TRIZ METHODOLOGY FOR ANALYSIS AND SYNTHESIS OF INNOVATION

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ABSTRACT

TRIZ methodology developed since 1946 by G.A. Altshuller is continued in Russia, USA, UK, Czech Republic, France, Germany, Japan, and in other countries by Altshuller followers. TRIZ is a powerful methodology for systematic as well as creative problem solving in a wide range of technology. It can mean a qualitative change in learning, education, and in technical creativity necessary at the start of all processing and product innovations in practice.

TRIZ methodology consists of single steps of the systematic analysis of the problem situation and of recommended approaches (principles) leading to synthesis – to innovated solution. TRIZ has been created step by step as a result of patent studies and generalization of successful solution procedures. It was found out that strong solutions of higher innovation degrees and invention levels can be reached through a relatively small number of objectively applied repeatable procedures which can be studied and acquired towards the solution. Understanding of these approaches at the educational process improves both the acquirement of the known technological solutions and the effectiveness of the searching new solutions of the technological problems in practice.

The **TRIZ methodology** is supported by unique software tool - **Goldfire® Innovator**. It helps engineers to formulate problems effectively thanks to deep analyses of the existing problem or situation, and to search in many databases filled with potentially relevant ideas and solutions. From the point of view of physics teaching, the **Goldfire® Innovator** overcomes usual lack in the educational process – the insufficient interconnection between theory and practice. It gives an excellent

possibility to show students technical applications of physical laws, and helps in this way to the understanding of physical theories. At the same time, it demonstrates that significant technical innovations can be solved only with theoretical background.

Goldfire Innovator is trade mark of IHS, Boston, USA.

Keywords: TRIZ methodology; Goldfire Innovator.

Summary

Theory of Inventive Problem Solving (TRIZ) is a relevant tool not only for managers, engineers, and scientists on the way of searching the optimal solution of various technological tasks but it is very useful pedagogical tool for teachers at technical high schools and technical universities, too. A brief description of analytical and solving instruments of innovative TRIZ methodology and its software support Goldfire Innovator is presented.

Introduction

Innovation of production is the condition of long-term competitiveness. There is a lot of ways of object innovation. The researcher should have not only subject knowledge in the field of study but also methodical knowledge how to proceed by problem definition, information collection, problem solving, and verification of the founded solution. The preparation to the systematic problem solving belongs to the fundamentals of engineering education. Engineering graduates provided with the methodology of systematic and creative thinking can adapt more easily and rapidly to the variable demands of the practice. There are many methods offered to the support of technical creative work, and many new emerge. For effective support of innovation practice the methods that are usable for solving of specific practical problems are most important. The methodology of creation and solving of innovation problems (TRIZ) and its software support help the innovator with recommendation and information by analysis of the technical object, with the formulation of the problem to be solved, with the synthesis in the process of searching of problem solving variants, and with the verification of the founded solution. We introduce shortly specific methodical and software tools.

TRIZ Methodology

TRIZ methodology has developed since 1946 on the base of results of study of great amount of patented technical solutions. In the last few years this methodology has been studied and used by establishment of outstanding schools and companies in the USA, Japan, Russia, South Korea, Germany, Great Britain, France, Italy, Sweden, Czech Republic and Slovakia. The methodology leads the solvers from vague problem situation to the problem description, through comprehensive analysis of the object and the formulation of innovative task, to the conceptual recommendations of solution variants, and finally to the verification of founded solution. The methodology uses two complementary methods: analytical Functional Costs Analysis (FCA) of the object, and research method Algorithm for Solving Invention Problems (ARIZ). Nowadays, the TRIZ methodology is supported by unique software tool – Goldfire Innovator.

Functional Costs Analysis (FCA)

FCA helps to find answers to questions “WHAT” and “WHY” should be innovated in the object. It helps the user:

- To study the object step by step by means of analysis of components, connections, functions, parameters;
- To define key elements according to their functional, problem and costs importance;
- To choose proper innovative tasks in agreement with development trends;
- To formulate correctly numerous innovative tasks: “what” and “why” should be improved in the object.

It is known that proper innovative tasks and correctly derived assignments are more than one half of the solution. The worst losses arise when teams of specialist develop good solutions on the base of wrongly formulated problem.

Algorithm for Solving Invention Problems (ARIZ)

ARIZ helps the user to find answers to many questions “HOW” could and should be solved innovative tasks in agreement with experiences of generation of inventors. These experiences are concentrated in methodical-research process of algorithmic type. Research tools offered in ARIZ help the user:

- To find in tasks technical contradictions and hidden physical contradictions that represent the kernel of the problem;
- To generalize the model of the conflict pair of material elements in time and place;
- To formulate precisely the problematic technical function in the solved problem;
- To find innovative solutions of contradictions by means of relevant recommendations (obtained by study of patent technical solutions) and relevant applications of these recommendations in various parts of technique;
- To confront and revised founded solution ideas with objective tendencies of technical progress.

For solution of technical contradictions in the problem ARIZ recommends heuristic principals, for solution of physical contradictions in a technical contradiction it recommends separating progress, for solution of conflict pairs of material elements in time and place it recommends solution patterns, and finally for other solution of a technical function in the problem it recommends theoretically suitable phenomena and effects from the database of phenomena and effects that are known and described in natural sciences. To all recommendations relevant information (patent technical applications of these recommendations) are offered for study and inspiration. Tendencies of technique development serve as confrontation of the object state with development laws valid in technique. The user can think about recommendations how to solve his task; he can draw relevant information (application of these recommendations) to extend his knowledge potential, and so increase the probability to find a new and progressive technical solution of his problem.

Goldfire Innovator

IHS Goldfire® Innovator is a unique software tool that supports the TRIZ methodology. This software extends abilities of developers, designers, and engineers to search systematic and verify new technical solutions. It supports researchers both in developing of new products and in removal of imperfections

or in design of modified properties of existing products and processes. Goldfire Innovator includes:

- Tried and tested methodologies and disciplines for innovation process control;
- Precise data retrieval and capacity for knowledge control;
- Critical content of 15 millions world patents;
- Database of more than 9 thousands physical and technical effects;
- Access to more than 2 thousands cross-disciplinary scientific www portals.

Goldfire Innovator consists of the following:

1. TechOptimizer

This part of SW allows the user to:

- Structure the conceptual design stages of any innovation or new product or process;
- Model systems or processes in terms of parameterized functions, apply sophisticated Value Engineering algorithms to perform a detailed value diagnostic of the model, and then formulate key problem statements (Fig. 1);
- Methodologically explore multiple design scenarios to reveal optimized systems that exceed original functionality, cost less, and have fewer problems.

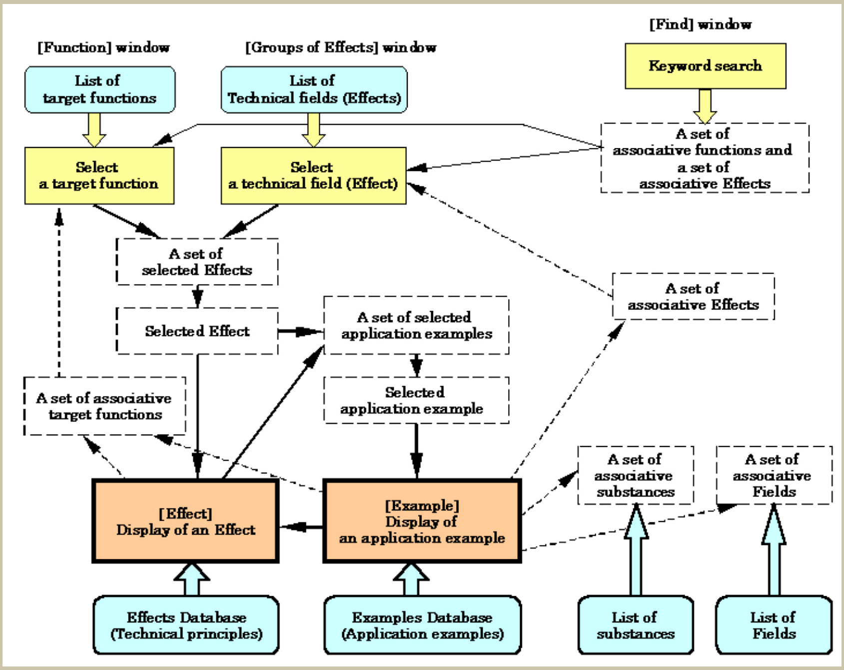

Fig. 1. Schema of Value Engineering algorithms

2. Knowledge Base

Of technological solutions Searchable Knowledge Bases are created using the natural language indexing technology. Unstructured electronic documents are processed into an index of “meaning fingerprints” for sentences and phrases, which define a clear pattern that can be matched by a computer during searches (Fig. 2). Furthermore, it allows users to build personal Knowledge Bases, transforming documents on their hard discs, networked drives, personal emails, and selected Internet sites into precision knowledge retrieval systems.

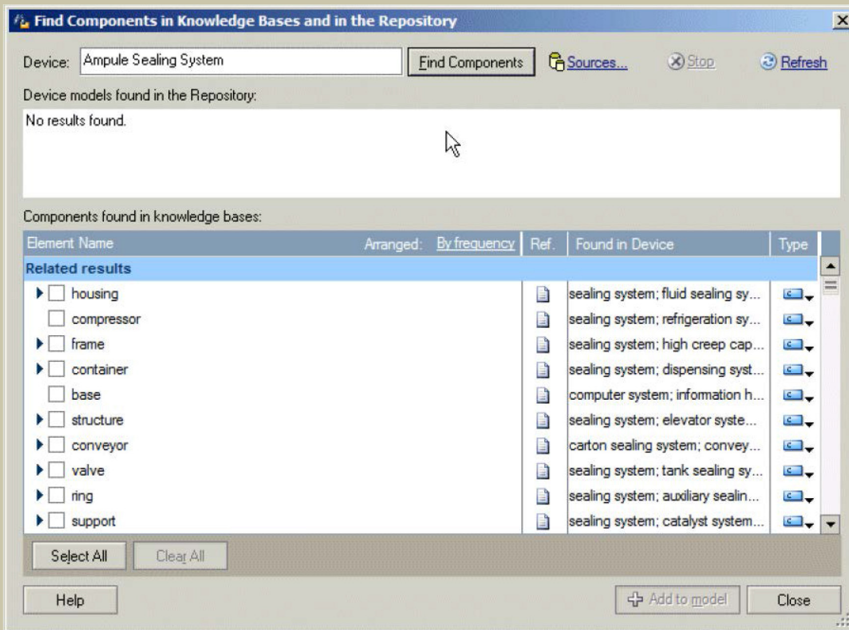

Fig. 2. Example of searching in Knowledge Base

3. Scientific Effects Database

This database contains animated descriptions of unique fundamental processes and their industry applications to assist engineers with both day-to-day and complex problem solving (Fig. 3). By drawing upon this extensive cross-disciplinary content, researchers quickly identify methods for performing specific design functions (Fig. 4). In addition, users can quickly create unique chains of processes that produce the desired output and utilize existing resources.

4. Solutions Search of Worldwide Patent Databases

The software provides a portal for access to a constantly updated database of patents worldwide. Researchers can harness the full value of patent documents as sources of innovative solutions and competitive intelligence. The patents are worldwide and constantly updated to ensure complete and timely information. The software has a natural language interface; this allows the users to formulate queries as free-form text to retrieve direct answers to their questions. Semantic processor finds and offers to the user only “knowledge” contained in documents and with the form of user’s created database that contains ordered representatives of information kernels of all processed sentences from all read documents. The user has not to read great amount of documents founded by the key words technology; he only search problems and their solvers ordered in the user's database that was created by semantic processor after "reading" all sentences in documents founded on Internet. The searching effectiveness of relevant information and knowledge is considerable.

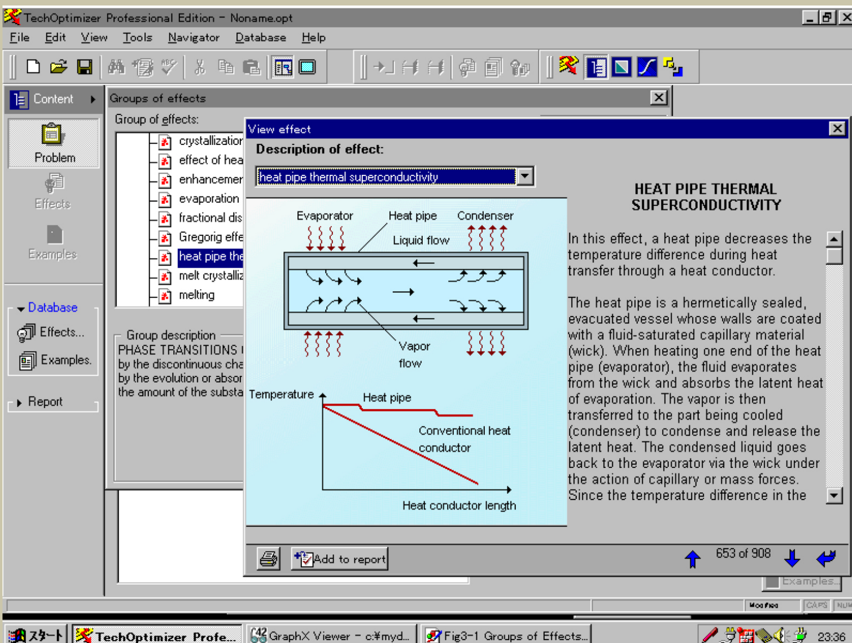

Fig. 3. Example of animated physical effect (Thermal Superconductivity) and its industrial application (Heat Pipe)

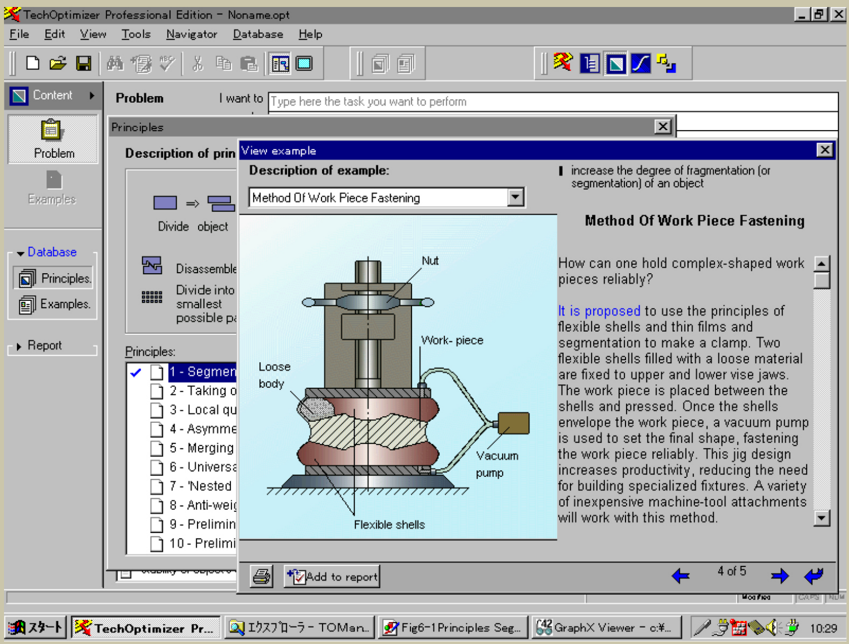

Fig. 4. Example of performing specific design function – Segmentation of an object

TRIZ methodology and Goldfire Innovator in education at FEEC BUT

At the Faculty of Electrical Engineering and Communication of Brno University of Technology the TRIZ methodology and its software support Goldfire Innovator are systematic taught in optional master course “Project Management of Innovation”. Course graduates are able to analyse the object, synthesize the innovative solution, and search relevant information and knowledge for problem solving. They also elaborate their own innovation project.

Scientific effects database of Goldfire Innovator can be used also in basic course of physics. It gives an excellent possibility to show students technical applications of basic physical laws, and helps in this way to the understanding of physical theories. At the same time, it demonstrates that no technical innovations are possible without theoretical background.

Conclusions

The brief description of the methodology of creation and solving of innovation problems (TRIZ) and its software support Goldfire Innovator has been presented. The methodology and the software tool are cross-disciplinary means of attractive technical education, methodical tools of systematic approach to the problem in the analysis period, tools of search for creative solution in the synthesis period, and the effective research tools of process and products innovations in practice.

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References

Busov, B., Bartlova, M., & Dobis, P. (2011). TechOptimizer – the Bridge between Theory and practice. *Proc. PTEE 2011*, Mannheim, Germany, 1-5.

Busov, B., Kapoun, K., & Bartl, J. (1999). TIPS and IM Methodology and Expert System for Education and Practice. *Proc. 4th CBLIS*, Twente, Netherlands, C31-C39.

Busov, B., Jirman, P., & Dostal, V. (1996). *Creation and Innovative Problem Solution*. Brno: Indus

TRIZ.