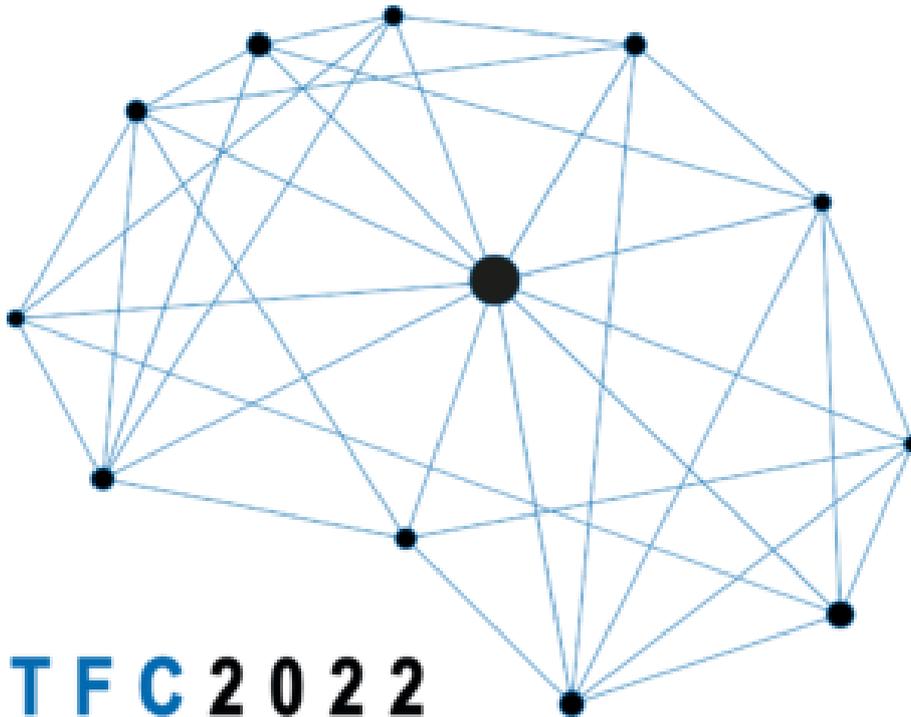


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## **Book of Abstracts**



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## Modular ideality for systematic segmentation

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**Abstract.** In modern developing world, there is a growing significance of the contradiction between versatility and ease of manufacturing. Products should exist in many user-centered variants, that are manufactured with the least resources possible. The purpose of this work was to formulate a novel method of modular design and assessment to improve design of multivariant products that undergo evolution of Main Parameters of Value. The proposed method represents a systematic approach in technical system segmentation, that is one of the 40 inventive principles in TRIZ. It is based on identification of system evolution and optimized selection of modules and connections between them. As a part of the method, a novel modular ideality parameter was defined that quantitatively describes segmentation principle in the scope of increase of the useful function, increasing versatility of a product with no to little harm to ease of manufacturing. This approach makes it possible to design multi-variant products that represent a systematic and structured application of a segmentation principle. The application of the methods was shown on an example of a Mobile Biogas Station. It was shown in the study, that modular ideality has an influence on ease of manufacturing and resources usage of multivariant product design.

**Keywords:** Modularity, TRIZ, Segmentation, Ideality.

## Combing TRIZ and LCA for a better awareness of the sustainability of a technical solution

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**Abstract.** A reflection about the evaluation of the environmental impacts arising from a technical solution obtained by applying some of the most common TRIZ (Russian acronym for Theory of Inventive Problem Solving) strategies is provided in this study. In fact, some of them provide suggestions to minimize the resources and make a device work better without adding additional substances or energy flows. However, the contained shortcomings for improving the environmental sustainability can only be fully understood only when applying a quantitative assessment such as Life Cycle Assessment (LCA). This was done in this study, by considering a selection of TRIZ strategies and collecting their pros and cons about environmental sustainability by applying LCA. To do this, the discussion of each strategy was supported by exemplary case studies about Comparative LCA, collected from the scientific literature. The intent of the authors is not to bring experimental evidence, but to provide a further and preliminary judging method to select the TRIZ strategies. In this way, problem-solvers can also base their choice on environmental sustainability.

**Keywords:** TRIZ; eco-design; Life Cycle Assessment (LCA)

## Mathematical Modelling and Formalization of TRIZ: Trimming for Product Design

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**Abstract.** This work aims to formalize TRIZ modelling framework and trimming techniques through mathematical notations to lay the foundations for rigorous analysis of TRIZ as a Science of Innovation. Mathematical modelling has been employed to formalize the heuristic models of trimming. A case study was presented to demonstrate the use of the proposed modelling scheme. The paper has demonstrated the correlation of TRIZ modelling framework and trimming techniques with well-established mathematical fields such as Formal Logic, Set Theory and Graph Theory. It presents initial efforts in formalizing the functional analysis and trimming techniques as a rigorous formal approach. The acceptance of systematic innovation as a scientific discipline that can be supported by knowledge systems and can be connected to mathematical models remains a dream. This work provides directions for inquiry into this non-trivial endeavour. The value of this work will see future computational models for supporting systematic innovation. The real-life use case demonstrates the powers and gaps with regards to Genrich Altshuler's modelling of product innovation using heuristics.

**Keywords:** Data Dictionary, Graph Modelling, Trimming Principles, Trimming Iteration, Semantic Invariant, Formal Logic, Set Theory, Graph Theory.

## Improving the TRIZ Creative Engineering Methodology to Take into Account the Notion of the Value of the Idea

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**Abstract.** Most of the time, the notion of the value of an idea, if not ignored by the company, seems to be established toward the end of the technical development of the idea during the resolution of a problem or in the final stages of the innovation management process for the development of products or services. Generally speaking, the birth of ideas with or without the use of creativity methods consists in the resolution of a technical problem, i.e., the technical aspect of the idea. This paper proposes an experiment using a creative process integrating a TRIZ approach and seeking to demonstrate that taking into account the notion of value, expressed by value proposition statements, in the evaluation of ideas for selection purposes influences the selection of the best idea that satisfies the client's needs, i.e., the value aspect, but neglects the technical aspect that the client expects. Currently, the TRIZ creative engineering methodology is used to solve mainly the technical aspect of a problem, among others the technical and physical contradictions of technological processes and technical systems. When using a TRIZ approach to find and discover solutions to a problem, it is proposed to associate the value aspect with the technical aspect of the ideas or solutions generated. Thus, in parallel to the search for solutions, be able to associate a set of value proposition statements also generated during the process.

**Keywords:** TRIZ, Problem solving, Notion of the value, Idea selection, Decision-making.

## TRIZ-based Remodeling of Body Enclosure for Corpse

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**Abstract.** This project started as an effort to gauge the epidemiological study for Road-Traffic-Accident (RTA). The data collected enabled us to make a Personalised product for management of the deceased. The deceased-on-site need to be handled with respect, compassion and safety in mind. For this purpose, a body bag is required. The nature of the death requires this body bag to work efficiently in various situations for example during accidents, arson, infectious disease death and other criminal acts. Currently the available body bag is a one-size-fits-all and at the same time the body bag poses a health hazard of exposure to harmful microorganisms for the forensic workers. This obvious contradiction suggests an inventive problem. The technical and physical contradiction in this particular problem allowed us to use TRIZ to better understand and discover a solution for the existing problem. Using TRIZ we were able to come up with Body Enclosure for Corpse (BEC). This product stands out as a solution for forensic workers and psychologically supports the family members of the deceased.

**Keywords:** Body Bag, Body Enclosure for Corpse, TRIZ

## **Eco-design Pilot Improvement Based on TRIZ and ASIT Tools**

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**Abstract.** Eco-design is a relevant research topic because of the need of powerful and confirmed systematic methods that can support companies in their efforts to develop green products within acceptable time and costs. Eco-design Pilot, developed by ADEME and Vienna University of Technology, is one of the tools that seeks this purpose. It proposes measures depending on the nature of the environmental impact of the product. However, the assessment phase of the measures proposed by this tool is both subjective and does not stimulate the development of creative solutions. To overcome this major drawback, this paper seeks to rely on TRIZ and ASIT tools to better assess the proposed measures and develop creative ideas within a new framework for Eco-design Pilot measures assessment. This framework has been tested first on the Eco-design Pilot Improvement Objective and Strategy “Reduction Packaging”. As result, 31 realization ideas, that could be used by packaging designers in green context, have emerged from this application. A non-exhaustive research on packaging industry practices has shown that some realization ideas have already been applied to produce innovative solutions. In perspective, we will discuss other Eco-design improvement objectives and strategies in a quest for the framework generalization.

**Keywords :** Eco-design, Eco-design Pilot, TRIZ, ASIT, Reduction Packaging

## Using NLP to Detect Tradeoffs in Employee Reviews

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**Abstract.** This paper presents a methodology to identify industry-specific tradeoffs using natural language processing (NLP) to analyze employee reviews from Glassdoor. The analysis is based on 400,000+ reviews from employees working in the financial sector between 2008 and 2020. For each review, the pros and cons sections are classified in a one-to-many approach in terms of the most prevalent topics in the sector. The most prevalent noun chunks within a representative sample of reviews are used as topics. The classification of reviews is based on the cosine similarity between the sentence embeddings of these topics and the sentence embeddings of the comment sections using a sentence-transformer model. Based on this classification, the count of pro-con topic pairs is tested for statistical significance against a control of randomly generated pairings from the same sample of classifications. The process is repeated 10,000 times and only pairs with a p-value  $< .05$  (after Bonferroni-Holm correction) are considered. If both, a pro-con pair of topics and its opposite pairing are significantly frequent, this combination of topics qualifies as a tradeoff. Depending on whether the same pairing constitutes a significantly frequent pro-pro pair, it can be determined whether a solution for the tradeoff exists in the sector (at least within the limitations of this approach). Using 13 topic labels, 2 tradeoffs – *work-life balance vs. opportunity* (without solution in the sector) and *work-life balance vs. management* (with solution in the sector) – have been identified. In addition to that, 8 more pro-con pairs were identified as significant.

**Keywords:** Tradeoffs, Glassdoor, Employee reviews, Natural Language Processing, Machine Learning.

## TRIZ-based Approach in Capturing and Managing Indigenous Innovation and Knowledge

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**Abstract.** Indigenous people who are still connected to traditional lifestyles and are living closely in touch with nature's patents, remain custodians to vast treasures of knowledge. The ability to tap on indigenous inventions can be useful within a contemporary context in providing insights to help solve emergent problems such as global warming and climate change. This research focuses on exploring ways to capture this implicit and tacitly held knowledge among these remote indigenous communities of Sarawak, Borneo. Engaging with the local community in exploring the immense challenge requires a participatory model for eliciting innovative expressions across time and space boundaries. Mechanisms to associate such discovered knowledge within the context of current scenarios requires a standard framework for achieving the alignment. In this paper, a TRIZ-based framework for connecting to and mapping these past innovations has been proposed. The 40 inventive principles of Genrich Altshuler has been adopted as a means of bridging knowledge gaps and connecting the diverse knowledge forms. The collection of customized TRIZ instruments served as a collaborative visual knowledge mapping framework for acquiring and organizing knowledge for local indigenous communities. This study has demonstrated the ability to unlock tacit knowledge amongst community knowledge-custodians living in remote and isolated communities. The 40 Inventive Principles served not only as an index for innovative expressions but also as a good platform for these communities to make systems innovation as a way of life, and also to acquire expertise from external sources. The continuing efforts in knowledge-based activities has a potential for expansion to be used by other communities. Despite the initial challenges where there was a need to address language and intergenerational gaps, the proposed model has also demonstrated interest amongst youths to connect to their roots and share the past inventive moments with community elders.

**Keywords:** TRIZ, indigenous inventions, knowledge-based innovation, knowledge acquisition and knowledge representation.

## The potential of creative methods for IT project management

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**Abstract.** IT support is now one of the key elements in the competitive advantage of almost every organization. Hence, the IT project management has started to play an increasingly important role. Therefore of concern is the observed low percentage of successful IT projects and use of IT systems functionality in organizations. Business expects more and more flexibility and innovation from the IT sector. Solutions not supported by creative techniques will not be satisfactory for the recipient. Although there is a proven positive correlation of creativity with effective project management, overall organization performance and client satisfaction, there is no detailed research in the literature on the actual use of creative methods by IT teams in project management. The research undertaken combines the area of IT project management with creative methods. The article presents the results of the study of IT teams in the Polish SME sector in the field of their knowledge and experience in the application of creative methods in IT project management. Experimental research allows an assessment of the potential and effectiveness of selected creative methods in the IT project management and an indication of the areas of their application in the project life cycle.

**Keywords:** IT project management; creativity; TRIZ; problem solving; innovation.

## Innovation Portfolio Management: How can TRIZ help?

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**Abstract.** Prioritising the right innovation projects is necessary for effective strategic roadmaps and portfolios in a dynamic market with ever-increasing resource constraints. Innovation portfolio management is a process that informs decision-makers to help them focus and prioritise innovation projects to capitalise on their investments. On the other hand, the applicability of TRIZ in management is an ever-growing area proving its systematic and scientific capabilities. This paper builds on the foundation of expanding TRIZ and identifies several opportunities for TRIZ tools in the innovation portfolio management process. The study extracts data from the scientific literature to study innovation portfolio management as a process to find two distinct approaches to innovation portfolio creation: Emergent and deliberate innovation portfolio processes. The study investigates the pros, cons and gaps in these processes to potentially strengthen them with modern TRIZ tools. The research explores and explains which TRIZ tools can enhance the output of innovation portfolio management. This research finds TRIZ tools such as Main parameters of Value analysis, function analysis, S-curve analysis, Trends of evolution, contradiction analysis and quantum economic analysis critically benefit the portfolio process and can provide better innovation portfolio outputs through new unexplored insights.

**Keywords:** Innovation portfolio management, TRIZ, Innovation Management.

## Modeling IT systems in TRIZ

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**Abstract.** Today's world extensively uses Information Technology (IT) and heavily depends on IT systems. The evident and justified need to model IT systems in TRIZ projects faces some doubts or objections because the fundamental concepts of classic TRIZ were formulated before computer times. This paper aims to analyze terminology and guidelines regarding Function Analysis for products and Flow Analysis in the context of modeling IT systems and devising necessary adjustments so that components like hardware, software, and data may be modeled consistently.

We describe the approach taken and introduce a minimal complete IT system using the TRIZ approach, with a detailed description of components and functions supported by examples of IT systems. A conceptual perspective allowing for uniform modeling of mechanical and IT systems is intended to alleviate the problems of trainers and practitioners encountered in this area and increase TRIZ acceptance in the IT industry and IT communities.

**Keywords:** TRIZ, Function Analysis, IT systems, Hardware, Software, Data, Flow Analysis, Information Technology Modeling, IT Modeling.

## Modeling Software in TRIZ

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**Abstract.** Although many papers have been published in the past on the use of TRIZ in the field of Information Technology, questions still arise as to whether the TRIZ methodology is also suitable for software as purely intangible systems.

Doubts remain because the methodology was developed at a time when patents for IT and software systems, in contrast to physical products, could not yet be considered in the underlying patent analysis.

Because of these questions, this paper examines the transferability of the TRIZ methodology to software systems on the basis of two fundamental TRIZ concepts: the Law of System Completeness and the Function Analysis for Processes.

After an introduction regarding the immaterial nature of software systems, the transferability of TRIZ concepts to the software domain is shown with the help of case studies and ends with an outlook on possible further additions to the conceptual mapping of TRIZ to the software domain.

**Keywords:** TRIZ, Software, Information Technology, Function Analysis for Processes, Function Modelling for Software, Software Development.

## Inventive principles extraction in inventive design using Artificial Intelligence methods

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**Abstract.** Today, companies are seeking effective approaches to improve their innovation cycle time. Among them, it is possible to mention Inventive Design Methodology (IDM) as a TRIZ-based systematic inventive design process. However, the application of this approach is time-consuming due to requesting a complete map of a problem situation at the initial phase of the inventive design process. To solve this drawback, the Inverse Problem Graph (IPG) method has been developed to increase the agility of the process. Nevertheless, authors of IPG did not mention how the designers could achieve the innovative solutions by using the formulated problems. The purpose of the research presented in this article is to integrate the doc2vec method and machine learning text classification algorithms as Artificial Intelligence methods into the IPG process. This integration helps introduce an automatic approach for the inventive design process, helping to formulate the contradictions among TRIZ parameters in the contradiction matrix and extract the inventive principles in their intersection. The capability of the proposed methodology is finally tested through its application in a case study.

**Keywords:** Inventive design, TRIZ, Text classification, Document embedding, Artificial Intelligence.

## AI based Patent analyzer for suggesting solutive actions and graphical triggers during problem solving

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**Abstract.** This paper proposes an idea for developing a computational model of creative processes in design. This model facilitates and accelerates idea generation in the inventive design, increasing the solution space definition by suggesting technical actions and graphical triggers.

The problem solver has to state the required design objective using any verbal action, then an automatic system generates an appropriate set of triggering actions indicating different ways of accomplishing that goal. In addition, for each verb is associated a list of evocative images indicating how that action can be implemented in space/time and through specific physical effects. The system is capable of handling the huge number of verbs that the English language offers. To select all functional verbs of the technical lexicon, the patent database has been processed using the most advanced text mining techniques. Among them, a customized version of Word2Vec model has been exploited to learn word/actions associations from a large corpus of patents.

The article explains how the libraries have been created, the progress the software prototype and the results of a first validation campaign.

**Keywords:** CAI - Computer aided inventing, Cosine similarity, problem solving, creative trigger, TRIZ, AI.

## VA++ - the Next Generation of Value Analysis in TRIZ

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**Abstract.** Around twenty years ago, two methods relevant for systematic innovation and improvement - TRIZ and Value Analysis - have been merged in a specific way, which was then incorporated in software packages about innovation and became part of certified TRIZ education as well. An intended key purpose of this nowadays established method of Value Analysis in TRIZ is to identify system components of low ideality - or value, respectively -, i.e. parts of the system, that do not give a satisfactory functional contribution in relation to their cost. Hence, Value Analysis should point out the sweet spots for subsequent improvement, innovation or even patent circumvention activities. Unfortunately, the commonly used standard approach for Value Analysis in TRIZ, which is based on a function ranking algorithm, leads to results, that are inconsistent and not trustworthy in general. This work illustrates these shortcomings and explains their origins. Derived from key requirements necessary for a meaningful concept, VA++, a new advanced approach for Value Analysis in TRIZ, is presented and validated.

**Keywords:** TRIZ, Value Analysis, Systematic Innovation, Function Analysis, Function Ranking, Ideality, Algorithm, CAI, Trimming.

# Development of an Ontology of Sustainable Eco-Friendly Technologies and Products Based on the Inventive Principles of the TRIZ Theory (OntoSustIP) – Research Agenda

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**Abstract.** Rising societies' demands require more sustainable products and technologies. Although numerous methods and tools have been developed in the last decades to support environmental-friendly product and process development, an interdisciplinary knowledge base of eco-innovative examples linked to the eco-innovative problems and solution principles is lacking. The paper proposes an ontology of examples for eco-friendly products and technologies assigned to the Inventive Principles (IPs) of the TRIZ methodology in accordance with the German TRIZ Standard VDI 4521. The examples of sustainable technologies and products build a database for sharing and reusing eco-innovation knowledge. The ontology acts as a tool for systematic solving of specific environmental problems in typical life cycle phases, for different environmental impact categories and engineering domains. Finally, the paper defines a future research agenda in the field of the TRIZ-based systematic eco-innovation.

**Keywords:** Sustainability, Eco-Innovation, Eco-Design, Knowledge-based Innovation, Ontology, TRIZ.

## Market Impact Chain Analysis - MICA, new TRIZ tool

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**Abstract.** In case when we have a key disadvantage that stops us from achieving the goal, we know what to do. But in situation when we have a key positive feature, this is not obvious how to proceed. This work is trying to start a discussion about this direction using a TRIZ toolbox. From many possibilities it looks that none of them is not a perfect choice.

In TRIZ there are many tools that use the opposite state as a source of new, creative ideas. The author just builds a hypothesis that something should exist as a mirror tool compared to CECA (Cause and Effect Chain Analysis). The base, starting point will be not a disadvantage but a unique, positive feature that will be used for creation of marketing message. All those results should pay off in the future and make a stronger position company on the market.

The present work is only a proposal on how to deal and fulfill the gap in the very narrow area – transfer features into benefit language.

Better understanding purpose decision of buying from perspective specific features and parameters of existing products or services will be another strong advantage for using TRIZ by wider spectrum on clients.

**Keywords:** CECA, MICA, feature, benefit, marketing, value, marketing, TRIZ.

## TRIZ-based Approach in Co-creating Virtual Story-maps

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**Abstract.** TRIZ based models are particularly instrumental in formulating knowledge-based solutions in a variety of areas. The knowledge engineering capacity gained by systematic approaching problems according to the TRIZ structuring and modelling of problems, enables a powerful mechanism for drilling into the core conflicting or operating zone of the problem. This research then explores the knowledge engineering capacity of TRIZ to enable inventive solutions to solve even complex socio-technical problems. This paper presents a TRIZ-based methodology in the participatory design of shaping community-based virtual tourism programmes for indigenous communities living in the highlands of Borneo. In this paper, we demonstrate digital story-maps as a platform for unlocking tacit knowledge and giving indigenous communities a capacity to promote the uniqueness of their culture and heritage. Based on the initial TRIZ based framing of the problem, the use of digital story-maps has given rise to a systems-approach that has managed to bring out untold stories. These models have also supported the characterization of parameters of the virtual story-map solutions.

**Keywords:** TRIZ, Virtual tourism, Story-maps, Indigenous knowledge-base, Inventive principles

## **Bridging Two Different Domains To Pair Their Inherent Problem-Solution Text Contents: Applications to Quantum Sensing and Biology**

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**Abstract.** The multifaceted purpose of this study is to explore the potential of fusing quantum sensing with bioinspired-based principles toward efficient solutions aiming to amplify innovation. The morphological, functional, and biochemical parameters of the biological retina, integrated with parallel and decentralized vision-sensing architectures coupled with neuromorphic computing and polarization principles, would yield unparalleled new-generation domains of knowledge. This paper exposes a roadmap for such a research and investigates how various techniques from Artificial Intelligence could pave the way of a future where TRIZ, assisted with AI, could accelerate innovation.

**Keywords:** Biomimetism; TRIZ; Neuromorphic; Contradictions; Artificial Intelligence.

## Inventive Design Solutions for the Complex Socio-Technical Problems in Preserving Indigenous Symbolic Visual Communication

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**Abstract.** Visual symbolic communication systems such as emojis are increasingly important to facilitate casual communications and spontaneous information exchange in our daily lives. However, the use of such systems poses dangers to the preservation of local visual symbolic languages as practised by many indigenous and culturally rich local communities. This research aims at developing a local cultural value-based visual communication system for indigenous people in the Malaysian Borneo state of Sarawak. The design of such systems requires systematic analysis and identifying the core issue in solving complex socio-technical system problems. Meaningful engagement with different community levels, the sustainability of local knowledge, and cultural values were the primary considerations in designing a culture-preserving model. By utilising the Law of System Completeness of TRIZ, and the engagement of the interaction of supersystems, a conceptual model that can map and analyse indigenous symbolic visual communication systems was developed. This modelling approach has provided numerous insightful ideas for transforming global communication approaches to be sensitive to the cultural needs of indigenous communities.

**Keywords:** Indigenous Knowledge Communication System (IKCS). TRIZ. Law of System Completeness. Information Communication Technology for Development (ICT4D).

## Automated TRIZ domain mapping

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**Abstract.** The automatic analysis of patents is still one of the main challenges in R&D, particularly in terms of establishing automatic states of the art. Indeed, this is still mostly done manually, which is very time-consuming. The progress of artificial intelligence allows us to go a step further in the understanding of patents and in particular of the issues they address. In this paper we present an end-to-end tool that allows us to map the main trends in term of research directions in a sector in a few minutes from a simple keyword search. To do so, we will rely on TRIZ formalization with contradictions and evaluation parameters.

**Keywords:** Domain Mapping, TRIZ, Deep Learning.

# Adoption of Artificial Intelligence in Romania: Innovative Policies to Overpass Vulnerabilities with TRIZ and Deep-Thinking Tools

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**Abstract.** Adoption of artificial intelligence (AI) in all aspects of society and the economy is a major desiderate at the EU level. Nevertheless, this demarch is influenced by a series of contexts and endowments, such as talents, sophistication, and specificity of the business models, maturity of public processes, social mindset, etc. This paper analyzes opportunities and threats associated with AI adoption in Romania, possible measures to improve the predicted outcome together with lessons learned at the global level. The research methodology includes analysis of the current situation and formulation of innovative solutions to overpass various barriers and constraints. Based on TRIZ and deep-thinking approaches we formulate novel policies to overpass the status of evolution and create a new foundation for AI development and adoption in the Romanian ecosystem, with implications at the EU level. TRIZ and the deep-thinking systematic approach reveal several healthy patterns of evolution to deviate the current course of actions toward better results and outcomes. Critical findings relevant to AI at the EU level are also underlined in relation to the conclusions at the national level.

**Keywords:** Artificial Intelligence, Public Policies, TRIZ, Deep Thinking, Critical Analysis.

## Using MBSE for conflict managing TRIZ on a systems engineering level

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**Abstract.** The objective of the presented research is to find a method to identify and resolve high level conflicts with TRIZ applications in systems engineering on a parameter level. These conflicts are caused by several competing TRIZ problem solving patterns (innovative principles) on lower system levels. Here, interference parameters result from the physical adoption of the general innovative basic principles in a specific application context (e.g. vibration, heat, additional energy consumption). To manage these conflicts on a parameter level, the system engineering point of view is matched with the physical parameter level in the engineering design of a product. Within an experimental research approach, an exemplary MBSE system model of a technical device is used to resolve parameter conflicts on a higher system level. The conflicts only arise on a higher system level consideration, which makes computer-aided conflict identification essential to design engineers. The presented method does help system engineers to foresee conflict potentials of innovative principles on a system level and to control them accordingly using a MBSE system model approach.

**Keywords:** MBSE, Systems Engineering, Systematic Innovation, Methodology, Engineering Design.

## Hypotheses analysis as a development of the System Operator method used in TRIZ

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**Abstract.** The purpose of this work was to formulate a novel method of problem definition and to apply this method as an extended version of the System Operator. In TRIZ, System Operator is used to describing context of the problem in time and space, which is of vital importance in many problem-solving approaches and forecasting applications. However, this known method concentrates on a single technical system and its alternatives and does not take into account other systems, that directly interact with each other. The proposed approach takes into consideration not only sub- and supersystems in the past and future but also the outcome of the problem and phenomena occurring in relation to the identified problem. The method is organized in a systematic way through a dedicated diagram and also utilizes a heuristic approach to identify and describe the context of a problem. The proposed method was applied to identify drivers and barriers to the development of vehicles and biogas distribution solutions. It was shown, that the proposed approach represents a significant and novel development of a System Operator that improves problem definition in the problem-solving approach.

**Keywords:** System Operator, TRIZ, Problem-solving, Inventive Engineering.

## TRIZ Training Within a Continuous Improvement (Kaizen) Event – Exploration and Evaluation

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**Abstract.** This paper discusses the implementation and evaluation of an online-based TRIZ training that was simultaneously conducted within a Kaizen (continuous improvement) event. The purpose of the training was to introduce and show the application of TRIZ tools using a real problem that was undertaken as part of the Kaizen exercise. The problem was a software related problem. The TRIZ tools that were presented in the training were Situational Analysis (SA), Functional Modelling (FM), Cause and Effect Analysis (CEA), Substance-Field (SF) Analysis, 40 Inventive Principles, Patterns of Evolution and Function Oriented Search (FOS). The research questions investigated were: 1) *Can combining a TRIZ training within a Kaizen event which was conducted online, result in an effective training session?* and 2) *Which TRIZ tools that were presented during the event were perceived by the participants to be the most useful and which ones were the least useful when delivered in this manner?* It was found that embedding the TRIZ training in the online Kaizen session was well-received and considered effective. It was identified that participants in the study prefer TRIZ tools that assist in problem identification. Areas of improvements were also sought from the participants' responses. The study has implications for organisations wishing to develop in-house TRIZ training.

**Keywords:** TRIZ training, engineering professional development, kaizen, problem solving, self-efficacy, evaluation, action research, online training.

## TRIZ Training in Pandemic Time

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**Abstract.** Pandemic time forced us to change our life. Suddenly we faced many new problem to solve. One of them was the following contradiction: we have to stay isolated and we have to continue our activities. In case of lectures and training it seemed to be quite easy: go online. The Internet is available almost everywhere and it offers many opportunities to teach/to learn while remaining at home. Unfortunately, many things went wrong and many students and teachers soon started to dream to come back to face-to-face classes. The article is a case study based on own experiences of remote training, which have been highly rated by participants. It is a practical example of using TRIZ at TRIZ training, a suggestion which TRIZ tools are useful at teaching online and explanation how we use them in our everyday practice.

**Keywords:** TRIZ, Training, Online, Communication, Experience.

## **WTSP Report (5) Catalogs of TRIZ and Around-TRIZ Sites in the World: We Can Learn Full Scope of TRIZ-related Works in the World**

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**Abstract.** World TRIZ-related Site Project (WTSP) is a volunteer-based international project working to build Catalogs of TRIZ and Around-TRIZ Websites in the World. It aims at creating a reliable information resource in the field of Creative Problem Solving Methodologies in general. We collect good websites widely and list the selected ones with brief or close annotations in categories. Starting in Dec. 2017, we built the Beta Edition of World WTSP Catalogs in 2020, which have good maintainable and extendible structure. We select websites using multi-aspect criteria, and grade them in 5 levels as: ☉ top about 30 sites, ○ next about 100, □ worthy in World Catalogs, △ worthy in Country Catalogs, and — not listed. We have recently re-visited the Around-TRIZ websites obtained by Internet surveys in 2019, and revised the Basic Catalog (with 30 ☉ sites and 143 ○ sites) and newly built the Extended Catalog (with 244 □ sites). On the other hand, WTSP World Catalogs of TRIZ Sites have been updated very little from the Beta Edition (with 23 ☉ sites and 39 ○ sites), while waiting for contributions of manuscripts from individual countries. We carried out Internet surveys of TRIZ sites in 52 individual countries, and detected 1200+ sites. For 40 (less active) countries of them, we selected 103 □ sites and 43 △ sites. For 12 other countries (including 6 TRIZ-active major countries) we detected 480 sites but not investigated them yet while knowing there must be many good TRIZ websites. Anyway, WTSP World Catalogs already have abundant reliable information of selected websites, and are certainly helpful for many professionals and users to study and apply TRIZ and Creative Problem Solving Methodologies in general.

**Keywords:** WTSP Project, World Catalogs of TRIZ Sites, World Catalogs of Around-TRIZ Sites, Guide to Good Websites

## Analyzing the Role of Human Capital in Strengthening National Innovation System through University-Industry Research Collaboration: A TRIZ-Based Approach

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**Abstract.** University-industry research collaboration (UIRC) is seen as a key measure in formulating national-level indicators of research and innovations and economic growth. Despite the extensive availability of shreds of evidence indicating the importance of such areas of collaboration in developed and developing countries, existing literature on the strengthening of the National innovation system (NIS) via UIRC is still scarce. Literature has highlighted the impact of human capacity as having a strong influence on researchers' innovative activities as well as on the NIS. Moreover, in strengthening the NIS, it is considered mandatory to model human capacity, specifically, in the aspects of universities- industries personnel. In this paper, we explore the usage of the TRIZ thinking models together with the adaptation of its toolkit to shed insights on the influence of human capacity on NIS. Using the TRIZ heuristic modeling paradigm, a systems model of human capacity and its significant influence on NIS has been demonstrated. Thus, the findings of this research suggest the tremendous potential of employing TRIZ as a systems modeling tool for explorative analysis of intangible outcomes. The potential of using TRIZ as an explanation module for systems thinking will be a game-changer for knowledge-based modeling of national innovation systems.

**Keywords:** University-Industry Research Collaboration, National Innovation System, Human capital, Theory of inventive problem solving (TRIZ) approach.

## Exploitation of causal relation for automatic extraction of contradiction from a domain-restricted patent corpus

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**Abstract.** Altshuller contradiction matrix is one of the most popular tools among TRIZ practitioners, especially beginners, due to its simplicity and intuitive design. However, scientific and technological progress induces the constant appearance of new scientific vocabulary, which lower accuracy when using this static tool from the end of the sixties. Some attempts to rebuild the matrix or update it has been made within the past four decades but without any successful legitimation due to the lack of scientific proof regarding its relevance. Our recent findings in the use of Natural Language Processing (NLP) techniques allow the creation of a methodology for automatic extraction of the necessary information for establishing a domain-restricted contradiction matrix. In this paper, we relate a technique that exploits the internal language semantic structure to mine the causal relation between terms in patent texts. Moreover, the subject or domain restriction for a patent collection allows observing the links between extracted information at the over-text level. Such an approach relies on inter-and extra-textual features and permits a real-time extraction of contradictory relations between elements. These extracted elements could be presented in matrix form, inspired by The Altshuller contradiction matrix. We postulate that such a representation allows the construction of a state of the art in each domain, which will facilitate the use of TRIZ to solve contradictions within it.

**Keywords:** TRIZ, NLP, contradiction matrix, text-mining, automatic extraction

## Systems, Resources, and Systemic Development in TRIZ

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**Abstract.** In TRIZ theory, resources play an important role when it comes to operate a systemic solution. It is only in this phase that the resource identified in the detailed solution plan as “any type of tangible or intangible matter that can be used to solve an inventive problem” must prove itself in practice. Conceptual distinctions such as “role definition” and “role occupation”, which are central for the management of human resources, play only a subordinate role in the TRIZ resource conception. In this paper, the close connection of the terms resource and component with systemic operating conditions is analysed in more detail and it is shown which influence, for example, the management and reproduction of scarce resources has on systemic development processes in a supersystem. The resulting questions are compared with corresponding theoretical approaches from component software in order to work out the significance of higher-level abstraction concepts such as component models, component architectures or middle-ware.

It is proposed to bundle these overarching questions of the interplay of independent third parties providing resources in the huge real “world of technical systems” and thus constituting resource management structures in a new area *Resource Management Analysis* in the TRIZ theory corpus.

**Keywords:** systemic approach, resource, operating conditions, place and content, interfaces, component models.

## Integration of TRIZ methodologies into the digital product development process

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**Abstract.** Iterative and waterfall software development processes such as V-model or UP (unified process) are widely used in project development. Nevertheless, modern Agile methodologies are aimed to reduce risks and achieve more predictable results in the digital world. Despite the difference between them, the software development life cycle splits into specific deliverables by breaking a project into smaller segments where the TRIZ toolkit can be effectively applied. Application of the TRIZ theory and core techniques can be valuable for new ideas generation and decision-making process at any point of product development from business model development and product vision definition to user experience design, implementation, and go-to-market strategy. As a result, the product quality grows, continuous delivery is accelerated, and new features are introduced to the final user in a more operative manner. The goal of this article is to demonstrate how TRIZ methodologies integration empowers software development for new products release and continuous improvement.

**Keywords:** TRIZ, Product Design, Product Management, Product Development, Digital Product

## Eco-Feasibility Study and Application of Natural Inventive Principles in Chemical Engineering Design

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**Abstract.** The early stages of the front-end process development are critical for the future success of projects involving new technologies. The application of eco-inventive principles identified in natural systems to the design of chemical processes and equipment allows one to find ways to mitigate or avoid secondary ecological problems such as, for example, higher consumption of raw materials or energy, generation of hazardous waste and pollution of the environment by toxic chemicals. However, before implementing a new technology in a real operational environment, it is necessary to completely investigate its undesirable ecological impact and to evaluate the future viability of this technology. Therefore, the research paper presents a study of ecological feasibility of an innovative process design utilising natural eco-inventive principles and analyses the correlations between applied inventive principles. Such eco-feasibility study can be considered as an important decision gate to determine whether the technology implementation should be moved forward. Furthermore, the study evaluates the practicability of natural inventive principles to the eco-friendly process design and is illustrated with an example of a sustainable technology for nickel extraction from pyrophyllite.

**Keywords:** Eco-inventive Principles, Nature-inspired Innovation, Feasibility Study, Chemical Engineering, Process Design, TRIZ

## Analysis of Tools Used for Implementation of a Knowledge Base Based on an Ontology for a Service Robot in a Kitchen Environment

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**Abstract.** The work presents the process of systematic invention in relation to the design of a robot companion component. The component is responsible for knowledge management in the kitchen environment and its automatic use. Based on the TRIZ method, in particular the Contradiction Business Matrix 3.0, the Inventive Principles are listed. Then, an analysis is carried out regarding potential tools for the implementation of inventive principles. The results of the analysis carried out on the KnowRob and Armor tools in terms of: documentation quality, difficulty of installation, usability and performance. The analysis was carried out to determine the superior tool in knowledge processing for robots. KnowRob is a popular tool in this area. Armor is a young and interesting tool with a potential to become widely used. These kinds of tools need to respond quickly and guarantee reliability. For this purpose, installations and configurations of both environments were performed and documented. Then, a set of queries in Prolog and SPARQL were prepared and tested. The ontology used in testing is based on Web Ontology Language (OWL). Our findings indicate that KnowRob is the superior tool in the tested areas.

**Keywords:** Knowrob · Armor · Owl · Robotics · Ontology

## **Focusing the first phase – an interdisciplinary approach to modeling an interactive system on the Use-Case Indoor-Blind-Navigation**

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**Abstract.** Concepts such as “resource” or “system” pose a challenge when it comes to adapting to the context. So the main problem is to adapt the concepts and the development process to the requirements of the users. The user is not only the methodological foundation of the concepts, but also a resource and a component of the system. Therefore, the initial phase of the development process becomes crucial. In order to explore the basic requirements of the product and the requirements of the potential use, it is necessary to combine several methods for interactive modeling. By linking qualitative research methods and formal iteration processes, new insights are generated. For handling the complexity of the problem, the experiences of AppPlant, Gräbert GmbH and a team at Leipzig University are applied. The project “Outdoor and Indoor Navigation for Blind and Visually Impaired People” (IBN) combines systems research with the application of social methods to improve successful human-machine interaction. The developed solution is based on the term “interactive system” of ISO 9241-11 as a methodological starting point. The key concept for an interactive system is usability, which describes the extension to “which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”. In order to focus on user requirements, the iterative approach of Design Thinking, TRIZ Modeling and Mixed Methods of social sciences were combined.

**Keywords:** Human-machine interaction, design thinking, qualitative research, Outdoor-Indoor-Blind-Navigation, TRIZ and requirements analysis

## Lean and TRIZ for improving the maintenance process

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**Abstract.** Maintenance plays an essential role in the progress of an organization. In order to achieve excellent performance, maintenance strategies must be linked to manufacturing strategies such as Lean. Based on the available data, this paper provides an understanding of the existing research related to the use of Lean and TRIZ within the maintenance process. In order to identify the need for further research in this area. The objective of this paper is then to answer the following question: How can Lean and TRIZ improve the maintenance process? To do this, we focus mainly on the analysis of previous work where TRIZ tools or Lean manufacturing methods have been used individually to improve the maintenance process. The results of previous studies were analyzed and then the main problems that were detected in the previous literature were identified.

**Keywords:** Lean manufacturing, maintenance, TRIZ, Lean maintenance, process.

## An Interactive Artificial Intelligence System for Inventive Problem-Solving

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**Abstract.** There is a vast space of potentiality for inspiration in the design and engineering of technical systems that are poorly valorized; the cyberspace that stores and daily adds high volumes of global collective intelligence. This space could be more productively tackled with the assistance of Artificial Intelligence algorithms led by Natural Language Processing (NLP) models. We investigate the application of Structured Activation Vertex Entropy (SAVE) method in combination with Question Answering Machine (QAM) algorithms to explore information that is stored in big datasets, accessible within unstructured dataspace. The SAVE method is transformed with the assistance of TRIZ into a set of searching meta-terms or meta-concepts. Taking off from a clear description of the problem, target results, and the current (eco)system, meta-terms, and concepts are incorporated into a spiral searching-answering process called 'D-SIT-SIT-C', driven by a Retrieval Augmented Generation (RAG) model to create an “intelligent” Natural Language Processing pipeline, with inserting the human in the loop at each iteration. We have found that the proposed pipeline based on a RAG model brings new valences to the creative thinking process and unleashes new dimensions of investigations that lead to higher quality solutions than those formulated with limited resources.

**Keywords:** Artificial Intelligence (AI), Natural Language Processing (NLP), Question Answering Machine (QAM), Deep Learning (DL), Theory of Inventive Problem Solving (TRIZ), Structured Activation of Vertex Entropy (SAVE), Retrieval Augmented Generation (RAG), Humans in the Loop (HL), Interactive AI Systems

## **Open Inventive Design Method (OIDM-Triz) approach for the modeling of complex systems and the resolution of multidisciplinary contradictions. Application to the exploration of innovative solutions to deal with the climate change impacts**

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**Abstract.** This paper aims to propose an approach for Open IDM-Triz oriented analysis for complex systems.

We propose an approach to model a complex system involving multiple points of view. In this way, a complex system is modelled by a meta-graph that is built using partial knowledge graphs based on the viewpoints of the different stakeholders and users around the complex system.

This work is also a contribution for resolving non-conventional pluridisciplinary contradictions by extending the limits of classic Triz patents databases which is mainly focused on technical aspects.

Thereby, we propose an approach to extend IDM-Triz solutions concepts exploration area by using web-scraping and AI reasoning to search for similar contradictions. These approaches are implemented in a TrizAlerts software that scans various databases and websites to find out ideas matching given contradictions.

Our Open IDM-Triz approach is applied in the Interreg Clim'Ability Design project, to analyze the climate change impacts on the activities that usually manifest themselves in multiple ways.

By applying the Open IDM-Triz approach to the "Low Water" issue, we are moving away from the classical application domain of Triz because of the context extended to a multi-scalar territory corresponding to a complex system of actors impacted by climate change.

The study is carried out by a multidisciplinary team made up of researchers from engineering and social sciences backed by a network of companies involved in logistics on the Rhine (institutional, shippers, operators, etc.).

**Keywords:** Open IDM-Triz, Open Innovation, Complex system Modeling, Pluridisciplinary contradiction resolution, Climate change impacts analysis, TrizAlerts Artificial Intelligence.

## Ideal Final Result for Agriculture: Striving for Sustainability

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**Abstract.** In this paper, we used TRIZ to resolve the existing contradictions between agriculture and the environment, which would make agriculture sustainable. Through the identification of strategic types of agriculture and their goals, we formulated ideal final result for agriculture. This formulation includes all the contradictions that exist between the strategic types. We proposed a strategy for the balanced development of agricultural technologies, which aims to realize the ideal final result for agriculture by resolving all contradictions between all the strategic types of agriculture. The balanced development means that in the resulting system of agriculture, the goals of all the strategic types of agriculture are achieved simultaneously. Regarding the issue of making agriculture sustainable, in accordance with the TRIZ methodology, administrative, technical and physical contradictions arising between agriculture and the environment were stated and examined. Some solutions to the physical contradictions were proposed. Based on these solutions, two main factors of making agriculture sustainable were determined: 1) making green technologies highly productive; and 2) the humane control of the growth of the world population.

**Keywords:** Strategic types of agriculture, Theory of inventive problem solving (TRIZ), Ideal final result, Kinds of contradictions in TRIZ, Physical contradictions, Sustainable agriculture, Balanced development of agricultural technologies.

# The Use of Publicly Available Image Search Engines to Find Solution Ideas

## Efficient Use of TRIZ Information Resources

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**Abstract.** The present paper proposes a set of steps to search for data and generate relevant information to come up with solution ideas for a given problem or product improvement. Among others, the terms data and information are defined and an overview of the current state-of-the-art, which contains the TRIZ tool Function-Oriented Search and the description of possible search engines, is given. For getting relevant search results and generating information a workflow is suggested. This workflow is based on pictorial analogy to a sketched problem situation and the use of standard internet browsers with image search functionality. The task of improving the design of a tea press illustrates the workflow and its steps. The obtained solution ideas show the feasibility of the proposed workflow and lead to the conclusion that even the single use of pictorial analogy yields useful results.

**Keywords:** TRIZ, Pictorial Analogy, Image Search Engines, Information Resources