

# TRIZfest-2015: ACCEPTED PRESENTATIONS WITH ABSTRACTS



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## **A New Analysis Model - SAFC Model**

*Mike Min Zhao (TRIZ Research Council of China Association of Inventions, China), Wucheng Zhang (Research Center for Technological Innovation, Tsinghua University, China)*

This paper constructs a new analysis model called SAFC model by combining the Su-field, Attribute, Function and Causality analysis together. By several case studies, it concludes that SAFC model could facilitate people to find the attributes of substances or components with harmful function in technical system exactly, and find the effective way to deal with those unnecessary attributes by effective operation, which enhance the efficiency of learning and using TRIZ.

Keywords : SAFC, Analysis, Model, Substance, Attribute, Function, Causal, Interaction

## **A Products Planning Approach by TRIZ and Information Integration Method**

*Heikan Izumi (NIPPON BUNRI University, Japan), Manabu Sawaguchi (WASEDA University, Japan)*

The theory of inventive problem solving (TRIZ) is among the most effective solutions for new product planning, and in our previous studies, we have proposed some approaches using TRIZ to improve products. Sawaguchi proposed effective new product planning activities utilizing “the patterns of technological system evolution.” However, we found that there were many cases in which certain features might be degraded even if some new functions had been created by these approaches. In practical product planning, new integrated evaluation methods comparing current products against those with new functions are required. Although the information integration method (IIM) is a quantitative evaluation method for products, new functions cannot be evaluated using this method. In this study, we propose a new quantitative product planning approach based on the IIM by assuming that there is potential demand for a new function even if current products do not have the function. We applied this product planning approach to hair dryer improvement planning as a case study.

Keywords: ThePatterns of Technological System Evolution, Product Planning, Information Integration Method

## **Advanced Function Approach in Modern TRIZ**

*Oleg Feygenson (Samsung Electronics, South Korea), Naum Feygenson (Russia)*

Advanced Function Approach (AFA) was introduced in 2010 at TRIZ Future Conference conducted by ETRIA. At that time, it was shown how utilizing the spatio-temporal parameters can further enhance such a powerful analytical tool as Function Analysis for Engineering Systems. Since then, AFA has proved its practical efficiency in dozens of TRIZ projects. Methodological recommendations for applying AFA have been developed and verified in the following areas:

- Specifics of Function Analysis for Engineering Systems at the exploitation stage (TRIZ Fest 2012);
- Revealing and describing the synergetic effect of combining two Engineering Systems (TRIZ Fest 2013);
- Novel approach to categorizing functions that Engineering Systems perform (TRIZ Fest 2014).

Here we reflect milestones in developing Advanced Function Approach and incorporating it in Modern TRIZ. The main recommendations of AFA are also summarized in this paper.

Keywords: Function Analysis, Spatio-temporal Parameters, Advanced Function Approach.

## **Applications of Purpose Axis as a part of Multi Screen Thinking**

*Yoon Hong-yul (TRIZ Center, South Korea)*

Multi Screen Thinking or 'Talented Thinking', was suggested by G. Altshuller in order that problem models may reflect the real world of the relevant problems. As for him, the world is complex, dynamic and dialectically evolving and then our models must be capable of treating such characteristics of the world. In his Multi Screen Thinking, Time Axis, System Axis and Anti System Axis were given to fulfil the requirements. Many additional Axes have been suggested during TRIZ development. Especially, N.Khomenko developed a variety of Axes of Multi Screen Thinking in accordance with his own OTSM viewpoint of problem model transformation to solve difficult problems. The axes of Multi Screen Thinking were not always originally novel but many of them had been used in other fields for the benefits of their own. That means new axes can be suggested if they can serve the essential roles of Multi Screen Thinking. This paper offers Purpose Axis as a part of Multi Screen Thinking. The author has gotten lots of benefits by considering purpose relationship among problems over some typical application of TRIZ. Purpose Axis will be discussed on its usefulness and applicability to engineering problems like patent design-around and business problems like blue ocean creation.

Keywords: Multi Screen Thinking, Talented Thinking, Purpose Axis.

## **Applying System Thinking in Evolutionary Trends**

*Arthur Lok (China Institute for Innovation, China)*

Evolutionary trends is one of the most promising fields in TRIZ where a lot of people are putting a lot of research efforts in. Current research mainly focuses on finding new evolutionary trends and application of evolutionary principles in different areas. However, evolutionary trends only explains the different possibilities that could happen in the future, while the area of defining which possibility is most probable is still a field that is not fully covered yet. This article explores the possibility of further applying system thinking in technological system evolution and uncovering the internal dynamics for technological system evolution. More specifically, this article explores the following three aspects for the technological system evolution: traction forces that generate new variants and moves technological system forwards along evolutionary trends; constraint forces that prevents technological system from generating new variants; selection forces that presides which variants are replicated and widely adopted. After exploring the different forces inside the technological systems, this paper establishes a new model to predict the emerging technologies across different industries. This initial theoretical research implies new opportunities in finding the new patterns inside technological systems that explains and predicts the advancement of new technologies. The intention is also to draw attention to this field of further articulation of technological system evolution.

Keywords: system; engineering trends; evolutionary tension; technology forecasting.

## **Applying TRIZ Across Companies**

*Oliver Mayer, Tiziana Bertonecchi (GE Global Research, Germany), Martha Gardner (GE Global Research, USA), Robert Adunka (TRIZ Consulting Group GmbH, Germany)*

TRIZ is a very powerful tool for innovation generation. In the last years this method has spread across industry and revolutionized innovative thinking.

Industrial reality is up to now often organized in a way that engineers follow processes that cover the span from idea to maturity of a product. In that time span only a short piece is using TRIZ to generate ideas systematically. The major part is compiling the boundary conditions that are seldom of physical nature and evaluating and then demonstrate, prototype and finally design the mature product.

Considering a development time of average about 2 year for a complex part, only very few times TRIZ is used, mostly as brainstorming aid tool in the concept phase or occasionally when specific problems arise during project execution.

TRIZ is a tool that needs to be trained and continually used in order to make most use of it. If working conditions do not allow this, one has to search for other ways to realize this. This paper shows how a solution was found to work the conventional way industrial processes are operated and at the same time keeps up using TRIZ continuously and in surplus to widen one's technological knowledge.

The solution is to set up a group of TRIZ knowledgeable persons from different institutions and to periodically set up meetings at the different facility sites to solve a company specific problem for which no IP or competition issues are present with TRIZ tools. This kind of open access innovations keeps up

TRIZ application and trains its usage, it is fun, serves widening of technology knowledge and comparing different application approaches, enables learning from other innovators and sets up a network. This paper is a report on an example of application of TRIZ effectively in a company and cross companies. It is not targeted to add novel contributions to the TRIZ methodology, rather to introduce new frameworks for application.

Keywords: TRIZ, heterogenic groups, cross companies working, learning TRIZ, innovation method.

### **Approach to Knowledge Systematization**

*Victor D. Berdonosov, Elena V. Redkolis (Komsomolsk-on-Amur State Technical University, Russia)*

The article discusses the importance of solving problem of knowledge summary and systematization that is particularly topical in terms of IT-technology rapid development and rising number of interdisciplinary research and commercial projects. The article represents a short review of existing approaches to modeling of the systems evolution in TRIZ and describes authorial TRIZ evolutionary approach to knowledge systematization eliminating the disadvantages of known techniques. Authors discuss main terminology and approach application features for knowledge systematization in technical, humanitarian and mathematical fields on the example of studying the evolution of programming, numerical methods and budgeting paradigms. Trends of future researches within development of TRIZ evolutionary approach and alternative spheres of its application are considered.

Keywords: concept, budgeting, frame, forecast, numerical methods, paradigm of knowledge, programming, TRIZ-evolution.

### **BIG Patent DATA: an opportunity for TRIZ**

*S. Dewulf (AULIVE, Australia), F. Vanmoerkerke (AULIVE, Belgium), P. Carl (AULIVE, Australia)*

Today the world says BIG DATA, TRIZ can say BIG Patent DATA. And unlike BIG DATA, BIG Patent DATA has structure. Most patents have a title and abstract (summary), claims (proposed solution), description (problem), citations (relation), and text structure.

Keywords: patent, big data, patent analysis, trends, property, function

This contribution is available as presentation only.

### **Creativity and Innovation Process**

*Mark Barkan (The International TRIZ Association - MATRIZ)*

People started to innovate at the dawn of civilization. When man picked a rock for a purpose, say, of breaking a nut, he invented a tool. Nobody recorded the very first invention. Yet, today we know that the biggest difference between humankind and the rest of the biological world is our ability to engage in a directed thought process. Therefore, we can solve various problems much faster than any other species. The problem solving skills are the foundation for developing creative thinking skills, which are a must for commencing and sustaining any innovation process.

In this paper, I discuss the importance of teaching problem solving for developing creative thinking skills, which is a prerequisite for any form of innovation process.

Keywords: TRIZ, problem solving methodologies, creativity, innovation, open problems

### **Development of Symbiotic Systems and Products**

*Valeriy Prushinskiy (Natural Innovations LLC, USA)*

Symbiosis (from Greek σύν "together" and βίωσις "living") is defined in biology as close and often long-term interaction between two or more different biological species. In Theory of Inventive Problem Solving, symbiotic systems were initially described by Boris Zlotin and Alla Zusman as a way to create bi- and poly-systems.

This article will consider role of symbiotic systems for creation of modern consumer products and provide recommendations for development of these types of the products.

Keywords: Hybridization, symbiotic systems, how to create symbiotic products

### **Evolution of Electric Vehicles - a TRIZ Based Approach**

*G Nagashiresha, Vinodh Mewani (GE Global Research, India)*

The purpose of this paper is to study the current status of electric vehicle (EV) industry using TRIZ based S-curve methodology. The energy density of electric vehicle has been considered as the Main Parameter

of Value (MPV) since it directly affects the performance of the engine as well as determines customer purchasing decision. An increase in the capacity of energy density of batteries was observed over a period of time. This was correlated with patent trend & global sales numbers and inferred that EV industry is in the 2nd stage of the S-curve. The indicators from the EV industry that are typical for 2nd stage of the evolutionary curve are discussed. Based on the indicators, TRIZ based recommendations for growth of an engineering system in the 2nd stage are provided.

Keywords: Electric vehicle, TRIZ, S-Curve, Main Parameter of Value, Energy density.

### **Identification of Conceptual Directions at the Initial Project Stage**

*Yury Fedosov, Pavel Sedykh (Russia)*

There are a number of various recommendations on identification of conceptual directions for engineering system improvement. The authors propose to group solutions into conceptual directions based on implementation difficulty features (short-term, long-term); based on identified components of engineering system; based on specific features of principles used for the elimination of identified problems, etc. But such an approach is very efficient when ideas or concepts of solutions have been already outlined. It is impossible to use them (or very difficult to use them) at the early stage of an innovation project.

The authors suggest outlining conceptual directions by using the developed multi-level flow chart of possible goals for an innovation project. The proposed flow chart of goals for engineering system improvement is based in ideality formula. If a researcher identifies the block of target problem to be solved on this flow chart, he would be able to see and choose possible conceptual directions for future solutions on the lower level.

The authors use this approach in the practice successfully and have good reason to believe that it will be useful for wide circle of TRIZ-practitioners. In addition, the authors do not exclude using this approach by some TRIZ-practitioners. But publications about this approach are not discovered in public sources of information.

Keywords: ideality, concept, idea, conceptual direction, innovation project, project goal, problem solving.

### **In Situ Magnetizer with TRIZ**

*Tiziana Bertonecell, Jan Hemmelmann, Alexander Fiseni, Oliver Mayer (GE Global Research, Germany)*

Innovation in the electric machine world follows the pattern of system and process integration and a stronger attention is paid to multidisciplinary design rather than to single device topology. Usual design and optimization are often just slightly incremental, aimed to fine tuning optimization. The so-called traditional electric machines have been studied for decades and their further improvement is very much dependent on material research. In fact, during design processes, walls are often hit, as far as topology and performance are concerned. In this scenario problem solving tools like TRIZ can be very helpful to reconsider domain specific problems and identify novel solutions, even when solid processes as Six Sigma come to a stuck point. After a S-Curve analysis of electric machines and a TRIZ application review for this field, an example is offered by the post-assembly magnetization for a permanent magnet electric machine: a highly desirable manufacturing step which has seen so far hardly ever implementation. The review of this issue at GE Global Research Munich by means of Six Sigma tools saw a turning point thanks to TRIZ application bringing to a new concept and a filed patent.

Keywords: electric machines, design, TRIZ, Six Sigma, magnetizer

### **Input VAT Recovery**

*Antoni Baszczeski (ASK Consulting, Poland)*

Global FMCG Company was producing and selling millions bags of snacks in Poland per annum. In order to increase an attractiveness of the product inserts (small plastic discs) with a picture of football players, Pokemon, or other famous characters were placed into the plastic, sealed bag. The input VAT on these discs was 22%. The output VAT for final product in bags was 7%.

The producer was not allowed to claim the input VAT (22%) on promotional inserts, which created an additional cost element, which was not tax deductible from the CIT (Company Income Tax perspective). The existing VAT rules were not clear enough which created ambiguity.

Hired Consultants from two of Big-4 Consulting Firms were arguing with the Tax Office for 4 years

without any success.

With a support of tools and methods proposed by TRIZ - author was in position to design, propose and implement effective and cheap solution resulted in recovery of few million dollars of historical VAT.

Keywords: Ideal Final Result, Multi Screen Diagram, Root Cause Analysis, VAT, Tax Office.

### **MyTRIZ Journey in Malaysia**

*Teong San Yeoh (Malaysia TRIZ Innovation Association, Malaysia), Eng Hoo Tan (Multimedia Development Corporation, Malaysia)*

The Malaysia TRIZ Innovation Association (MyTRIZ) was formed in 2010. It has embarked on 3 strategies namely to: (i) create a national platform which focuses on ensuring TRIZ training delivery, standardization, and quality; (ii) create a learning platform which focuses on proliferating TRIZ to schools, universities, and industries, while creating new products, services, or systems; and (iii) create a sharing platform by organizing TRIZ conferences in order to generate momentum, share learning and best practices, and advance methodology application.

Although the association is considered relatively young, it has grown quite significantly in terms of growth of MyTRIZ Level 1 practitioners which has exceeded the 5,000 mark within 5 years. The latest MyTRIZ Conference 2014 was a 4 day event consisting of conference, workshop, competition, and community service; and had a record 1,024 participants. The uniqueness of the MyTRIZ association is the holistic support of industries, government linked organizations, and government ministries. This has enabled a steady growth of TRIZ in Malaysia. The TRIZ momentum is growing with much interest and enthusiasm across schools, universities, and industries.

Keywords: TRIZ, MyTRIZ, Innovation, Malaysia, Intel, MdeC

### **Network Analysis of TRIZ Principles and Contradiction Maps to Recommend Research Orientation and Patent Strategy**

*Srikanth Tadepalli, Vinodh Mewani, Anand Biswas (GE Global Research, India)*

Development of a patenting strategy is imperative for a company to protect its IP portfolio. This paper explores various means of incorporating TRIZ for evaluating a patent landscape to develop a research path and support it with a patenting mechanism. The approach incorporates TRIZ and S-curve analysis to gauge the state-of-art and predict direction of technical progression. The results are compared with insights obtained from patent landscape. A set of dominant TRIZ principles defining the technology are identified and related to the maturity level of the industry, and also to the protection policy that needs to be employed.

Keywords: TRIZ, S-curve analysis, principles, contradiction analysis, technology trends, patent strategy.

### **Numerical Construction of S-Curves Using the TRIZ tool of Trends of Engineering System Evolution (TESE)**

*Srikanth Tadepalli, Anand Biswas, Vinodh Mewani (GE Global Research, India)*

Evaluating maturity stage of a product is important to understand remaining life of the device and to plan for its next offering or potential retirement. Currently, S-curves are employed to map the product to an appropriate part of the curve based on market, functionality, cost and design information. We propose and develop a novel procedure in this paper where construction of S-curves is performed using quantified metrics. Hence, the key research problem addressed in this paper is how the maturity level of a product can be estimated mathematically and how such indices can then be used to trace an S-curve to highlight the relative positioning of such products. By combining Trends of Engineering Systems Evolution (TESE) and product features, we build measurable metrics (TESE scores) first, another novelty introduced in this paper, that are then used to ascertain the current stage of product evolution. We present an example of a set of audio devices to highlight robustness of this innovative methodology.

Keywords: TRIZ, S-curve analysis, TESE, MPV, product maturity, feature maturity, growth index

### **One Day at the Museum – Using a Museum as Resource for Teaching and Learning TRIZ**

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*Consulting Group GmbH, Germany), Neumuth, T. (Innovation Center Computer Assisted Surgery (ICCAS), Germany)*

This article describes a specific learning experience of ten participants during a MATRIZ Level 3 training program – made in the “Deutsches Museum” in Munich under the mentorship of a TRIZ-master. Besides the introductory background and the empirical description of the experiences of three different learning groups, the article concludes some insights out of this event. These are the base for the formulation of some recommendations and ideas regarding intensification of teaching and learning TRIZ in a museum in future.

Keywords: TRIZ, teaching, learning, innovation, trends, TESE.

### **Parallel Evolutionary Lines – Combination of Function-Oriented Search and Evolutionary Trends**

*Simon Ltviv (GEN3 Partners, USA)*

Very often engineering systems (products or technologies) pass similar evolutionary stages during their evolution. Besides, one of the systems is always at a more advanced stage compared to others. This fact enables one to forecast the evolution of a less developed system. In contrast to the well known in TRIZ Trends of Engineering System Evolution (TESE), which, as a rule, predict general directions for the evolution for practically all systems, the Parallel Evolutionary Lines (PEL) give specific directions and even suggest some innovation solutions for a restricted class or category of engineering systems. At the same time, comparing to Function-Oriented Search that is transferring specific technologies from the leading industries to the initial area, PEL transfer entire trends.

Knowing the evolutionary stage of a certain product or technology, it is possible forecasting, with reasonable confidence, the evolution of parallel systems. Four major sources of similarity (parallelism) of evolutionary lines have been identified:

- Functional similarity
- Action Principle similarity
- Features similarity
- Application similarity

The algorithm of analysis of PEL was developed and tested for numeral products and technologies in different areas of engineering. The presentation is furnished with case studies from real consulting projects.

This contribution is available as presentation only.

### **Perspectives for Development of Automatized Enterprise Management Systems**

*Victor D. Berdonosov, Alena A. Zhivotova (Komsomolsk-on-Amur State Technical University, Russia)*

The article describes the evolution and development perspectives of automated enterprise management systems (AEMS) which are currently one of the most important tools of management. Such systems as EDP, MIS, ERP, MRP, APS, MES, OLAP, and CSRP were analyzed. Key contradictions of modern management systems were revealed. Elimination of these contradictions is the moving force of further development of such systems. To perform the analysis TRIZ evolutionary approach is used as an effective tool of knowledge systematization.

Keywords: TRIZ evolutionary approach, AEMS, management, EDP, MIS, ERP, MRP, APS, MES, OLAP, CSRP.

### **Practice for solving problems and generating new concepts based on TRIZ-DAGEV roadmap**

*Hyung-Seok Yeo, Jung-Hyeon Kim, JaeMin Lee, Jun-Young Lee (Samsung Electronics, South Korea)*

A creative solution for most problems of administration, TRIZ has been used for creating ideas and solutions in various fields of R&D. However, there are some issues regarding using TRIZ in terms of its effectiveness and efficiency. For example, although TRIZ offers many thinking tools, users have reported that they used only a few tools to develop a solution or new concept. In addition, some users do not properly understand the TRIZ thinking process even after taking learning courses for more than 40 hours.

This paper aims to review some issues regarding the use of TRIZ and present a brief analysis of how TRIZ tools have been used in real practice. For this review and analysis 198 projects were screened. The majority of those projects have led to new patents and ideas. In addition, all of the projects were classified as having two groups: problem solving and new concept generation.

For the research, data collection was done through an assignment report based on a TRIZ-DAGEV roadmap (DAGEV stands for Define, Analyse, Generate, Evaluate, and Verify). TRIZ-DAGEV roadmap was predetermined process based on ARIZ. Through the TRIZ-DAGEV template, the information concerning the frequency of use of TRIZ tools was collected from TRIZ users, from which then TRIZ experts evaluated the user's understanding of the TRIZ tools by an oral examination.

The main results of this research are as follows. First, TRIZ users are mainly applying easy tools, such as the inventive principles and contradiction matrix to solve their problems and generate ideas. But the better ideas, the much more tools were used in TRIZ projects. For generating new concepts, TRIZ users prefer to use idea generation methods such as FOS rather than problem analysis tools such as multi-screen thinking or function analysis. Second, most TRIZ users responded that it is easy and useful for them to apply TRIZ-DAGEV roadmap and TRIZ tools for their R&D projects. However, there are still some users those who mentioned that TRIZ process is complicated and difficult. Finally, TRIZ experts have stated that some users have used TRIZ methodology, not by an inductive thinking process, but by a deductive thinking tool.

Keywords: TRIZ, TRIZ-DAGEV roadmap, Problem Solving, New Concept Generation

### **Redesigning the Way Future Engineers Learn to Solve Inventive Problems**

*Aisha Mahmood (Namal College, Pakistan), Zulhasni Abdul Rahim (Proton Holding, Malaysia), Muhammad Mansoor and Mariam Altaf Tarar (University of Nottingham, Malaysia)*

The potential interplay between design thinking and TRIZ motivated engineering educators to redesign the inventive problem solving experience for future engineers. The rationale of using design thinking as a research methodology is its revolutionizing and iterative nature. It encourages researchers to craft superior elucidations by learning from initial mistakes that make sense to them and its interactive processes to approach complex problems, collaborate with innovation, create holistic and sustainable solutions through a human-centered lens. The complex problem of promoting and integrating design thinking with TRIZ for future engineers demanded the fusion of various perspectives and the knowledge of engineering practice and education. The design thinking processes allowed us to effectively channel the potential of interdisciplinary and transdisciplinary collaboration by creating a shared problem awareness and establishing a common language to address the workplace demands. Guided by the design thinking methodology, the authors collaborated to design the interactive process of inventive problem solving through inductive teaching and learning methods for continuous improvement in engineering education.

Keywords: Design Thinking; TRIZ; Engineering Education; Inductive Teaching; Continuous Improvement.

### **Research on Clip Improvement in Heavy Haul Railway Line Based on TRIZ**

*Hu Lianjun, Yang Jizhong, Zheng Xiaoyan, Yuan Zhigang (China Railway Eryuan Engineering Group Co, China)*

Currently, some specific problems exist in heavy haul railway fastener system, such as concrete tie deterioration, failure of plastic plate, insufficient restrict effect on plastic plate, and so forth. These could be solved by adopting TRIZ theory and CAI software. According to the structure of II elastic clip, basic functional model is built in Goldfire Innovator. By analyzing the functions that need to be improved, using inventive principle, substance-field model, system evolution laws and other tools, further researches are conducted and corresponding solutions are proposed. Ripple damping plastic plate structure, tofu-like plastic plate, ringlike (spherical) restrict of plastic plate and other solutions could improve original system function.

Keywords: TRIZ, functional analysis, inventive principle, substance-field model, system evolution

### **Research on TRIZ Integrated Affordance Analysis**

*Ren Gaohui, Shi Dongyan, Zhang Hong, Li Zhen (Harbin Engineering University, China)*

Aimed at the analysis issue on the relationship between technical system and the environment in the evolution process of technical system, the integration of TRIZ with affordance analysis provides technical support for function solving and improvement of technical system. The method combines the analogical reasoning method and regards function solving, diagnosis of the solution and improvement of the solution as the main line. Through situated analogy, affordance is put forward to describe the relationship between technical system and the environment. The affordance of analogy source design is

to be realized to find out the poor affordance of the target design, thus turning to TRIZ theory for analysis and solution. The paper takes the evolution process of spiral drum for shearers as an example, verifying the practicality of this method in the evolution process of technical system.

Keywords: TRIZ; technical system; evolution; analogy; affordance

### **Simplification of System of Standard Solutions for TRIZ beginners using MAR Operator**

*TriZit Benjaboonyazit (Thai-Nichi Institute of Technology, Thailand)*

The System of Standard Solutions is one of the powerful TRIZ tools for solving common inventive problems, but due to its complexity, it is difficult to understand and apply, especially for TRIZ beginners. This paper aims to simplify the System of Standard Solutions by investigating into the contents of suggestions in each standard solutions and compiling them into a user-friendly operator called MAR Operator. The MAR Operator consists of 3 suggestions for Modifying, Adding, and Replacing the component (substance and/or field) of the system with the purpose to generate ideas for improving the useful function and/or eliminating the harmful effect of the system. Case studies on wireless power transfer system for electric vehicle (EV) have been demonstrated to show its effectiveness in idea generation for solution concepts.

Keywords: TRIZ, Standard Solutions, Substance-Field Model, MAR Operator, Electric Vehicle

### **Statistic Study of an Alternative Way to Formulate a Pair of Engineering Contradictions so as to Seek for Solutions Which Satisfy the Contradictory Requirements of its Equivalent Physical Contradiction**

*Stéphane Savelli (MP Solving, Belgium), Oleg Feygenson (Samsung Electronics, South Korea)*

A systematic study of the inventive problems from the Altshuller book "And suddenly the inventor appeared", proves the statistical validity of the alternative formulation (actually two formulations) of a pair of engineering contradictions so as to seek for solutions which satisfy the contradictory requirements of its equivalent physical contradiction. A novel categorization of pairs of engineering contradictions emerges from this study and is related to the estimated usefulness of this alternative formulation.

Keywords: alternative problem formulation, pair of engineering contradictions, physical contradiction, satisfaction, statistical analysis, thinking pathway

### **Super-Effect Analysis**

*Sergei Ikoenko (Massachusetts Institute of Technology (MIT), USA)*

The paper presents a strategy and the approach to identification of super-effects.

Keywords: TRIZ, Super-Effect Analysis

### **Systematic Business Innovation: a Roadmap**

*Valeri Souchkov (ICG Training & Consulting, The Netherlands)*

Since 1956, TRIZ has been gradually evolving to bridge all sorts of gaps between systematic approach to innovation and technical creativity: from solving specific problems to systems analysis and forecast of future generations of technical products and technologies. In the early 1990s, the first attempts were made to use the core paradigm of TRIZ to explore if a systematic approach can be used for innovation within the areas of business and management. Although the number of such attempts have been considerably lower than within technology and engineering, the experience gained during past dozen of years of applying TRIZ to business and management helps with drawing conclusions which parts of TRIZ can be directly used in the areas of business and management, which parts still have to be adapted and what kind of new knowledge is needed to enable a systematic approach to business and management innovation.

Keywords: TRIZ, business and management innovation, systematic innovation.

### **Teaching, Learning and Applying TRIZ at University**

*Issac Lim Sing Sheng (Monash University Malaysia, Malaysia), Khoo Boon How (Multimedia Development Corporation (MDeC), Malaysia), Tan Eng Hoo (Malaysia TRIZ Innovation Association (MyTRIZ), Malaysia)*

This research proposes a new approach towards teaching innovation skills to university students. A new subject is developed using a proposed elements of innovation in education framework. The framework highlights the need of having a proven methodology and also the need for motivation behind the

process of innovating. All of the students are expected to develop a new conceptual innovation that solves a common everyday problem. TRIZ tools are taught to the students to complete the project. To motivate the students to do well, marks are allocated for their project. Besides that, a competition for their project is held at the end of the semester to motivate the students to do better than their peers. Their final exam is structured to test their knowledge of the TRIZ tools. In the pilot semester, first year 91 university students from technical and non-technical faculties enrolled in this subject. The outcome is the development of 15 novel and innovative concepts. Feedback from the students in regards of the subject's contents, delivery, and effectiveness is gathered through surveys. The average grade of distinction achieved by the students for their project and final exam signify the deep understanding of the theoretical and application aspects of the TRIZ tools.

Keywords: TRIZ, Education, Innovation Skills, New Concept Development

### **The Application of Bionics Combined with TRIZ Thinking in the Insulator Detecting Robot Design**

*He Xu, Baochao Zong, Wenlong Wang, Zhen Li, Peiyuan Wang (Harbin Engineering University, China)*

As two widely used methods and theories in the field of innovation design, Bionics and TRIZ have been achieved more significant results in multiple areas. But, they also have their limitations respectively. Firstly, the advantages and disadvantages of Bionics and TRIZ are analysed separately in this paper. Secondly, the creative thinking that combining Bionics and TRIZ is proposed, and a novel design process model is constructed based on Bio-TRIZ theory. Lastly, a new kind of insulator inspection robot was designed based on the design process model verified the effectiveness of the proposed model.

Keywords: Bionics; TRIZ; Combination of Bionics and TRIZ; Insulator Detecting Robot

### **The New Approach to Problem-Solving Algorithm**

*Sang-Ha Kim, Gwang-Seob Shin, Sang-Il Lee, Hak-Shon Han, Min-Soo Shin, Hyun-Soo Ahn (Hyundai Motor Group, South Korea)*

TRIZ includes a number of tools for problem-solving. However, it can be difficult to select properly a specific TRIZ tool, or a group of tools during a project for a beginner. We need a new approach in using TRIZ tools easily and quickly. Obviously, ARIZ is a systematic approach to solve inventive problem and a sequential process which is developed as an algorithm, but it requires a lot of time to master ARIZ to be used quite freely

This paper proposes a new approach to problem-solving algorithm to be used to select properly a group of tools for some types of problems.

Keywords: TRIZ tools, ARIZ, type of problem, Algorithm, systematic approach

### **The Way to Define the Goal of Problems**

*Youshin Han, Ahreum Lee, Sansung Park (LG Electronics, South Korea), S.A. Logvinov (R&BD Partners, South Korea)*

By using TRIZ, it is possible to solve a real problem after transforming the problem into an inventive problem. A solution would not be desirable, if a goal is not set well. In other words, by designing goal of the project properly, a well-defined problem which leads to desirable solution could be derived. TRIZ is powerful methodology to set an ideal goal with one of its concept ideality. The way to set a goal well and changes of solutions from different goals will be covered in this paper.

Keywords: Ideality, Ideal Final Result, Problem definition.

### **Trend of Transition of Engineering Systems to Microlevel Today and Tomorrow**

*Yury Danilovsky (QM&E / Gen3 Partners Korea, South Korea), Sergey Ikovenko (Massachusetts Institute of Technology (MIT), USA), Rajesh Menon (GILBARCO USA, India)*

The work is focused at almost 40-year history of theoretical content and practical use of the trend "Transition of systems to micro level" from the author of this term within the discipline of TESE G.S.Altshuller (1977 "On trends of engineering systems evolution") till the present day. Examples are shown, which illustrate the use of this trend in practical performance of actual projects, and hypotheses of filling this notion with new meanings are offered.

The essence of the hypothesis, which was set forth, is that the scope of observing this trend should include all phenomena, which are connected with the transition of ES to the zone of IT area, to which the authors applied the term Digital Embodiment of Function.

This format enables to more exhaustively use all new resources of engineering development, which appeared during the last 20 years, which are associated with the development of computer science, Internet and could be helpful in explaining such phenomena as Google, Internet of Things , Defensive computing , Cloud computing and other modern phenomena.

Keywords: substance, field, Digital Embodiment of Function, resources of engineering evolution

### **Trend of Increasing Virtualization**

*Alex Lyubomirskiy (GEN3 Partners, USA)*

This presentation focuses on introducing background and goals of Sub-trend of Value Increasing: Increasing Virtualization. The presentation is illustrated with examples and discusses applications, results, conclusions and next steps.

This contribution is available as presentation only.

### **TRIZ used in iCPA, a Tech Startup**

*Joseph Patrick B. Roxas (University of the Philippines, Philippines)*

This paper summarizes the process from ideation to implementation of a start-up company called iCPA. It was done by ideating the product using TRIZ Tools, forming a team to work on the product, and iterative improvement using voice of customers and voice of product. There have been three primary models: B to C model (free) – 20,000 users after 3 years, B to B model (revenue-generating) – 2 educational institutions in 2015, and B to G model (entrenchment) – collaboration with the Philippine Regulatory Commission. Once a critical mass is hit, this tool can cause disruptive innovation in education. The goal within 5 years is to have 30 million users.

Keywords: startup, education, platform

### **TRIZ Systematic Innovation Framework and Program to Support a Government Link Company's Innovation Policy**

*Mohd Sufian Abdul Karim (Universiti Tenaga Nasional, Malaysia)*

Innovation is an important agenda in Malaysia. The National Innovation Strategy and National Innovation Model set the direction and serves as guidelines with regards to innovation for individuals and organizations in Malaysia. Tenaga Nasional Berhad (TNB) is a government link company and has initiated an innovation policy to inculcate an innovation culture among its employees. This paper presents a TRIZ systematic innovation framework and program proposal that was submitted to TNB in a recent open innovation competition that was organized by the company to tap innovative ideas for it to consider in implementing its innovation policy. The proposal has been accepted by TNB as one of the top 20 innovation proposals from over 260 proposals that were submitted by employees in the TNB group of companies. The author has started a bottom-up approach based on the proposal to promote TRIZ to UNITEN students and employees in a number of TNB departments. Experience to-date has indicated that a top-down approach as in the proposal is necessary for an effective adoption of TRIZ by TNB employees.

Keywords: TNB, innovation policy, TRIZ, framework, program.

### **TRIZ, Qualimetry and Marketing: Three Different Approaches to Measuring the Competitive Ability of the Future Products**

*Alexander Priven (Corning Korea, South Korea), Garry Azgaldov, Alexander Kostin (Central Economics and Mathematics Institute RAS, Russia), Alexander Kynin (Russia), Yuri Danilovsky (QM&E / Gen3 Partners Korea, South Korea)*

Three areas of knowledge – TRIZ, qualimetry, and marketing, independently developed different approaches to determination of the common measure of competitive advantages of artificial products. In the paper, these approaches are compared with each other. The results of our analysis demonstrate that the approaches differ from each other in methods of obtaining the results but use nearly identical qualitative and even quantitative models. We performed the numerical evaluation (assessment) of three characteristics specified in these approaches: ideality (TRIZ), integral quality (qualimetry) and consumer satisfaction (marketing). The results demonstrate very strong correlation between all of these characteristics, which can be easily explained under the assumption that all of them are the measures of the same fundamental quantity: competitive ability of products. Correspondingly, we suggest measuring

at least two of them to make the estimates of the competitive ability more accurate, less biased, better reproducible and, finally, better predicting the characteristics of future innovations.

Keywords: ideality, integral quality, consumer satisfaction, competitive ability, kano, triz, qualimetry

### **TRIZ-Based Cause and Effect Chain Analysis vs Root Cause Analysis**

*Oleg Y. Abramov (Algorithm Ltd., Russia)*

This article represents a comparative study of the benefits and shortcomings of two analytical tools widely adopted in industry: Root Cause Analysis (RCA) tools and Cause and Effect Chains Analysis of disadvantages (CECA) that is used in modern TRIZ. Both RCA and CECA are aimed at identifying the deep underlying causes (called 'root causes' in RCA and 'key disadvantages' in CECA) of a target problem; both employ cause-effect analysis for this purpose, which sometimes leads people to think that these two approaches are essentially the same. There are, however, significant differences in how CECA and RCA are performed, which allow CECA to avoid the shortcomings of RCA and generally make it more robust than RCA. In this paper, the author is trying to highlight these differences and show the advantages of CECA.

Keywords: Cause and Effect Chains Analysis, CECA, key problems, Root Cause Analysis, RCA, root causes, TRIZ, TRIZ tools

### **TRIZ-based Innovative Concept Design of a Small Mobile Horizontal Axis Wind Turbine**

*Thursday Emmanuel, Zhao xin Jun (Northeastern University School of Mechanical Engineering and Automation, China)*

This paper presents an innovative concept design of a manual operated small mobile horizontal axis wind turbine. The wind turbine is designed specifically for remote and urban areas to reduce on current high costs of wind turbine components, onsite installation and improve on small wind turbine reliability. CAD models of manual foldable turbine blades, manual retractable wind turbine tower and wind turbine outrigger are designed in Inventor Autodesk 3D software and optimized using TRIZ inventive tools.

Keywords: TRIZ tools, concept design, mobile wind turbine.

### **Universal Unsolvable Problem and Process of Resolving It**

*Len Kaplan, SeHoon Cho (Samsung TechWin, South Korea), Eric Prévost (TRIZ France, France)*

What problems should we solve with TRIZ? The problems unsolvable with use of professional knowledge and expertise. Why problem becomes "unsolvable"? Due to incorrect formulation.

These understandings facilitated discovery of universal structure of unsolvable problem. Availability of such structure, in its turn, facilitated discovery of universal process of resolving the unsolvable problems. This process involves four problem-solving stages having same structure; each stage has its specific task. Shift from previous stage to the next one happens only if the previous stage could not produce the satisfactory solution.

Every problem-solving stage includes the following steps: collecting the information; analysis and formulation of Opportunities; idea generation; combining the ideas into Solutions; evaluation and selection of Solutions. Each stage requires minimum information about problem situation and minimum analytical work.

This process is successfully tested at Samsung TechWin and in a Manufacturing 4.0 innovation contest organized by TRIZ France/INSA CVL France & MDBA.

Keywords: TRIZ, problem-solving, unsolvable problem, problem-solving process, analysis, idea generation, solution, evaluation.

### **"Voice of Product" to Supplement "Voice of Customer"**

*Oleg Y. Abramov (Algorithm Ltd., Russia)*

This paper addresses a problem often experienced when generating product ideas. In particular, the ideas generated frequently do not yield successful products. One of the main reasons for this is that the voice of the customer (VOC) is the main input for generating and screening new product ideas. However, the VOC may incorrectly reflect customers' wants and needs, especially in the case of a truly novel product; that is, a product that has never before existed. The author is proposing to supplement the VOC with the more objective 'voice of the product' (VOP), which is derived using TRIZ tools, such as the Trends of Engineering Systems Evolution. The paper includes two brief case studies illustrating the

importance of using VOP.

Keywords: Idea generation; new product development; NPD; TRIZ, trends of engineering systems evolution; TESE, voice of the customer; voice of the product.

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