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ALGORITHM OF CONSECUTIVE HYBRIDIZATION OF PRODUCTS AND HYBRIDIZATION SCHEMES

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Introduction

Increasing ideality of technical systems is carried out through increasing the complexity – development of the quantity and quality of functions performed by system, and trimming – simplification of the system while maintaining or increasing the quantity and quality of useful features. The practice of this approach began with the introduction of an inventive principle "Combining" (by Genrich Altshuller [1]) as part of the "Mono-Bi-Poly" transition (by Genrich Altshuller [2]), "Development of alternative (or competing) technology systems through combining them into super-system,"(by Vladimir Gerasimov, Simon Litvin [3]), as well as in framework of deployment of bi-and poly-systems (by Boris Zlotin, Alla Zusman [4]), and the development of Algorithm of Hybridization of Alternative Systems (by Vladimir Gerasimov [5]).

This paper discusses schemes of deployment and simplification of systems through hybridization. The author developed the Algorithm of Consecutive Hybridization of Systems (Products), which was first published in 2005. In this work, the approach of genetic engineering in biology was transferred to the evolution of technical systems. While selecting examples and illustrations to develop schemes of hybridization, the author was focused on the most successful manipulations, those that resulted in products with multi-million dollar sales. The most common and basic manipulations are described through simple schemes. As a result of this research, various algorithms and recommendations on hybridization of products were proposed. In order to describe principles of hybridization, very simple examples were carefully selected. At the same time, simple algorithms can accomplish serious results even in the most difficult cases, and one of such projects was described in the chapter "The practice of multi-step hybridization for the creation of complex concepts."

Actuality of Research Topic

Increasing complexity through combining systems is described in great detail in Algorithm of Hybridization of Alternative Systems developed by Vladimir Gerasimov. This algorithm teaches to combine two alternative systems. Intuitively, it was clear that combining multiple systems is the prospective path to creating and developing the technical systems, but there were no clear recommendations about how to do it. The following questions arise: what if the systems are not alternative ones? Or, what to do if there are many more than two systems?

There is the endosymbiotic theory of evolution in biology (from Greek *endo* means inside and *symbiosis* means joint existence). This theory was proposed at the beginning of the last century by the Russian scientist K. Merejkovskiy. This theory was initially rejected by the scientific community, and then revived and expanded based on experimented data in works of the American biologist Linn Margolis. Endosymbiotic theory explains that relations between the organisms from different classes are the driving force of evolution. Genetic variability takes place due to exchange of genetic information between bacteria, viruses and complex cells [6]. Now it is recognized that a substantial part of the human genome has bacterial or viral origins – the result of the endosymbiotic relations, which happened in ancient or recent time. This statement supports the idea that endosymbiotic relations are driving force of both human evolution, and evolution of other organisms. If given principles works nicely for living nature, why can't they be transferred into technological systems? It is not so simple, because there are no modeling tools, supporting the existence of transfer of hereditary traits in TRIZ.

TRIZ traditionally uses functional and su-field models to describe the process of the development of technological systems. According to su-field modeling, a technical system is as combination of fields and substances, and functional modeling – a set of functions of the system.

This way, during the description of evolution of technological systems (or products) from the point of view of the biological evolution, there is the need to create own modeling instruments. These instruments should conditionally, but graphically describe products, features or traits, selected and utilized in the process of crossing, and the final hybrid product – the result of process of crossing. This approach is described in form of Basic Schemes of Hybridization (Appendix 1). There is a question: why is the word "hybridization" used for this algorithm and schemes? Why don't we use already available technological terminology with such words as "combining", "merging" and "integration"?

The use of word "Hybridization" is not a fashion trend, but a necessity, because combining technical systems is considered in most of the early attempts, but in genetic engineering, manipulations oftentimes can be considered an addition, subtraction, division, multiplication and exchange of genetic material. That is why it was decided to use "hybridization" in terminology, as the word to describe any manipulations with genetic material, and not just combining the materials of two systems. Here we make note, that in framework of the given work, only hybridization schemes involving addition, subtraction, division and multiplication are considered. For simplification of the work with hybridization schemes, special algorithms and recommendations were worked out. These algorithms allow user step-by-step transition through the process of crossing of products or technical systems.

This way, the goal of this research is developing algorithms and modeling tools to describe the processes of the technical systems evolution existing in the conditions of market economy from the point of view of multi-step crossing.

In the framework of given work, both the expressions "Product" and "Technical System" are actively utilized. Why? First of all, to describe an evolutionary process there is a need for extended interpretation of the “technical system”. For example, yogurt has no engine or transmission, so it is an incomplete technical system. But it does not prevent us from considering the given product and the history for obtaining new generations of the product through hybridization. Second of all, in order to have efficient communications with designers, sales and marketing specialists, it was decided to use a familiar term, “product,” because “product” is anything that can be sold on market, including any technical system.

Overview of known approaches to given problem

The earliest known approaches to resolving the given problem in the framework of TRIZ were the inventive principles “Combining” and “Separation” developed by Genrich Altshuller. In 1984, Boris Zlotin proposed the term “competing systems” and described work with these systems. At the end of 80-s of the last century, Vladimir Gerasimov and Simon Litvin developed methodology for combining alternative systems as a special tool, which provided very good results in practice. At the same time, Boris Zlotin and Alla Zusman continued detailed development of their instruments for combining of competing systems. It is interesting, that later, Vladimir Gerasimov proposed idea of work with chains of alternative systems in process of transition into the super-system.

Detailed statement of problem

Thus, the need to develop methods, algorithms and modeling tools that help users to go through a process of hybridization of multiple systems to resolve the contradictions of their combining appeared and was recognized. The methodology should be clear and work in the hands of both advanced users and amateurs in TRIZ. That is, the methodology should be clear and simple when studied, but powerful, giving excellent results when applied.

Hybridization methodology should work in the conditions of market economy and not only to support the inventive problem solving in the process of innovation, but also to help in creating concepts of new products. Currently, the need to create and market more new concepts and follow-up generations of products is also caused by the trend of transitioning toward the disposable products and the reduction of life-cycle of consumer products.

That is to say, developing concepts for new products faster, more accurately and cost effectively is imperative now and requires ever more powerful tools for innovations. Methods and tools should be simple, easy, modular, allowing effortless modifications to the structure of the innovative process. Sources of methodology and processes should be open, allowing the developer community application, improvement and continuous development.

Methods of solving of problem

The initial analysis and development of methodology are conducted by the author in the traditional form of TRIZ-research: via data collection and analysis of the evolutionary history of various products.

Formally, the accumulation of information took place during the stage of studying the initial situation of tens of projects conducted during the author's work at Ideation International Inc., and his continuing work at Samsung Mobile Display. The study of the evolution of consumer products in a market economy has allowed the author to recognize, describe and compare features of biological evolution and technological evolution of products.

After a description of the existing processes, algorithms and schemes of hybridization have been developed in order to help users to generate concepts of the next generations of their products using a limited number of steps. Thus the main requirement for the technique is to focus on practical application, simplicity, clarity and user-friendliness (i.e., methods should be concise and clear, and should not cause frustration and antipathy by using too many confusing steps).

Results of research

The methodology of the multi-step sequential hybridization of various products based on features selected for creation of most attractive novel hybrid products was developed. Selection is based on the analysis and selection of positive and negative features of products, resolving the hybridization contradiction and creating a portrait of the new hybrid product.

In the process of multistep hybridization, various schemes of hybridization can be applied, one after another. In the framework of this paper, hybridization schemes for addition, subtraction, division and multiplication of selected traits / features for development of concepts of new generations of products were considered.

In this case, even if the result of the process is unusual and "monstrous" concepts which look "incorrect,” they are used for subsequent iterations, crossings, for working out more sophisticated, elegant and logical concepts. At the same time, development is not limited to crossing old concepts. Using old concepts is one of the options, but most importantly, in order to move forward in hybridization, new evolutionary resources - fresh discoveries, engineering solutions and concepts for new products - are actively used.

The main motivation for using algorithms that cross is their mating transparency for the new generation of engineers and designers, who mastered a variety of CAD programs such AutoCAD, Solid Works, Pro Engineering. The ideology of modern design is largely shaped by the accumulation and re-use of 3D drawings of parts and assemblies of various products. In the spirit of these programs, the framework of algorithms of hybridization is proposed to imagine crossing products, selecting the part responsible for selected traits and resolving the contradictions of hybridization while mentally manipulating these images. From this point of view, the developed algorithms are particularly suitable for users who are accustomed to working with the image, visual information, because it is quite natural for them to represent the process of creating new concepts as a series of mental images, gradually changing during the passage through the steps of the algorithm.

Practice of application

The study proposed algorithms and recommendations for the hybridization products. Multistep hybridization approaches and the creation of populations of new products via hybridization have been successfully used by the author in carrying out projects for leading U.S. companies (Homedics, Helen of Troy, Procter and Gamble, BP Amoco, Unilever, etc.) in areas such as healthcare, consumer products, home care products, oil production and refining, packaging, food and automotive industries. Now the author works for Samsung Mobile Display, continuing improvement of the methodology. Over the last year, based on the results of applying this approach in various projects, the author filed 12 patents.

In this paper multi-step crossing is illustrated by some examples of the project "Development of new endoscopic instruments and procedures for NOTES" [NOTES - an abbreviation of the term "Natural Orifice Transluminal Endoscopic Surgery" - VP]. Nine patent applications were filed as a result of the project. Prototypes of the instruments were designed and built, and animal experiments were conducted. This gave the opportunity to attract investment and create a commercial company, which received the right to continue to work and use intellectual property developed in framework of this project. After initial research the company successfully conducted the next round of investment for follow-up research and introduction of new products on the market.

Analysis of the results of the study

As a result of the development of algorithms for multi-step hybridization, a novel technique allowing description and working with hereditary features in the framework of technological evolution has appeared.

Hybridization schemes allow the description of the transfer of hereditary traits in the evolution of products and describe the possible interaction of different products.

The developed approach supports common evolutionary processes of living and man-made nature. Various elements of the developed technique can be used to improve product quality, create new markets, develop product lines, reduce costs, improve production process, reduce the impact on the environment, reduce energy consumption, harmonize with legislation, develop concepts for a new generation of products, solve inventive problems, set up and enhance intellectual property portfolios, forecast product evolution.

The personal contribution of the applicant

Selecting research objectives, analyzing historical information, and developing recommendations and algorithms for sequential hybridization of products are the personal contributions of the applicant.

List of articles published on the topic of the thesis

1. Reconstruction of Technological Evolution through Hybridization of Technical Systems. V. Prushinskiy, V. Gerasimov, G. Zainiev. 3rd Annual Conference of the Altshuller Institute for TRIZ Studies, 2001.

2. Joint Application of Hybridization and Idealization Approach. V.Prushinskiy. 4th Annual Conference of the Altshuller Institute for TRIZ Studies, 2002.

3. Typical Failure Analysis Problems: Their Symptoms and Recommended Solution Procedures. Vladimir Proseanic, Svetlana Visnepolschi, Valeriy Prushinskiy. 4th Annual Conference of the Altshuller Institute for TRIZ Studies, 2002.

4. HYBRIDIZATION: THE NEW WARFARE IN THE BATTLE FOR THE MARKET. Val Prushinskiy, Vladimir Gerasimov, Gafur Zainiev. ISBN 1-59872-069-4

5. Operating Systems for Innovation: What Roles do they play in technology management and how do they increase the value of intellectual assets? Valeriy Prushinskiy, Zion Bar-El. 31st Annual Great Lakes Biomedical Conference. From Ideation to Product Launch, 2007.

6. Applying TRIZ to Breakthrough Innovations in Healthcare. V. Prushinskiy. Annual Conference of the Altshuller Institute for TRIZ Studies, 2010.

7. Hybridization of Alternative Systems. Basic Schemes of Hybridization. Hybridization of Populations. V. Prushinskiy. Creativity as an Exact Science – Vinci, Italy, Annual Conference, September 20-22, 2010.

8. Basics of Hybridization for new concept development. Valeriy Prushinskiy, Minsoo Kim, HeungYeol Na, Wonsik Hyun. Global TRIZ Conference 2011 in Korea. March 9-11, Seoul, Korea, 2011.

9. Case Study: Applying TRIZ for improving endoscopic instruments and procedures. Valeriy Prushinskiy, Minsoo Kim, HeungYeol Na, Wonsik Hyun. Global TRIZ Conference 2011 in Korea. March 9-11, Seoul, Korea, 2011.

10. Hybridization of alternative systems and multi-step hybridization for new concept development. Valeriy Prushinskiy. TRIZ Conference. May 7, 2011, Taipei, Taiwan.