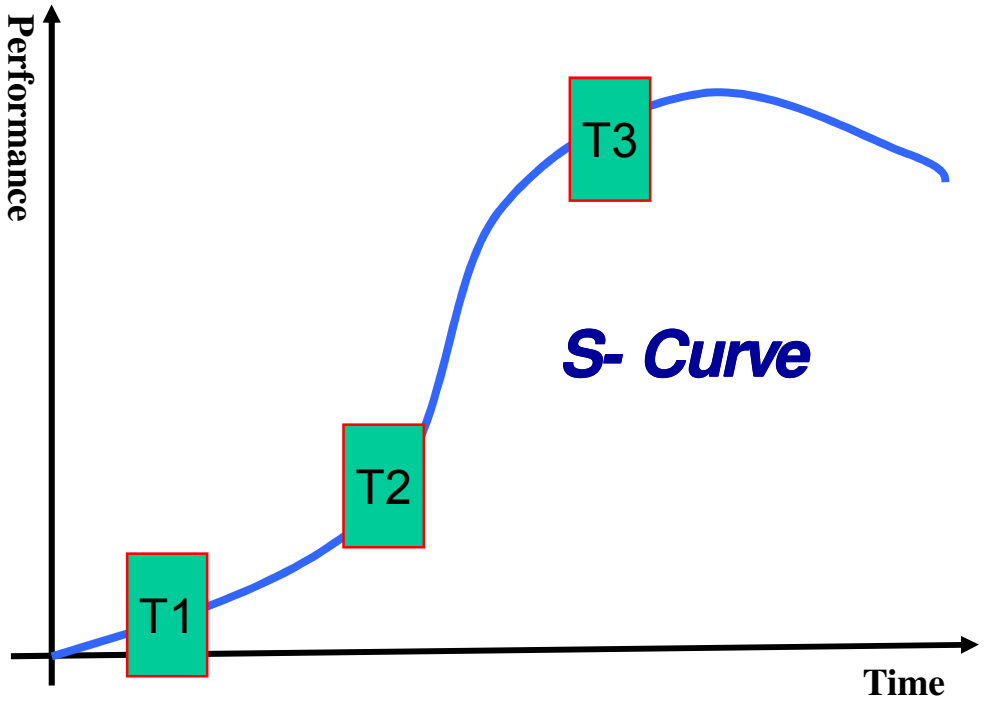
- Harmful Machine means the “Disadvantages of system”
- People develop "machines" in a direction of elimination of disadvantages and using at the moment algorithm of a choice of the cheapest Resources for achievement of thes e purposes

Resources in development (6 Categories)



Harmful Machine corresponds with all resource
Disadvantages are from every categories of resource

Type of Disadvantages vs. S-curve Evolution



- Type of disadvantages (Harmful Machine) vary with evolution stage on S-curve
- Disadvantage is classified as 6 types with each resources

Classification of disadvantages (harmful machines)

6 Categories of Resource →

6 Types of disadvantages (S-Curve) ↓

Young TS

T1

T2

T3

Old TS

Substance	Field	Space (shape)	Time (velocity)	Information (need)	Information (cost)
Harmful substances	Harmful fields (small noise-stability)	The big dimensions at carrying	The small longevity (time of a life)	There is no corrective function	The big cost of preparation of manufacture
Presence of account materials	The big weight	The big dimensions at keeping	The big time at recharge	Low repairability	The small cost – bad
The small productivity	The big total power consumption	The eccentric shape	The small time of autonomous work	The mobility is absent	The big price – bad
Low power saturation of substance	The big power consumption at inclusion	Banal shape and color	Ergonomics (the little time before appearance of tiredness	Few additional functions	The big cost of repair
Necessity take away substance	The big power consumption at switching	The shape is not coordinated with super system	Low velocity (the big time of implementation)	Many additional functions (uncertainty)	The big cost of consumable materials
Necessity supply with power-supplier, management	Many movable parts	Small "range"	The big time mastering by skill (complexity)	Demands presence of additional systems	High cost of recycling

36 types of harmful machine are classified

- If techincal systems(TS) have similar disadvantages, similar solution can be applied
- If the disadvantage of TS1 and TS2 is similar, we can use technology from TS1 for TS2

Analogy for Solution 1

Examples to solve each types of disadvantage are in Database.

Substance	Field	Space (shape)	Time (velocity)	Information (need)	Information (cost)
Harmful substances	Harmful fields (small noise-stability)	The big dimensions at carrying	The small longevity (t ime of a life)	There is no corrective function	The big cost of prepar ation of manufacture
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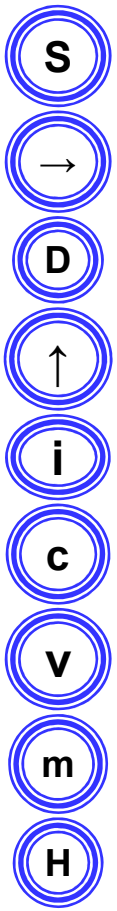
TESE (Trend of Engineering System Evolution)



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Analogy for Solution 2: Connection with 9 Trends of TESE

The solutions for 36 types of disadvantage are defined as 9 trends of TESE and examples of solutions are in Database.

Substance вещество	**Field** Поле	**Space** (shape) Пространство (форма)	**Time (velocity)** Время (скорость)	**Information** (need)	**Information (cost)**
Harmful substances Вредные вещества	Harmful fields (small noise-stability) Вредные поля (маленькая помехоустойчивость)	The big dimensions at carrying Большие габариты при переноске	The small longevity (time of a life) Маленькая Долговечность (время жизни)	There is no corrective function Нет исправительной функции	The big cost of preparation of manufacture Большая стоимость подготовки производства
Presence of consumable materials Наличие расходных материалов	The big weight Большой вес	The big dimensions at keeping Большие габариты при хранении	The big time at recharge Большое время перезарядки	Low repairability Низкая ремонтопригодность	The small cost – bad Маленькая цена - плохо
The small efficiency Маленькая Производительность	The big total power consumption Большое суммарное Энергопотребление	The eccentric shape Экстравагантная форма	The small time of autonomous work Маленькое время автономной работы	The mobility is absent Отсутствует мобильность	The big price – bad Большая цена - плохо
Low power saturation of substance Низкая энергонасыщенность вещества	The big power consumption at inclusion Большое энергопотребление при включении	Banal shape and colour Банальная форма и цвет	Ergonomics (the little time before appearance of tiredness Эргономичность (малое время до возникновения усталости)	Few additional functions Мало дополнительных функций	The big cost of repair Большая стоимость ремонта
Necessity take away substance Необходимость убирать вещества	The big power consumption at switching Большое энергопотребление при переключении	The shape is not coordinated with super system Форма не согласована с НС	Low velocity (the big time of implementation) Низкая скорость (большое время исполнения)	Many additional functions (uncertainty) Много дополнительных функций (ненадёжность)	The big cost of consumable materials Большая стоимость расходных материалов
Necessity supply with power-supplyer, management Необходимость снабжения Энергоисточником, управлением	Many movable parts Много движущихся частей	Small "range" Маленькая «дальность»	The big time mastering by skill (complexity) Большое время овладения умением (сложность)	Demands presence of additional system Требует наличия дополнительных систем	**High cost of recycling** Высокая стоимость утилизации

Steps to apply Harmful Machine Theory

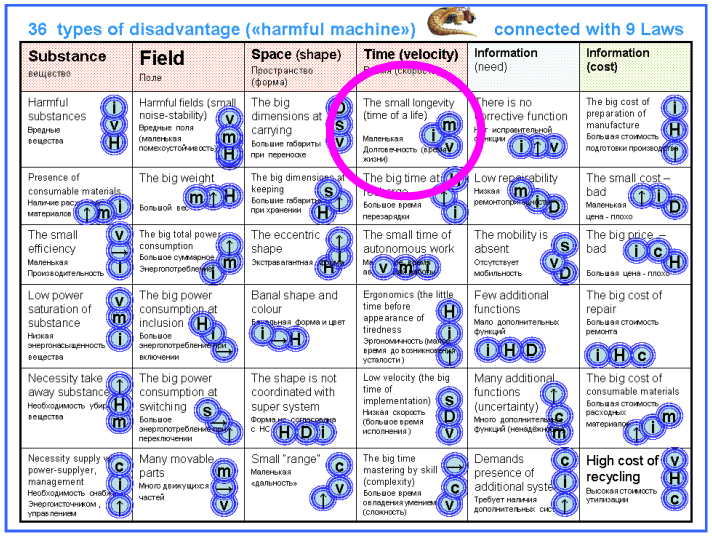
Step 1. Define disadvantage of technical system

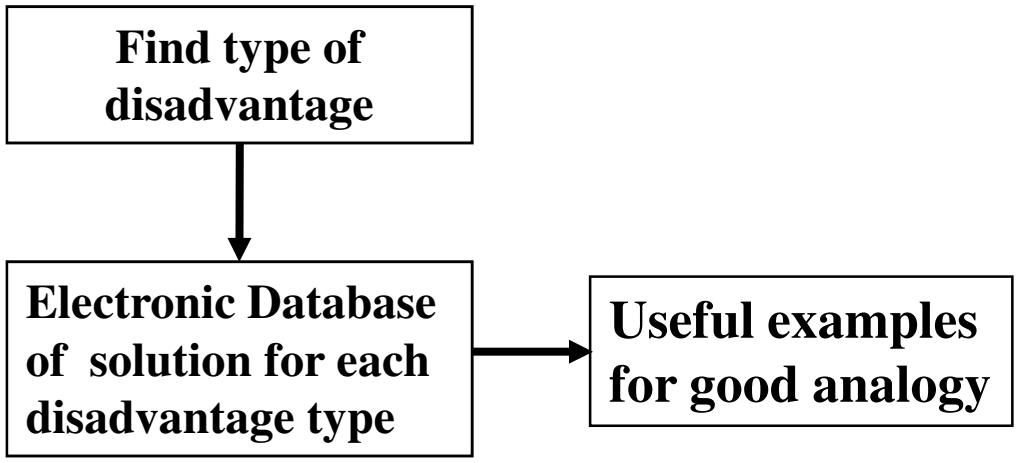
Step 2. Find type of disadvantage in Harmful Machine Matrix

Step 3. Find useful examples in database

(Use recommendation from TESE)

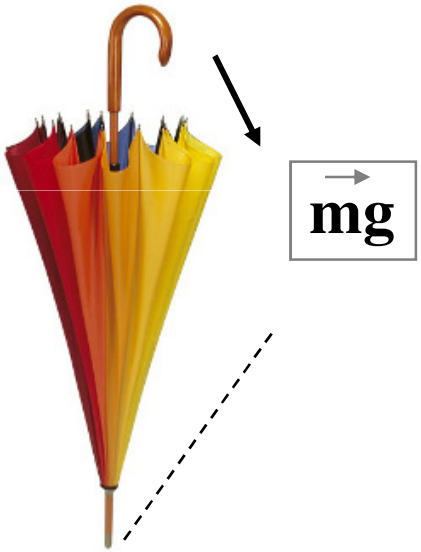
Step 4. Analogy for solution





Case study 1 : Umbrella

Step 1. Define disadvantage of technical system



Disadvantage
"Falling Down Problem"

Step 2. Find type of disadvantage in Harmful Machine Matrix

36 types of disadvantage («harmful machine») connected with 9 Laws

Substance	Field	Space (shape)	Time (velocity)	Information (need)	Information (cost)
Harmful substances	Harmful fields (small noise-stability)	The big dimensions at carrying	The small longevity (time of a life)	There is no corrective function	The big cost of preparation of manufacture
Presence of consumable materials	The big weight	The big dimensions at keeping	The big time at recharge	Low reparability	The small cost – bad
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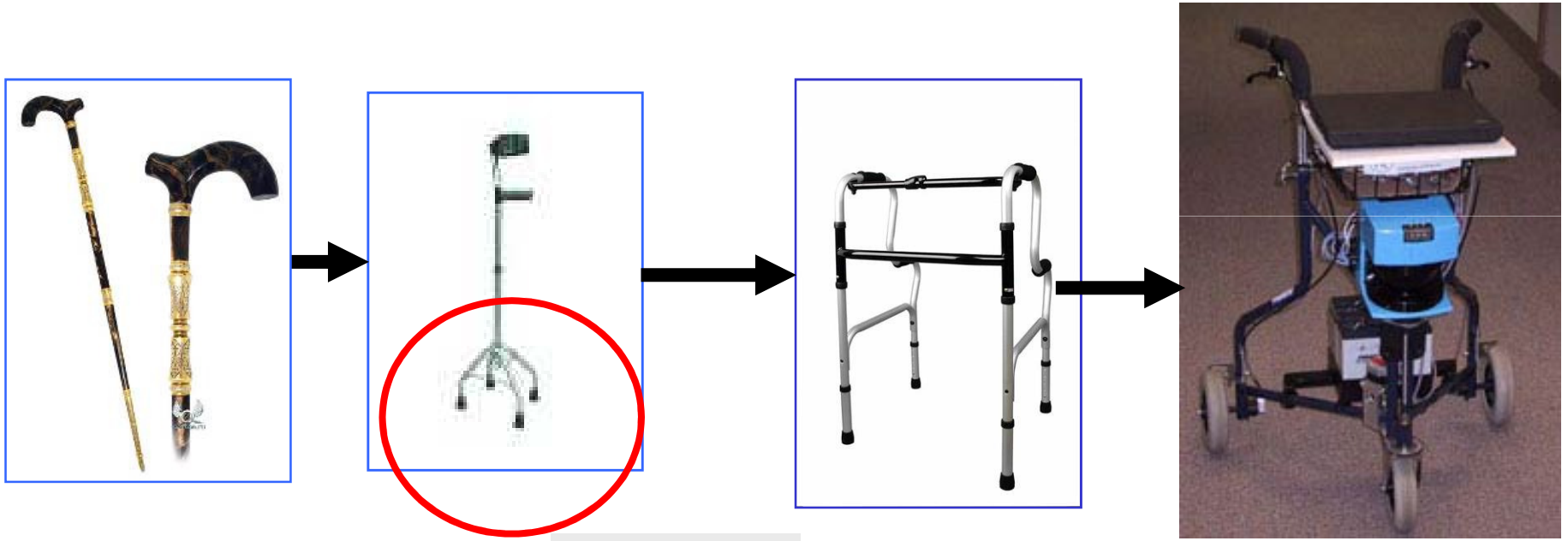
Necessity supply with power-supplyer, management	Many movable parts	Small "range"	The big time mastering by skill (complexity)	Demands presence of additional system	High cost of recycling

Disdvantage Type 2.1
Harmful Field
(small noise-stability)

Case study 1 : Umbrella

Step 3. Find useful examples in database

(Use recommendation from TESE)



And different…

Case Study 1 : Umbrella

Step 4. Analogy for solution

Old System

New System

Disadvantage “problem of falling down” is solved

“Harmful Machine" (DISADVANTAGES) Theory, summary of example

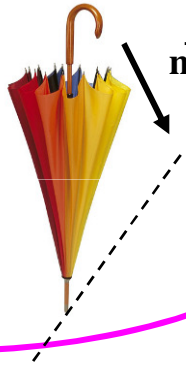
Similar DISADVANTAGE can create similar engineering solution

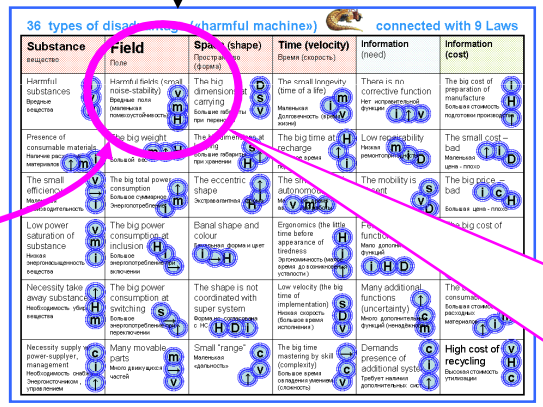
- if NE (TS1) ≈ NE (TS2) => we can use technology from TS1 in TS2

Electronic Database of “DISADVANTAGES” for FOS

DISADVANTAGE “FALLING PROBLEM”

2.1. Harmful Field Small noise stability





Useful example as good analogy

Case study 2 : Fountain Pen with Logo

Step 1. Define disadvantage of technical system

Step 2. Find type of disadvantage in Harmful Machine Matrix

36 types of disadvantage («harmful machine») connected with 9 Laws

Substance	Field	Space (shape)	Time (velocity)	Information (need)	Information (cost)
Harmful substances	Harmful fields (sma noise-stability)	The big dimensions at carrying	The small longevity (time of a life)	There is no corrective function	The big cost of preparation of manufacture
Presence of consumable materials	The big weight	The big dimensions at keeping	The big time at recharge	Low reparability	The small cost – bad
The small efficiency	The big total power consumption	The eccentric shape	The small time of autonomous work	The mobility is absent	The big price – bad
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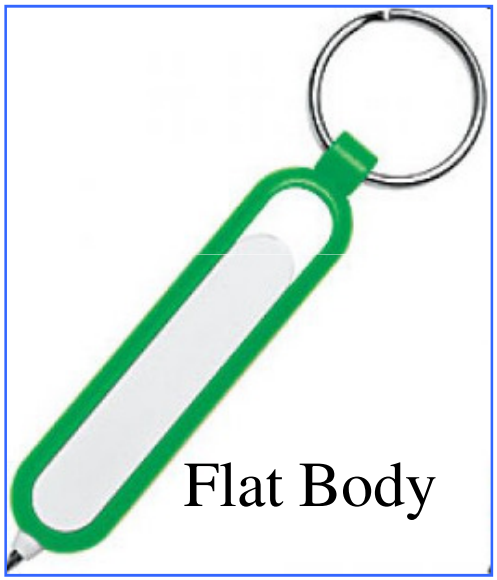
Necessity take away substance	The big power consumption at switching	The shape is not coordinated with super system	Low velocity (the big time of implementation)	Many additional functions (uncertainty)	The big cost of consumable materials
Necessity supply w power-supplyer, management	Many movable parts	Small "range"	The big time mastering by skill (complexity)	Demands presence of additional syste	High cost of recycling

Disadvantage:
Pen has limited space capability to hold information

Disadvantage Type 3.1
The big dimension at carrying

Step 3. Find useful examples in database (Use recommendation from TESE)



Telescopic principle (nesting)

D

Dynamicity

Step 4. Analogy for solution

“Harmful Machine" (DISADVANTAGES) Theory, summary of example2

Similar DISADVANTAGE can create similar engineering solution

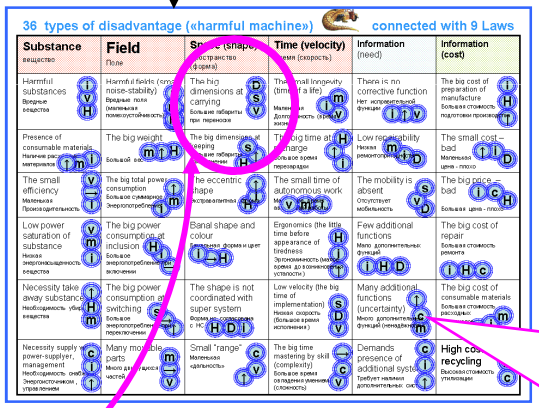
- if NE (TS1) ≈ NE (TS2) => we can use technology from TS1 in TS2

Electronic Database of “DISADVANTAGES” for FOS

DISADVANTAGE
“Little information”

Many info is
The big dimension
At carrying

3.1.
The big dimension
At carrying



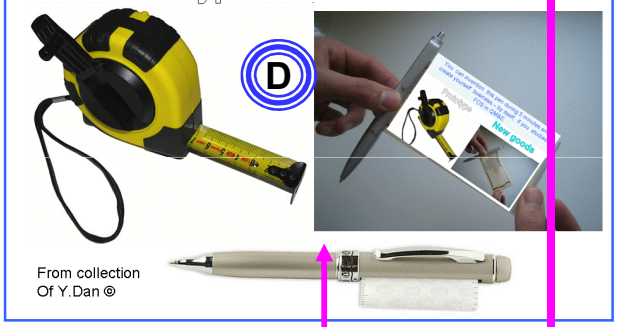
Recommend Laws for 3.1.

D S V

Useful example as good analogy

SOLUTION_1

Flash Memory



Contents

1. Create Solutions using Analogy in TRIZ
2. FOS (Function Oriented Search)
   - Example : "Cosmetic Liquid"
3. Physical Contradiction
   - Example : "Wall Socket" & "Clothes Hanger"
4. TESE (Trends of Engineering System Evolution)
   - Example : "Business Card".
5. Harmful Machine Theory
   - Example : "Umbrella", & "Pen with Record"
6. FOS + TESE
   - Example : "Automated Labeling of Bottles"
7. Conclusions

FOS+TESE Example: *"Automated Labeling of Bottles"*

"Automated Glue Labeling of Bottles" Process

FOS+TESE Example: *"Automated Labeling of Bottles"*

- **Disadvantage in label machine**

  - Low production speed because of stopping and rotating to label

FOS+TESE Example: *"Automated Labeling of Bottles"*

- **Steps for generating solution**

36 types of disadvantage («harmful machine») connected with 9 Laws

Substance вещество	Field Поле	Space (shape) Пространство (форма)	Time (velocity) Время (скорость)	Information (need)	Information (cost)
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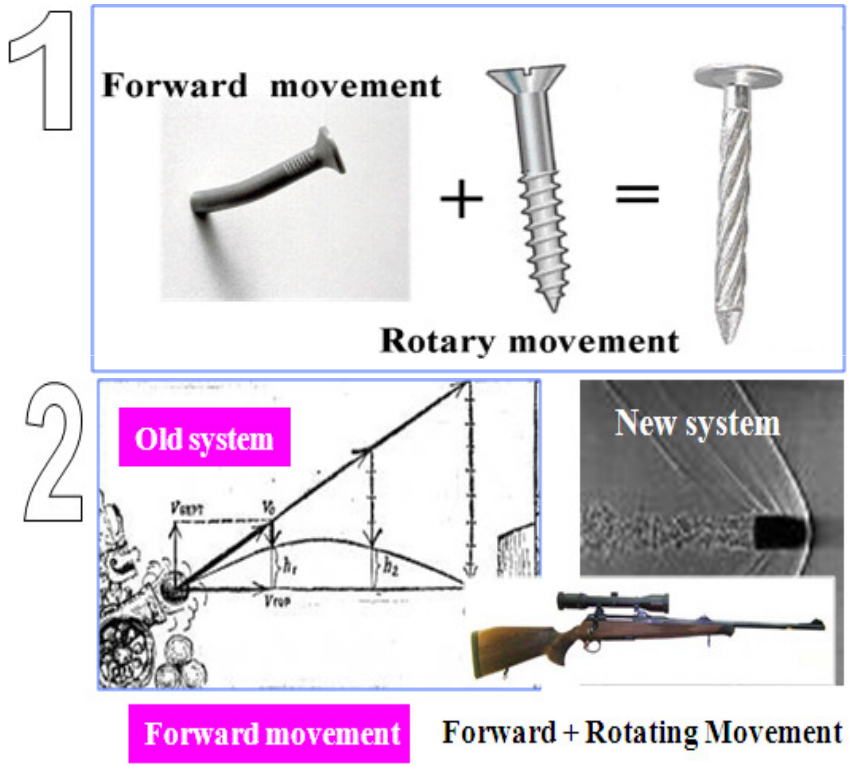
- Step 1: Go to classification table of "36 types of disadvantages", and select **2.5** "The big power consumption at switching"
- Step 2: See recommendation of TESE Laws

S – Curve Analysis → Conductivity ↑ SUPER SYSTEM

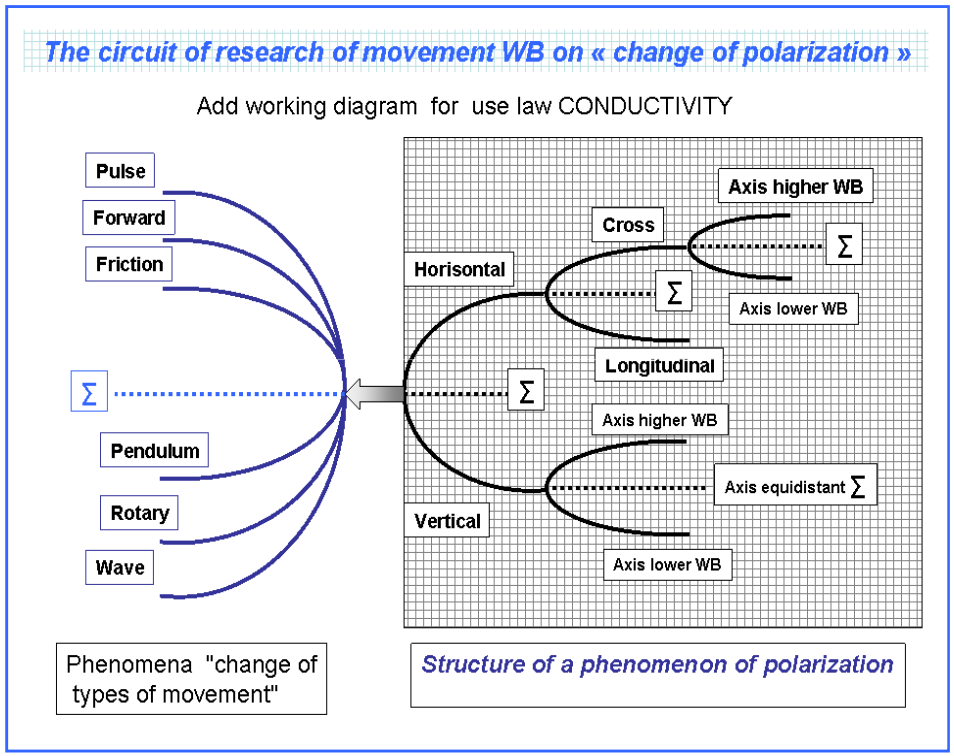
- Step 3: Go to electronic database to look for useful examples

FOS+TESE Example: *"Automated Labeling of Bottles"*

Recommendation from FOS



Recommendation from Conductivity



- **Conclusion:** *"Necessary to combine Forward and Rotating movement"*

FOS+TESE Example: *"Automated Labeling of Bottles"*

Old System

- Stop and Rotate to Label

New System

- Move and Rotate to Label
- Add Two Labels

Conclusions

1. Four Efficiency Method of "Analogy" in TRIZ:
   A) similar FUNCTION, similar solution (FOS)
   B) similar PC, similar solution (Physical Contradiction)
   C) similar disadvantage, similar solution (HM theory)
   D) similar scenario, similar solution (TESE)
2. FOS, PC and HM are closely related to TESE
3. Can use "Analogy" in "Analysis Stage" and "Solution Generation Stage".

Conclusions

FOS + TESE is very popular tool in search of good analogy.

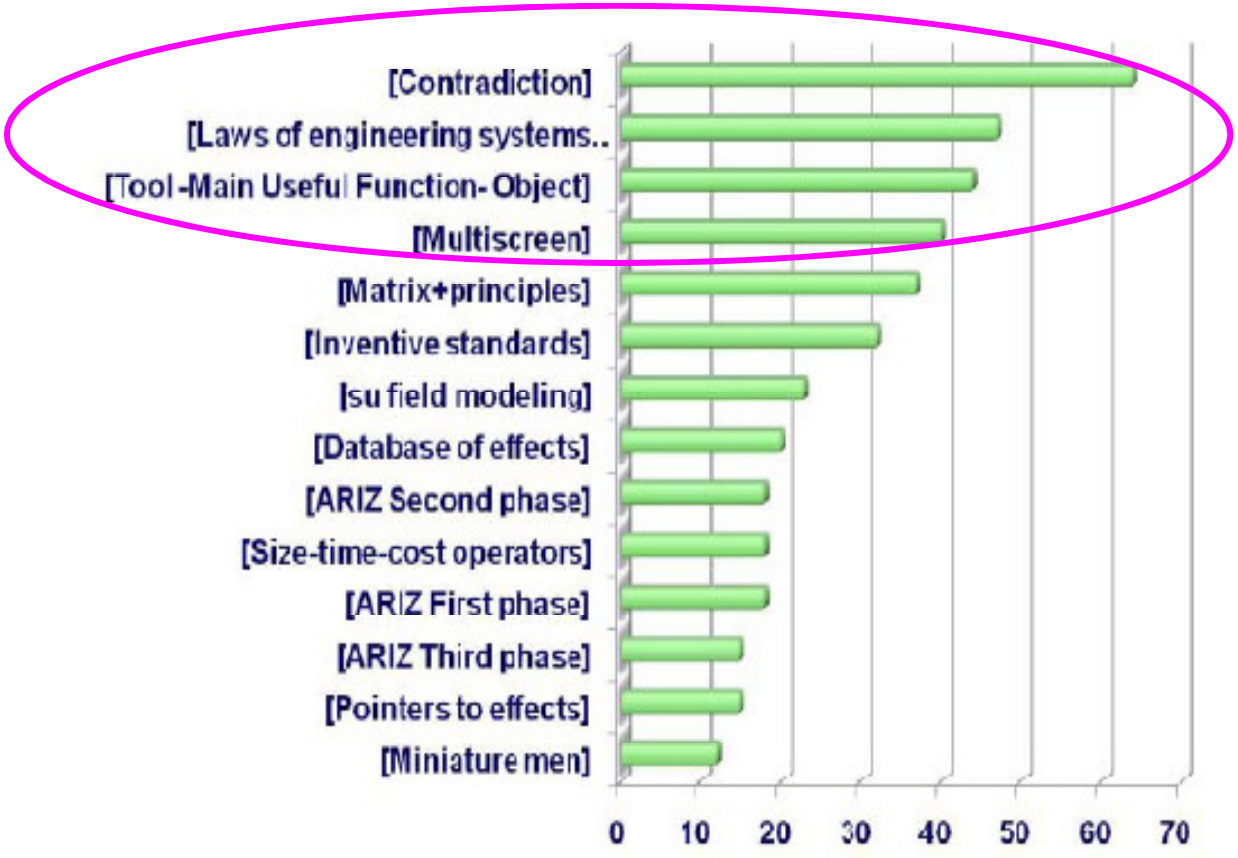


Figure 9: Frequency of TRIZ's main components: most often used

Figure 9 from ETRIA report 2009

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