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"TRIZ in a bi-system with Lean Sigma"

AUTHOR'S ABSTRACT

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July 2011

General Characteristics of Research Work

The author first became acquainted with TRIZ in April 1991. In late June, early July 1991 a first ever week long TRIZ Seminar in the USA was conducted by Simon Litvin, Vladimir Gerasimov and Igor Devoino, the author served as an interpreter. As a result, the author was completely sold on power of TRIZ for technical problem solving.

By the time of his acquaintance with TRIZ the author was well familiar with Six Sigma, the Theory of Constrains and Value Engineering/Value Management methodologies. Save for VE/VM, no other problem solving methodology was fully embraced by the industry. Then, in 1993 General Electric adopted Six Sigma, developed at Motorola, as their Quality Enhancement Methodology. This act was followed by the rapid growth of interest in Six Sigma, a large number of training and consulting companies, offering Six Sigma based services, sprang up almost overnight.

Six Sigma is a methodology for detection and fixing of defects in technological and business processes. Six Sigma methodology is based on well studied and tested statistical methods of quality control, data analysis and systematic training of the entire company's personnel, involved in technological or business process. Six Sigma enables determination of the number of defects in any process or any step of the process.

Therefore, Six Sigma is a methodology for uncovering defects, inherent in various processes, based on statistical analysis of available data. Yet, this methodology does not offer any tools for elimination of these defects. A human is left to his/her own wits and, most often, brainstorming process, for resolution of found issues. On the other hand, in TRIZ, statistical data is used for discovery and use of the laws and patterns of technology. Integration of these approaches allow for development of an instrument, capable of broadening of the capabilities of both methodologies.

A while ago, consultants, who practice Six Sigma and Lean Manufacturing, merged these methodologies, creating, so called, Lean Sigma or Lean Six Sigma. Lean Manufacturing is methodology developed in Japan on the basis of Toyota Production System. The aim of this methodology is elimination of various wastes in technical and business processes. According to various sources, the number of most frequently occurring wastes is 7 to 10.

The author first thought about a merger of Six Sigma and TRIZ as a way to promote TRIZ in the industry. In other words, utilize Six Sigma as a towing system, similar to, say, a steam engine on a sail boat. At the time, it was a worthy undertaking as TRIZ providers had hard time selling their services. And for a very understandable reason. While Six Sigma providers promised a $170,000 economic benefit from a single Six Sigma supported project and Lean Manufacturing consultants operated with concrete numbers of economic benefits from Lean supported process improvements, TRIZ consultants were offering to solve problems… In addition, every other “improvement technique” was offered by a uniform, well structured process, while TRIZ offering differs greatly from provider-to-provider… However, while Six Sigma has a uniform process, regardless of the provider, Design for Six Sigma is a different story. The reason? DFSS is an attempt at creativity, which requires independent thinking in addition to some kind of algorithm.

Secondly, TRIZ is qualitative in nature. This is one of the major reasons TRIZ is a difficult subject to comprehend for engineers and scientists, who are used to operate with numbers in their work. Thus, “the digitization” of TRIZ became one of the topics of TRIZ research. And in particular, the digitization of the very moment when a solution is obtain. In many seminars the author was confronted with – well, the tools are understood, but how do you transit from a tool to a solution? The debate on this subject continues and escalates. The only reprieve is to work a problem, introduced by a team of students. Then, it happens naturally.

Thirdly, Six Sigma and Lean practitioners, faced with lack of creative approach in their methodologies, began “incorporating” TRIZ into their offerings. In every such case, TRIZ was presented as a contradiction matrix only, thus severely limiting the potential impact TRIZ tools could have in a particular problem solving process.

Relevance of the topic of the research

As any other system, TRIZ behaves according to the trends of the General Systems’ Theory. According to one of the trends, technological systems evolve in a general direction from mono-systems to bi- or poly-systems. Then the bi- and poly-systems convolute into mono-systems. TRIZ is not an exception to this trend. Today, TRIZ and a modified Value Engineering (VE) function analysis module comprise a mono-system of contemporary TRIZ.

At a close view, TRIZ provides qualitative assessment and analysis of the system under consideration. Yet, in a technical systems’ analysis, based on numerical representation of system’s features, functionalities and problems, is very important as it provides a universal assessment of system’s capabilities and provides foundation for comparative analysis of the system and its environment.

Therefore, TRIZ based process would benefit greatly if accompanied by some kind of quantitative assessment. That there is such a need is supported by the fact that many TRIZ practitioners are attempting at inclusion of quantitative methods into TRIZ based problem solving process. For example, Alexander Kudryavtsev’s Mater Thesis, presented to Dissertation Council in October of 2006, is devoted to “digitization” of TRIZ based problem solving process; GEN3Partners Company introduced Main Parameters of Value, or MPV, into analytical portion of a problem solving process; quite a few papers were presented at various websites, devoted to TRIZ and its Tools, most notably on website Metodolog.

Goals and tasks of the research

The goal of this work is to examine the potential ways of using TRIZ in some kind of unified system with Lean Sigma. To this end the following steps were taken –

- Determine possibilities of integration Lean Sigma and TRIZ;
- Develop a roadmap for application of newly developed bi-system;
- Test the newly developed process.

Research methods

By and large, TRIZ traditional research methods were used. Mostly review and analysis of the existing scientific and technology papers and books, case studies, etc. It is fare to say, at this point, that this particular field of TRIZ application/utilization is not much explored by experienced TRIZ practitioners. Of course, the author can't claim the review of all available sources. Most of the existing literature on the subject was generated by the specialist in adjacent methodologies. Thus, the existing research is mostly shallow where TRIZ is concerned. The works by V. Sibiryakov, J. Bradley and S. Ikovenko are the only pleasant departure from the rest. In addition, during the period of the last 15 years the author had numerous opportunities to test main concepts of Lean Sigma/TRIZ integrated process within various projects for improvement of technical and business processes. Field test enabled better understanding of the requirements and resources, associated with "digitization" of TRIZ.

Scientific novelty of the research

There is no dispute over the mono-bi-poly trend of systems' evolution. This research addresses certain ways for integrating TRIZ with Lean Sigma in accordance with this trend. In particular, the author considers the following as new contributions:

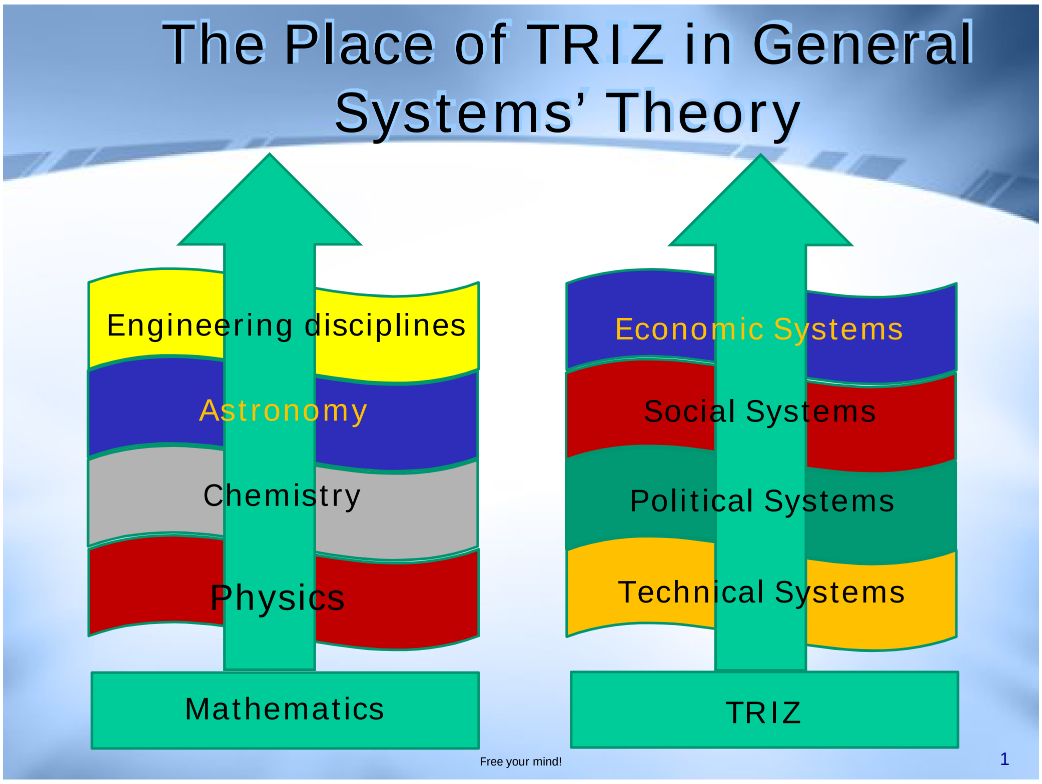
- ✓ A physical contradiction – TRIZ must be described by mathematical apparatus and TRIZ can't be described by mathematical apparatus, is resolved by separating these mutually exclusive requirements in time and in space. Thus, an application of statistical approaches, contained within Lean Sigma, allows an increase in "digitization" of TRIZ.

- ✓ Developed a process of Situation Analysis, based on concurrent use of TRIZ and Lean Sigma. TIZ was mined for tools, enabling application of the resources, required for non-conventional solutions. Lean Sigma was mined for tools, which enable quantitative assessment of most problematic nodes in technical and business processes.
- ✓ Created a foundation for continuing development of TRIZ/Lean Sigma integration process, where TRIZ plays the leading role

Super effect

Usually, application of TRIZ tools for problem solving and/or system research of systems' transformation leads to the so called "Super effect". In other words, unplanned positive outcome appears out of thin air. In this case, the author views the following hypothesis as such "Super effect" **–**

TRIZ is a part of the General Theory of Complex Systems'. As such, it has a role similar to that of mathematics in natural sciences. Mathematics provides the tools for description of natural behaviors; TRIZ provides the tools for description of systems' behavior. TRIZ helps with the development of models of systems' behavior. There is strong evidence of a lot of effort expended on developing TRIZ based systems' modeling techniques and tools. The works of Boris Zlotin and Alla Zusman, Simon Litvin and GEN3/Algorithm, Anatoly Guin and Sergey Faer, Gennady Ivanov, Julius Murashkovsky. And this is not complete by any stretch… Graphically this hypothesis is represented in the following slide:



In other words, natural sciences flow in parallel, subject to diffusion along the borders. Mathematics runs in perpendicular to the rest of natural sciences, providing common methods of research and analyses. A parallel flow of various systems, subject to diffusion along the borders, is pierced by TRIZ, which provides common methods of research and analyses. The difference is in that while mathematics operates with numbers and precise formulas, TRIZ operates with images.

Practical significance of the research

The practical significance of this work is manifested by:

- ✓ development of an algorithm for use of a quantitative tool, Lean Sigma, in a TRIZ based problem solving process
- ✓ practical recommendations on the use of different TRIZ and Lean Sigma tools based on a system's position on S-curve

Main provisions presented for defense

- TRIZ based project may benefit from inclusion of Lean Sigma quantitative methods
- TRIZ and Lean Sigma supplement each other in a bi-system
- As a hypothesis – TRIZ is a core science in the field of Complex Systems' Theory

Personal contributions of the applicant

Majority of the offerings in the Scientific Significance of the Research are personal contributions of the author. At the same time, the authors owes to a large number of TRIZ practitioners, who at various times provided constructive critique and sound advice.

Validation of the research work

The process, developed as a result of this research, was utilized in the performance of more than ten projects in the various fields of industry. Most notably, in manufacturing, where author spent over 30 years as an engineer, engineering manager, continuous improvement manager and consultant. In addition, this approach was tested on a number of projects in petro-chemical and power industries with very good results in the area of nuclear power applications. It is important to note that this approach should have the best application under condition of high speed/high volume manufacturing. At the present, the author is working with the Industrial Engineering Department of University of Tennessee, Knoxville, on the development of Engineering Management curriculum. Management of Innovation Process and Systems Analysis are part of this curriculum.

Selected publications on the subject:

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Structure of the thesis

The thesis consists of an Introduction, 11 chapters, Selected publications and References, on 37 pages with 14 figures.

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