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A SYSTEM OF STANDARD INVENTIVE SOLUTION PATTERNS FOR BUSINESS AND MANAGEMENT PROBLEMS

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Abstract

In Classical TRIZ, Substance-Field Analysis and a System of Standard Inventive Solutions has been regarded as two complimentary tools to solve a majority of inventive problems emerging in the areas of technology and engineering. The paper addresses the question: can the same or a similar approach be used to deal with problems and challenges emerging in the areas of business and management?

In addition to introducing a problem modelling framework similar to Substance-Field modeling, a new categorization of types of inventive problems and a new system of Standard Inventive Solution Patterns for Business and Management (ISBM) are proposed. The approach is illustrated by a number of new definitions of Inventive Standards for business and management.

Keywords: TRIZ, Standard Inventive Solutions, Inventive Standards, TRIZ for business and management.

1. Adaptation to Business and Management

1.1. A Classical Approach

As follows from the studies performed to identify which TRIZ technique is used most often, it was found that the most popular technique are a combination of the contradiction approach with 40 Inventive Principles and Contradiction Matrix [1]. However, it is not well known that both 40 Inventive Principles and Contradiction Matrix were abandoned from the use in TRIZ by their author G. Altshuller who, after many years of developing TRIZ, came to the conclusion that the Contradiction Matrix and Inventive Principles provide rather low effectiveness due to the high degree of trials and errors [2].

During development one of the major TRIZ techniques -- ARIZ, it was revealed that the vast majority of inventive problems occur due to an undesired effect which appears as a result of physical interaction between two components or several groups of components. in ARIZ, such components are known as a "tool": a component which is a carrier of a function (producing action), and a "product": a component whose attribute or a group of attributes experiences change as a result of the action produced by the tool. A combination of a "product" and a "tool" is known as a "conflicting pair" in ARIZ [3]. Further development of ARIZ helped to extract, generalize and describe a number of typical physical interactions between a product and a tool as well as effects emerging from such interactions and match them with a number of typical solution patterns. Such solution patterns specify how a certain problem can be solved by modifying a system that includes the conflicting pair. Such typical patterns of solutions were collected to a system which is known as a "System of Inventive Standards" [4]. As a matter of fact, the collection of Inventive Standards was developed to replace the Contradiction Matrix and 40 Inventive Principles. Inventive Standards are more formal than Inventive Principles since they operate with specific models of systems and problems. Inventive Standards are more accurate than Inventive Principles and narrow down search field towards a solution space which includes most ideal solution models.

The term "Inventive Standard" means that there is a common, or a "standard" method to solve a group of different inventive problems that have the same problem model. To solve a problem with Inventive Standards, there is no need to explicitly formulate a contradiction, which still presents but remains hidden in the problem formulation.

To model different technical problems in uniform way, so-called "Substance-Field Modelling" approach is used. The basic concept is that any part of a technical system where a problem emerges can be presented as a system of interacting substance components and the problem is exposed as undesirable change of either a substance component or an interaction. Interactions between substance components are presented by so-called "technical fields" or physical forces. The role of fields and forces is to carry a function produced by one of the modelled components. Examples of such technical fields are mechanical, acoustic, thermal, electric, magnetic, electromagnetic, etc.

A problem model is defined in terms of a substance-field ("su-field") which consists of at least two substance objects and a field/force between them, which provides interaction responsible for the problem. An object might be an aggregated group of objects as well. For instance, su-fields presenting a model of a system and a model of a problem of ineffective cutting of frozen butter (object 1) by a knife (object 2) are shown in Fig. 1. The dashed line indicates a problem: cutting is delivered ineffectively. Both the substance components interact with each other via mechanical field.

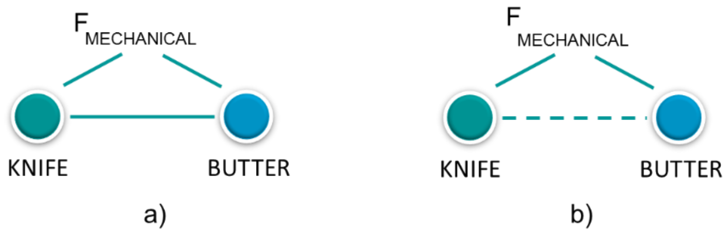


Fig. 1. Substance-field models of a) a system for cutting bread with a knife and b) of a problem of ineffective cutting of butter by a knife. A dashed line indicates that the function of cutting is delivered ineffectively.

An Inventive Standard consists of two parts. The left part specifies a generic model of a problem and might include some critical restrictions. The right part shows a model of a solution. For example, one of the Inventive Standard which can be applied to the problem model presented above includes the following recommendation: "*If it is necessary to improve efficiency of su-field, and replacement of su-field components is not allowed, the problem can be solved by the synthesis of a dual su-field by introducing a second field between the substance components which is easy to control.*" (Fig. 2)

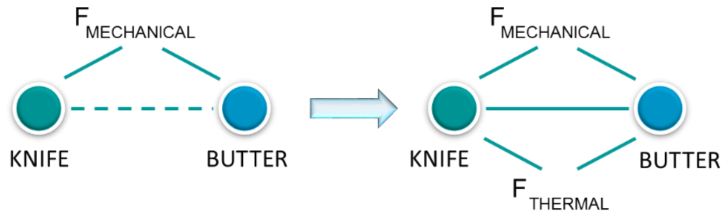


Fig. 2. Solving a problem of cutting frozen butter by applying an Inventive Standard "Transition to dual Su-Field". A solution is that the knife produces heat during cutting which melts butter.

In the past decade, TRIZ has become recognized as the best practice of the innovation front-end at a number of world-leading companies. While the vast majority of TRIZ applications cover technology and engineering, the fundamental concepts of TRIZ approach to problem analysis and creative ideas generation are based on several fundamental concepts which can be used within a broader context than technological and engineering only.

Among such areas where innovative problems emerge and which cause large interest are business and management. One of the authors has been exploring applicability of TRIZ to business and management since 1998 [5], including application of the System of Inventive Standards, and the results seem to be rather encouraging.

The phenomenon of successful applications of TRIZ and its tools in non-technical domains (e.g. [6]) can be explained by the fact that TRIZ focuses on studying high-level patterns and regularities of non-linear (in other words, inventive) evolution of technical systems. However, these systems are a subset of a broader class of artificial, man-made systems. Since the TRIZ paradigm was successfully confirmed across many engineering domains from mechanics to microelectronics, a key assumption can be made that general mechanisms of systems formation and evolution are similar and do not depend much on a domain. Thinking patterns which we use during a phase of creative problem solving process, deal with changing systems, would it be a car, or a building, or a pizza shop. Therefore another assumption is that once we need to solve a problem in the knowledge area which is based on evolution of systems, such as business systems, or social systems, we tend to apply the same abstract patterns as in case of technical systems.

For example, imagine a system (in any domain) which consists of two objects: 1 and 2. Objects 1 and 2 interact with each other, and the result of this interaction is that object 1 negatively affects object 2. There is a set of abstract solution patterns to prevent this problem from reoccurrence by changing a system of objects 1 and 2:

- We can shield object 1 from object 2 by introducing a new object 3 between them.
- We can remove object 1.
- We can increase the distance between object 1 and object 2.

The usability of one or another pattern depends on a specific set of constraints and demands. A more difficult case happens when we need to maintain the interaction between objects 1 and 2 since it produces a positive effect in addition to the negative effect. In this case, the solution patterns are as follows:

- We can introduce object 3 between objects 1and 2 which will filter out the negative part of interaction while letting the positive action to pass through.
- We can eliminate a property of object 1 which produces the negative effect.
- We can neutralize a property of object 1 which produces the negative action.
- We can decrease sensitivity of object 2 to be affected by the harmful effect.

- We can modify the environment of objects 1 and 2 so that the environment neutralizes the harmful effect.
- etc.

As we can see, such abstract patterns can be interpreted within and applied to virtually any type of systems: from microelectronics to social systems even if these domains incorporate rather different backgrounds.

The problem with the Classical TRIZ System of Inventive Standards is that it was developed for engineering applications and therefore brings specific technical language. There have been attempts to create either universal or simplified systems of Inventive Standards through further abstraction, for example, presented in [7], [8]. However, too much abstraction leads to a contradiction: the more abstract problem solving patterns are, the more universally they can be applied but their use becomes difficult due to a large gap between the degree of generalization of such patterns and specifics of real-world problems. This contradiction can be resolved by maintaining a balance between the patterns of the high degree of abstraction and patterns of a lower degree of abstraction which can be less universal but important for a specific knowledge domain.

Another interesting approach is suggested by M. Rubin [9] who attempts to develop a universal system of standard solutions in which the problem solving patterns are structured along the lines of solutions evolution. However, while the approach is promising, several critical questions arise: for example, one of the lines of evolution is the line of software evolution which may not be treated as universal.

1.2. Object-Field Modeling Instead of Substance-Field Modeling

As mentioned above, earlier attempts to directly apply the original TRIZ techniques and knowledge bases to non-technical areas caused certain difficulties, primarily due to the specific language used in the original TRIZ texts related to technology and the lack of examples and case studies from business and management. Due to this, attempts of some TRIZ experts to transfer TRIZ to business and management by using classical TRIZ materials, which were designed for the use in technology and engineering, often failed. For example, trying to explain a substance-field analysis to a human resource manager in most cases creates confusion when the manager tries to imagine that a person is "substance". Using original definitions leads to a perception gap and difficulty with transferring TRIZ knowledge to the non-technical world.

Regarding classical TRIZ-based substance-field analysis, a problem with the word "*substance*" can be easily solved by replacing the word "substance" with the word "object" which means any material or non-material matter within specific context and borders (e.g. person, paper, car, report, conversation, salary, bonus). Even such the words as "promise" and "advice" can be considered as objects since they capture clear contents within specific borders. In addition, a process or its part can be identified as an object.

However, a larger difficulty is created by the attempt to understand what to consider as a "*field*" when modelling business and management problems in terms of substance-field (or "object-field") analysis. We must note that the definition of the term "technical field" in the TRIZ version for technology and engineering does not match definition of the term "field" in physics (for example, such fields as "thermal field" or "mechanical field" do not exists in physics), but they were introduced to improve convenience of modelling and solving technical problems.

Some TRIZ developers tend to eliminate a field from a problem model to simplify the problem solving approach by leaving only objects and a function between them in the problem model. But the use of the concept of field is essential due to the fact that it is a field which defines background of interaction. For example, when two persons have a conversation in a room, we can define several fields creating this interaction: visual, verbal, emotional, informative. But not all these fields are usually a source of a problem: it can be either visual field if one person does not like how the other person looks; or emotional field if one person's confuses another person; or informative field if one person does not receive all facts he expected to hear. As known in classical TRIZ, a more ideal solution to a problem most often can be obtained when we focus on the improvement of a specific field which causes a negative or insufficient effect. A solution has to be found while maintaining this field without replacing this field. Therefore if one person visually irritates another person, the most effective and a solution most close to ideal one can be obtained by dealing with visual field rather than verbal or informational fields (thus trying to solve a wrong problem). A model of a problem in case of a problem caused by irritation must include visual field.

To create a classification of such fields, Belski [10] proposes so-called "human fields" which are based on human perception and are organized to five classes: 1) Senses, 2) Verbal communication, 3) Non-verbal communication, 4) Real material possession, 5) Non-real material possession. While this classification is useful, other types of fields can be used, for example a field of "cohesion". In addition, fields presenting physical interactions can be used as well when modelling inventive problems. As follows from our experience, when modelling systems in object-field terms, some fields can be aggregated. For example, there is no need to separate between visual and verbal components in communication unless only one of them causes a problem. Several examples of object-field models of business systems are shown in Fig. 3. The study of types of fields which can be used to define functional interactions in business and management systems is currently under way.

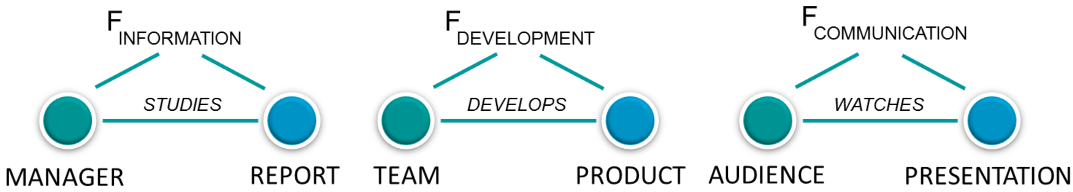


Fig. 3. Several instances of object-field models which include critical fields.

1.3. Problems and Solutions

Similar to technology, in business and management, vast majority of problems arise when a specific interaction can not affect value of a certain attribute of at least one of the objects engaged to interaction or both objects as desired, or the interaction can not prevent value from being affected. A problem emerges because it is not known how to either change value of an attribute within the constraints and demands given, or opposite, how to prevent the value of an attribute from being changed.

Since none of known solutions and problem solving methods available in a specific business domain help, a new solution which has not been known before is required. In technology, such problems are called "inventive". A major difference between technology and business is that once a problem in technology is solved, it can be patented and a solution can be called "invention". In business, however, patents are not available and business solutions are rarely called "inventions". Nevertheless, if a radically new solution in a certain business domain has been proposed, it makes sense to call such both solutions and problems "inventive".

For example, a very common case in various businesses is that sales of a product at the consumer market do not bring sufficient revenue. Such a problem can be modelled as ineffective result of interaction between two objects: a supplier and a consumer. But depending on a situation, a field in each specific case which is responsible for the interaction that creates the problem might differ: for example, it can be informative – if the supplier does not convince the consumer to buy the product; or trust – if the consumer does not trust the supplier. As clear, in both situations both problem models and solutions will be different. In the first case, the problem will be created by the interaction between a supplier who does not provide enough information to the customer, and in the second case, it will be a problem based on the field of "trust" which has nothing to do with either the lack of information or with the qualities of the product.

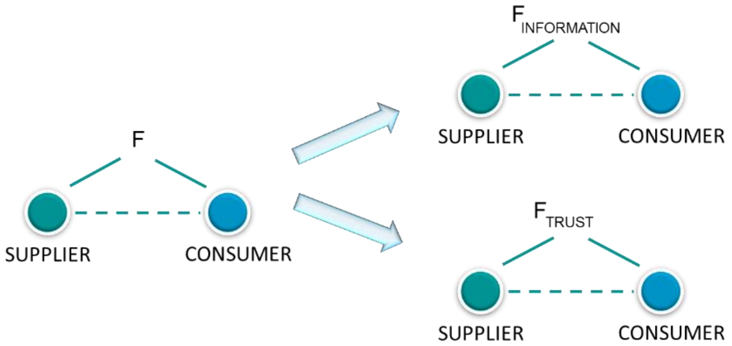


Fig. 3. Role of specific fields in modeling problems in object-field terms.

On top of that, there might be another reason why consumers do not purchase the product: because they do not feel happy about owning this particular product due to its design. In this case, the field will be emotional, and the interaction will be between the product and the consumer, while the field will be emotional: the product does not produce sufficient emotional impact on the consumer.

In summary, understanding what "field" is responsible for creating a problem helps to narrow down the scope of future solutions towards most ideal solutions space by focusing exactly on dealing with that particular field.

1.4. Modelling Problems

In both substance-field and object-field models presented graphically, problems are specified by defining a specific problem-creating type of interaction. There are five general types of interactions which identify problems, as shown in Table 1.

Table 1

Types of interactions specifying problems in object-field models

Type of interaction	Graphic notation used	Examples
Insufficient (ineffective) result of interaction		1) The project is not delivered in time. 2) Revenues from selling a product are insufficient. 3) Advertisement does not produce sufficient conversion rate.
Excessive (non-optimal) result of interaction		1) Too much budget is spent for advertising. 2) Too many visitors overload reception workers.

Poorly controlled result of interaction		1) A manager poorly controls a business process. 2) Deliveries by a supplier can not be properly controlled.
Harmful (negative) result of interaction		1) An office worker irritates other people in the office. 2) Loud packaging process disturbs employees in a room.
Non-informative or incorrect result of measuring effect of action or interaction		1) Results of audit are inaccurate. 2) A company produces wrong forecasts. 3) Information about results of partner's activity is missing.

It is often a case, when insufficient, excessive or poorly controlled results of actions or interactions are misinterpreted as harmful. It is important to identify harmful interaction by the following rule: a harmful (negative) interaction is such interaction which does not produce any positive effect but which results in the negative effect that is absolutely not desired. For example, if the supplies are not delivered in time, it can be either insufficient or poorly controlled result of interaction since the final result – delivery – is a positive effect but not delivered as expected. However, in case if a product is broken during delivery we deal with a harmful effect of interaction since there is no desire to have a product to be broken at all.

2. A New System of Inventive Standards for Business and Management

2.1. Structure and Organization

The classical System of 76 Inventive Standards was organized and structured by G. Altshuller on the basis of evolution of technical systems: from a non-existing technical system to the point when a technical system experiences transition to a microlevel of integrates to a supersystem. The system is divided to classes to separate Inventive Standards for change from Inventive Standards for measurement. The system of Inventive Standards for business and management is organized in a slightly different way: there are no classes, but there are groups according to a category of problems. Each Inventive Standard has a number where the first number stands for the group (category of problem), and the second one locates place of the Inventive Standard in the group. A current version of the system is based on combination of a study of over 1200 different business cases.

Similar to the classical system of 76 Inventive Standards, where the same substance-field models of solutions can be used for the problems of change and measurement/detection, in the system of Inventive Standards for Business and Management (ISBM), the same object-field solution models can be used for different type of problems.

Currently all Inventive Standards for business and management are organized to five groups:

- Group 1: Improving insufficient effect of an interaction.
- Group 2: Improving excessive effect of an interaction.
- Group 3: Improving poorly controllable effect of an interaction.
- Group 4: Eliminating negative effect of an interaction.
- Group 5: Organizing or improving measurement and detection.

In each group, inventive standards are ordered according to the degree of system change, which is required to solve a problem. Inventive Standards which do not require large change are located in the top of the list and Inventive Standards which require a large-scale change are located at the end of the list.

It is important to note that only those solution patterns are included to each group which are most often used to solve this particular category of problems.

Currently the ISBM system [11] includes 39 inventive standards (fig. 4). As said above, some of the inventive standards in different groups have identical solution models while the problem models are different.

- Group 1: Improving insufficient effect of an interaction
    - Standard 1-1: Transition to internal complex model
    - Standard 1-2: Transition to external complex model
    - Standard 1-3: Introducing intermediary
    - Standard 1-4: Using existing resource
    - Standard 1-5: Using modified or new environment
    - Standard 1-6: Transition to dual model
    - Standard 1-7: Transition to periodic action
    - Standard 1-8: Introducing selective protection
    - Standard 1-9: Introducing selective amplification
    - Standard 1-10: Segmentation of objects and processes
    - Standard 1-11: Dynamization of objects and processes
    - Standard 1-12: Transition to bi- and poly-systems, networks
    - Standard 1-13: Increasing differences in bi- and poly-systems
    - Standard 1-14: Increasing depth of nesting
    - Standard 1-15: Paradigm change
- Group 2: Improving excessive effect of an interaction
    - Standard 2-1: Introducing filtering
    - Standard 2-2: Modified environment
    - Standard 2-3: Removing excess of action
- Group 3: Improving poorly controllable effect of an interaction
    - Standard 3-1: Introducing intermediary
    - Standard 3-2: Transition to external complex model
    - Standard 3-3: Replacing paradigm
    - Standard 3-4: Outsourcing to supersystem
    - Standard 3-5: Transition to chain model
- Group 4: Eliminating negative effect of an interaction
    - Standard 4-1: Introducing intermediary
    - Standard 4-2: Introducing modified intermediary
    - Standard 4-3: Distraction by a new field
    - Standard 4-4: Introducing antipodal action
    - Standard 4-5: Introducing conditions
    - Standard 4-6: Modified object in advance
    - Standard 4-7: Periodic action
    - Standard 4-8: High speed
    - Standard 4-9: Paradigm change
- Group 5: Organizing or improving measurement and detection
    - Standard 5-1: Problem change
    - Standard 5-2: Using a copy
    - Standard 5-3: Successive detection
    - Standard 5-4: Indirect resource measurement
    - Standard 5-5: Transition to a dual model
    - Standard 5-6: Transition to bi- and poly-systems
    - Standard 5-7: Measuring derivative

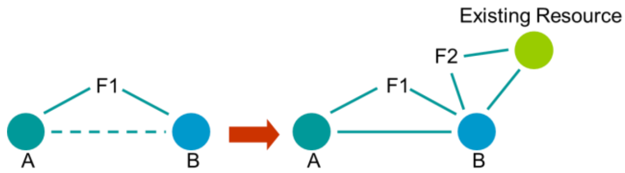
Fig. 4. Contents of current version of the System of Inventive Standards for Business and Management.

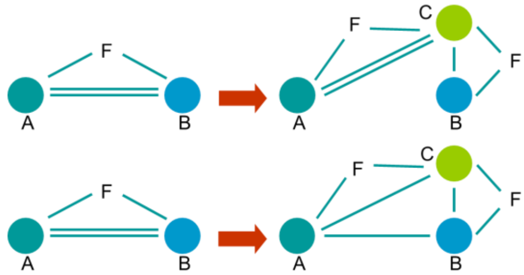
2.2. Examples of Inventive Standards for business and management

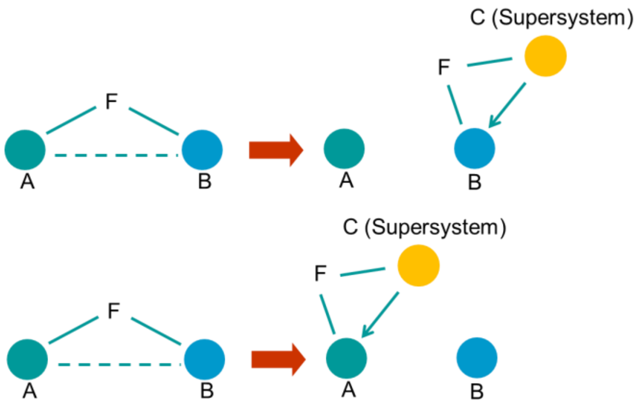
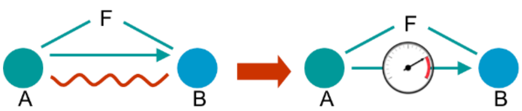
To illustrate how inventive standards are presented in ISBM, we present several inventive standards from the ISBM system developed in 2015 (Table 2). As in the classical Altshuller's system, each inventive standard is accompanied with one or more examples of specific solutions to better explain meaning and applicability of an inventive standard.

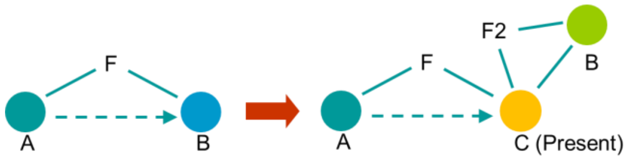
Table 2

Randomly selected Inventive Standards from each group

<table>
<tr><td colspan="3">Group 1: Standard 1-4:</td></tr>
<tr><td>1-4</td><td>If there is an insufficient (ineffective) effect of interaction between two objects A and B, and it is not possible to introduce a foreign object, analyze if there is already any object(s) in the existing environment of objects A and B which property can be used to achieve the desired effect of the interaction. The existing object can be used as available system resource to boost, accelerate or amplify the effect of the insufficient interaction.


Explanation: If it is not possible to introduce a foreign object to your system, study what resources (material, energy, information, knowledge, human) a system already has to which your objects belongs. In many cases, the environment within a system has readily available resource with a property to “amplify” the effect of an interaction without changing other conditions or introducing additional objects to the system. In this case, a main principle behind the interaction (usually, a process which provides the interaction) does not change. However in some cases, the resource object can provide a new field.</td><td>Example: Using the company's disposable paper coffee cups to print company news on the cups to keep the customers continuously updated in order to improve information flow from management to employees.</td></tr>
<tr><td colspan="3">Group 2: Inventive Standard 2-1:</td></tr>
<tr><td>2-1</td><td>If there is an excessive effect of interaction between the objects A and B, introduce a new object between the two objects, which possesses the property to withdraw the excess of the interaction while providing only the necessary degree of effect (filtering), or to redirect only the needed part of the interaction.

</td><td>Example: At a large company, all feedback information arriving from the department employees would overload a department manager. To solve the problem, the manager assistant position is introduced to deal with growing information flows and selecting those critical issues that should be forwarded to the manager.</td></tr>
</table>

	Explanation: Excessive interaction is different from the harmful one because it does not directly produce a negative effect or the negative effect produced can be neglected, but we would still like to have some optimal effect as a result of interaction. A foreign object has to become a kind of a "filtering mediator" which would receive an action from object A and transfer the action on object B without excessive effects that would accompany the excessive interaction. Often, the excessive action is not allowed due to some negative effect that would be caused by the existing type of the flow providing the interaction. Analyze what attribute of object B has to be changed, and find such a mediator that would convert the flow from the object A to another form but the required change of the object B would be achieved.	
Group 3: Inventive Standard 3-4:		
3-4	**If there is a poorly controlled effect of interaction between two objects A and B, consider replacing an object A or object B with object C that resides in supersystem.**  Comment: A field behind the interaction can remain the same or can be replaced with a more effective field (e.g. replacing manual control with automated control).	*Example: In case of a project, which requires specific competence not available in the organization, the competence can be brought by hiring an independent expert.*
Group 4: Inventive Standard 4-8:		
4-8	**If there is a harmful effect resulting from positive interaction between two objects A and B, and if the object is subjected to harmful or hazardous actions within the process of the interaction, consider conducting the process at a very high speed.**  Explanation: Many processes are accompanied with harmful or undesired effects due to the nature of the processes. These factors can be removed or considerably reduced if the process is conducted at a speed significantly greater than the current speed of the process.	*Example: Restructuring a department can be a painful process if performed slowly. It is suggested to produce restructuring within the shortest term possible*

Group 5: Inventive Standard 5-4:		
5-4	**If a certain parameter is difficult to detect or measure, a problem can be solved by indirect measurement or detection of another object or a field present in the system, change of which depends on a change of the parameter to be measured. Instead of direct measurement or detection of the parameter needed, another parameter identified with the first one is measured or detected.** 	*Example: It is difficult to directly detect an exact moment when a supplier shipped the needed materials through the courier mail if a supplier has not provided information to a customer timely. However, it is possible to learn about the shipment by requesting service from a postal company used by the supplier which will alert the customer each time the shipment has been made.*

3. Practical Applications

Currently, the ISBM system is used in two types of TRIZ-related activities: training and innovative problem solving. The ISBM system has been taught regularly since 2012 at training workshops on TRIZ for business and management worldwide for business professionals [12] (fig. 5). The system has been accepted rather well, despite the lack of technical background by many students. Often, students find successful solutions to real-world problems which they bring to a training workshop.

Regarding application of ISBM for solving real problems outside the training activities, during last several years, a number of solutions were obtained with different categories of customers. Such solutions mostly addressed resolving conflicts either within an organisation, or between an organization and its supersystem, for example, a supplier or a customer. Sometimes ISBM was used to improve customer relationships, enhance a product image, increase revenues, and so forth. Unfortunately, the size of this paper does not allow us to demonstrate these cases in detail.

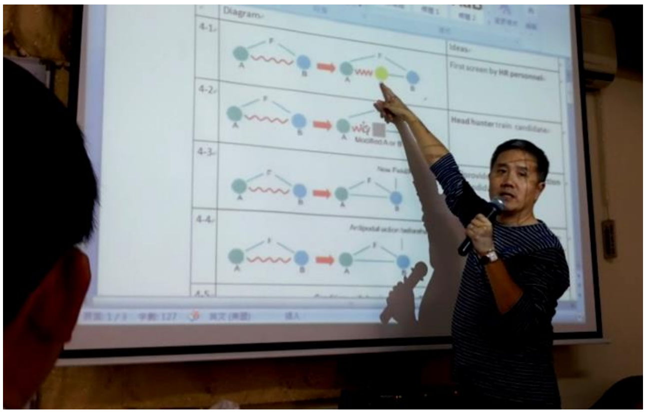


Fig. 5. Applying a System of Inventive Standards for Business and Management to solve a real problem related to improvement of training business during training process. Hsinchu, Taiwan, December 2015.

4. Conclusions

Fast and efficient solving of non-standard, “inventive” problems becomes critical for survival and development of virtually every business. Today many business professionals start to realize that traditional ways of innovative problem solving which rely heavily on random methods of idea generation like brainstorm may look fascinating and inspirational, but they often lead to considerable waste of time and resources, as well as to making incorrect decisions. New systematic and structured methods supporting continuous process of new business ideas generation are demanded.

Problems can greatly vary in scope: for example, one problem is how to resolve a local conflict between a manager and an employee at a start-up, while another problem is how to increase worldwide sales of a product by a large multinational corporation. However, despite the scale, solution patterns to both problems may be identical. Knowledge of such patterns drastically accelerates search for solutions close to ideal and enhances personal problem solving skills.

In summary, the ISBM system has the following features:

- No need to learn TRIZ for technology and engineering. Basic TRIZ concepts and fundamentals as well as basic concepts and fundamentals of ISBM system can be learned directly for business and management.
- Language used is understandable within business and management environments.
- Classification between problem categories helps to quickly move to the group of inventive standards which is most adequate for solving a problem required.
- Examples are brought from the areas related to business and management.
- The system can be used for solving problems of various scale and used both by large and small businesses.
- The system can be used to solve all types of problems causing conflicts even if such problems are not recognized as “innovative”.

Further development activities will focus on refinement of Inventive Standards included and organization of ISBM system propsed, as well as with extracting and structuring new patterns. In addition, work on the improvement of a theory of “fields” for business and management areas is scheduled.

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