See also:
4.1.2 – Model of a Minimal Technical System
4.2.2 – Classification of standard solutions

4 SU-FIELD ANALYSIS AND STANDARD SOLUTIONS

4.1 – SU-FIELD ANALYSIS AND STANDARD SOLUTIONS: BASIC NOTIONS AND RULES

Definition

Su-Field analysis is a TRIZ modeling technique aimed at representing the behavior of a Technical System in terms of elements and interactions

The Standard Solutions are a system of prescriptions for the synthesis and the transformation of a Su-Field model, aimed at the solution of a technical problem.

Theory

The Function of a Technical System (TS) is the motivation for its existence; at the Structure level, a TS is constituted by elements, attributes of these elements and relations among them (see also the ENV model).

Su-Field modeling is a technique to represent elements and interactions characterizing the behavior of a technical system. Thus, a Su-Field model is a means to analyze a technical system and to represent problems in terms of missing, insufficient or undesired interactions, inefficiencies etc.

A problem represented by means of a Su-Field model can be approached by the system of Standard Solutions which suggest transformations of the Su-Field model capable to improve the performance of the technical system and/or to eliminate its undesired effects.

Model

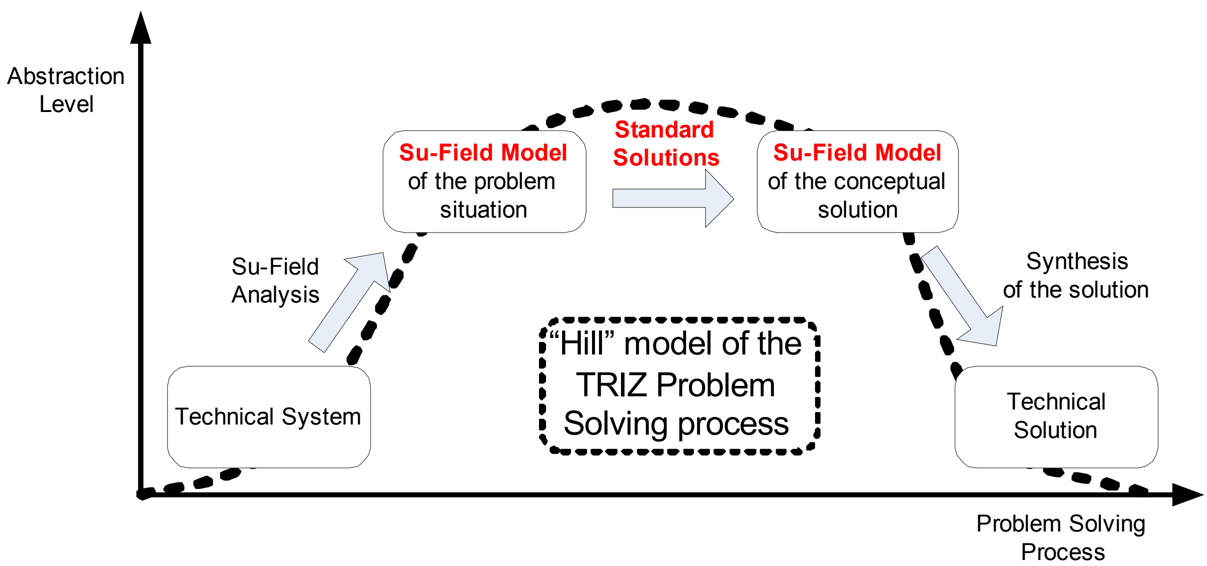


Fig. 1.a – "Hill" model of the TRIZ Problem Solving process and role of Su-Field modelling and the Standard Solutions

Instruments

The problem solving process based on the Adoption of the Standard Solution consists in the following steps (fig. 1.a):

- Describe the problem to be solved by using general terms (technical terms are strong psychological inertia vectors) – Identify evaluation/selection criteria to be applied to generated ideas
- Build a Su-Field model of the problem situation (abstraction process)
- Select the most appropriate Standard Solutions to approach the problem situation according to the characteristics of the Su-Field model (2.2 - Classification of Standard Solutions). Identify the Su-Field model of the conceptual solution
- Generate a practical solution to the problem stated at step 1, by implementing the conceptual solution of step 3 according to the Substance-Field resources available in the specific situation.

Example

<u>Problem situation:</u>

It is requested to improve agriculture opportunities in a sandy region. By means of a piping system, current water has been widely distributed into the fields, but still the growth of plants is too slow.

What should be done?

<u>Step 1:</u>

We want to increase the growth speed of some plants in a sandy area. The plants are properly watered, but their nutritional needs are not properly covered.

<u>Step 2:</u>

A Su-Field model of the problem situation is built according to the directions of section 1.2 – Model of a Minimal Technical System (Figure 1.b): there is an insufficient useful interactions between the earth and the plant by means of a chemical field.

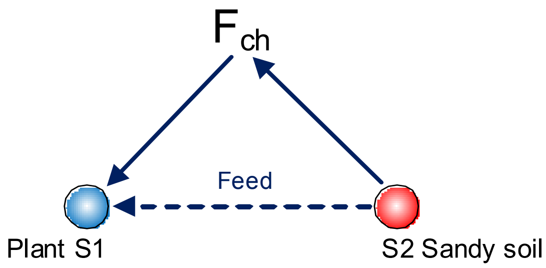


Fig. 1.b – Su-Field model of the problem situation

<u>Step 3:</u>

In order to improve the positive effect of a Su-Field interaction it is suggested to take into account Standard Solutions belonging to Class 1.1 (2.2 - Classification of Standard Solutions).

The first relevant Standard is the number 1.1.2: improving interactions by introducing additives into the objects (Fig. 1.c).

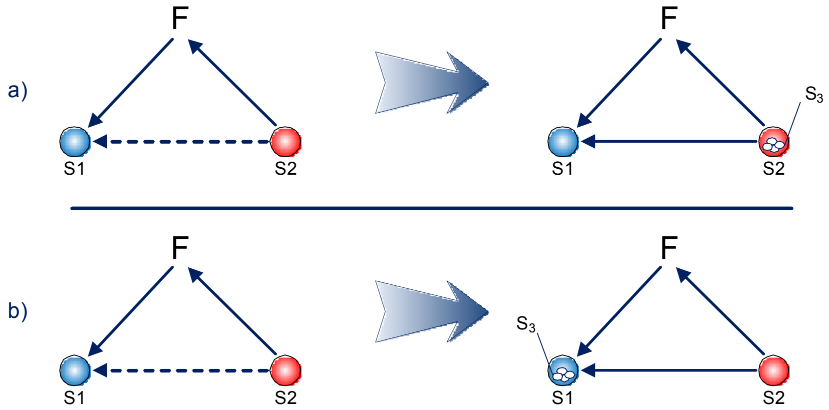


Fig. 1.c – STANDARD 1-1-2: Improving interactions by introducing additives into the objects

The Su-Field models on right side of fig. 1.c represent conceptual solutions to the problem described at step 1 and formalized at step 2.
With a similar approach further conceptual solutions could be identified by applying other Standards.

Step 4:
In order to synthesize a practical solution from the model of conceptual solution it is necessary to take into account the specific situation (Fig. 1.d). It is worth to notice that an alternative interpretation of the same standard solution would point to the introduction of additives into the plant (figure 1.c, below).
What kind of Substance S_3 could be added to the sandy soil in order to improve its chemical interaction with the plant?
A fertilizer could provide the expected improvement.

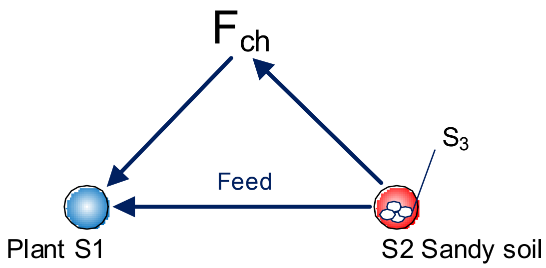


Fig. 1.d – Exemplary application of the Standard 1-1-2 to the Su-Field model of Fig. 1.b: the interaction can be improved by introducing additives into the earth (fig. 1.c, above).

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

See also::
4.1.1.1– Types of fields and related symbols
4.1.1.2 – Types of interactions and related symbols

4.1.1 – ELEMENTS OF A MINIMAL TECHNICAL SYSTEM

Definition

The minimal technical system capable to perform a certain function must be constituted by three elements: two substances and a field.
A Substance is an element of a system (a basic part or a complex subsystem) which can be involved in a functional interaction with other substances both as a function carrier and as the object of the function itself.
A Field is an interaction characterized by a flow of energy (of any type), or information, or mechanical force etc. generated by a substance, potentially impacting other substances.

Theory

The essential elements of a functional interaction are a function carrier (working tool), an object of the function and a field. Both the function carrier and the object are called Substances.
In TRIZ terms, a Substance can be a system of any level of complexity, from a single elementary item (e.g. a pin, a ball, a dust particle) to a complex assembly (e.g. an airplane, a laptop, a satellite).
Whatever is the complexity of the system, its interaction with other substances necessarily requires the presence of at least a Field, i.e. a flow of any kind of energy, a flow of information, a force etc.
There are several types of Fields (1.1.1- Types of interactions and related symbols) as well as there exist several kinds of interactions between two substances (1.1.2 – Types of Fields and related symbols)

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

4.1.1.1 – TYPES OF FIELDS AND RELATED SYMBOLS

Definition

Gravitational Field: the natural force of attraction between any two massive bodies, which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them

Mechanical Field: interaction relating to, or governed by mechanics, i.e. forces on matter or material systems (friction, inertia, elasticity, lifting, buoyancy, pressure of fluids)

Acoustic Field: interaction arising from, actuated by, containing, producing, or related to sound waves, even outside the audible frequency range.

Thermal Field: interaction related to heat transfer of any type (conduction, convection, radiation).

Chemical Field: interaction related to the composition, structure, properties and reactions of a substance

Electrical Field: physical phenomena arising from the behavior of electrons and protons that is caused by the attraction of particles with opposite charges and the repulsion of particles with the same charge.

Magnetic Field: force exerted between magnetic poles, producing magnetization

Electro-Magnetic Field: interactions related to the generation, propagation, and detection of electromagnetic radiation having wavelengths greater than x-rays, e.g. light and vision

Biological Field: interactions relating to, caused by, or affecting life or living organisms, e.g. fermentation, decay.

Nuclear Field: interactions related to forces, reactions, and internal structures of atomic nuclei, e.g. Fusion, Fission, Rays

Theory

A Field is an interaction characterized by a flow of energy (of any type), information, mechanical force etc. generated by a substance, potentially impacting other substances.
The type of field is defined by the nature of the interaction between two substances. It is worth to notice that the definitions of the field types are sometime overlapping: a biological field can be considered also chemical at a deeper detail level; heat transferred by radiation can be considered as a thermal and as an electro-magnetic field. Nevertheless, such ambiguity does not impact the usability and the effectiveness of the modeling technique as far as a coherent definition is followed within the entire analysis of a certain technical system.

Model

Field type	**Symbol**
Gravitational	F_{Gr}
Mechanical	F_{Mec}
Acoustic	F_{Ac}
Thermal	F_{Th}
Chemical	F_{Ch}
Electrical	F_{El}
Magnetic	F_{M}
Electro-Magnetic	F_{EM}
Biological	F_{B}
Nuclear	F_{N}

Fig. 1.1.1.a – Field types and related symbols

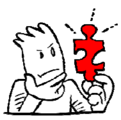
Example

Field type	**Examples**
Gravitational	Gravity, attraction between planets
Mechanical	Friction, pressure, inertia
Acoustic	Sound waves, ultra-sounds
Thermal	Heat exchange by conduction, convection, radiation
Chemical	Oxidation, solution, combustion, reduction, bonding
Electrical	Electrostatics, electric induction
Magnetic	Magnetostatics, magnetic induction
Electro-Magnetic	Light, laser, microwaves, X-rays, gamma-rays
Biological	Fermentation, decay
Nuclear	Nuclear fusion, nuclear fission

Fig. 1.1.1.b – Exemplary fields

Self Assessment

<u>Exercise 1:</u>



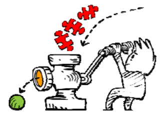
Analyze the following interactions between substances, identify the type of fields and assign the appropriate symbol:

1. a broom sweeping the floor;
2. a fridge cooling a bottle of water;
3. a radio playing music;
4. an oven roasting a chicken;
5. a paint coloring a wall;
6. a torch lighting a cave;
7. the flame of a match lighting a cigarette;
8. the orientation rotating the needle of a compass;

9. a hammer hitting a nail;
10. a vegetable going mouldy;
11. some sugar dissolved into a cup of coffee;
12. a neutron added to a nucleus of hydrogen.

<u>Answer 1:</u>

Interaction	**Type of field**	**Symbol**
a broom sweeping the floor	Mechanical (pushing force)	F_{Mec}
a fridge cooling a bottle of water	Thermal (convection)	F_{Th}
a radio playing music	Acoustical (sound waves)	F_{Ac}
an oven roasting a chicken	Thermal (radiation) or Electro-magnetic (infrared)	F_{Th} - F_{EM}
a paint coloring a wall	Chemical (adhesion)	F_{Ch}
a torch lighting a cave	Electro-magnetic (light)	F_{EM}
the flame of a match lighting a ciga-rette	Chemical (combustion)	F_{Ch}
the orientation rotating the needle of a compass	Magnetic (Earth's magnetic field)	F_M
a hammer hitting a nail	Mechanical (impact force)	F_{Mec}
a vegetable going mouldy	Biological (decay)	F_B
some sugar dissolved into a cup of coffee	Chemical (solution)	F_{Ch}
a positron added to a nucleus of hy-drogen	Nuclear (fusion)	F_N



References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

See also:
4.1.1.1– Types of fields and related symbols

4.1.1.2 – TYPES OF INTERACTIONS AND RELATED SYMBOLS

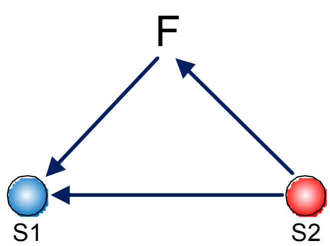
Definition

Let's consider two interacting Substances, S1 and S2, such that S2 exerts a certain impact on a property EP (Evaluation Parameter) of S1.
Useful action: An action is considered useful when the impact on EP is desired
Harmful action: An action is considered harmful when the impact on EP is undesired or goes in the wrong direction
Insufficient, incomplete action: A useful action is considered insufficient or incomplete when the impact on EP is less than the desired value
Missing action: A useful action is considered missing when the expected impact on EP is potentially available, but not implemented in the system
Uncontrolled action: An useful action is considered uncontrolled when the range of values assumed by EP is too large
Excessive action: A useful action is considered excessive when the impact on EP exceeds the desired value
Superfluous action: An useful action is considered superfluous when the impact on EP is not necessary to the functioning of the system, but doesn't provide any harm

Theory

A function is characterized by a function carrier (in TRIZ terms a "tool"), an action and an object receiving the function. The action is properly defined if it can be expressed as a combination of one among four verbs (increase, decrease, change, stabilize) and the name of a property of the object (ENV model). The property of the object, e.g. a size, the colour, the electrical conductivity, the shape, is thus set to a certain value e.g. one meter, red, five siemens per metre, spherical, due to the impact of the function. If the modification of the object property is desired, the function is considered useful, while if the modification of the object property is undesired, the function is considered harmful. Among the useful functions, if the property of the object assumes precisely the expected value, we have a sufficient useful function; besides, if the value of the property is inadequate the function is considered useful but insufficient.

Model

Type of interaction	**Symbol**
Useful	

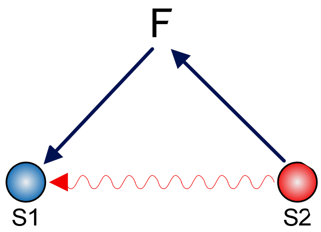
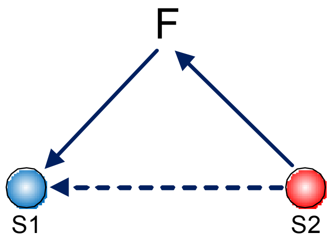
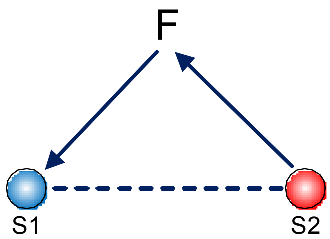
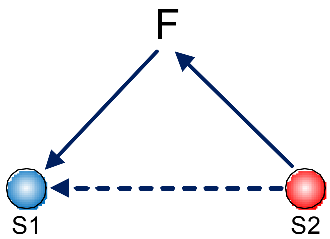
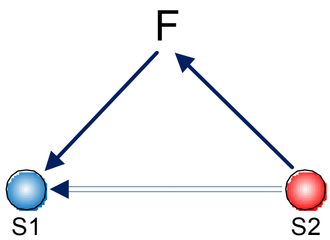
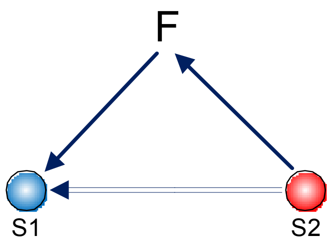
Harmful	
Useful Insufficient	
Missing	
Uncontrolled	
Excessive	
Superfluous	

Fig. 1.1.2.a – Interaction types and related symbols

Instruments

Steps to classify an interaction between two substances:

1. identify the interacting substances distinguishing between the tool and the object
2. identify the type of field (1.1.1 – Types of fields and related symbols)
3. identify the evaluation parameter of the object impacted by the tool through the field
4. analyze the influence of the field on the evaluation parameter (EP):
   - a if the impact on EP is desired, the field determines a useful interaction;
     1. if the impact on EP is desired, but less than expected, the field determines an insufficient useful interaction;
     2. if the impact on EP is desired, but its range of variations is too large, the field determines an uncontrolled useful interaction;
     3. if the impact on EP is desired, but is absent, the field determines a missing useful interaction;
     4. if the impact on EP is desired, but more than expected, the field determines an excessive useful interaction.
   - b. if the impact on EP is undesired, the field determines a harmful interaction;
   - C if the impact on EP is not desired, but doesn't produce any harm, the field determines a superfluous interaction.

Example

Example 1:

Summertime: Nina would like to offer some chilly fruit juices to her friends because they are thirsty and it's very hot. Unfortunately, the fridge is empty and all the juices are quite warm. She puts the juices in the fridge, but it cools them quite slowly, after 15 minutes they are still warm.

Let's classify the interaction of the last sentence.

- the interacting substances are the fridge and the juices, tool and products respectively;
- fridge and juices interact through a thermal field (heat convection in the fridge interior);
- the parameter of the juice (product) impacted by the fridge (tool) through the thermal field is the temperature (EP): the fridge "decreases" the temperature of the juices;
- the impact of the fridge on EP is desired (it is desired that the fridge decreases juices temperature), but less than expected (the temperature is still too high after 15 minutes), thus the field determines an insufficient useful interaction (fig. 1.1.2.b).

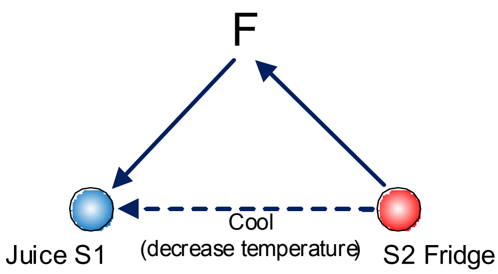


Fig. 1.1.2.b – The interaction between the fridge and the fruit juices is useful, but insufficient since it takes too much time to cool them down.

Example 2:

Wintertime: at Nina's town the temperature in January goes often below 0°C, thus the water in the pipes sometimes freezes. Since ice has a larger volume than liquid water, it exerts a high pressure on the internal pipe surface such that it happens that a pipe breaks.

Let's analyze the interaction of the last sentence.

1. the interacting substances are the ice and the pipe, tool and products respectively (it is worth to notice that the pipe is here considered a product since it is impacted by the action of the ice);
2. ice and pipe interact through a mechanical field (pressure due to the volume increase of the water from liquid to solid);
3. the parameter of the pipe (product) impacted by the ice (tool) through the mechanical field is the material stress (EP): the ice "increases" the material stress of the pipe;
4. the impact of the ice on EP is undesired (it is undesired that the ice increases the material stress of the pipe), thus the field determines a harmful interaction (fig. 1.1.2.c).

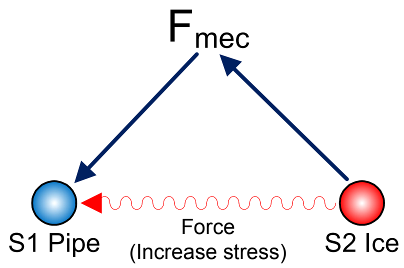
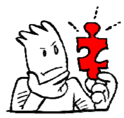


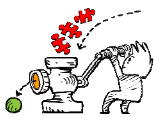
Fig. 1.1.2.c – The interaction between the ice and the pipe is harmful since it is not desired to increase the material stress in the pipe.

Self Assessment

Exercise 1:
Nina is in the kitchen. She notes that the pan is on the gas cooker, and while the fire heats the bottom of the pan heats also the pan haft. Try to model the two situations.



Answer 1:
We have two models to build: the first one is relative to the function of the fire toward the bottom of the pan. There are two substances, the pan bottom (S_1) and the fire (S_2), and a field, a thermal one. The action developed is useful and sufficient, fig. 1.1.2.d.



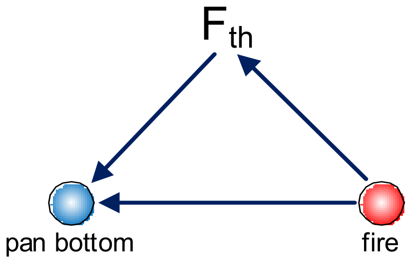


Fig. 1.1.2.d – Su-field model of a pan on the fire

The second model to build is the part of the situation represents the heating of the haft. In this case the two substances are the haft itself (S_1) and the fire (S_2). The field is always thermal, but this time the action developed by the fire toward the haft is harmful, because a hot haft may burn Nina's hand (fig. 1.1.2.e).

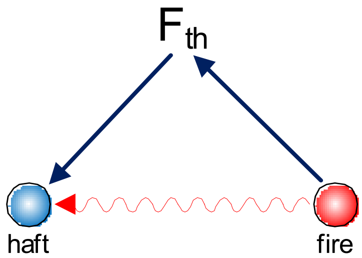
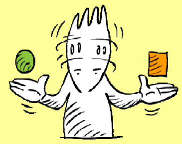


Fig. 1.1.2.e – Su-field model of the harmful action developed by the fire on the haft of the pan

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3



See also:
4.1.1.1– Types of fields and related symbols
4.1.1.2 – Types of interactions and related symbols

4.1.2 – Model of a Minimal Technical System

Theory

The minimal technical system capable to perform a certain function must be constituted by three elements: two substances and a field.
Thus the simplest model of a working system is a triad S1, S2, F such that the substance S2 accomplishes an action on the Substance S2 through the Field F (Fig. 1.2.a).
The Field is classified according to the criteria defined in 1.1.1 Types of fields and related symbols.
The action exerted by S2 on S1 can be classified according to the criteria defined in 1.1.2 Types of interactions and related symbols
A Su-Field model is graphically represented by means of specific symbols and rules (1.2.1 Graphical representation of a Su-Field Model)

Model

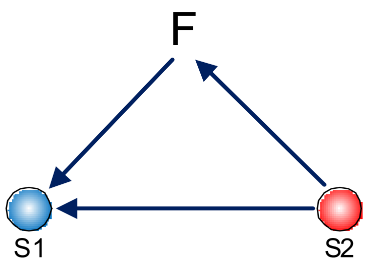
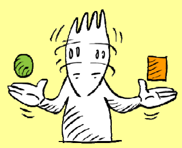


Fig. 1.2.a – Model of a Minimal Technical System



See also:
4.1.1.1– Types of fields and related symbols
4.1.1.2 – Types of interactions and related symbols

4.1.2.1 – GRAPHICAL REPRESENTATION OF A SU-FIELD MODEL

Model

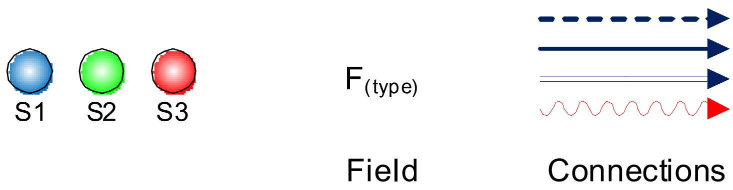


Fig. 1.2.1.a – Elements of a Su-Field model: Substances, Fields, Connections

Instruments

Steps to build a Su-Field model of a functional interaction:
1. identify the substances involved in the functional interaction;
2. check the presence of one or more fields between each pair of substances;
3. classify the field (1.1.1) and the interaction (1.1.2)

assign a suitable symbol to each element (Fig. 1.2.1.a)

Example

Example 1: Nina prepares sandwiches

While cutting the bread to prepare some sandwiches for a picnic, Nina slightly injured her finger with the knife.

Let's build a Su-Field model of the situation.

1. Here we have three main substances: S1, bread (object of the action to cut); S2 Nina's finger (object of the action injure); S3 knife (subject of the actions cut bread and injure Nina's finger) – fig. 1.2.1.b.

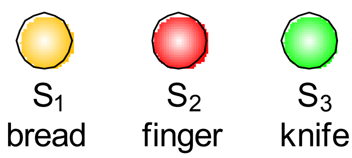


Fig. 1.2.1.b –Substances interacting while Nina is preparing the sandwiches

2. There are no fields between the bread and the finger (according to the description above, it is not relevant to represent that Nina holds the bread by the fingers); there is a field (an interaction) between the bread and the knife as well as between the finger and the knife – fig. 1.2.1.c

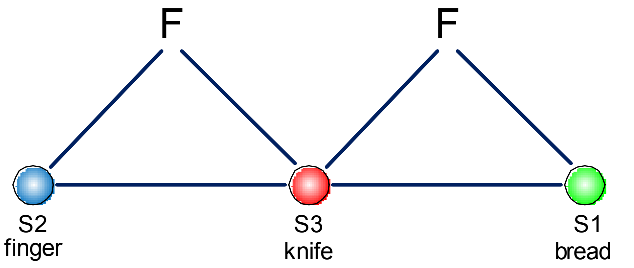


Fig. 1.2.1.c – Fields acting between the identified substances

3. The field F_1 between the knife and Nina's finger is clearly mechanical: the knife causes a wound into the finger by a high local pressure, or with a formal expression "increases the number of wounds of the fingers" (from zero to one) or "decreases the health of the finger". Since the impact of the knife (tool) on the evaluation parameter of the product (number of wounds of the fingers, or health of the finger) is undesired, the interaction between S_3 and S_2 is harmful.
4. The field F_2 between the knife and the bread is also mechanical: the knife cuts the bread, or with a formal expression "increases the number of slices of the bread". Since the impact of the knife (tool) on the evaluation parameter of the product (number of slices) is desired and we don't have any information about an improper amount of slices, the interaction between S_3 and S_1 is useful.

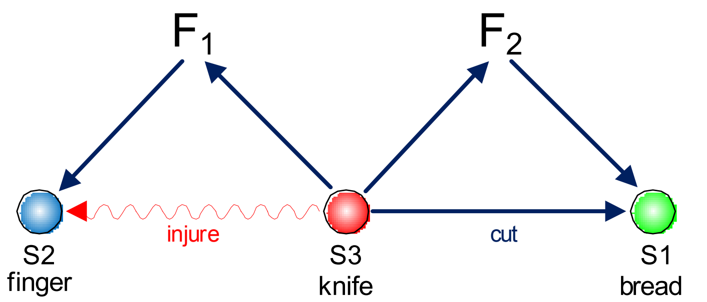
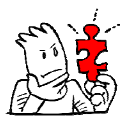


Fig. 1.2.1.d – Su-Field model of Nina preparing the sandwiches

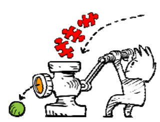
Self Assessment

<u>Exercise 1</u>:



Nina has to give a MP3 famous song of 4.6 Mbyte, that she has in the PC, to her friend Mat. Yet he doesn't have an internet connection, so Nina has to write the file on a support. Her USB pen drive is broken, so she think to use a CD. When she open the drawer she realizes that her CD are finished, and she has only a DVD. Try to build a Su-Filed model of the file transfer.

<u>Answer 1</u>:



The first step is to identify all the substances present in the scene: in this case we have the PC (S_1), the DVD support (S_2) and the MP3 song (S_3), fig. 1.2.1.e.

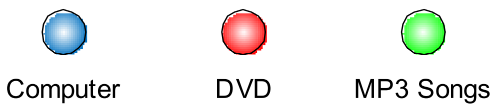


Fig. 1.2.1.e – the three substances presents in the scene

To complete the model also the fields among substances are requested, fig. 1.2.1.f. The first part of the model represents the act of transfer the file from the PC to the DVD, so the act of “writing”, while the second one depict that the file is now contained within the DVD

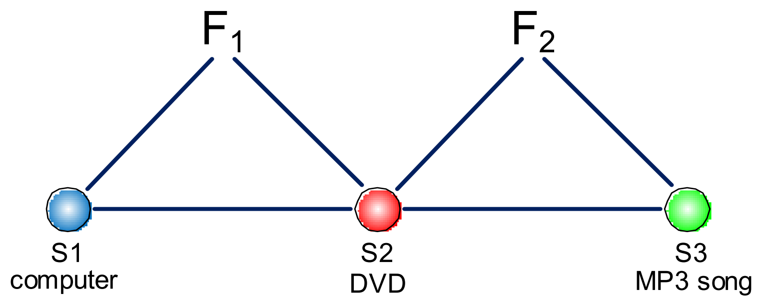


Fig. 1.2.1.f – the first step toward the constitution of a Su-Field model

Now we have to find what kind of fields are F1 and F2. Computer writes file on the DVD by a laser, so F1 could be considered as an electromagnetic field; the DVD contains a magnetic track which represent the file, so F2 could be a magnetic field. The act write, developed by PC toward the DVD is an useful action and it is sufficient; also the DVD develops an useful action, “contains file”, but this time it could be considered excessive: Nina has used a 4.7 GByte of capacity oaf a DVD to transfer a file of only 4.6 Mbyte, fig. 1.2.1.g.

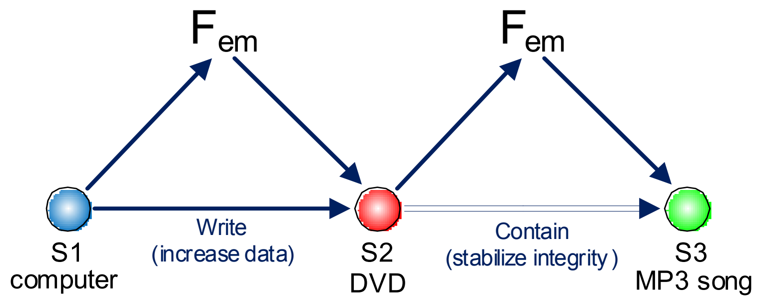


Fig. 1.2.1.g– the final Su-Field model

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

4.2 - STANDARD SOLUTIONS

Definition

A *standard solution* is a model of solution of a typical problem modeled by means of *Su-Field* interactions

Theory

The *Standard Solutions* (sometimes briefly named Standards) are a system of 76 models of synthesis and transformations of technical systems in agreement with the *Laws of Evolution* of Engineering Systems.

Together with *ARIZ*, the database of *Effects* and the *Laws of Engineering Systems Evolution* the Standard Solutions constitute the most advanced and effective set of instruments of Classical TRIZ, thus substituting Altshuller's *matrix of technical contradictions* and the *Inventive Principles*.

The Standards have been developed between 1975 and 1985 with the aim of providing a structured approach to the solution of a technical problem, browsing individual's knowledge, as well as databases of *physical chemical geometrical effects*, systematically.

Originally the standards were listed as separate solution models, numbered according to the order of formalization.

In 1979 a system of 28 integrated Standards classified in three main subsets was presented and published by Altshuller in [1]. In the following years further standards were added and the final structure of 5 classes was released (figure 2) [2].

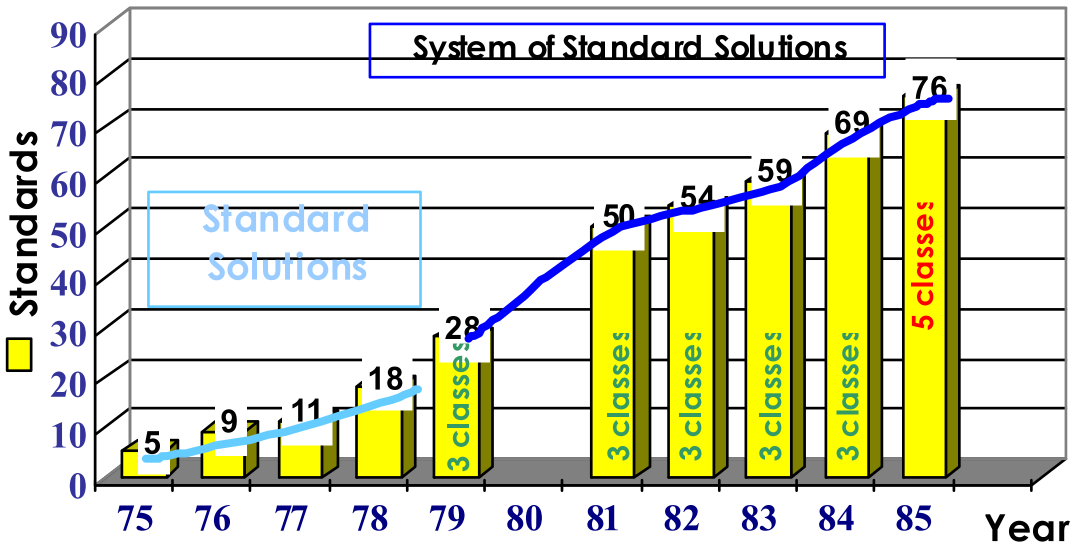


Figure 2 - History of development of Standard Solutions

Instruments

Standards Solutions should be used to solve the biggest majority of "typical" problems to be represented by means of *Su-Field models*, i.e. when an insufficient or undesired interaction exists between two or more *subsystems*.

They allow to overcome or circumvent *contradictions* without the need to identify and formulate the contradiction itself.

Standards are also useful to browse individual's knowledge following a systematic process.

In order to apply a Standard Solution it is requested to:
1. build a Su-Field model of the problem
2. chose the most appropriate Standards
3. follow the guidelines of the selected Standards

References

[1] Altshuller G.S., Selutskii A.B.: Wings for Icarus (in Russian). Petrozavodsk: Karelia, 1980.

[2] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

4.2.1 - STRUCTURE OF A STANDARD SOLUTION

Theory
Each standard solution is structured as a transformation of an initial “problematic” *Su-Field model* into a modified *Su-Field model*, where the undesired characteristics of the interactions between the *subsystems* disappear (Figure. 2.1.a).

Model

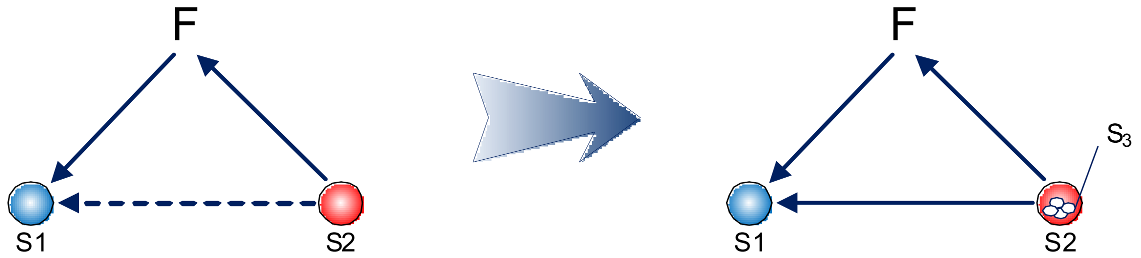


Figure 2.1.a - Exemplary model of a standard solution: an undesired Su-Field interaction (in this case an insufficient interaction) disappear by means of a transformation of the Su-Field model

Instruments
A standard solution is constituted by three main elements:

D: (Description) the description of the typical problematic situation when it is appropriate to apply that standard;
G: (Guidelines) the guidelines to introduce modifications in the system to solve the typical problem;
M: (Model, when available) a visual representation of the transformation by means of Su-Field models (Figure 2).
The visual model of the transformations is not always available; more specifically, it is omitted when the transformation of the Su-Field model deals with a qualitative modification of a substance or a field, instead of the introduction of new/modified elements in the system.
N: (Notes) Sometimes a note is added to the guidelines to provide further explanations about their implementation.

Example
The three elements of the Standard 1.1.2 are the followings:

D: the description of the typical problematic situation when it is appropriate to apply that standard:
“If there is a need in a Substance-Field System to improve the positive effect of an interaction and the conditions do not contain any limitations on the introduction of additives to at least one of the given substances”;
G: the guidelines to introduce modifications in the system to solve the typical problem: ”the problem is to be solved by a transition (permanent or temporary) to an internal complex Substance-Field System, by introducing additives in the present substances. These additives enhance controllability or impart the required properties to the Substance-Field System”;
M: see figure 2.1.b

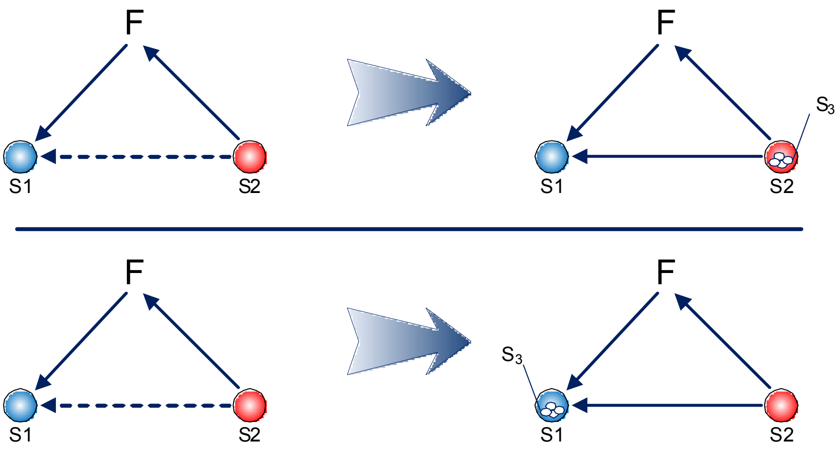
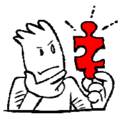


Fig. 2.1.b – Model of Standard 1.1.2

Self Assessment



Exercise 1:
Look at the following Standard Solution and identify their constitutive elements.

STANDARD 1-1-4
If there is a need in a Substance-Field System to improve the positive effect of an interaction, and the conditions contain limitations on the introduction or attachment of substances, the problem can be solved by using the existing environment as the substance to increase the efficiency of the existing interaction.

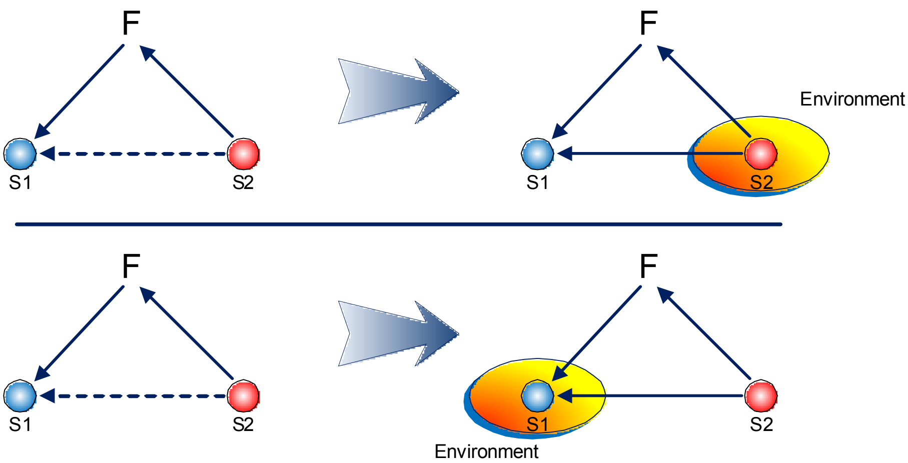
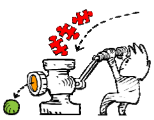


Fig. 2.1.c – Model of Standard 1.1.4

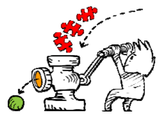


Answer 1:
D: If there is a need in a Substance-Field System to improve the positive effect of an interaction, and the conditions contain limitations on the introduction or attachment of substances,
G: the problem can be solved by using the existing environment as the substance to increase the efficiency of the existing interaction.
M: (figure 1.1.4)

Exercise 2:
Look at the following Standard Solution and identify their constitutive elements.

STANDARD 2-2-2
The efficiency of a Substance-Field System can be improved by increasing the degree of fragmentation of the element which acts as a tool in the interaction.
The standard displays one of the major trends of the technology evolution, i.e. fragmentation of the element or its part interacting with the product (“tool”). The process is ended when the tool is replaced by a new field capable to deliver its function.
Thus, the evolution of the tool passes through the following phases: Non-fragmented object; Fragmented object; Powder; Liquid; Gas; New field.

Answer 2:
D: The efficiency of a Substance-Field System can be improved
G: by increasing the degree of fragmentation of the element which acts as a tool in the interaction



N: The standard displays one of the major trends of the technology evolution, i.e. fragmentation of the element or its part interacting with the product (“tool”). The process is ended when the tool is replaced by a new field capable to deliver its function. Thus, the evolution of the tool passes through the following phases: Non-fragmented object; Fragmented object; Powder; Liquid; Gas; New field.

References

VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

4.2.1.1 - TRANSFORMATION OF A SU-FIELD SYSTEM

Theory

According to the system of standard solutions, the following transformation may be applied to a Su-Field System:

- Introduction of a New *Substance*
  - a new element (figures 2.1.1.a-b)
  - an internal additive
  - an external additive
  - a resource already available in the environment
- Introduction of a New *Field* (figures 2.1.1.c-d)
- Modification of a Substance
  - modification of the *Tool* (figure 2.1.1.e)
  - modification of the *Object*
  - modification of the environment surrounding the substances of the Su-Field System
- Modification of a *Field* (figure 2.1.1.f)
- Use of Physical, Chemical, Geometrical *Effects*;
- A combination of any of the previous transformations.
- The above modifications can be applied to a whole element or to a portion in terms of changes/variations of any *resource*, like:
- Space: number of dimensions, topology, shape, size;
- Time: timing of action, duration of action, frequency of action;
- Properties: chemical properties, physical (electrical, magnetic, optical…) properties
- Energy: amount of energy, type of energy (kinetic, thermal, electrical…)

Model

Exemplary models of transformations of a Su-Field System:

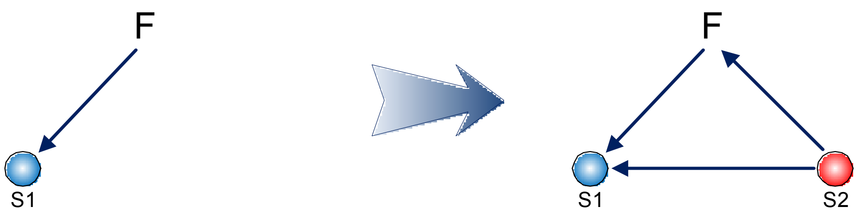


Fig. 2.1.1.a – Introduction of a New Substance

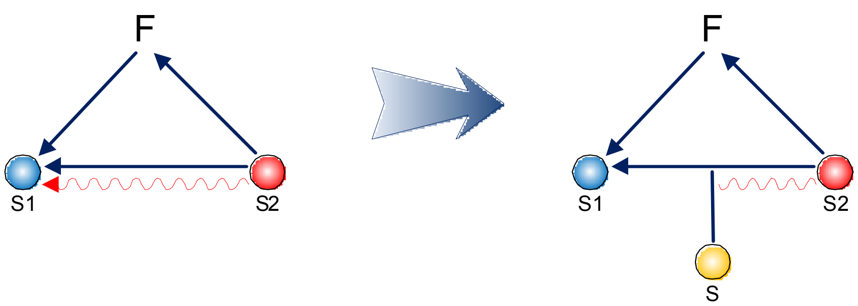


Fig. 2.1.1.b – Introduction of a New Substance

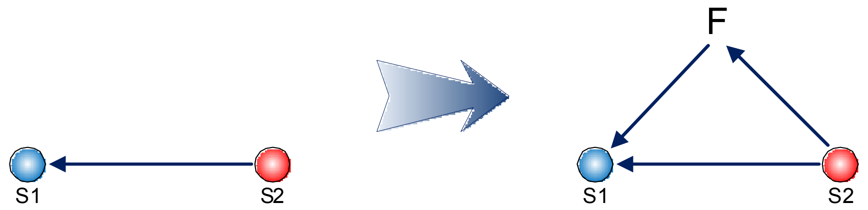


Fig. 2.1.1.c – Introduction of a New Field

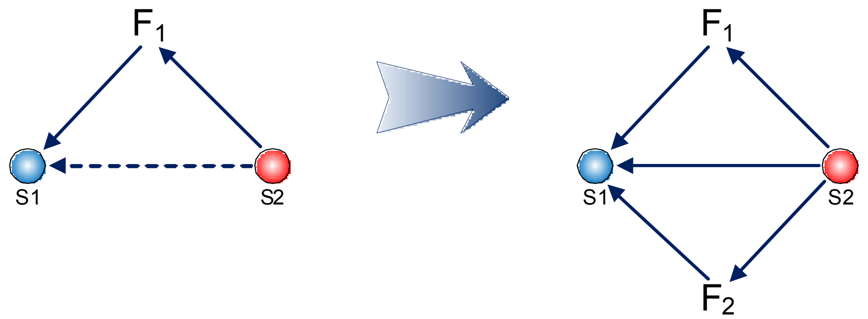


Fig. 2.1.1.d – Introduction of a New Field

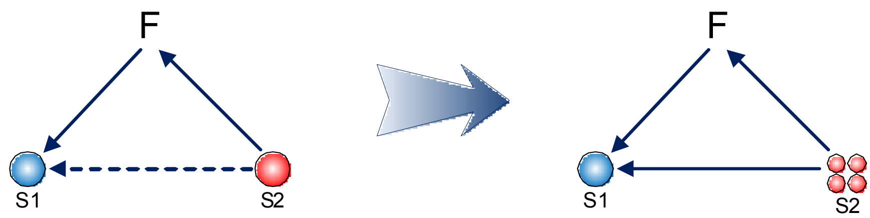


Fig. 2.1.1.e –Modification of the Tool

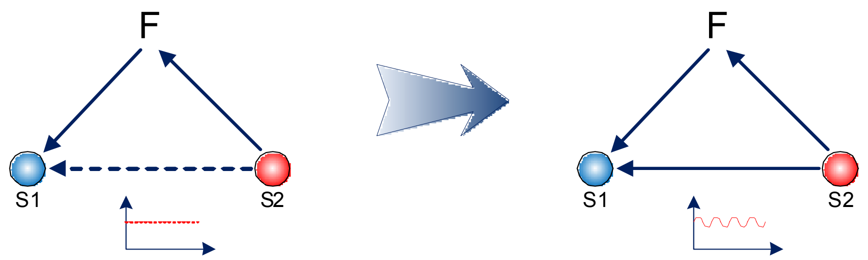


Fig. 2.1.1.f –Modification of the Field

Instruments

The application of a Standard Solution means following the directions of the selected standard in order to transform the original Su-Field System characterized by poor efficiency and/or undesired effects into another Su-Field system where the problem disappears.

The transformation suggested by the selected Standard must be applied taking into account the *Substance-Field Resources* already available in the system and secondarily new/modified resources to be integrated in the system itself.

Such a task can be supported by the navigation of a *database of effects*, in order to complement individual and team knowledge.

Example

It is necessary to speed up the sterilization of a food container by means of chemical reagents. After *building a Su-Field model* of the actual situation, one of the relevant Standards to approach this problem suggests the following transformation (figure 2.2.2.g).

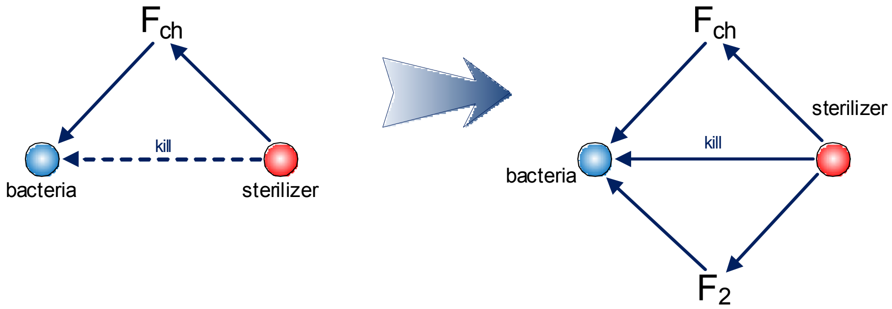


Fig. 2.1.1.g – Suggested transformation to improve the efficiency of a sterilization process

The analysis of the available resources, also supported by a search in the database of effects, suggests hyperthermia as a possible solution to improve the efficiency of the process (figure 2.1.1.h).

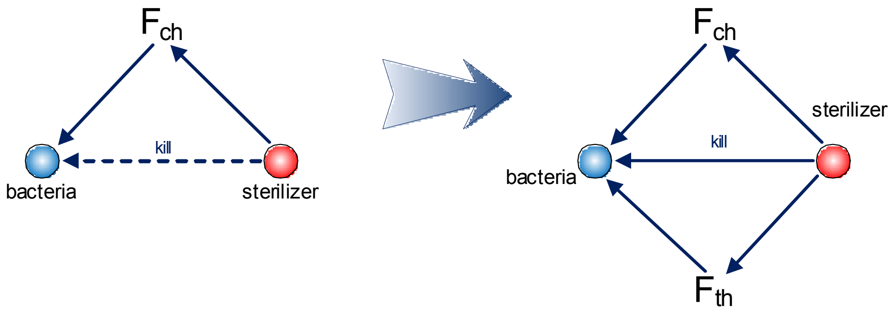


Fig. 2.1.1.h – Adoption of hyperthermia as a complementary action to kill bacteria

Self Assessment

<ins>Exercise 1:</ins>

When the sound is shut off (e.g. during a meeting), a mobile phone advises when a call is arriving by vibrations, but if the cell phone lays on a soft surface (e.g. leather folder, newspaper etc) the vibration doesn't produce any sound and the user might not perceive it. After building a Su-Field model of the actual situation, one of the relevant Standards to approach this problem suggests the following transformation (figure 2.2.2.i).
Develop a solution according to the suggested direction.

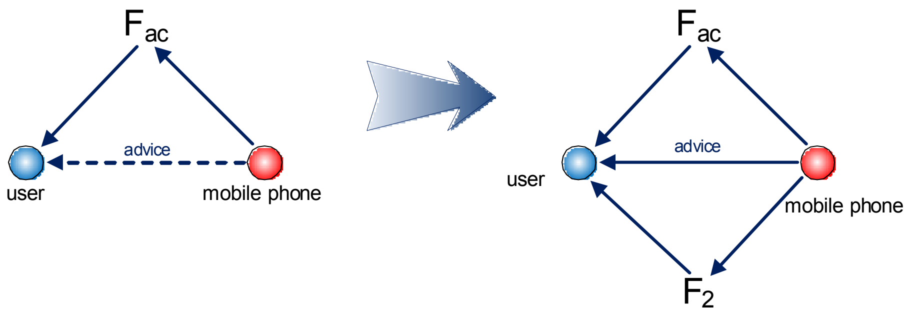


Fig. 2.1.1.i – Suggested transformation to improve the efficiency of alarm in a mobile phone

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Solution 1:

In order to complement the vibration/acoustical field already present in the system a parallel optical signal can be added to the mobile phone (e.g. by blinking the light of the LCD screen, figure 2.1.1.j)

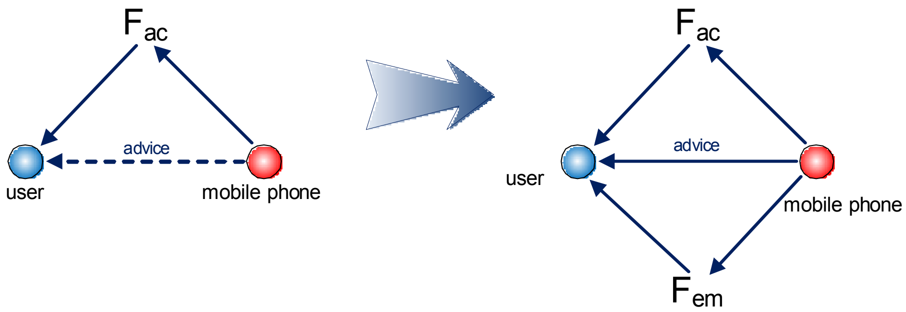


Fig. 2.1.1.j – Adoption of an optical signal as a complementary means to advice the user of an incoming phone call

4.2.2 - CLASSIFICATION OF STANDARD SOLUTIONS

Definition

In Classical TRIZ the Standard Solutions are grouped in 5 classes:

1. Improving interactions and eliminating harmful effects
2. Evolution of systems
3. Transition to macro and micro level
4. Detection and measurement problems
5. Meta-solutions, helpers

Theory

The Standard Solution were developed since the second half of the ‘70s by collecting “typical” solutions to technical problems. Originally they were just numbered sequentially, according to the order of discover.

In March 1979 Altshuller developed the first System of Standard consisting in three classes:

1. Standards for systems modification
2. Standards for detection and measurement
3. Standards for the application of the Standards

By the end of 1984 the majority of TRIZ schools in the former Soviet Union has adopted such a System of Standards for the solution of any “ordinary” problem, while ARIZ was applied for the analysis of non-standard, i.e. inventive, problems, as well as for the recognition of further Standards.

After the identification and formalization of the *Laws of Engineering System Evolution* (LESE, 1983-1986) Altshuller suggested a novel classification of the 76 Standard Solutions in five classes in order to harmonize them with the LESE:

1. Improving interactions and eliminating harmful effects
2. Evolution of systems
3. Transition to macro and micro level
4. Detection and measurement problems
5. Meta-solutions, helpers

Model

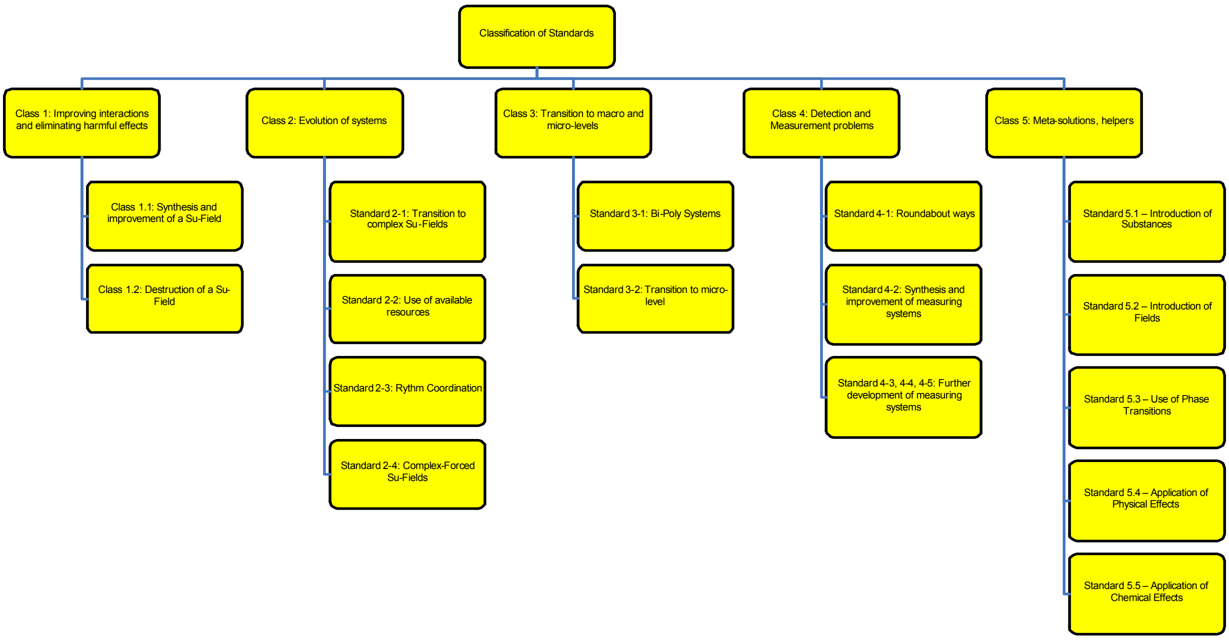


Fig. 2.2.a – Classification of the Standard Solutions

Instruments

The classification of the Standard Solutions is a guide for selection of the proper Standards to apply (figure 2.2.a):

* if a function is missing or an useful interaction between two elements of a *Technical System* should be improved, relevant Standards can be found in Class 1.1;
* if a problem is characterized by a harmful interaction between two elements of a Technical System, relevant Standards can be found in Class 1.2;
* in both cases, the modification of the existing substances/resources can be applied by following the Standards of Class 2;
* more critical problems require more radical changes of the Technical System, by an integration at *Super-System* level (Class 3.1) or by a transition to a smaller scale of interaction (Class 3.2).
* detection and measurement problems can be approached by eliminating the need of measurement (Class 4.1), building a new interaction for information deliver (Class 4.2), further evolving existing measurement elements (Class 4.3);
* whatever is the Standard to be applied, some special precautions can be adopted to prevent drawbacks while introducing a new substance (Class 5.1), a field (Class 5.2), a phase transition (Class 5.3), Physical and Chemical Effects (Class 5.4 and 5.5).

More detailed directions about the selection and use of Standards are provided in *section 3*.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

CLASS 1: IMPROVING INTERACTIONS AND ELIMINATING HARMFUL EFFECTS

Theory

The first class of Inventive Standards is dedicated to the synthesis of a Su-Field interaction, to the improvement of the positive effect of a Su-Field interaction or to the elimination of the negative effect of a Su-Field interaction, by means of a Su-Field transformation (*section 2.1.1*)

CLASS 1.1: SYNTHESIS AND IMPROVEMENT OF A SU-FIELD

Definition

The synthesis of a Su-Field consists in the creation of a complete triad Substance 1 – Field Substance 2, which is the *minimal model* of a technical system.
Improving a Su-Field means improving the positive effect of a functional interaction between Substance 2 (*Tool* or *Working Organ*) and Substance 1 (*Product* or *Object*).

Instruments

The first standard (1.1.1) is aimed at the creation of a new Su-Field interaction by introducing the missing elements of the system.
Besides, while applying the other standards of class 1.1 (1.1.2-1.1.8), the main field existing between the working organ S_2 and the object S_1 should be kept and the addition of substances should "boost" the existing interaction under the existing field.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1-1-1: SYNTHESIS OF SUBSTANCE-FIELD SYSTEM

Definition

The synthesis of a Su-Field consists in the creation of a complete triad Substance 1 – Field Substance 2, which is the *minimal model* of a technical system.

Theory

If there is a need to provide a positive effect to an *object* (Substance 1) by delivering an *useful function*, i.e. by modifying a parameter or a feature of the object itself, and the conditions do not contain any limitations on the introduction of substances and/or fields, the problem is solved by synthesizing a complete Su-Field model: the object is subjected to the action of a physical field which produces the necessary change in the object.

Model

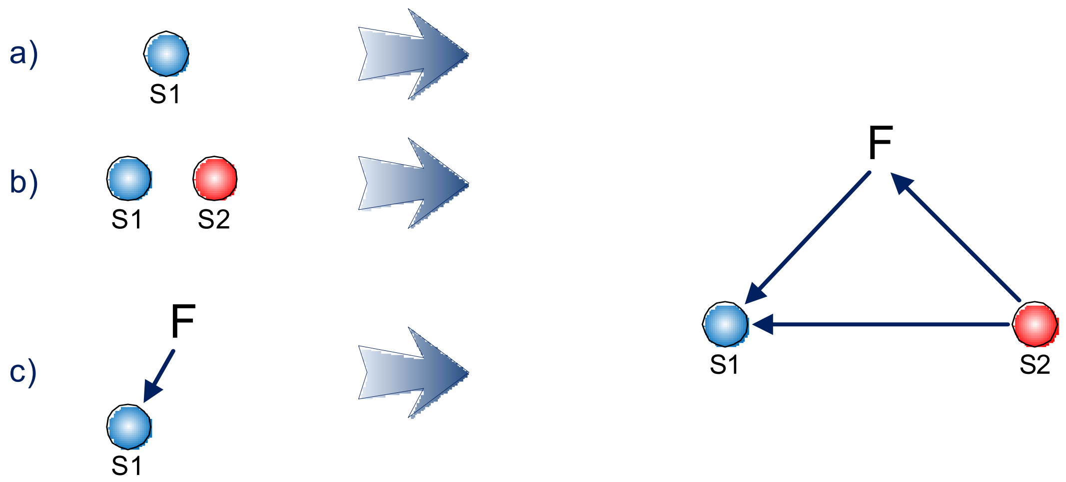


Fig. 2.2.1.1.1.a – STANDARD 1-1-1: Synthesis of substance-field system

Instruments

This standard is applied when an useful function should be performed on a given object (S_1), but an interaction capable to provide the expected modification of the object is missing.

Three different situations can be encountered (fig. 2.2.1.1.1.a, left):
no other elements are present;
a working element is present (S_2), but no fields make it interact with the object (S_1);
a field is present (F), but the working element is missing.
In order to deliver the useful function the system must be completed by adding the missing elements (fig. 2.2.1.1.1.a, right), i.e. by introducing a substance and/or a field in the system.
In order to perform a systematic search for the substance/field to be added to the system, it is suggested to browse the tables of *Substance/Field resources*.

Example

It is requested to keep the door of a freezer firmly closed in order to minimize heat exchanges.

First, it is necessary to determine the useful function to be delivered: keeping the door closed can be translated into the function “hold the door”, i.e. “stabilize its orientation in the closed position”. It is worth to notice that the function is properly expressed when the parameter of the object to be controlled (i.e. increased, decreased, changed, stabilized) is explicit.
The initial situation is thus constituted by just one object (the door), since no other elements have been mentioned (fig. 2.2.1.1.1.a, sub-case a).

According to the Standard 1.1.1, it is necessary to introduce a substance and a field (figure 2.2.1.1.1.b).

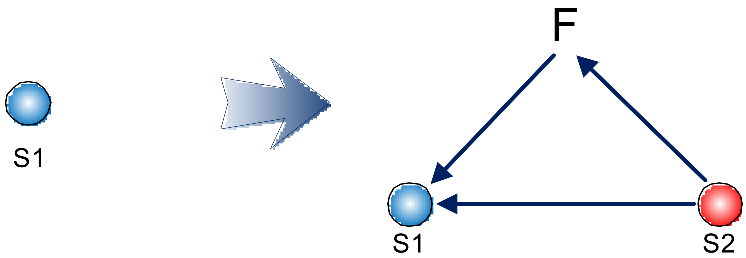


Fig. 2.2.1.1.1.b – STANDARD 1-1-1: Synthesis of substance-field system

Browsing the tables of Substance-Field resources or just focusing the attention on the problem solver experience, several solutions can be triggered: a mechanical field can be created by means of a hook (working element); a magnetic field can be applied by a magnet etc. (figure 2.2.1.1.1.c).

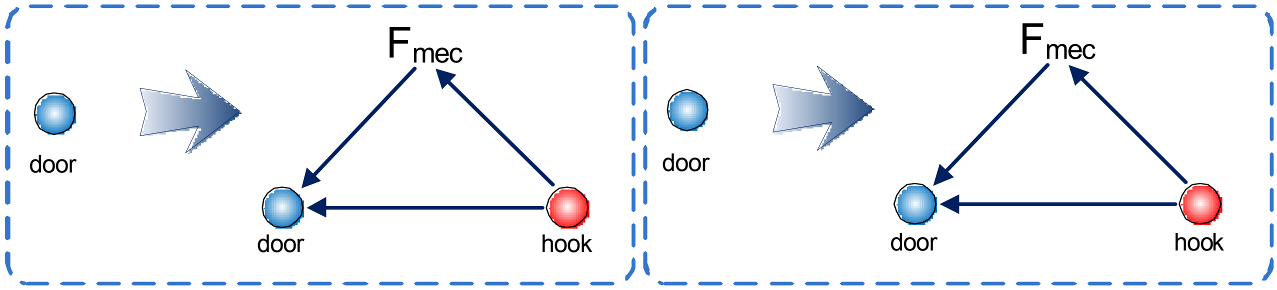
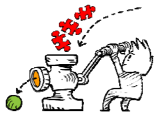


Fig. 2.2.1.1.1.c – Exemplary applications of standard 1.1.1 to deliver the function "hold the door"

Self Assessment

Exercise1:
Nina is in the kitchen, and with her mother she is making a cake for dinner. They need some cwhipped cream, so the mom prepared a bowl with the cream and a whisk, leaving them on the table. Obviously doing so, the cream remains liquid. When Nina arrives, she complete the S-Field model quickly. What does she do?

<u>Answer1</u>:
This problem is obviously very simple, but it is resolved going to complete a mini model that was incomplete (fig. 2.2.1.1.1.d left). On the table we have two substances: the cream, within the bowl, and the whisk. According to standard 1.1.1, it is easy to see that a field is missing. Unfortunately for Nina, a mechanical field could be a good solution, so she starts to shake the whish inside the cream in order to whip it (fig. 2.2.1.1.1.d right).



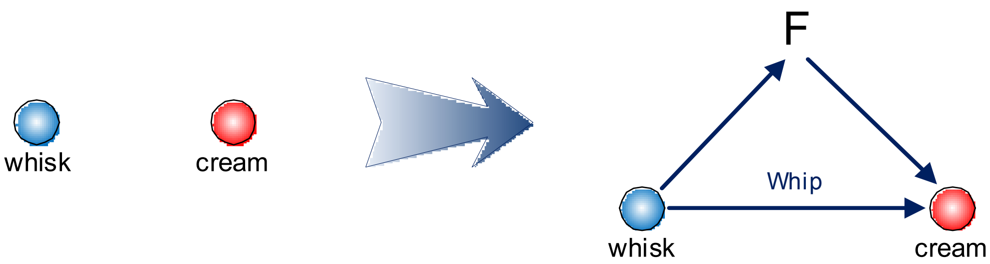


Fig. 2.2.1.1.1.d – an easy example of usage of standard 1.1.1: whipping the cream

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1-1-2: IMPROVING INTERACTIONS BY INTRODUCING ADDITIVES INTO THE OBJECTS

Definition

Improving a Su-Field means improving the positive effect of a functional interaction between Substance 2 (*Tool* or *Working Organ*) and Substance 1 (*Product* or *Object*), without modifying the main field existing between the substances.
The interaction can be improved by introducing an internal additive to the substances.

Theory

If there is a need to improve the positive effect of an useful function to an object, and the conditions do not contain any limitations on the introduction of additives to the given substances, the problem can be solved by introducing foreign additives in the present substances to enhance controllability or impart the required properties to the Su-Field interaction.
The role of these additives is to amplify the effect of the existing interaction between the substances under the present field, or to increase the degree of control over the interaction. Therefore, it is not allowed to modify the nature of the field existing between the two substances.

Model

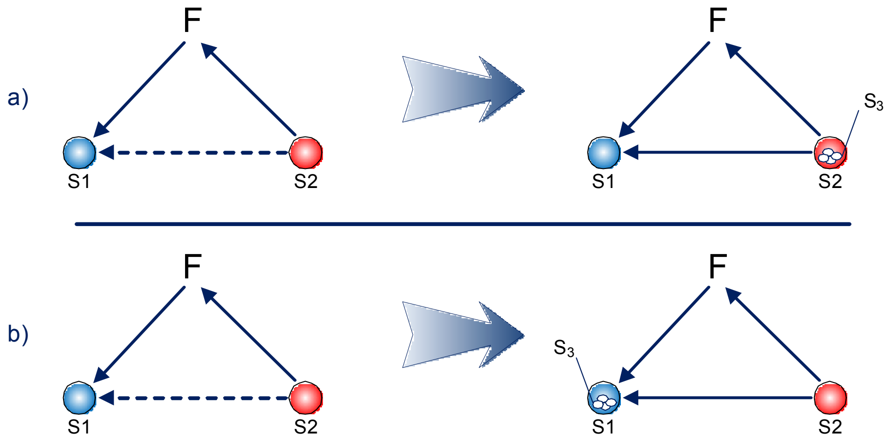


Fig. 2.2.1.1.2.a – STANDARD 1-1-2: Improving interactions by introducing additives into the objects

Instruments

This standard is applied when an useful function is not sufficient, i.e. the modification exerted on the object doesn't fit the expectations, and it is allowed to introduce additives in the working element (fig. 2.2.1.1.2.a, above) or in the object (fig. 2.2.1.1.2.a, below).
The following steps should be applied:

1. build a Su-Field model of the insufficient useful function; identify the parameter modification to be improved;
2. check whether it is possible to introduce additives in the working element and/or in the object;
3. search for substances which might improve the efficiency of the existing field;
4. check if there are any limitations to the introduction of such specific substance into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

To clean the surface of a gas stove in a kitchen, we use a wet sponge, in order to dissolve dirt particles of food.

If the sponge contains just water, the process is very slow and some fat substances remain stuck to the stove. According to the Standard Solution 1.1.2, such an insufficient interaction can be improved by means of an internal additive (fig. 2.2.1.1.2.b).

In facts, while it is relatively complicated to introduce internal additives to the dirt, an ordinary solution is adding some detergent (S_3) to the water in order to increase its capability to dissolve the dirt.

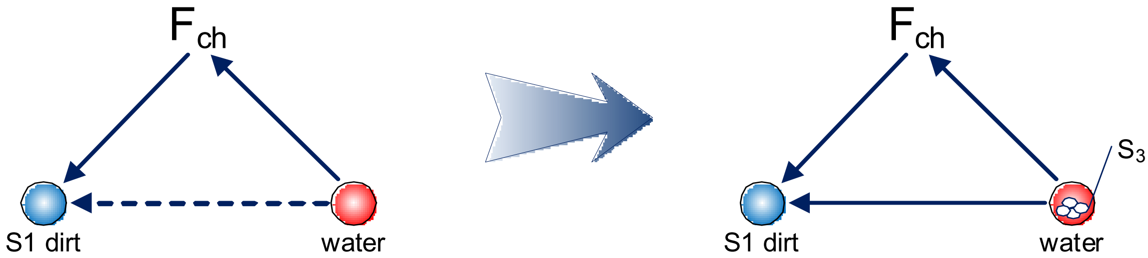


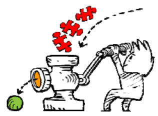
Fig. 2.2.1.1.2.b – Exemplary applications of standard 1.1.2 to improve the useful function "dissolve dirt"

Self Assessment

Exercise 1:

Driving a car when the road is covered by snow can be dangerous, since the adherence of the wheel is pretty low (example of section 2.2.1.1.3).

Generate a solution according to the Standard 1.1.2 (and not standard 1.1.3!!).



Answer 1:

A model representing the insufficient interaction between road and wheel is represented in fig. 2.2.1.1.2.c, left.

The parameter to be modified (increased) is the friction existing between wheel and road, in order to have higher grip the directions of standard 1.1.2 can be followed: introduce additives in the working element and/or in the object to improve the efficiency of the interaction (fig. 2.2.1.1.2.c, right).

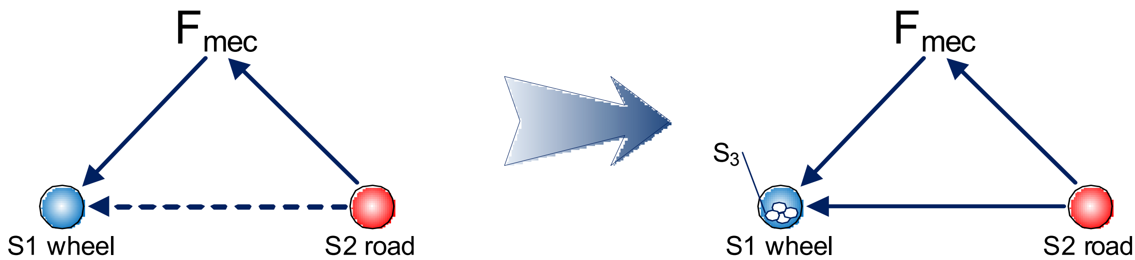


Fig. 2.2.1.1.2.c – Exemplary applications of standard 1.1.2 to improve the useful function "support wheel"

Instead of introducing internal additives in the road, it is more convenient to add a substance S_3 into the wheel.

A well known example is constituted by snow tyres with spikes (fig. 2.2.1.1.2.d)

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Fig. 2.2.1.1.2.d – Exemplary applications of standard 1.1.2 to snow tyres (internal additives = spikes)

<u>Exercise 2:</u>
Everyone today has a notebook. We can carry it from home to work or to school, for example. We use to have a canvas bag to hold the computer, but it may occur that this pouch falls down with the consequent breakdown of the pc. So sometimes protection offered by canvas bag is not sufficient. How could we improve it?

<u>Answer 2:</u>
In the initial situation we have S_1 represented by the bag which by way of a mechanical field contains and protects a second substance (the notebook) (see fig. 2.2.1.1.2.e left). The parameter that must be improved is the protective capability of the bag. so according to standard 1.1.2 we must add a new substance S_3 to make it sufficient. We can chose if putting something within the bag or into the notebook: in this case the first choice is more useful. This substance could be some foam rubber between the canvas layers (fig. 2.2.1.1.2.e. right).

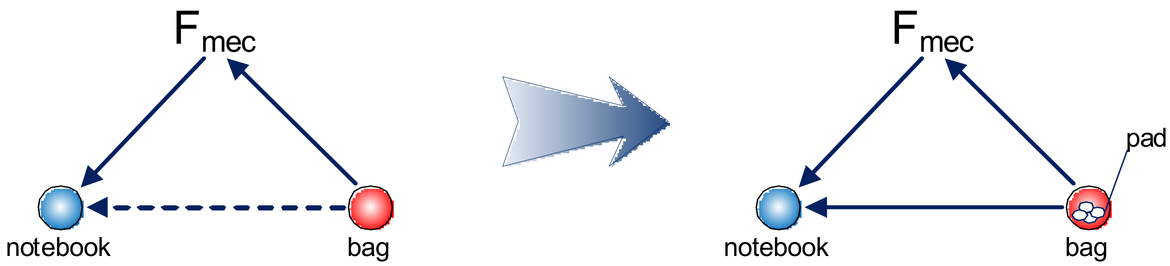

Fig. 2.2.1.1.2.e – the Su-Field model of a bag for the notebook.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

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STANDARD 1-1-3: IMPROVING INTERACTIONS BY INTRODUCING ADDITIVES INTO A SYSTEM

Definition

Improving a Su-Field means improving the positive effect of a functional interaction between Substance 2 (*Tool* or *Working Organ*) and Substance 1 (*Product* or *Object*), without modifying the main field existing between the substances.
The interaction can be improved by introducing an external additive to the substances.

Theory

If there is a need to improve the positive effect of an useful function to an object, and the conditions do not contain any limitations on the introduction of additives to the given substances, the problem can be solved by attaching an external additive to the present substances to enhance controllability or impart the required properties to the Su-Field interaction.
The role of these additives is to amplify the effect of the existing interaction between the substances under the present field, or to increase the degree of control over the interaction. Therefore, it is not allowed to modify the nature of the field existing between the two substances.

Model

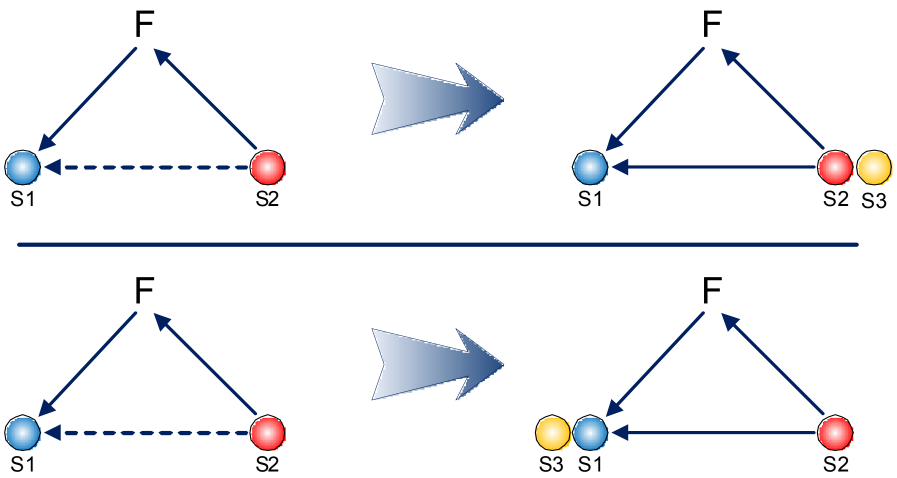


Fig. 2.2.1.1.3.a – STANDARD 1-1-3: Improving interactions by introducing additives into a system

Instruments

This standard is applied when an useful function is not sufficient, i.e. the modification exerted on the object doesn't fit the expectations, and it is allowed to add external substances to the working element (fig. 2.2.1.1.3.a, above) or to the object (fig. 2.2.1.1.3.a, below).

The following steps should be applied:

1. build a Su-Field model of the insufficient useful function; identify the parameter modification to be improved;
2. check whether it is possible to apply external additives to the working element and/or to the object;
3. search for substances which might improve the efficiency of the existing field;
4. check if there are any limitations to the introduction of such specific substance into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

Driving a car when the road is covered by snow can be dangerous, since the adherence of the wheel is pretty low. A Su-Field model representing the situation is shown in fig. 2.2.1.1.3.b, left.
Nota: il passo 3 può essere sopportato dalla tabella Substance-Field.

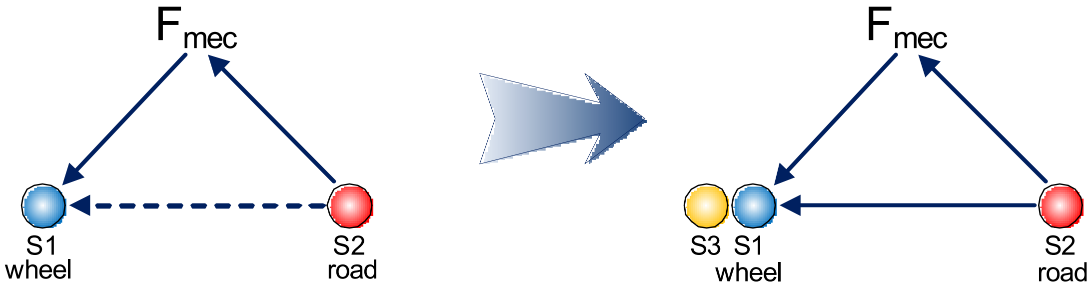
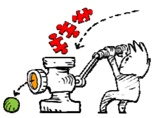


Fig. 2.2.1.1.3.b – Exemplary applications of standard 1.1.3 to improve the useful function "support wheel"

In order to improve the useful interaction between the road (covered by snow) and the wheel, the standard 1.1.3 suggest adding an external substance to the road or to the wheel (fig. 2.2.1.1.3.a). Despite it's possible in theory to apply an external substance to the road in order to improve its grip, it is clear that it is much more convenient to apply a the external additive to the wheel (fig. 2.2.1.1.3.b, right).
A well known solution is the adoption of snow chains.

Self Assessment

Exercise 1:
A plastic cover must be painted, but it is very smooth and porous by no means. So the paint doesn't stick and cover enough the plastic surface. Try to solve this problem by using the Standard 1.1.3.



Answer 1:
The initial situation shows another time an useful but insufficient action between S_2 (the paint) and S_1 (the part to be painted) as represented in fig. 2.2.1.1.3.c left.

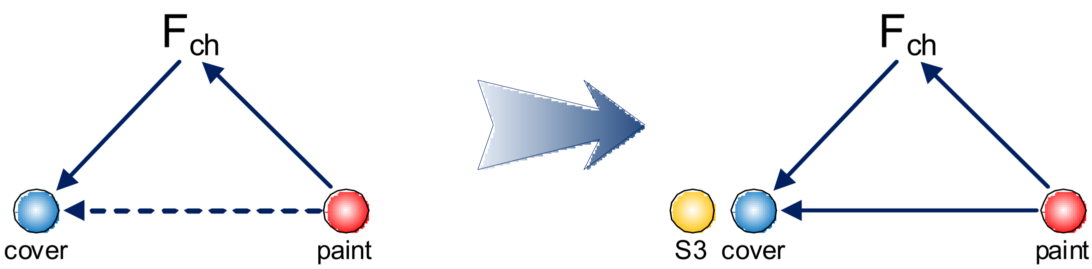


Fig. 2.2.1.1.3.c – how to paint a cover with a Su-Field model

The parameter to improve is the sticking of paint to the cover. To resolve this problem, following the standard solution 1.1.3 suggestions, we have to add an external substance S_3 or to the paint or to the cover, as modeled in fig 2.2.1.1.3.c left. Placing something inside the paint means following the standard 1.1.2 direction. Thus the external substance has to be placed near or over the cover. An explanatory solution could be a fixative spread over the cover before painting (fig. 2.2.1.1.3.c right).

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1-1-4: USE OF ENVIRONMENT TO IMPROVE INTERACTIONS

Definition

Improving a Su-Field means improving the positive effect of a functional interaction between Substance 2 (*Tool* or *Working Organ*) and Substance 1 (*Product* or *Object*), without modifying the main field existing between the substances.
The interaction can be improved by using the environment as third substance which can increase the efficiency of the system.

Theory

If there is a need to improve the positive effect of an useful function to an object, and the conditions contain limitations on the introduction of additives to the given substances, the problem can be solved by using the environment as third substance to enhance the controllability or to impart the required properties to the Su-Field interaction. The role of the environment is to amplify the effect of the existing interaction between the substances under the present field, or to increase the degree of control over the interaction. Therefore, it is not allowed to modify the nature of the field existing between the two substances.

Model

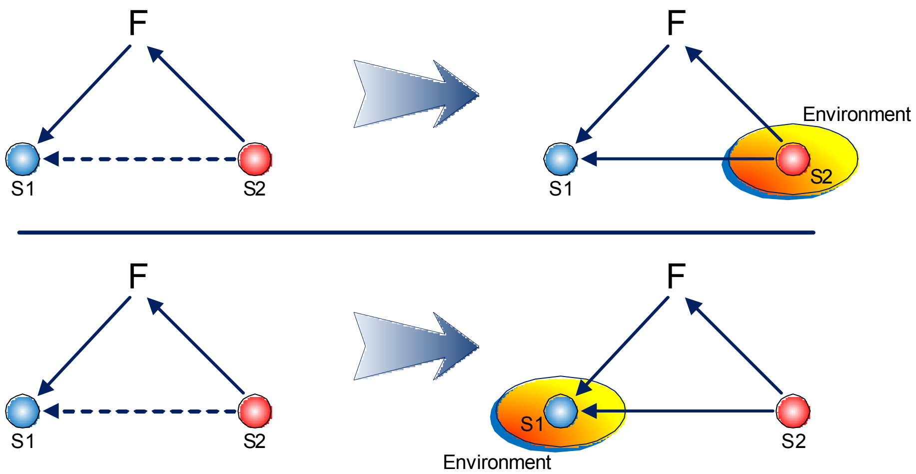


Fig. 2.2.1.1.4.a – STANDARD 1-1-4: Use of environment to improve interactions

Instruments

This standard is applied when an useful function is not sufficient, i.e. the modification exerted on the object doesn't fit the expectations, and it is not allowed to add external substances to the working element. In such a case, it must be checked if the environment surrounding any of the interacting substances can provide the expected properties to the field.
The following steps should be applied:
1. build a Su-Field model of the insufficient useful function; identify the parameter modification to be improved;
2. define candidate properties capable to improve the efficiency of the existing field;
3. analyze the characteristics of the environment surrounding the working tool (fig. 2.2.1.1.4.a, above) or the object(fig. 2.2.1.1.4.a, below) and check if any of the properties defined at step 2 are available;
4. check if there are any limitations to the adoption of the environment as the third substance of the Su-Field interaction.

Note: the second and third step can be driven by a table of substance resources.

Example

In order to improve the efficiency of an air-conditioning system, the outdoor fans are installed on the northern side of the building, thus taking advantage from the shady environment (Fig. 2.2.1.1.4.b).

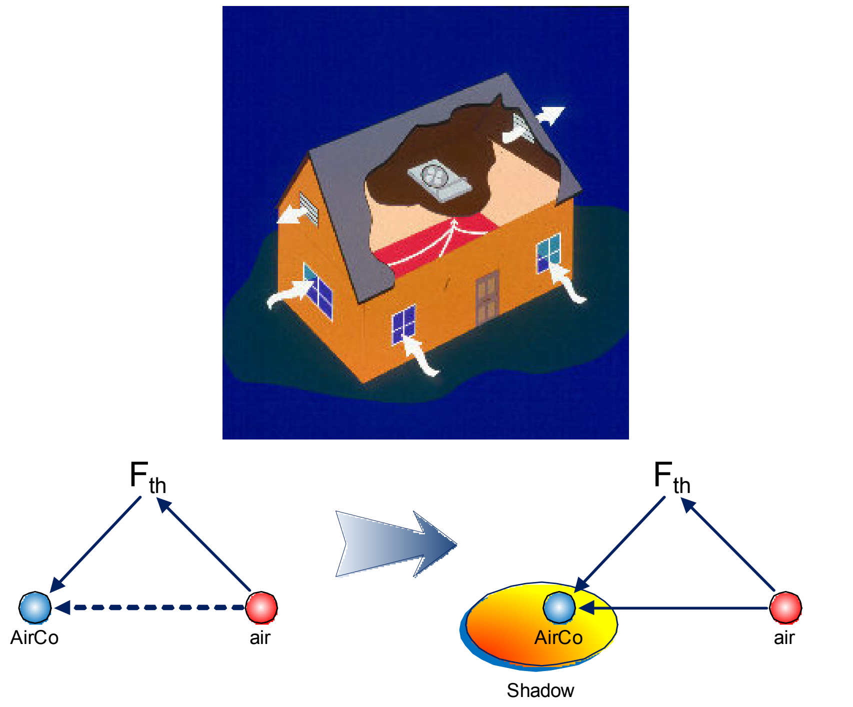


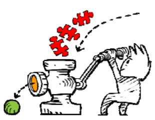
Fig. 2.2.1.1.4.b – Placement of an AirCo system on the shady side of a building

Self Assessment

<u>Exercise 1:</u>

How many times we have taken a slice of pizza in a fast food and it is bad because it is too cold? Too many. So how is it possible to avoid an excessive pizza cooling according to standard 1.1.4?

<u>Answer 1:</u>



The problem is very simple to represent with a minimal model. There are two substances, the pizza and the fast food counter. The field between them is a thermal one, in fact we can consider the insufficient action of insulating the pizza by the counter (fig. 2.2.1.1.4.c left). Obviously we can't build a counter with an hot floor, because it would be too expensive; so we should use some substance already present in pizza and counter environment as the standard solution suggests: the lamps over the floor could be a good solution (fig. 2.2.1.1.4.c right).

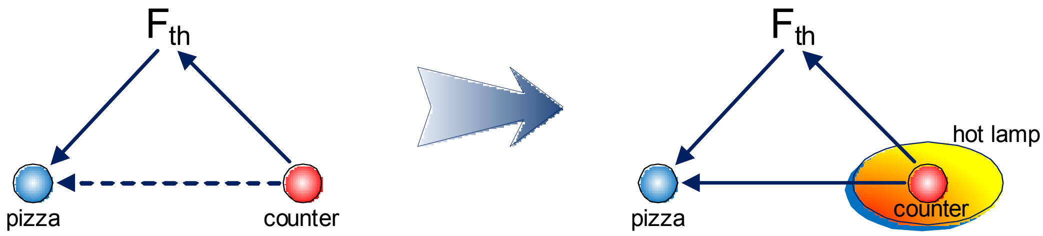


Fig. 2.2.1.1.4.c – the pizza counter modelled with Su-Field

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1-1-5: MODIFICATION OF ENVIRONMENT TO IMPROVE INTERACTIONS

Definition

Improving a Su-Field means improving the positive effect of a functional interaction between Substance 2 (*Tool* or *Working Organ*) and Substance 1 (*Product* or *Object*), without modifying the main field existing between the substances.
The interaction can be improved by using a modification of the environment as third substance which can increase the efficiency of the system.

Theory

If there is a need to improve the positive effect of an useful function to an object, and the conditions contain limitations on the introduction of additives to the given substances, while the existing environment does not contain substances with suitable properties, the problem can be solved by replacing the existing environment with another one, or by decomposing the environment, or by introducing additives into the environment so that the modified environment can play the role of third substance to enhance the controllability or to impart the required properties to the Su-Field interaction.
The role of the modified environment is to amplify the effect of the existing interaction between the substances under the present field, or to increase the degree of control over the interaction. Therefore, it is not allowed to modify the nature of the field existing between the two substances.

Model

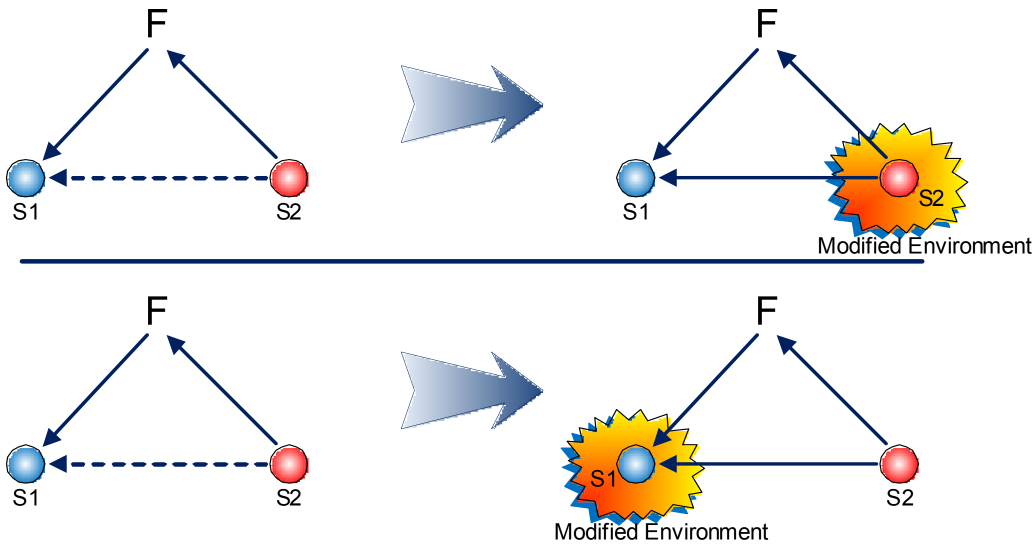


Fig. 2.2.1.1.5.a – STANDARD 1-1-5: Modification of environment to improve interactions

Instruments

This standard is applied when an useful function is not sufficient, i.e. the modification exerted on the object doesn't fit the expectations, it is not allowed to add external substances to the working element and the existing environment lacks of suitable properties to improve the interaction between the two substances. In such a case, it must be checked if a modification the environment surrounding any of the interacting substances can provide the expected properties to the field.

The following steps should be applied:

1. build a Su-Field model of the insufficient useful function; identify the parameter modification to be improved;
2. define candidate properties capable to improve the efficiency of the existing field;

∗ analyze the characteristics of the environment surrounding the working tool (fig. 2.2.1.1.5.a, above) or the object(fig. 2.2.1.1.5.a, below) and check if any of the properties defined at step 2 can be obtained by:
  - ∗ introducing a third substance into the environment;
  - ∗ decomposing the environment into its constituent substances;
  - ∗ replacing the environment;

4. check if there are any limitations to the selected modification of the environment.

Note: the second and third step can be driven by a table of substance resources.

Example

In a smoker room, even after short time, air becomes unbreathable even for chain smoker, because air surrounding smokers doesn't dissipate smoke adequately (fig. 2.2.1.1.5.b left).

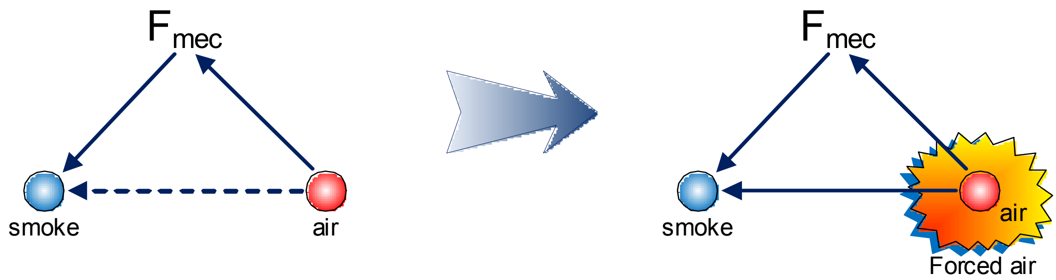


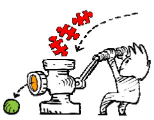
Fig. 2.2.1.1.5.b – an explanatory model of standard solution # 1.1.5

If we try to observe the environment we can find, for example clean air, that could help to dissolve smoke quickly. But if air, both the clean part and the polluted one, is immobile, the problematic situation doesn't change enough. So we could imagine to put into the room clean forced air in order to take away a lot of smoked air in a very short time (fig. 2.2.1.1.5.b right).

Self Assessment

<u>Exercise 1:</u>

Nina has invited her friends for dinner to eat homemade Italian pizza. She reads the recipe in a cookery book and prepares the dough, but just finished, she discovers that it doesn't rise quick enough for dinner, because the leavening time is quite long. Having just studied the Standard 1.1.5, how do you think to help our friend Nina?



<u>Answer 1:</u>

The initial stressful Nina's situation is represented in fig 2.2.1.1.5.c left, where the S_2, the leaven, through a chemical field is not able to rise sufficiently S_1, (the dough) in time.

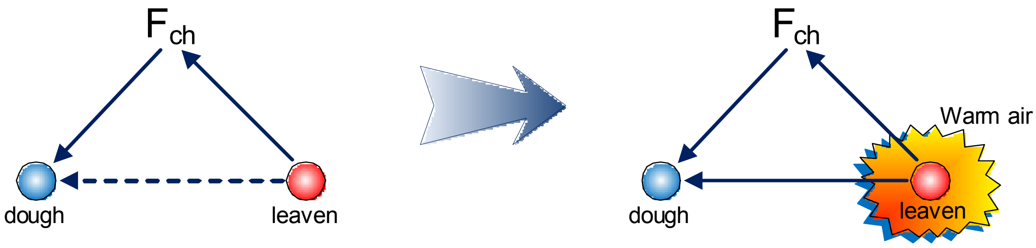


Fig. 2.2.1.1.5.c – the model to improve the leavening process

The parameter to improve is time of rising, and it depends, among the others, on temperature. According to standard 1.1.5 we must consider the impasto environment and try to change it somehow. So if the dough is invested by quite hot air the leaven rises dough quickly (fig. 2.2.1.1.5.c right).

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1-1-6: PROVIDING MINIMUM EFFECT OF ACTION

Definition

Providing minimum effect of action is requested when a useful excessive action is delivered, thus it is necessary to reduce the impact of the Tool on the Object of a Su-Field interaction.

Theory

When there's an excess of a Substance or an excess of a Field and it is difficult or impossible to provide a controlled (measured, optimal) amount of it, it is recommended to keep the status of the excessive substance or field and to remove the superfluous secondarily. The excess of a substance is removed by a field (fig. 2.2.1.1.6.a, above), while excess of a field is removed by a substance (fig. 2.2.1.1.6.a, above).

Model

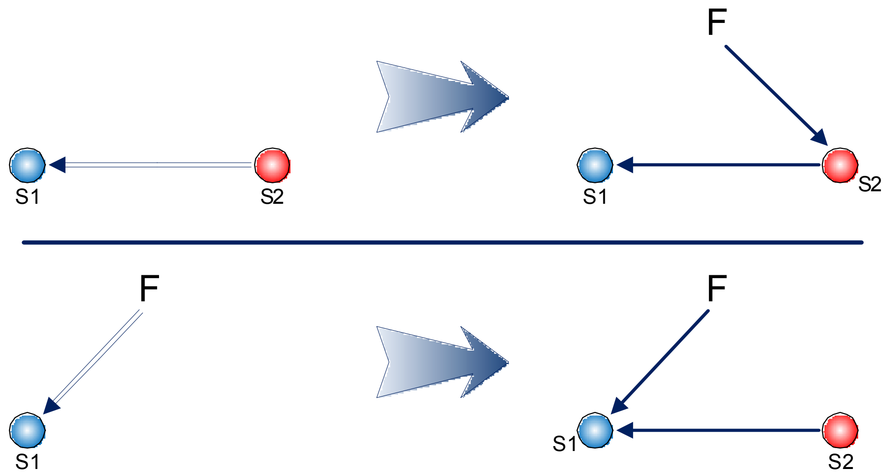


Fig. 2.2.1.1.6.a – STANDARD 1-1-6: Providing minimum effect of action

Instruments

This standard is applied when an excessive amount of substance is present in the system or when a useful interaction is excessive (*1.1.2 – Types of interactions and related symbols*).
If it is too difficult or even not possible to reduce and control the amount of substance/field, the following steps should be applied:

4. build a Su-Field model of the excessive useful interaction;
5. identify the parameter characterized by an excessive value;
6. introduce a modification capable to remove the excess:
   - if the excessive parameter is related to a substance S2, look for field resources to be applied to S2, capable to produce the desired value of S2 parameter;
   - if the excessive parameter is related to the impact of a field F on a substance S1, look for substance resources to be applied to S1, capable to produce the desired impact of the field F;

Note: the third step can be driven by a table of substance-field resources.

Example

Nina is at the beach, and she's sunbathing to become tanned and so prettier. But as it is known, too much sun is dangerous for our skin, especially the UV-B rays. She is a TRIZ student and immediately recognizes that she could apply a standard solution to solve her problem. The sun is the sun, e she has nothing to do, neither with the electromagnetic field which it produces even if it is excessive, but she wants to sunbathe. So the initial situation is like that reproduced in fig. 2.2.1.1.6.b left.

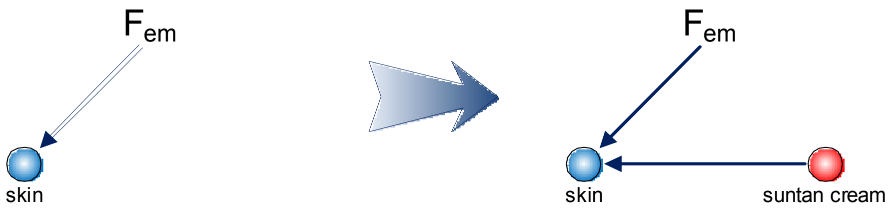


Fig. 2.2.1.1.6.b – to solve the problem of sun burns with Su-Field

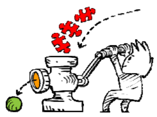
Applying Standard solution 1.1.6 a second substance S_2 is needed to reduce the effect produced by sun. This substance is the suntan lotion that cuts down the intensity of sun rays reaching Nina' skin (fig. 2.2.1.1.6.b right).

Self Assessment

<u>Exercise 1:</u>

Bill is at work, and he must design a device to fill with small pellets all the sixty holes that are disposed in a radial way on a spinning wheel. The wheel has a horizontal axis, and it rotates at a very high speed. The holes help to deliver a single pellet at a time to another mechanical device that pulls out the pellet and deposits it on a conveyor belt. The actual loading system of the wheel is composed by a tank full of pellets; the wheel goes through this tank, and pellets fall down into the hole aided by gravity and by an air stream. But at the given speed there is a high percentage of failures. How Bill can improve his device using standard 1.1.6?

<u>Answer 1:</u>



The first step toward the solution is to see that the wheel is filled with a number of pellets greater than necessary. In this way the initial situation to use standard 1.1.6 is obtained: an excessive number of pellets (S_2) is filing external portion of the wheel (S_1) as represented in fig. 2.2.1.1.6.c.

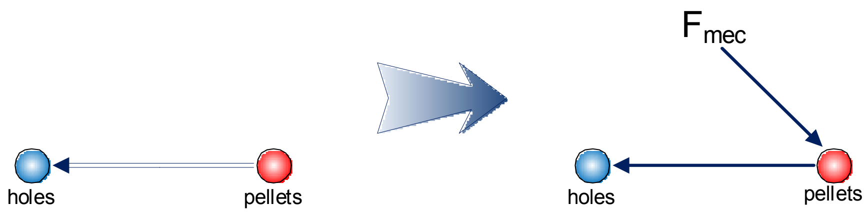
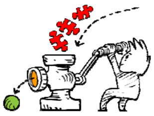


Fig. 2.2.1.1.6.c – a device improving using standard 1.1.6

The number of pellets is the parameter at its excessive value and it is provided by a substance to another one. So we have to find a field able to grant that the chosen parameter is at the right value. We have a wheel, rotating at a high speed: centrifugal forces could represent our resource to fulfill Standard's model.

Exercise 2:
Sometimes to clean bathroom surfaces from limestone or other kind of blemish some acids are needed. But its chemical effect could be excessive for pottery that may be eroded. According to standard 1.1.6 how could you resolve this problem?



Answer 2:
Start with modeling the initial state: we have only a field (F_{ch}) that performs an excessive action toward the pottery (S_1), as represented in fig.2.2.1.1.6.d left. In this case we can choose as parameter at an excessive value the pH of the cleaner. According to standard 1.1.6 suggestion we have to find a second substance (S_2) in such a way that the action becomes useful and sufficient. This second substance could be a diluting agent inside the bottle of acid that absorbs some of its corrosive power and lows solution pH values (fig. 2.2.1.1.6.d right).

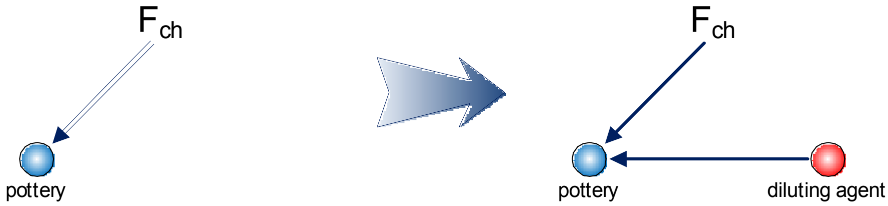
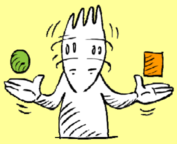


Fig. 2.2.1.1.6.d – a possible solution for an excessive active field

References
[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3



See also:
4.1.1.2 – Types of interactions and related symbols

STANDARD 1-1-7: PROVIDING MAXIMUM EFFECT OF ACTION

Definition

If a maximum effect of action on a substance (Object) is required and this is not allowed, the maximum action has to be preserved but directed to another substance attached to the object itself.

Theory

When it is desired to exert the maximum effect on a certain object, but the conditions of the system determine some impediments to the direct action of such a strong field on the object itself (fig. 2.2.1.1.7.a, left), it is suggested to address the same field on another substance linked to the object, in order to keep the benefits, without violating any constraint of the system and7or introducing any harm (fig. 2.2.1.1.7.a, right).

Model

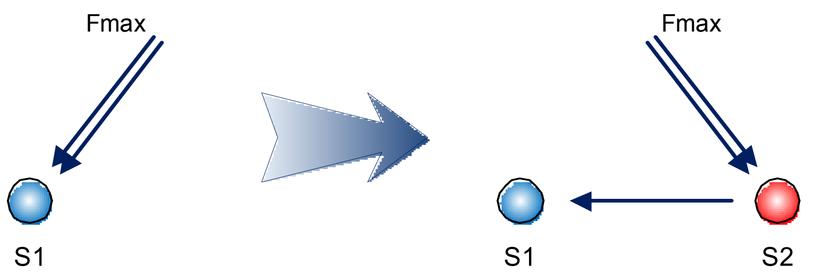


Fig. 2.2.1.1.7.a – STANDARD 1-1-7: Providing maximum effect of action

Instruments

This standard is applied when a useful interaction is desired at its maximum extent, but cannot be applied at the same time, and thus results excessive (*1.1.2 – Types of interactions and related symbols*).

If it is not desired to reduce and control the amount of field, the following steps should be applied:

1. build a Su-Field model of the excessive useful interaction;
2. identify the parameter characterized by an excessive value;
3. look for substances which can be submitted to the same useful interaction and tolerate its maximum effect;
4. Identify possible resources (properties, characteristics) of the substance S1 which can be linked to the added substance S2.

Note: the third and the fourth steps can be driven by a table of substance-field resources.

Example

Frequently a right torque is required to tighten screws. If a little force is applied on the wrench, it is impossible to reach the required result. If a too strong force is applied the limit of desired torque on screw could be overtaken, causing also risk of breaking screw's head. Translating this situation in Su-field language, there is a substance S_1, the screw, on which a mechanical field is applied, (fig. 2.2.1.1.7.b left).

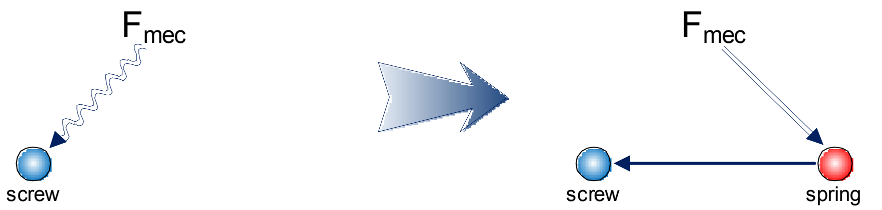
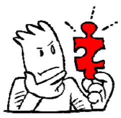


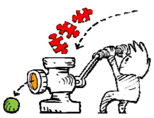
Fig. 2.2.1.1.7.b – the model of a mechanical problem solved with standard 1.1.7

This field must be at its maximum level to reach the goal, but it is impossible to apply it because of risk to pass screw yield stress. So a second substance S_2 is required between the F_{mec} and S_1: this substance could be a spring that lets transfer the torque till a certain given value, then it warps, in such a way even with a maximum force screw is safe (fig. 2.2.1.1.7.b right).

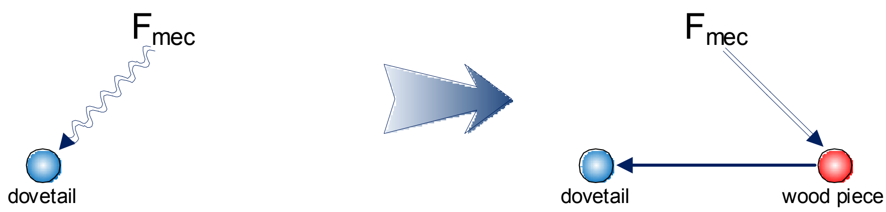
Self Assessment



<u>Exercise 1:</u>
Nina's grandfather is a joiner. He is realizing a wood closet, and he has to force a dovetail. To do this he must hit the wood piece with an hammer, because a lot of force is needed, but the hammer bruise the wood. Can you help the joiner?



<u>Answer 1</u>:
The initial situation could be modeled with a field, developed by the hammer so a mechanical one, that interact in a excessive harmful way toward the wooden dovetail (S_1), see fig. 2.2.1.1.7.c left. According to standard 1.1.7, we have to find a second substance attached to the first one which preserve the maximum effect of the field, fig. 2.2.1.1.7.c right. This could be a wood piece over the dovetail that transmit the hammer hit force to the joint avoiding any harmful consequence of the hit distributing the force in a larger surface.



FFig. 2.2.1.1.7.c – a standard solution applied in a joinery

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1-1-8: PROVIDING SELECTIVE EFFECT

Definition

A selective effect of action is required when the effect of a certain field on a substance (object) is required to have different values in different regions of the object itself.

Theory

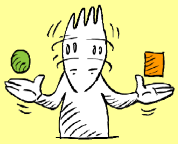
When an useful field is applied to a certain object, but it is desired a different impact of such a field on different regions of the object itself, two options are possible:

apply a maximal field, then a protective substance is introduced in places where a minimum effect is required (see 2.2.1.1.8.1);

apply a minimal field, then introduce a new substance capable to amplify the local effect where the maximum effect is required (see 2.2.1.1.8.2).

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3



See also:
4.1.1.2 – Types of interactions and related symbols

STANDARD 1-1-8-1: PROVIDING SELECTIVE EFFECT BY MAXIMUM FIELD AND PROTECTIVE SUBSTANCE

Definition
A selective effect of action is required when the effect of a certain field on a substance (object) is required to have different values in different regions of the object itself.

Theory
When an useful field is applied to a certain object, but it is desired a different impact of such a field on different regions of the object itself, it is possible to apply a maximal field to the whole object and then a protective substance is introduced in places where a minimum effect is required.

Model

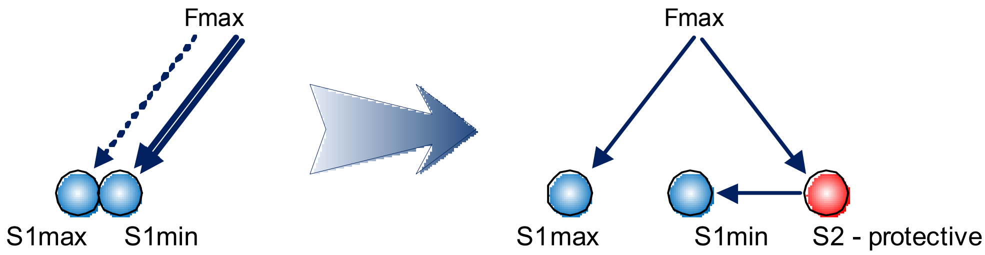


Fig. 2.2.1.1.8.1.a – STANDARD 1-1-8-1: providing selective effect by maximum field and protective substance

Instruments
This standard is applied when a useful interaction is desired at its maximum extent, but cannot be applied to the whole object, and thus results excessive on a portion of the object itself (*1.1.2 – Types of interactions and related symbols*).
If it is not desired to reduce and control the amount of field, the following steps should be applied:

1. build a Su-Field model of the excessive useful interaction;
2. identify the operational space of the interaction and distinguish the regions of the Substance s1 where different values of the same parameter are required;
3. look for substances which can play a protective role for the Substance S1, and more precisely for its region where a minimum effect is required;
4. Identify possible resources (properties, characteristics) to link the substances S1 and s2.

Note: the third and the fourth steps can be driven by a table of substance-field resources.

Example
Modern cars have wide widows and windshields to maximize the visibility of the external environment. Nevertheless, especially in summer time, when the sun is high and its light very bright, a large windshield lets pass too much light on the face of drivers and passengers.

Let's build a model of the situation: there is the sun light, that is an electromagnetic field, which impacts the whole passenger compartment through the windshield (fig. 2.2.1.1.8.1.b left)

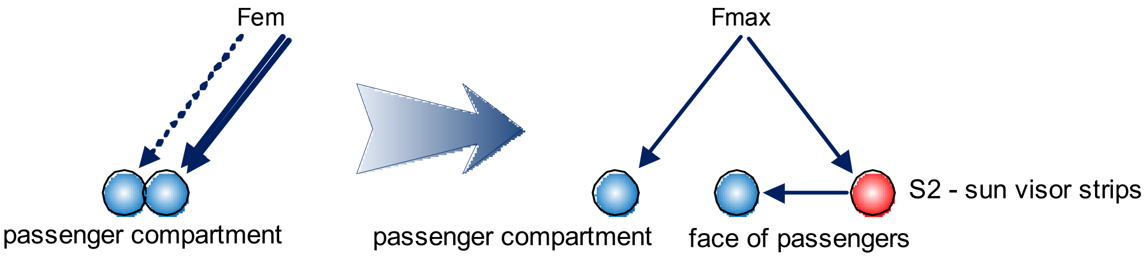


Fig. 2.2.1.1.8.1.b – to solve an everyday problem Standard solution 1.1.8.1 has been used

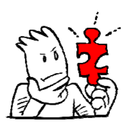
Since the light is excessive for a portion of the passenger compartment (where the faces of driver and passengers are positioned), according to standard 1.1.8.1 we have to add an external substance between the field and the eyes when we are driving, that absorbs the excessive field effect where it could be inconvenient. The solution can be a windshield sun visor strip on the top of the windshield as showed in fig. 2.2.1.1.8.1.b right and 2.2.1.1.8.1.c, which it lets see through but stops the excessive brightness of the sun light.

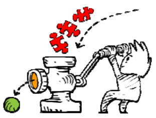
Fig. 2.2.1.1.8.1.c– on the top of the windshield the sun strip is visible; it lets see through but the sun is no more inconvenient because it is darker than transparent windshield glass.

Self Assessment

Exercise 1:

We are at the hospital. Nina's brother had an accident, and he has to be submitted to an X-ray analysis. However the doctor must examine not all body but only some interesting and critical parts of it. Like everybody knows X-rays aren't healthy at all, so Nina proposes an inventive solution. Have you any idea, according to Standard 1.1.8.1?





Answer 1:

The initial situation could be modeled as follows: a strong electromagnetic field hits Nina's brother body, but in some zones it is useful, in other ones it could be very dangerous. See fig. 2.2.1.1.8.1.d left.

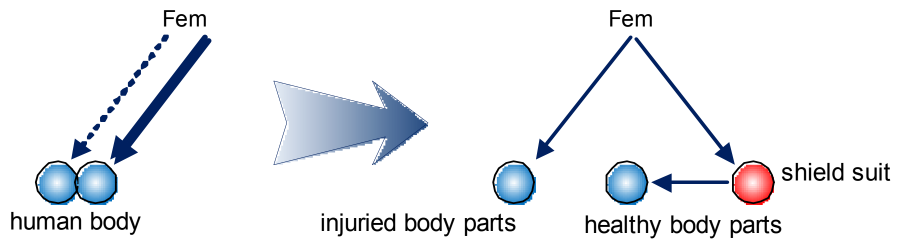
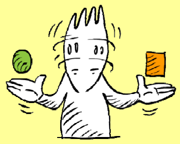


Fig. 2.2.1.1.8.1.d – an application of standard 1.1.8.1 in a sanitary environment

The same field is expected in some areas but it is unwished in others. So, following standard 1.8.1 suggestions, we need a substance S_2 that is hit by electromagnetic field and affords protection by X-rays in all non interesting zones (fig 2.2.1.1.8.1.d right). This second substance could be a special suit, made with an X-rays absorber or reflecting material, with holes in correspondence of interesting diagnosis zone.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3



See also:
4.1.1.2 – Types of interactions and related symbols

STANDARD 1-1-8-2: PROVIDING SELECTIVE EFFECT BY MINIMAL FIELD AND ACTIVE SUBSTANCE

Definition

A selective effect of action is required when the effect of a certain field on a substance (object) is required to have different values in different regions of the object itself.

Theory

When an useful field is applied to a certain object, but it is desired a different impact of such a field on different regions of the object itself, it is possible to apply a minimal field, then introduce a new substance capable to amplify the local effect where the maximum effect is required.

Model

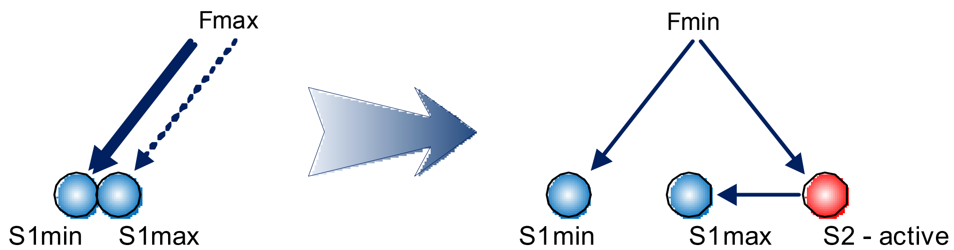


Fig. 2.2.1.1.8.2.a – STANDARD 1-1-8-2: providing selective effect by minimum field and active substance

Instruments

This standard is applied when a useful interaction is desired at its maximum extent, but cannot be applied to the whole object, and thus results excessive on a portion of the object itself (*1.1.2 – Types of interactions and related symbols*).

If it is not desired to reduce and control the amount of field, the following steps should be applied:

build a Su-Field model of the excessive useful interaction;

identify the operational space of the interaction and distinguish the regions of the Substance s1 where different values of the same parameter are required;

look for substances which can play an active (amplification) role for the Substance S1, and more precisely for its region where a maximum effect is required;

Identify possible resources (properties, characteristics) to link the substances S1 and s2.

Note: the third and the fourth steps can be driven by a table of substance-field resources.

Example

It could be strange, but some devices producing cool air, called direct-fired absorption chillers, need water at a temperature above 100 degrees Celsius. Air conditioning systems are used especially in summer time, when we have a lot of sunny days. So why don't use sun to warm water? As it is known a swimming pool, even if it remains a whole day under a hot summer sun doesn't reach boiling temperature. It is much easier warms up a bit of water by time, like in a boiler pipe, but sun itself can't reach this result. So we have an electromagnetic field, given by the sun that it is sufficient for earth life, but it is insufficient to warm a pipe fill of water till 100 degree Celsius. This is the initial model of standard, as is modeled in figure 2.2.1.1.8.2.b left.

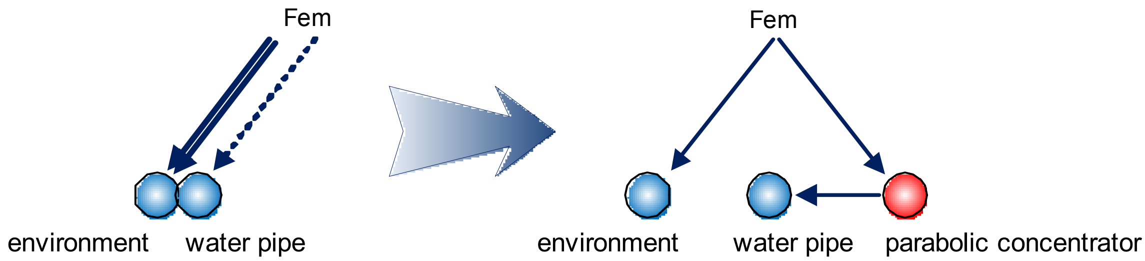
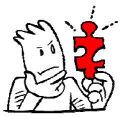


Fig. 2.2.1.1.8.2.b – an example of standard 1.1.8.2: parabolic concentrator

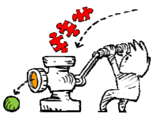
Since irradiation power of the sun cannot be increased, a substance S_2 doing that must be found (fig. 2.2.1.1.8.2.right). A parabolic mirror with the pipe in the focus could multiply sun effect a lot of time, warming water within the pipe in a very short time and also at temperature over 100 degrees Celsius.

Self Assessment



Exercise 1:

Nina's grandfather is 91 years old, and by now his hearing has some problem, so all the relatives are constrained to speak aloud to be heard. Nina doesn't like this situation and so she has studied the problem and she has found a good solution according to standard 1.1.8.2. Can you guess her solution?



Answer 1:

The first step Nina did was modeling the initial situation. We have a field, an acoustic field, generated by people speaking, that is sufficient to be heard from all (S_2) but insufficient for Nina's grandfather (S_1), see fig. 2.2.1.1.8.2.c left. Standard solution 1.1.8.2 states that if a field is needed to be high in certain zones, and low in others, it must be at its lower level and an external substance, interacting with the field, has to be introduced where the maximum effect is needful. An hearing aid is the right solution: it is put in grandfather ear and it amplify external acoustical field with no need for other people to shout to be understood.

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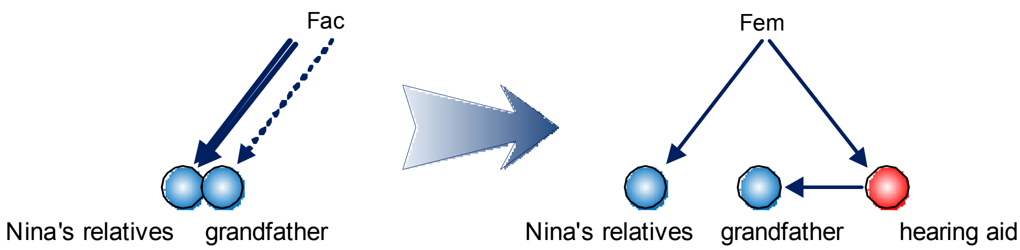


Fig. 2.2.1.1.8.2.c – standard solution could be used everywhere, with our grandfather too. In the picture the model of a problem with a deaf person.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

CLASS 1.2: ELIMINATION OF A HARMFUL INTERACTION

Definition

The elimination of a harmful interaction consists in the modification of a Su-Field system in order to avoid that a negative Tool exerts any undesired effect on the Object of the interaction.

Instruments

The standards 1.2.1-1.2.5 provide directions to eliminate, or at least minimize the harmful effect of un undesired functional interaction between two substances.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

4.

STANDARD 1.2.1 – Elimination of a harmful interaction by a foreign substance

Definition

The elimination of a harmful interaction consists in the modification of a Su-Field system in order to avoid that a negative Tool exerts any undesired effect on the Object of the interaction.

Theory

If useful and harmful effects appear between two substances in a SFM and there is no need to maintain a direct contact between the substances, the problem is solved by introducing a third substance between them.

Model

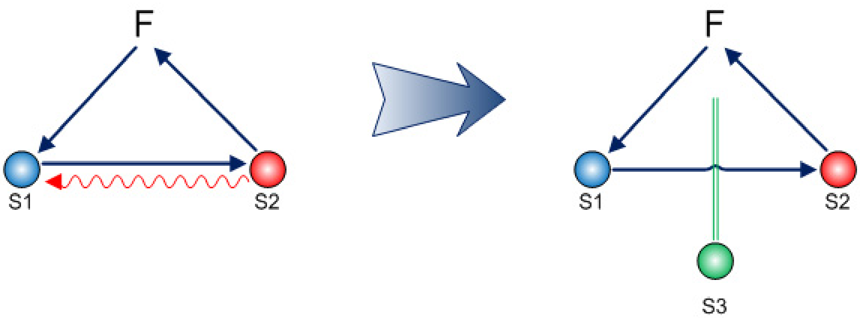


Fig. 2.2.1.2.1.a – STANDARD 1-2-1: Elimination of a harmful interaction by a foreign substance

Instruments

This standard is applied when two substances exchange both positive and negative interactions (i.e. useful and harmful functions are delivered), and it is allowed to introduce additives between the elements (fig. 2.2.1.2.1.a).

The following steps should be applied:

1. build a Su-Field model of the harmful function; identify the parameter modification to be eliminated;
2. check whether it is possible to introduce additives between the tool and the object, i.e. it is not mandatory to keep the two substances in contact with each other;
3. search for substances which might be interposed to interrupt the existing harmful interaction;
4. check if there are any limitations to the introduction of such specific substance into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

Nina's mother, sometimes, cooks some dishes within the oven, but she doesn't like this kind of cuisine because the baking tin becomes very dirty with encrusted oil. If we try to model this situation the result could be like represented in fig 2.2.1.2.1.b left, that is a baking tin (S_1) performs the useful action through a mechanical field of containing dish (S_2), but at the same time dish dirties the tin. We should find an external substance able of interrupting the harmful action. The solution could be a baking release paper under the dish that preserves clean the pan (fig. 2.2.1.2.1.b right).

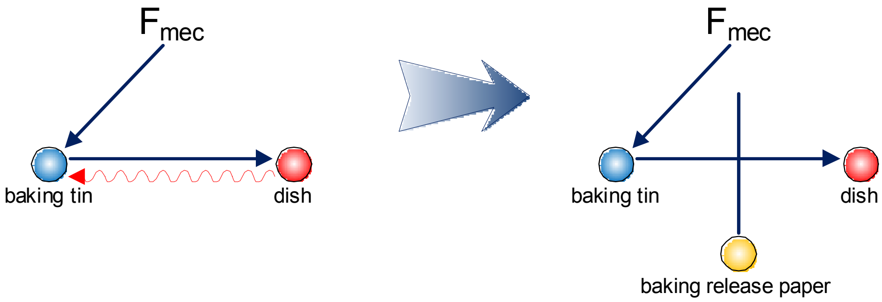
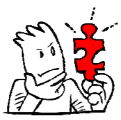
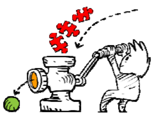


Fig. 2.2.1.2.1.b – Exemplary applications of standard 1.2.1 to remove the secondary harmful effect generated by S_2: a third substance has been introduced between S_1 and S_2.

Self Assessment



Exercise 1:
We are in our car, and outside it is raining. To clean the windshield we can use the windscreen wiper. Yet the friction force between the rubber and the glass, useful for cleaning, is harmful because of wasting of the blade. Try to solve this problem following the standard solution 1.2.1.



Answer 1:
The initial situation could be represented with a mini model composed by a first substance S_1, the rubber windscreen wiper blades, that by a mechanical field cleans a second substance S2, that is the windscreen. But in addition to the cleaning function, useful, we have to represent the harmful action too, given by the wasting of the rubber blade caused by the glass by means of same the friction forces helpful to clean fig. 2.2.1.2.1.c left. Standard solution 1.2.1 suggests to provide our system of a third substances able to stop the harmful effect of the mechanical field; see fig. 2.2.1.2.1.c right. The practical solution adopted is to cover the rubber with a graphite coating.

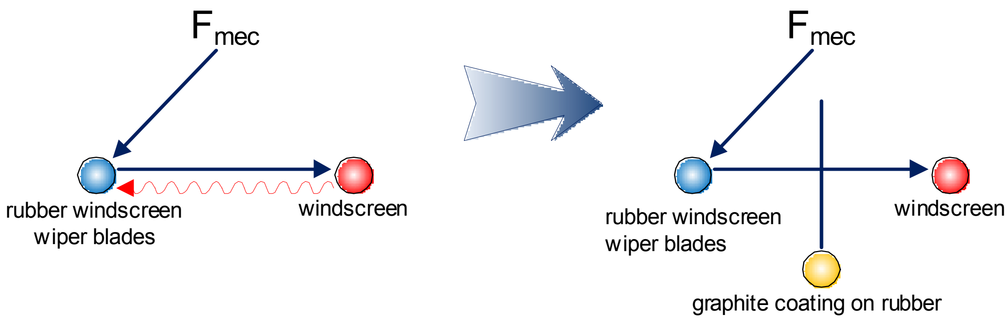


Fig. 2.2.1.2.1.c – how to use standard 1.2.1 to solve a problem with a windscreen wiper

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1.2.2 – Elimination of a harmful interaction by modification of an existing substance

Definition

The elimination of a harmful interaction consists in the modification of a Su-Field system in order to avoid that a negative Tool exerts any undesired effect on the Object of the interaction.

Theory

If useful and harmful effects appear between two substances in a SFM and there is no need to maintain a direct contact between the substances, the problem is solved by introducing a third substance between them, which is a modification of the first of the second substance..

Model

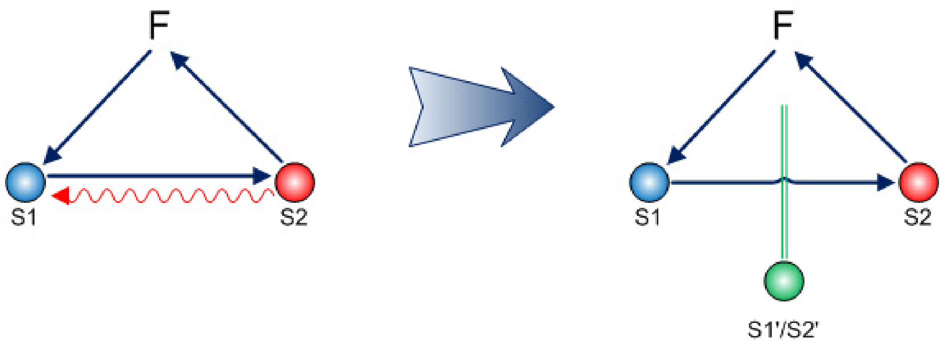


Fig. 2.2.1.2.2.a – STANDARD 1-2-2: Elimination of a harmful interaction by modification of an existing substance

Instruments

This standard is applied when two substances exchange both positive and negative interactions (i.e. useful and harmful functions are delivered), and it is allowed to introduce additives between the elements (fig. 2.2.1.2.2.a).

The following steps should be applied:

1. build a Su-Field model of the harmful function; identify the parameter modification to be eliminated;
2. check whether it is possible to introduce additives between the tool and the object, i.e. it is not mandatory to keep the two substances in contact with each other;
3. search for allowable modifications of the interacting substances S1 and S2, which might be used as a third substance to be interposed to interrupt the existing harmful interaction;
4. check if there are any limitations to the introduction of such specific substance into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

When one rides a motorbike can feel the air pressure given by speed. So sometimes it uses to mount a small windshield that breaks air in place of rider helmet, but at the same time it creates troublesome turbulences. Going to model this initial state we have the windshield (S_1) that by a mechanical field protect from air pressure rider head (S_2), but at the same time it creates turbulences. According to standard 1.2.2 S_1 or S_2 have to be modified in order to remove the harmful action of the windshield. A way to solve the problem is to create a hole in the

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windshield lower part so that the air can follow the windshield profile from both its sides and reduces whirls formation at the upper part of the glass.

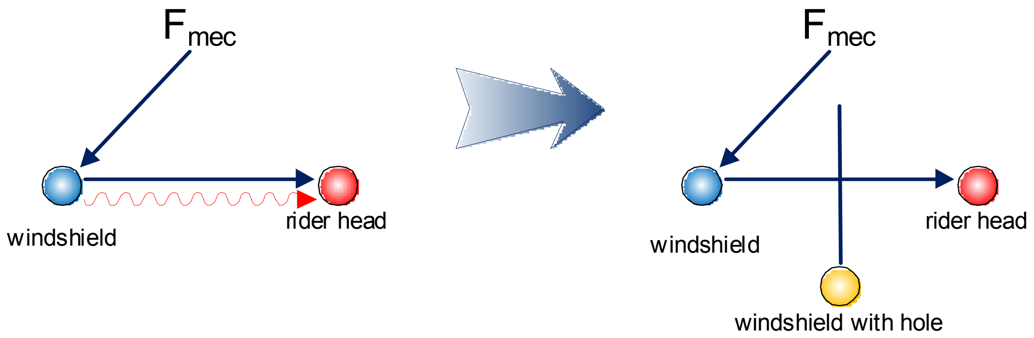
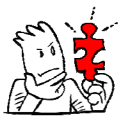
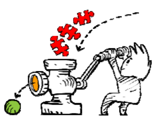


Fig. 2.2.1.2.2.b – Exemplary applications of standard 1.2.2 to remove the secondary harmful effect generated by S_1.

Self Assessment



<u>Exercise 1:</u>
When outside it is cold, we usually wear jackets, raincoats etc. Our body in fact is a good heat source and the jacket has the function of insulating from cold external air. But in particular situations it may occur that internal temperature increases, for example caused by a physical effort, and so also the formation of sweat. This moisture remains trapped in the zone where the jacket is closer to the body. Is it possible to solve this problem aided by standard solution 1.2.2?



<u>Answer 1:</u>
In this case we have the jacket which performs two action: the first, useful, is to insulate the body from the external air, and the second one, this time harmful, is to avoid that moisture goes away. In Su-Filed terms, this could be translated as represented in fig. 2.2.1.2.2.c left, where the jacket is S1 which by a thermal field insulates and wets body. Seeing that is quite difficult change some body properties, we can work only on the S_1, and we have to find its modification in order to break the making of moisture (fig. 2.2.1.2.2.c right). Knowing that warm air goes up, a special membrane on jacket shoulder could solve our problem (fig. 2.2.1.2.2.d).

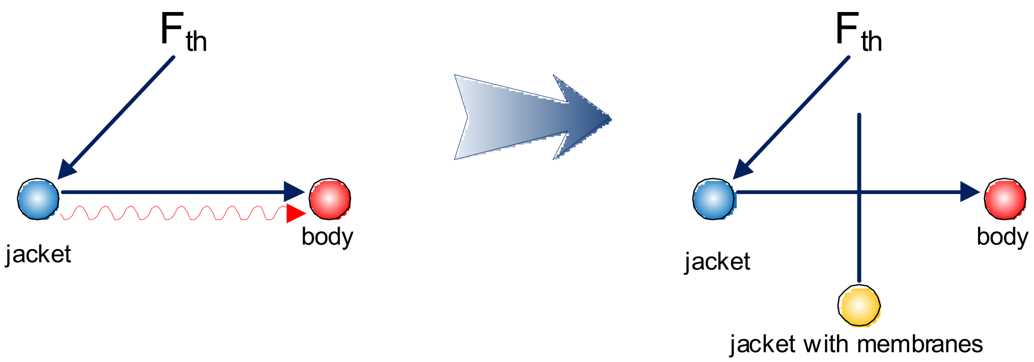


Fig. 2.2.1.2.2.c – Exemplary applications of standard 1.2.2 to remove the secondary harmful effect generated by S_1.

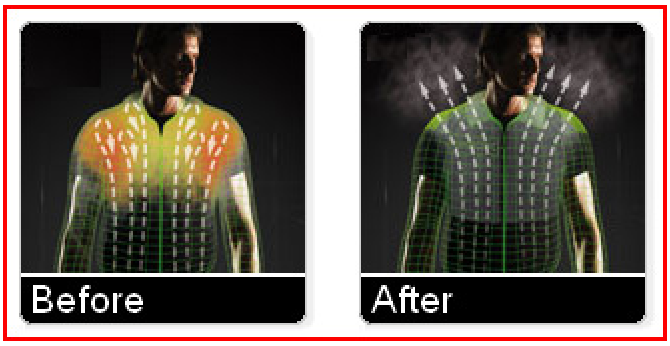


Fig. 2.2.1.2.2.d – The commercial solution of previous exercise.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1.2.3 – Elimination of a harmful effect of a field

Definition

The elimination of a harmful field consists in the modification of a Su-Field system in order to avoid that an undesired effect impacts a certain substance.

Theory

If it is required to eliminate the harmful effect of a field upon a substance, the problem can be solved by introducing a second substance that draws off upon itself the harmful effect of the field

Model

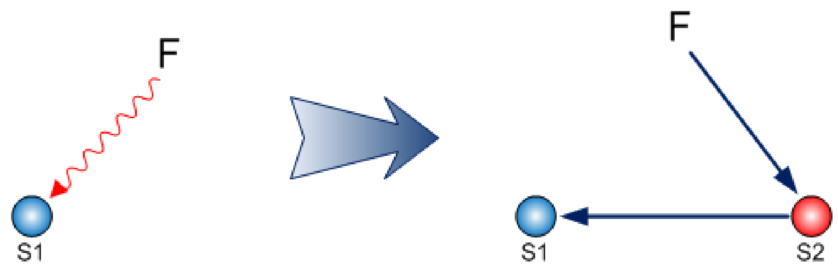


Fig. 2.2.1.2.3.a – STANDARD 1-2-3: Elimination of a harmful effect of a field

Instruments

This standard is applied when a harmful function is delivered to certain object, and it is allowed to introduce additives in the system (fig. 2.2.1.2.3.a).

The following steps should be applied:

1. build a Su-Field model of the harmful function; identify the parameter modification to be eliminated;
2. check whether it is possible to introduce additives in the system;
3. search for a further substance S2, capable to attract the existing harmful interaction and to preserve the system;
4. check if there are any limitations to the introduction of such specific substance into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

Our car body is made up of metal and it may be attacked by rust. If we build a Su-Field model, we have a chemical field (F_{ch}) that performs a harmful action toward the body car (S_1), see fig. 2.2.1.2.3.b left. This is properly the effect we have to remove. According to the Standard Solution 1.2.3 we have to add another substance to remove the harmful effect of the field. Obviously the desired substance is the paint that cover the car body, which protect the car against moisture attack (fig. 2.2.1.2.3.b right).

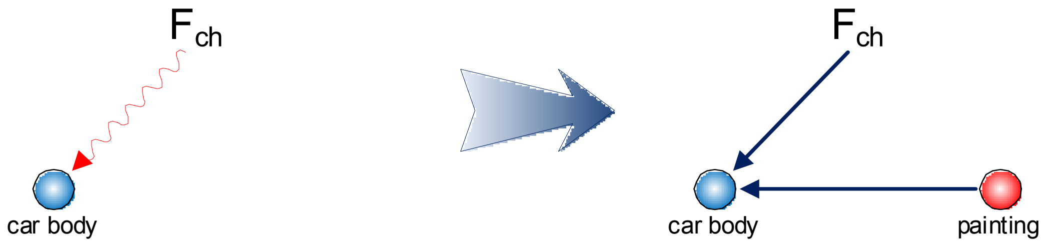


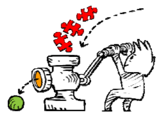
Fig. 2.2.1.2.3.b – Exemplary applications of standard 1.2.3 to remove the harmful effect of the field "chemical attack".

Self Assessment

<u>Exercise 1:</u>

When it is a sunny day, sunlight may be too bright for eyes. Try to model this easy situation and find a solution according to Standard 1.2.3.

<u>Answer 1:</u>



In the problem description we have just the elements to build a Su-Field model. In fact there is the sunlight which we can consider as an electromagnetic field; it performs an harmful effect toward our eyes, which represent the substance (S_1) (fig. 2.2.1.2.3.c left). A second substance is requested to break the effect of the field. The solution is played by dark sunglasses that allows eyes to see through, but reduce the brightness of sunlight (fig. 2.2.1.2.3.c right).

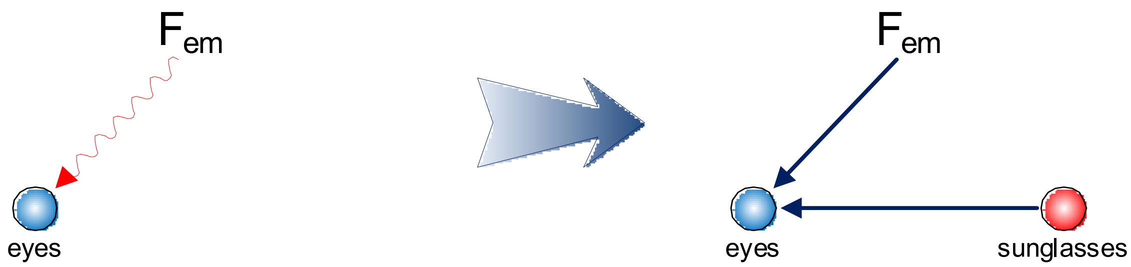


Fig. 2.2.1.2.3.c – Exemplary applications of standard 1.2.3 to remove the harmful effect of the electromagnetic field "to dazzle".

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 1.2.4 – Elimination of a harmful effect by a new field

Definition

The elimination of a harmful field consists in the modification of a Su-Field system in order to avoid that an undesired effect impacts a certain substance.

Theory

If useful and harmful effects appear between two substances in a Substance-Field System, and a direct contact between the substances must be maintained, the problem can be solved by transition to a dual Substance-Field System, in which the useful effect is provided by the existing field while a new field neutralizes the harmful effect (or transforms the harmful effect into a useful effect).

Model

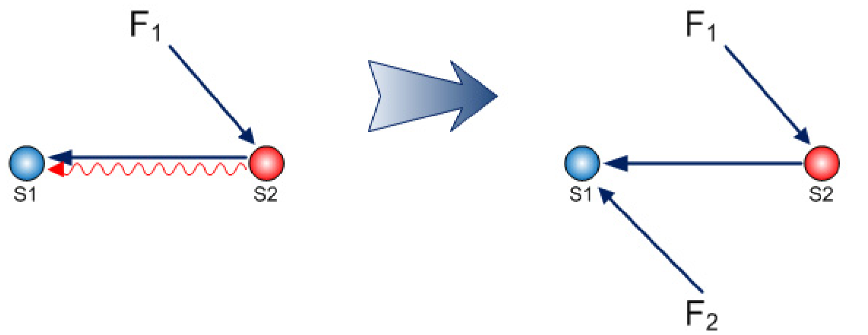


Fig. 2.2.1.2.4.a – STANDARD 1-2-4: Elimination of a harmful effect by a new field

Instruments

This standard is applied when a harmful effect impacts a certain object, and it is allowed to introduce a new field in the system (fig. 2.2.1.2.4.a).
The following steps should be applied:

1. build a Su-Field model of the harmful function; identify the parameter modification to be eliminated;
2. check whether it is possible to introduce a new field in the system;
3. search for a further field F2, capable to neutralize the existing harmful effect and to preserve the system;
4. check if there are any limitations to the introduction of such specific field into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

Matt works in a joinery. Very often he has to make some straight cut with a pendulum jigsaw, so at first he draws a straight line with a pencil on the wood part to cut as reference. Yet, when he starts to cut, sawdust covers the line near the saw and Gino is forced to blow to remove the dust. Is it possible helping Gino using standard 1.2.4?
At first we have to build the substance-field model: extracting from the description there is the saw (S_1) which by a mechanical field (F_{mech}) performs the useful action of cutting the wood piece (S_2), see fig. 2.2.1.2.4.b left. Yet, the saw executes also a harmful action: the dust covers the reference line on the wood. The parameter damaged from the harmful effect is the

possibility of seeing the sign, so, according to standard 1.2.4 we have to find a second field in order to clean the line from the dust or to overcome its presence. An electromagnetic field could be a good answer, in fact laser beam projecting a straight line could solve the problem (fig. 2.2.1.2.4.b right).

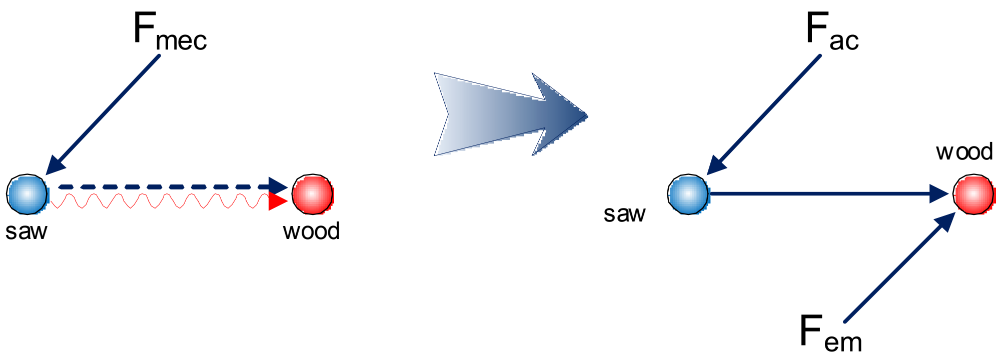
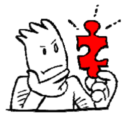


Fig. 2.2.1.2.4.b – Exemplary applications of standard 1.2.4: a second Su-Field model has been built to overcome the harmful effect generated by the first field.

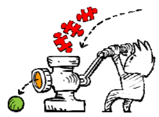
Self Assessment

Exercise 1:



In a mechanical workshop there are a lot of machines tool. One of them works very well at high RPM but the friction between the tool and the working object may cause an overheating and so possible deformation of the object making the work not so precise. Try to solve this problem aided by standard solution 1.2.4.

Answer 1:



We have to start with building the initial model of the situation. We have the tool of the machine (S_1) that works the object (S_2) by a mechanical field, developing an useful and sufficient function. But the description states that the friction between S_1 and S_2, the same useful for the tooling function, causes an overheating of the object: this one is obviously an harmful action, because it generates object's deformation and so the loss of accuracy of manufacture (fig. 2.2.1.2.4.c left). Standard 1.2.4 suggest to introduce a new field (fig. 2.2.1.2.4 right) with the aim to neutralize the harmful effect of the field developing also the useful function of the system. This field for example could be a thermal one, acting only on the object or on both tool and object, in order to cool down them to avoid object deformation and loss of accuracy.

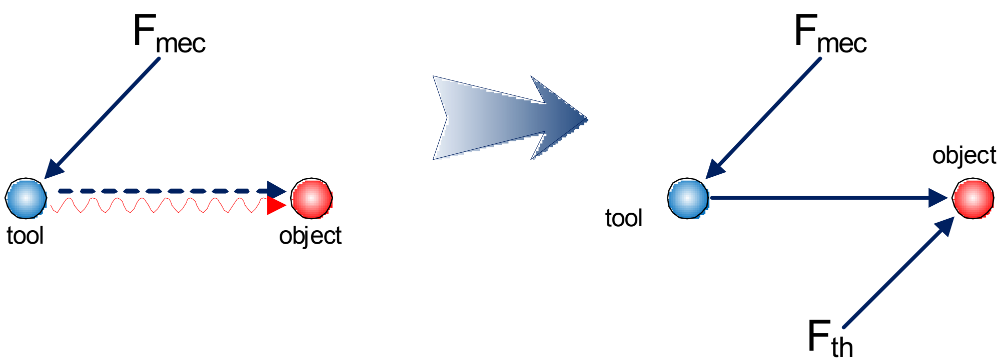


Fig. 2.2.1.2.4.c – the initial situation and the solved one of a machine tool system

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 2.1.1 – Synthesis of a Chain Substance-Field System

Definition

A Chain Substance-Field System is a complex systems where at least a substance generates and is subject to two different fields.

Theory

The efficiency of Su Field model can be improved by transforming one of the parts of the Su Field interaction into an independently controllable Su-Field, thus forming a chain Substance-Field system.

Model

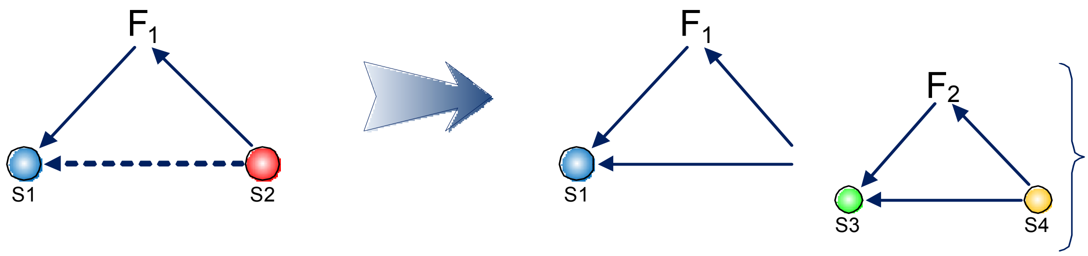


Fig. 2.2.2.1.1.a – STANDARD 2-1-1: Synthesis of a Chain Substance-Field System

Instruments

This standard is applied when an useful function is not sufficient, i.e. the modification exerted on the object doesn't fit the expectations, and it is not allowed to introduce additives in the system.

The following steps should be applied:

build a Su-Field model of the insufficient useful function; identify the parameter modification to be improved;

check whether it is possible to substitute the working element or the object with an independently controllable Su-Field subsystem;

search for resources which might improve the efficiency of the existing field;

check if there are any limitations to the introduction of such specific substances and field into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

Nina has to prepare a lot of sandwich for a party. When she cuts the bread slice from the whole baguette with a knife she realizes that the knife could be improved, because with her arm she has to make both the alternating horizontal movement and the vertical one to slice the bread, and often the cut is not perfect. Building the Su-Field model of this initial situation we have the bread baguette (S_1), the knife (S_2) and the interacting mechanical field fig. 2.2.2.1.1.b left. The function is developed by the knife that by means of a mechanical field slices or cut the bread; this function is useful but insufficient. According to standard solution 2.1.1 to improve the initial model we have to transform the tool, in this case the knife, in a new separate Su-Field model. So we have to add another substance (S_3) and another field bounded to blade, fig 2.2.2.1.1.b right. We can add a motor (S_3) that provide to the blade by a mechanical field the alternating movement in order to leave to Nina only the task of guiding the new knife (fig. 2.2.2.1.1.c).

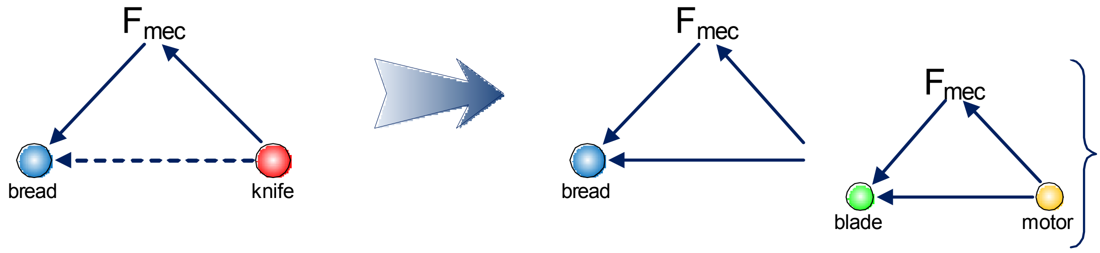
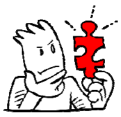


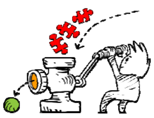
Fig. 2.2.2.1.1.b – the Su-Field model of the problem

Fig. 2.2.2.1.1.c – electrical knife

Self Assessment



Exercise 1:
Nina is at the shopping center to buy some stuff. While she comes back home by feet, it starts raining. So she takes out her umbrella from the handbag: when she tries to open the umbrella she is in trouble because with one hand she holds the shopping bag and unfolding is not easy only with the other hand. Try to solve this problem making evolve the umbrella according with standard 2.1.1.



Answer 1:
The first step understands the problem e building its Su-Field model. The initial situation could be represented with a mini model composite by: the umbrella (S_1) and a generic hand (S_2) which by means of a mechanical field has some difficulties to unfold S_1. So the function of opening is naturally useful but insufficient fig (2.2.2.1.1.d left). Now, to follow the standard 2.1.1 suggestion, we have to transform one of the substances in a new separated Su-Field model. On the hand side is difficult to operate, but it easier working on the umbrella side. So we have to add another substance and a new field, in order to improve the actual system. We can imagine the third substance as a spring that when it is requested by hand, by means of the new field, also in this case mechanical, opens the umbrella (fig. 2.2.2.1.1.d right).

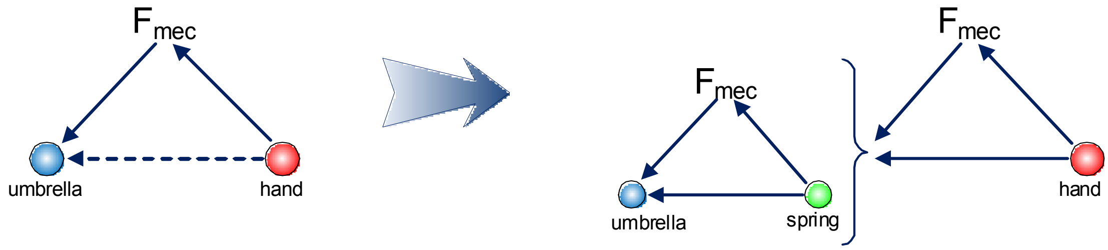


Fig. 2.2.2.1.1.d – standard solution 2.1.1 applied to un umbrella

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 2.1.2 – Synthesis of a Dual Substance-Field System

Definition

A Dual Substance-Field System is a complex systems where the substances interact through two parallel fields.

Theory

If it is necessary to improve the efficiency of Substance-Field System, and replacement of Substance-Field System elements is not allowed, the problem can be solved by the synthesis of a dual Substance-Field System through introducing a second field which is easy to control.

Model

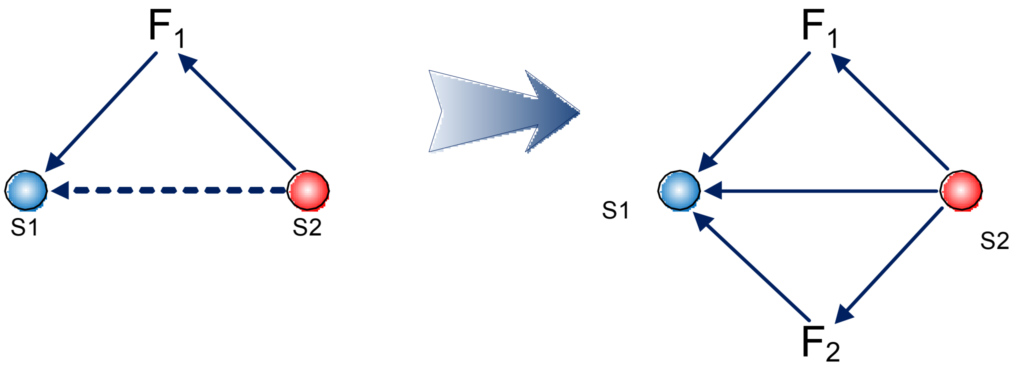


Fig. 2.2.2.1.2.a – STANDARD 2-1-2: Synthesis of a Dual Substance-Field System

Instruments

This standard is applied when an useful function is not sufficient, i.e. the modification exerted on the object doesn't fit the expectations, and it is not allowed to introduce additives in the system.

The following steps should be applied:

build a Su-Field model of the insufficient useful function; identify the parameter modification to be improved;

check whether it is possible to add a new field in the system;

search for new fields to be established between the original substances which might improve the efficiency of the existing interaction;

check if there are any limitations to the introduction of such specific field into the technical system.

Note: the third step can be driven by a table of substance resources.

Example

Nina went on holiday with her boyfriend Matt. When they arrived in the hotel, they found a nice room, with all comforts as minibar, air conditioning, sat-tv and trouser press (see fig. 2.2.2.1.2.c left). Before to go to sleep, Luca wanted to try to stretch his trousers with the press to be perfect the next day. The following morning he took out the trousers from the press yet they were stretcher than the night before but not as he has imagined. So he thought: "Why not improve this comfortable but unsatisfactory system ?".

The first step to do is building the model: in this case there are the trousers press (S_2), which by means of a mechanical field stretches in a useful but insufficient way the trousers (S_1), see fig. 2.2.2.1.2.b left. The standard solution 2.1.2 suggests to introduce in the initial model a new field in parallel with the existent in order to make the insufficient action as sufficient (fig 2.2.2.1.2.b right). Taking the list of all the possible field to add, the thermal one seems to be the more convenient. So to stretch the trousers instead using only a pressure that is a mechanical field, introduce in parallel also a thermal one to improve the useful action of the hotel trousers press (fig. 2.2.2.1.2.c right).

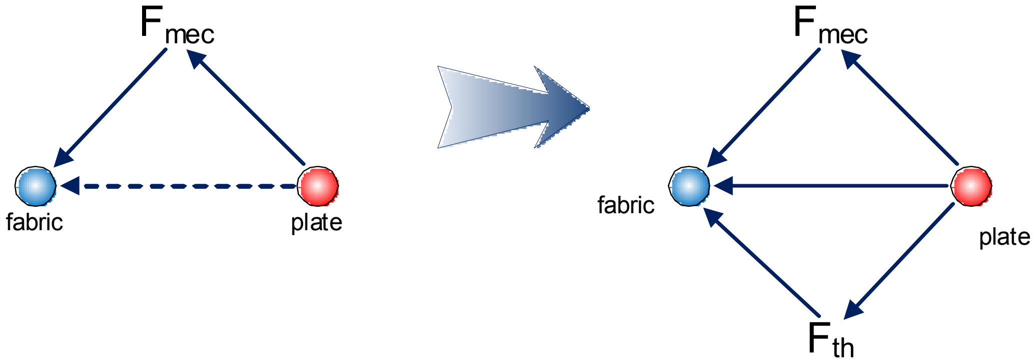


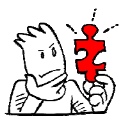
Fig. 2.2.2.1.2.b – the model of the problem

Fig. 2.2.2.1.2.c – on the left the first model of a trouser press, which works with a mechanical field. On right the evolved solution, which contains also a thermal field coupled with the mechanical one.

Self Assessment

<u>Exercise 1</u>:

To warm a room, usually a radiator is used. It heats up the air of the room by convectional movement: hot air leaves the radiator from its upper part, winds for all the room and in the meantime it cools down, and then it enters again in the radiator zone from its lower part. With this system warming up of the room is assured, but it needs a lot of time. How could you improve the radiator following the standard solution 2.1.2 suggestions?



Answer 1:

Start with building the Su-Field model of the initial situation. We can consider as a first substance the room we want to warm (S_1), as second the radiator (S_2), that is the tool of the system useful action, and as field a thermal one (fig. 2.2.2.1.2.d left). We have to improve this model by adding a new field working in parallel with the existent (fig. 2.2.2.1.2.d right). The time to warm the room must be decreased: actually hot air is shoved just by convectional movement, thus we have to find a way to speed up its motion. A mechanical field developed by a fan could be a good solution, (fig. 2.2.2.1.2.e).

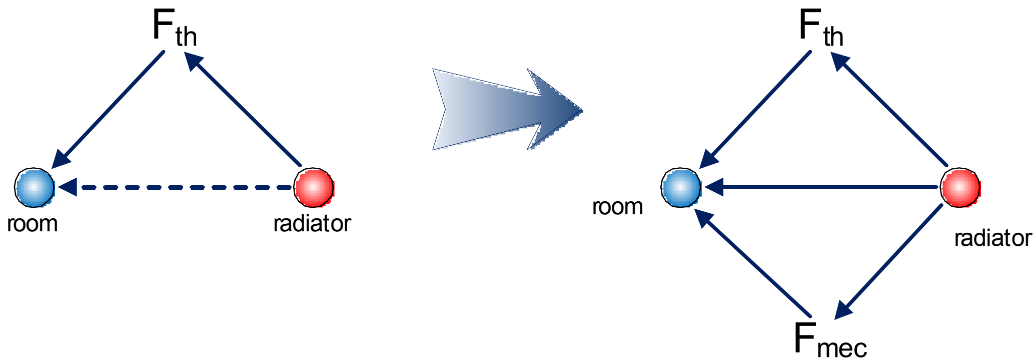


Fig. 2.2.2.1.2.d – the initial situation and the final solution modelled with Su-Field

Fig. 2.2.2.1.2.e – on the left a radiator; on the right a convector: within there is a radiator and a fan to move quickly warmed air.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 2.2.2 –– Increasing a degree of fragmentation of substance components

Theory

Efficiency of a Substance-Field System can be improved by increasing the degree of fragmentation of the object which acts as a "tool" in Substance-Field System, which in the end of its evolution will be replaced with a new field that can deliver a function of the tool.

Model

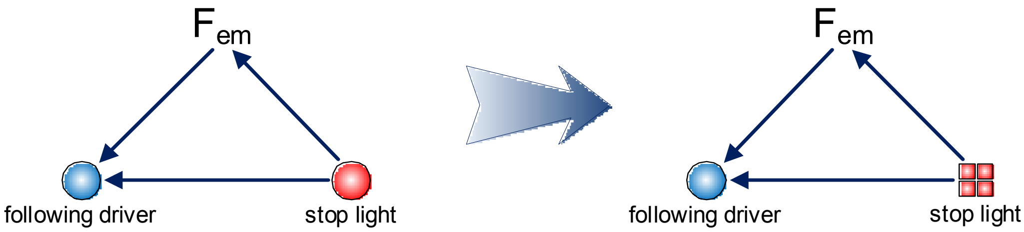


Fig. 2.2.2.2.2.a – STANDARD 2-2-2: Increasing a degree of fragmentation of substance components

Example

When we are driving a car, and we press the brake pedal, on the rear side of our car stop lights switch on to advise the following driver we are braking. Usually there are two stop light at the left and right part of the car and a central one. To improve this system by the suggestions of standard 2.2.2, start with build the mini model representing the initial situation. The function of the stop lights is to inform the following driver: so we have S1 represented by the driver, the object of the function, S2 are the stop lights, the tool, and the field of interaction is electromagnetic, fig. 2.2.2.2.2.b left. Standard 2.2.2 suggests increasing the degree of fragmentation of the substance which acts as a tool in the model, so we have to fragment the stop lights. It means that instead a single lamp by side, stop light may be composed by a set of small lamps like led, which allows to give different shape to the stop light, fig. 2.2.2.2.2.b right.

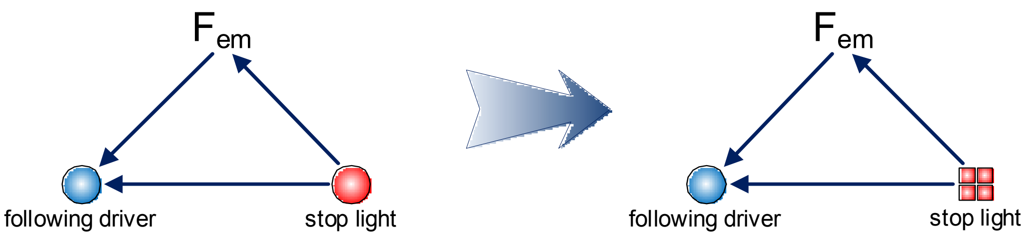
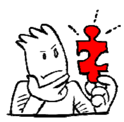


Fig. 2.2.2.2.2.b – the representative model of the system and its improving

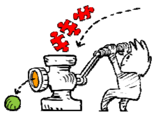
Self Assessment

<u>Exercise 1</u>:



Nina's father is lover of bricolage, and in his garage he has a lot of instruments: keys, screwdrivers, drills, hammers, screws, nails, saws, and so on. A lot of them are hanged at the wall, in order to be taken easily. Until he works in garage or near the wall supplied with accessories, he doesn't have any problem, but when he has to repair something around for the house he has to bring all the needed tools, or to go to and fro to take the necessary. Taking into account for example the screwdrivers, how could you improve them according to standard 2.2.2?

<u>Answer 1</u>:



The building of the mini model is very easy: we have to consider the screwdrivers. In their action they interact obviously with screws, so in the model there are: the first substance "the screw", the second substance "the screwdriver" and the field of interaction that in this case is a mechanical one (fig. 2.2.2.2.2.c left). Now, the given suggestion said that we have to increase fragmentation of the tool of the model, so of the screwdriver, fig. 2.2.2.2.2.c right. What does increasing the fragmentation of a screwdriver mean? A possible solution could be separate the haft from the head and make the tools interchangeable.

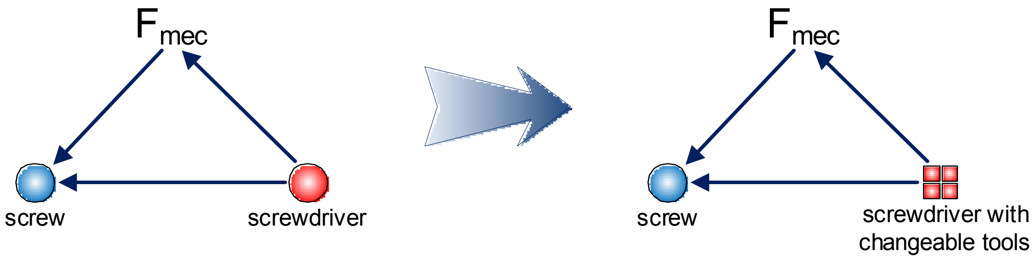
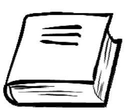


Fig. 2.2.2.2.2.c – the Su-Field model for a screwdriver

Fig. 2.2.2.2.2.d – on the left a set of screwdrivers with different head; on the right a single screwdrivers wit a set

of interchangeable heads for the different usages.



References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 2.2.3 – Transition to capillary porous objects

Theory

Efficiency of a Substance-Field System can be improved by replacing a solid object in the Substance-Field Mode with a capillary porous one.

Model

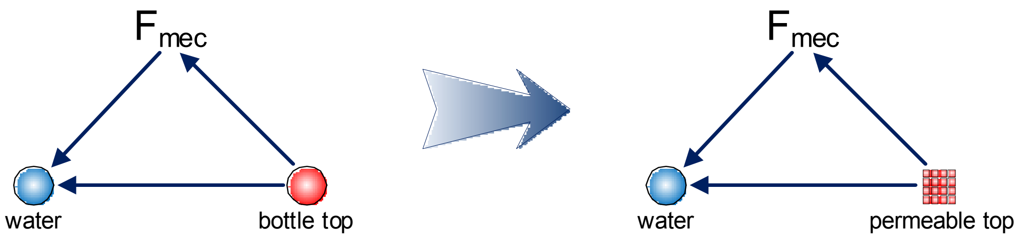


Fig. 2.2.2.2.3.a – STANDARD 2-2-3: Transition to capillary porous objects

Example

When Nina goes on bike, she takes always a water bottle to drink. This bottle must be closed in order to prevent that the water leaks. Yet, when Nina wants to drink she has to stop to open the bottle. If we want to improve the system "water bottle" following the standard 2.2.3, at first we have to model the original situation: the *tool* substance is the bottle top (S2), while the object is the water. The field of interaction is a mechanical one (fig. 2.2.2.2.3.b left); indeed we can say that the top stops the water and it is a mechanical action. Standard 2.2.3 suggests passing from a solid object to a porous one (fig. 2.2.2.2.3.b right). It means that the cap must be porous, that is it must be composed by a membrane that stops the water if the pressure is under a certain value, but it lets pass the water if the pressure overcome a certain threshold. The pressure could be increased for example squeezing the bottle.

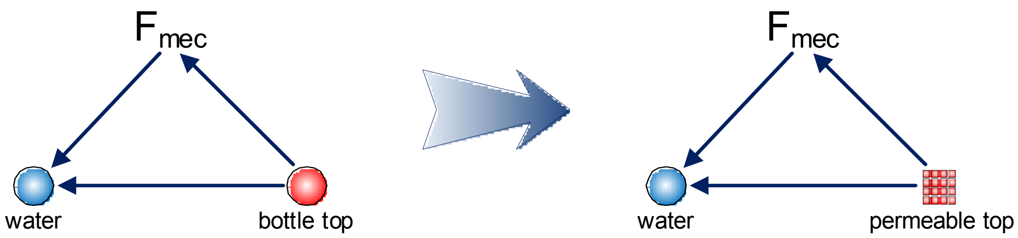
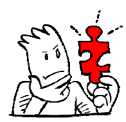


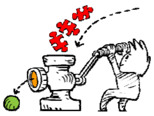
Fig. 2.2.2.2.3.b – improving a system increasing its porosity

Self Assessment

Exercise 1:

Nina is in the kitchen, and her mother is frying frozen fish and there is a problem with the hot oil. In fact, when the fish is put into the pan, the oil starts to spatter, dirtying the entire cooking plane and with the risk of burning Nina and her mother. The clear solution is covering the pan with a cap, but if there is the cap the smokes of the frying remains within and they give a bad taste to the fish. Is possible to improve the actual system with a new one according to standard solution 2.2.3?





Answer 1:

The first step must be focusing the system to improve: we have a cover to avoid that hot oil leak from the frying pan. So a substance is the frying oil (S_1), the other is the cover (S_2); they interact by means of a mechanical field (fig. 2.2.2.2.3.c left). The standard suggests to make a solid object before with a cavity, then with multiple cavities and so perforated, or at the end completely porous (fig. 2.2.2.2.3.c right). Now we have to translate this concept to our tool that is the cover. A good solution could be a cover made up of a very thick net, in order to stop the hot droplets of oil but at the same time let that the smoked pass through (fig. 2.2.2.2.3.d).

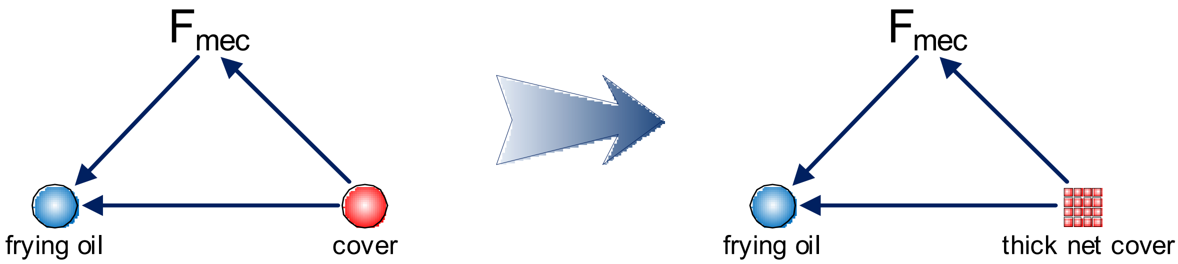


Fig. 2.2.2.2.3.c – the initial and final Su-Field model for a cover of a frying pan

Fig. 2.2.2.2.3.d – the first image represent a classic glass cover; on the right the cover made up of thick net

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 2.2.4 – Increasing a degree of system dynamics

Theory

Efficiency of a Substance-Field System can be improved by increasing the degree of dynamics (i.e. the degrees of freedom) of Substance-Field System, thus by a transition to a more flexible, rapidly changing structure of the system.

Model

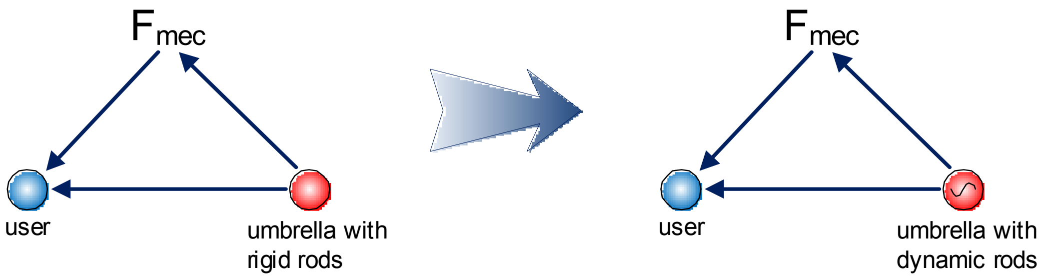


Fig. 2.2.2.2.4.a – STANDARD 2-2-4: Increasing a degree of system dynamics

Example

Nina is walking under the rain protected by an umbrella. While she's walking, she looks to the umbrella structure. It is made by a long haft connected with a set of rigid rods that have the function to maintain tight the impermeable canvas. When the umbrella is opened a large surface is needed to protect mostly, but this imply also a big encumbrance when it is closed. The function of the umbrella is to protect the user from the rain droplets, and when Nina starts to build the Su-Field Model she has to consider: as first substance the user, as second one the umbrella and the field of interaction obviously mechanical. At this point, she wants to improve this model using the standard 2.2.4: the tool of the system has to increase its of dynamics. The umbrella, as already said, is made of two rigid parts, the haft and the rods, and a flexible one, and so already dynamic, the canvas. So she has to make dynamic or the haft, or the rods or both. To make dynamic a rigid body means give it a degree of freedom, so instead of rigid rod she can imagine a rod with one or more joints in order to occupy less when the umbrella is closed. The same concept could be used for the haft.

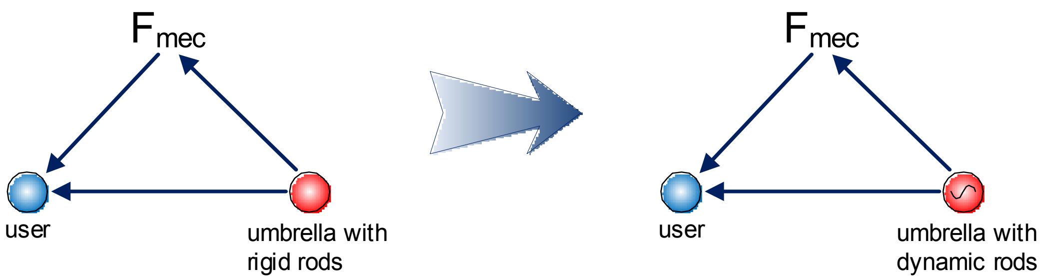
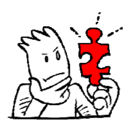


Fig. 2.2.2.2.4.b – increasing dynamics to a rigid umbrella

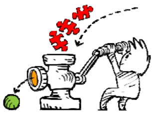
Self Assessment

<u>Exercise 1</u>:



If we look at the windows of houses in a lot of them we can find the wood shutters to avoid the sunlight enters in the room. Following suggestion of standard 2.2.4 try to find some solutions that increase shutter's degree of dynamics.

Answer 1:



The starting point is typically the building of the Su-Field model. The first substance is the sun light, the second one the wood shutters that by means of an electromagnetic field block the passing of the light (fig. 2.2.2.2.4 c left and fig. 2.2.2.2.4.d.1). The standard suggests making the model more dynamic and so more flexible. Obviously we can work with the sunlight, it is already at its maximum degree of flexibility, and it is a field! So we have to look a solution for the shutter. It is a rigid wooden blind, so the first step it to give it one more degree of freedom. This could mean that can be opened (fig. 2.2.2.2.4.d.2) in order to let pass a little bit of light more. But this is not enough; in fact we increase the dynamics degree, making all the bar of the shutter inclinable (fig. 2.2.2.2.4.d.3). The next step conveys toward a venetian blind, in which all the bars are moveable and the degree of darkening could be better chosen (fig. 2.2.2.2.4.d.4). The following degree of dynamics is to make the shutter completely flexible, as that represented in fig. 2.2.2.2.4.d.5 by a roller blind; the last step of the dynamic increasing process is the jump toward a field, that is the darkening capability is transferred to the glass of the window creating a self-diming window with the help of an electric filed (fig. 2.2.2.2.4.d.6).

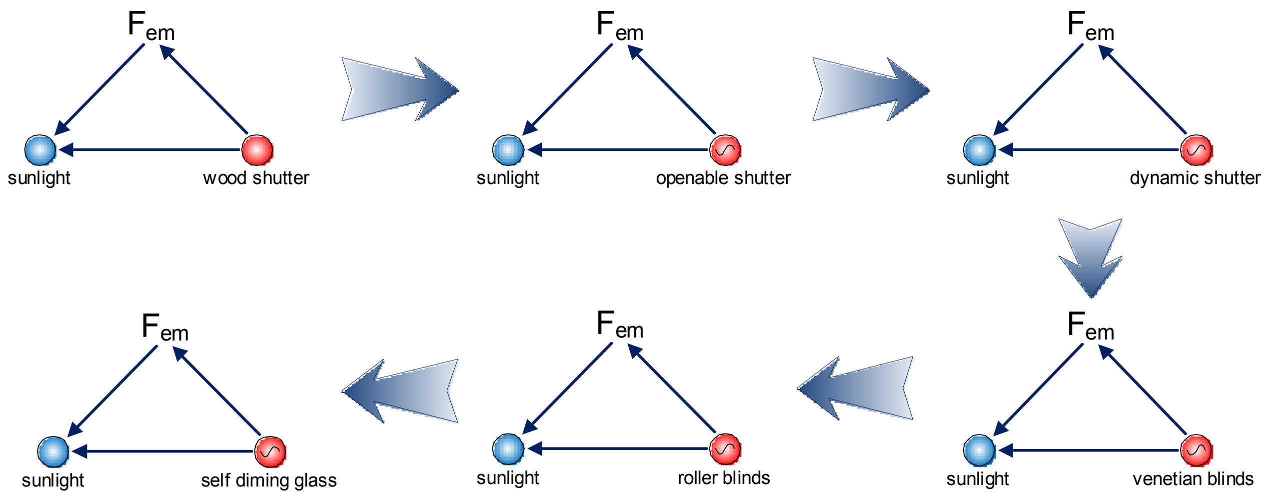


Fig. 2.2.2.2.4.c – how to improve a shutter by several Su-field models

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Fig. 2.2.2.2.4.d – the process of the rise of dynamic degree for a shutter: 1) the classical rigid wooden shutter; 2) a shutter with the capability to be open in half; 3) a shutter with all the bars dynamic; 4) a venetian blind; 5) a roller blind; 6) a self diming glass.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 3.1.1 - Formation of bi and poly-systems

Theory

System efficiency at any stage of its evolution can be improved by combining the system with another system (or systems) to form a bi- or poly-system.

Instruments

For a simple formation of bi- and poly-systems, two and more components are combined. Components to be combined may be substances, fields, substance-field pairs and whole Substance-Field Systems.

Example

Think to the lorries: they can carry very heavy weight, but sometimes these one are so weighty that the axles of the trailer could have some problems to sustain the load. So accordingly to the standard 3.1.1, the system can evolve passing to a poli-system, thus we can build a trailer with a lot of axles and small wheels to distribute the weight (fig. 2.2.3.1.1.b).

Fig. 2.2.3.1.1.b – in the image a trailer with axles evolved toward a poli-system

Self Assessment

<u>Exercise 1</u>:
On the Nina's desk, at office, there is all she needs for: the computer, the phone, the fax, the printer, the scanner and so on. Yet sometimes Nina needs more empty space on the desk to manage her documents. How can you help her following the statements of standard 3.1.1?

Answer 1:
To increase the efficiency of a system it must be combined with another one o with more of one in order to create a bi- or a poli-system. So in the Nina's desk instead of having a lot of different office tools, some of them could be merged in a single poli-system: for instance the printer, the scanner and the fax could be substituted by a multifunctional printers able to perform all the function of the single instrument (fig. 2.2.3.1.1.c).

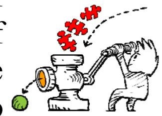


Fig. 2.2.3.1.1.c – a multifunctional printer: it is a poli-system composed by a printer, a scanner and a fax.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 3.1.2 - Developing links in bi and poly-systems

Theory
Efficiency of bi- and poly-systems can be improved by developing links between system elements.

Instruments
Links between elements of a bi- and poly-system may be made either more rigid or more dynamic.

Example
In the last generation car, a lot of electronic gadgets are assembled as optional. A classic bi-system is composed by the car stereo with the Bluetooth connection to receive cell phone and use the same speaker as hands-free kit. The evolution of this system, following the suggestion of standard 3.1.2, has to be realized developing some links between the elements of the system. One interaction could be to decrease the playing music volume when a calling is arriving.

Self Assessment

Exercise 1:
If you pay attention to the motorcycle, you can see that some of them have the stand system composed by two stands: a center and a side one. So there is a bi-system. Try to make evolve this system according to standard 3.1.2.

Answer 1:
The standard 3.1.2 suggests developing a link, an "interaction" between the components of the bi-system, which are two stands of the motorbike. An explanatory solution could be this one: when the motorcycle is over the center stand, opening the side one prevent the closure of the first (fig. 2.2.3.1.2.b).

Fig. 2.2.3.1.2 – in the picture the two stands: the first (the center stand) sustain the motorcycle, while the second could avoid the first closure.

References
[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 3.1.3 - Increasing the difference between system components

Theory

Efficiency of bi- and polysystems can be improved by increasing the difference between system components. The following line of evolution is recommended:
similar components
components with biased characteristics
different components
combinations of the "component + component with opposite function"

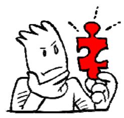
Example

All know the rechargeable battery, for example the one within a cell phone. Their charge could be restored by a battery charger. If we try to make evolve the battery charger in accord with standard 3.1.3 we have to create a bi- or a poli- system in which the component must be very different or even with opposite function. We could imagine a battery charger enclosed with a battery discharger (fig. 2.2.3.1.3.b).

Fig. 2.2.3.1.3 – a system enclosed with its opposite: a battery charger/discharger.

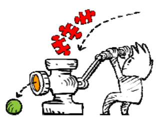
Self Assessment

<ins>Exercise 1</ins>:



When the cars were equipped with the first car radio, two front speakers were provided, one on the left and one on the right. So this system was born as a bi-system. Subsequently other speakers are set in the car, for example in the rear seats. Try to improve this poli-system according to standard 3.1.3.

<ins>Answer 1</ins>:



The steps followed by car audio speakers have been: two speaker (bi-system), four speakers (poli-system), six speakers and so on. But, independently from the number of the speakers, they are identical. Standard 3.1.3 proposes to differentiate the elements, or, if they are already different, increase their difference. So we can realize a sound system in which every speaker or every pair plays a different sounds: for example 2 speaker for the higher frequencies (tweeter), two for the lower frequencies (woofer) and two for the middle.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 3.1.4 - Integration of several components into a single component

Theory

Efficiency of bi- and poly-systems can be improved by "convolution" (integration of several components into a single component) by reducing auxiliary components. Completely convoluted bi- and poly-systems become mono-system again, and integration can be repeated at another level of the system.

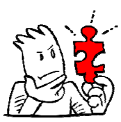
Example

Nina has a party with her friend, so she wants to be nice for her boyfriend. So she goes to buy some make-ups: lipstick, blusher, mascara, eyeliner and so on. When she is in the lipstick area of the shop, she notices a nice tool: a kind of pen with the lipstick at one side, and a lip liner at the other (fig. 2.2.3.1.4.b left). So she decides to purchase it. She remains very amazed with her shopping, but while she comes back home she has an idea to improve this bi-system: why not improve it following the advice of standard 3.14? A convolution of the bi-system is possible, making a lipstick with the lip liner included in (fig. 2.2.3.1.4.b right)

Fig. 2.2.3.1.4.b –on the left the bi-system lipstick & lip liner; on the right the convoluted bi-system

Self Assessment

Exercise 1:



Still few years ago, only desktop Pc existed, and like now, they were composed by the monitor, the case, the keyboard and the mouse. When usage of computer has become indispensable and the need to use the pc also over the office, a poly-system has been created: i.e. the idea of a portable Pc was born. This new system contains old previous separated element in a new one system. Accepting suggestion of standard 3.1.4 try to make evolving this system.

Answer 1:

Standard solution 3.1.4 suggests that to improve the efficiency of an existing bi or poli-system a convoluting process is needed. It means that we have to find a new system which is able to develop all the functions developed by the single component of the poli-system. So we need a black box able to be a monitor, a mouse, a keyboard and a case for the cpu. A good solution to this task are the latest generation tablet pc, in which all the actions could be performed on the touch screen monitor put on the top of the box containing all the electronic part of the pc (fig. 2.2.3.1.4.c).

Fig. 2.2.3.1.4.c – the latest generation portable tablet pc: all the input function are performed on the touch-screen monitor.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 3.1.5 – Distributing incompatible properties among the system and its parts

Theory

Efficiency of bi- and poly-systems can be improved by distributing incompatible properties among the system and its parts. This is achieved by using a two-level structure in which all the system as a whole has a certain property A, while its parts (particles) have property anti-A.

Example

Nina is going to buy something for dinner, and she goes also in a butcher's shop. When she enters she finds the butcher which is removing bones from a big piece of meat. Suddenly yet the butcher loses the control of the knife and he hurts itself in a hand. So Nina asks him how is it that she doesn't use a protecting glove with some iron inserts. He answers that some rigid parts, although it is protective it isn't comfortable to work at all because of their obstruction to moving. Then Nina explains him that a glove with iron inserts is a bi-system, and to increase its efficiency of this a distribution of incompatible properties among the parts of the system could be done: the system in its entirety has a certain property but the single components parts could have the opposite one. So a special glove that is macroscopically flexible in order to facilitate the work but microscopically rigid in order to prevent injury to the worker is needed (fig. 2.2.3.1.5.b left).

This solution has been already adopted long time ago by the medieval soldiers to protect themselves from blade attacks at the place of a rigid armour (fig. 2.2.3.1.5. right).

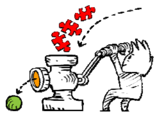
Fig. 2.2.3.1.5.c – on the left a special glove for the butchery activities; on the right a chainmail armour.

Self Assessment

<u>Exercise 1</u>:

In the old black and white television an high-energy electron beam, properly collimated and focused, excited a layer of phosphorescent coating on the screen that emitted light creating the image. But obviously this created image was in gray scale and not colored. According to standard 3.1.5 how is it possible rendering the image fully colored?

Answer 1:



The first step to use the standard 3.1.5 is to have a bi or a poli-system. Hot it is known all colors could be obtained by summating with different weight the three primary colors, red green and blue. So we can build a screen composed of three overlapping layer, each one creating an image in their own color scale, or a one layer with a special colored matrix able to be excited by three single electron beams, one for each color. In both cases, we have that the whole image, looked from outside the television is fully colored, but its parts (its pixel) are monochromatic (try to see TV from a very close distance, you will see RGB points clearly).

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 3.2.1 – Transition to microlevel

Theory

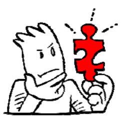
Efficiency of a system at any stage of its evolution can be improved by transition from a macrolevel to a microlevel: the system or its part is replaced by a substance capable of delivering the required function when interacting with a field.
It is worth to note that there is a multitude of microlevel states of a substance (crystal lattice, molecules, ions, domains, atoms, fundamental particles, fields, etc.). Therefore, various options of transition to a microlevel and various options of transition from one microlevel to another, lower one, should be considered when solving a problem.

Example

Take an electric device, for example an electric car. To perform some action it needs of some energy supplied by an electric storage cell (a battery). Obviously little by little that the cell provides energy to the tool it power runs down and so it needs to be recharged. Standard 3.2.1 suggests that to improve a system all of it or only one of its components must be changed and substituted by a new substance able to perform the desired function in interaction with a field. So in our case we have to find a new substance to introduce in our car to supply the energy needed by the engine looking at the microlevel. Einstein discovered that some material, if they are hit by wave light produce electrical energy. So using this principle we can provide the car of some solar cell to feed the engine.

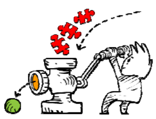
Self Assessment

<u>Exercise 1</u>:



Nina is cleaning her room using a simple vacuum cleaner. While she is working she thinks how this tool works. Then she’s got an idea to improve the cleaning system using the standard solution 3.2.1. And you, have you got any idea?

<u>Answer 1</u>:



The standard that Nina applied to find a solution suggests a transition from a macro to a micro level, i.e. we have to find a substance able to perform the function of removing dust and other small and light particles of dirty when it is subjected to some field. Some fabrics like wool or other synthetic ones could be electrostatically charged if rubbed, and so as polishing, in order to be able of develop the function of collect powder.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3

STANDARD 5.1.1.1 - Introducing substances to a system under restricted conditions

Theory
If it is necessary to introduce a substance in the system, and it is not allowed, a "void" can be used instead of the substance.

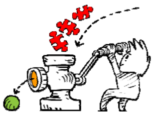
Instruments
Note: A "void" is usually gaseous substance, like air, or empty space formed in a solid object.
In some cases a "void" may be formed by other substances, such as liquids (foam) or loose bodies.

Example
In every house, windows are present. They have the function of letting the possibility of changing air of the room and of letting pass through light from outside. But if there is a delta of temperature from outside to inside, windows must have also the function of insulating the room. But sometimes, their glass is not sufficient to this aim. A possible way to solve the problem is to grow the thickness of the glass, but doing so the windows become more expensive and heavier. Another way to reach the solution is to introduce a layer of thermal insulating material, for example a wood layer, but the windows are no more transparent. Standard solution number 5.1.1.1 suggests that when to introduce a new substance in a system to reach some goal is not allowed, void could be the right solution. In our problem we have to introduce another substance (glass or wood or other one), but it isn't allowed because of some negative consequences, so we have to find a way to solve the problematic situation with void, or air or empty space and so on. A good solution could be two thin sheets of glass but with a gap between them full of air for example: air is a good thermal insulator and the window remains light and transparent (fig. 2.2.5.1.1.b left).

Fig. 2.2.5.1.1.b – a window section with an insulating hollow glass

Self Assessment

Exercise 1:
Nina is drinking a very hot coffee, insomuch that also the cup burns. So she starts thinking how and if is possible to improve the system to avoid that the user could burn his fingers to simply drink a cup of coffee. And you, have you got some idea to solve this problem using the standard solution 5.1.1.1?



Answer 1:
This standard suggests to introduce some void if any other substance is forbidden for any reasons. Nina’s cup of coffee is very hot also in its outer part. The standard thinking for instance is to introduce a new substance more insulating then the pottery of the cup. But it is more expensive and besides it complicate the production process. So we could follow the standard suggestion, and try to introduce void in some way. We know that air is a good thermal insulator, so we have to introduce air between the inner surface that is in contact with the hot coffee and the outer one in contact with user fingers. A simple solution could be a cup like that showed in figure 2.2.5.1.1.c.

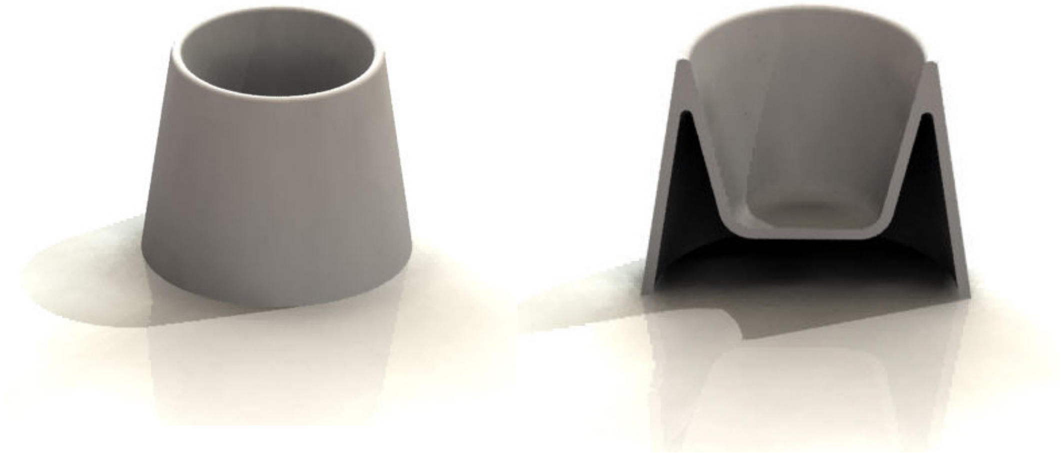


Fig. 2.2.5.1.1.c – a coffee cup that prevent finger burning. On the right its section.

References

[1] VV.AA.: A thread in the labyrinth (in Russian). Petrozavodsk: Karelia, 1988. ISBN 5-7545-0020-3