The intersections between TRIZ and forecasting methodology

Intersecţii între metodologia previziunii şi TRIZ

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Abstract

The authors' intention is to correlate the basic knowledge in using the TRIZ methodology (Theory of Inventive Problem Solving or in Russian: Teoriya Resheniya Izobretatelskikh Zadatch) as a problem solving tools meant to help the decision makers to perform more significant forecasting exercises. The idea is to identify the TRIZ features and instruments (40 inventive principles, i.e.) for putting in evidence the noise and signal problem, for trend identification (qualitative and quantitative tendencies) and support tools in technological forecasting, to make the decision-makers able to refine and to increase the level of confidence in the forecasting results. The interest in connecting TRIZ to forecasting methodology, nowadays, relates to the massive application of TRIZ methods and techniques for engineering system development world-wide and in growing application of TRIZ's concepts and paradigms for improvements of non-engineering systems (including the business and economic applications).

Keywords: *forecasting, TRIZ, methodology, problem solving* .

Rezumat

Intenţia autorilor este de a corela cunoştinţe de bază în folosirea TRIZ (Teoria innovative a rezolvării problemelor – în limba rusă: Teoriya Resheniya Izobretatelskikh Zadatch) ca metodă de rezolvare de probleme într-un instrument necesar şi util decidenţilor de a efectua previziuni. Ideea este de a identifica caracteristicile şi instrumentele oferite de TRIZ (cele 40 de principii inovative, de ex.) pentru a pune în evidenţă componente de timp perturbaţii - zgomot sau semnale de avertizare, pentru identificarea tendinţelor (calitative si cantitative) şi mijloace suport în prognoza technologică, pentru a rafina şi pentru a creşte încrederea in rezultatele previzionării. Interesul în legătura dintre TRIZ şi metodologia de previzionare, în prezent, poate deriva din aplicaţiile tot mai numeroase ale TRIZ în dezvoltarea sistemelor tehnice peste tot în lume şi în îmbunătăţirile aduse de aceasta în sisteme non-tehnice (cum sunt cele de business şi cele economice).

Cuvinte-cheie: *previziune, TRIZ, metodologie, rezolvarea problemelor.*

JEL Classification: C18, C53

Introduction

Innovation, technological progress, globalization and the financial unstable business climate have contributed to making decision making process more complex and potentially riskier. This has presented new challenges to the management field, both to the theoreticians and practicians, with respect to the need to base their decision on more flexible and sophisticated instruments (Hincu, Andreica, Ionescu, Ionescu, Visan, Andreica 2008).

The new need appear in designing the usage of a forecasting method as often, we (as data human-processors) delay to recognize and to be agree about problem; we tend to delay to solve problem and to be agree about solution and we delay to implement a potential solution and recognize its limitations. However, in spite of this, *forecast supposes to cover these delays for securing potentially threats: c*onsumption exponential growth; waste exponential growth; pollution exponential growth; environmental destruction exponential growth.

If we refer to the long term forecasting, the more intricate issues do appear; naming, for example, the technological forecast as a comprehensible description of emergence, performance, features, and impacts of a technology in a particular place of a particular point of time in the future. Its main function is to develop an explicit model in order to describe the future state of technology and its environment for target time-series at particular place. Main functions of technological forecasting are to provide a consensual vision of the future science and technology landscape to decision makers. High quality technological forecast denotes accurate, credible and visionary result aimed to portray the evolving relationships with adequate breadth and depth; to provide a comprehensive description of the evolution and relationship of most critical sciences and technologies in the past, present and future; to provide a high degree of certainty, reliability and objectivity (bias-free).

Technology advancement is a principal impetus for economic development. Foreseeing technological advancements that will shape the future is crucial for many industrial, financial, or social enterprises, since they can be deeply influenced by emerging innovations. Companies capable of undertaking technology forecasting can benefit in numerous ways, such as: take advantage over their competitors and dominate the market; be able to perform optimal planning and allocation of resources (investment, personnel, budget, inventory, etc.); increase effectiveness in monitoring of the market monitoring; maximize financial gains and minimize the losses; improve quality of decision making.

Various technology forecasting methods have been developed over the last few decades: linear extrapolation, morphological method, Delphi method, interlocking matrix, relevance tree, dynamic simulation model etc. While being different and generally useful, these techniques share the common philosophy and constraints:

- Traditional technological forecasts deal with parameters (e.g., speed, power, etc.) rather than with structures that are capable of realization of these parameters. They say nothing as *how to achieve* these parameters.
- It has been almost unanimously agreed by the experts that inventions shaping the future *absolutely cannot be forecast*.
- There are no *objective criteria* for evaluation of the forecasts.
- The reference ground for traditional forecasts deals with technological capabilities of the systems being foreseen. Yet many consumer products intended to please various people's tastes cannot be described only in conventional engineering dimensions and, therefore, do not submit to such a forecasting analysis.

To overcome above constraints, caused mainly by intuitive approach to innovation prediction, and make technology forecasting a practical tool for a long-term business development, a new approach, based upon a systematic logical analysis, has to be introduced – and the paper's proposal is set to TRIZ (Theory of Inventive Problem Solving).

Some aspects about TRIZ features

Following the '60 with the works of Altshuller, TRIZ is described, mainly as a method for inventive problems solving – called *Algorithm of Inventive Problem Solving* (ARIZ). Initially, the morphological analysis (namely, the TRIZ method) describes an understanding of how technologies evolve over time can be used to project future developments. The TRIZ method, commonly known as a powerful business tool for enhancing innovation and creativity, is a structured approach to managing innovation that engages a multi-sequential scientific process in the attempt of problem solving having a benefit that the individuals/ researchers/analysts etc. can generate more solutions of a higher quality, with lower consumption of resources (including time, attention, analytical or computer skills).

TRIZ complements performance improvement programs because it focuses on finding innovative new solutions rather than fixing problems inherent in an existing process. TRIZ is especially useful for new product development teams and in operational environments, but can be used in just about every situation to accelerate and streamline innovation and problem solving (Domb, Kling, 2006).

Many companies use TRIZ in everyday business to: generate new ideas and solve problems faster, forecast technologies and track product evolution, to build stronger patents and work around existing ones, to maximize the potential for new product success and to streamline the use of resources, to improve understanding of customer requirements and, to save time and money when developing new products.

To explain TRIZ as a problem solving methodology, one should pass through several steps: define the levels of innovation and explain their importance; understand and explain psychological inertia; identify and define problems in terms of contradictions; resolve contradictions using the *Contradiction Matrix Theory*, *Separation Principles* and the *System Approach*; create a function model of a system and use it for contradiction identification and resolution; understand and practice a number of key TRIZ concepts such as: *Zones of conflic*t, *Functional Analysis* (Su-field analysis, TOP, subject-action-object, problem formulator model), *System Constraints*, *the Ideal Final Result & Ideality*, the Utilization of Resources.

Example of a contradiction stated for forecasting

Table 1

If a forecasting method applies **qualitative** analysis, then it can be applied for long-term forecast due to compatibility with law (of dialectic) of transformation quantity to quality; however, it is difficult to achieve repeatable results from experts, it costs a lot, it takes a lot of time (low frequency to update results), the results contains a lot of biases.
If forecasting method applies **quantitative** analysis, then the results can be obtained a reproducible way, the process is cost effective, it is possible to update result frequently, the results consist less biases; however, it is not compatible with law of transformation 'quantity to quality', consequently it is mostly applied for short-term forecast.

The TRIZ uses the *Laws of Technological Evolution*, which describe how technologies change throughout their lifetimes because of innovation and other factors, leading to new products, applications, and technologies. The technique lends itself to forecasting (Kappoth, 2007); it provides a structured process for projecting the future attributes of a present-day technology by assuming that the technology will change in accordance with the *Laws of Technological Evolution*, which may be summarized as follows:

• *Increasing degree of ideality*. The degree of ideality is related to the cost/benefit ratio. Decreasing price and improving benefits result in improved performance, increased functionality, new applications, and broader adoption.

• *Non-uniform evolution of subsystems*. The various parts of a system evolve based on needs, demands, and applications, resulting in the non-uniform evolution of the subsystem. The more complex the system, the higher the likelihood of non-uniformity of evolution. The development rate of desktop computer subsystems is a good example of non-uniform evolution. Processing speed, disk capacity, printing quality and speed, and communications bandwidth have all improved at non-uniform rates.

• *Transition to a higher level system*. "This law explains the evolution of technological systems as the increasing complexity of a product or feature and multi-functionality". This law can be used at the subsystem level as well, to identify whether existing hardware and components can be used in higher-level systems and achieve more functionality. The evolution of the microprocessor from Intel's 4004 into today's multicore processor is an example of transition to a higher-level system.

• *Increased flexibility*. Product trends show us the typical process of technology systems evolution is based on the dynamization of various components, functionalities, etc. As a technology moves from a rigid mode to a flexible mode, the system can have greater functionality and can adapt more easily to changing parameters.

• *Shortening of energy flow path*. The energy flow path can become shorter when energy changes form (for example, thermal energy is transformed into mechanical energy) or when other energy parameters change. An example is the transition from physical transmission of text (letters, newspapers, magazines, and books), which requires many transformational and processing stages, to its electronic transmission (tweets, blogs, cellular phone text messaging, e-mail, Web sites, and e-books), which requires few if any transformational or processing stages.

• *Transition from macro - to micro-scale*. System components can be replaced by smaller components and microstructures.

The TRIZ method is applied in the following stages (Kucharavy & De Guio, 2005):

• *Analysis of system evolution*. This stage involves studying the history of a technology to determine its maturity. It generates curves for metrics related to the maturity level such as the number of related inventions, the level of technical sophistication, and the S-curve, describing the cost/benefit ratio of the technology. Analysis of these curves can help to predict when one technology is likely to be replaced by another.

• *Road-mapping*. This is the application of the above laws to forecast specific changes (innovations) related to the technology.

• *Problem formulation.* The engineering problems that must be addressed to realize the evolutionary changes predicted in the road-mapping stage are then identified. It is in this stage that technological breakthroughs needed to realize future technologies are specified.

• *Problem solving*. Many forecasts would terminate in the problem formulation stage since it is generally not the purpose of a forecast to produce inventions. In spite of this, TRIZ often continues. This last stage involves an attempt to solve the engineering problems associated with the evolution of a technology.

Although the attempt might not result in an actual invention, it is likely to come up with valuable information on research directions and the probability of eventual success in overcoming technological hurdles.

The link TRIZ-forecasting

In 1985, the G. Altshuller's problem statement stated that all forecasting methods are inherently highly subjective; even, if there are more than 100 methods of forecasting: scientific-and technological, economic, and social and still, an inventor has to look answers for qualitative questions (Altshuller, 1988). So, for application of curve fitting method in the view of Theory of Inventive Problem Solving (TRIZ) were proposed some steps to be followed: identifying four distinctive sections on the evolution curve; searching for peculiarities of theoretical and some real curves of substitutions; allowing natural reasons of ceiling for curves and building cases of data analysis for curves.

In 1988, Altshuller G. et. others described a forecasting procedure proposed in four stages and 26 steps to express forecast; to prepare to forecast; to make the forecasting using laws of technical systems evolution and finally, to aggregate forecast (Kucharavy, 2007).

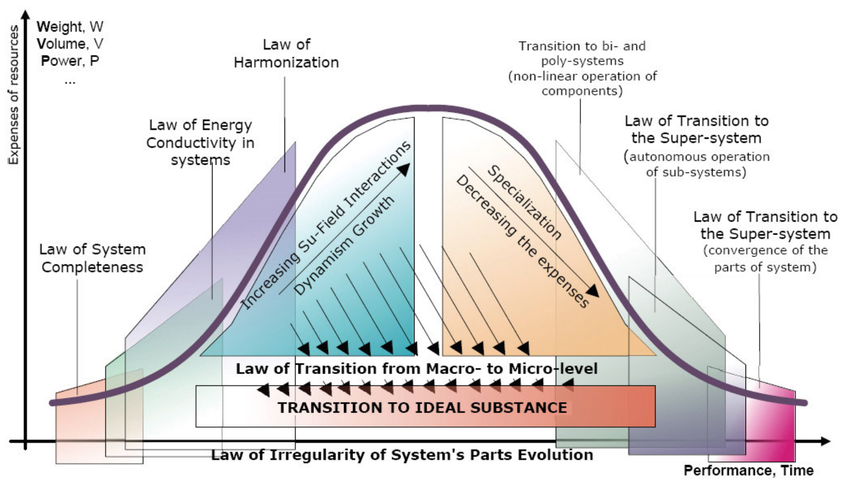

Figure 1. The wave model (bell-shaped running curve)- the Salamatov model
Source: (Salamatov, 1991)

Systematically applying the patterns of evolution to a company's technological system results in a number of possible solution paths. The solutions, or directions, recommended by one trend are not unique – they often overlap. Once a company has generated multiple solution paths, management decisions can be made to develop the R&D plan for the company. Russian scientist Genrich Altshuller, along with his colleagues, found that any system evolves in a biological pattern, meaning that it will go through four main stages also known as: infancy, growth, maturity and decline – all stages are plotted on the "S-curve" – Figure 2.

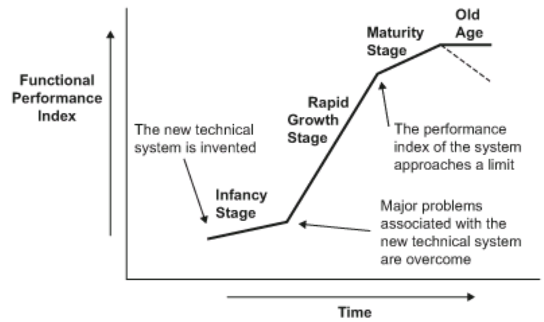

Figure 2. The S-model used for a system's performance

There are some descriptors are used to assess the life cycle stage (or technological maturity) of a technological system on its S-curve: number of patents per time period, level of innovation per time period, technical performance per time period (Hipple, 2005).

In SLO 2000, there is presented a case-study about forecasting self-heating technology patents; the associated aggregate level of inventiveness for this exercise was determined by: the required trial and error iterations (if known or surmised; the presence /absence or invisibility of a contradiction(s) (administrative, technical or physical); the number of contradictions; the strength of the contradiction(s); the impact on the relevant field; the impact on science and the degree of system change.

The inventive levels – the self-heating technology patents

Table 2

Level	Nature of the Solution	Where Did the Solution Come From?	Percentage of Patents
I	It was obvious	The designer's narrow specialty field	30
II	Some modifications were made	A single branch of technology	55
III	A radical change was made	Other branches of technology	< 10
IV	Solution is broadly applicable	From science – little known effects and phenomena of physics, chemistry and geometry	3-4
V	A true discovery previously unknown	Beyond limits of contemporary science	< 1

The stage indicators placed the existing self-heating technology in the infancy stage - the immature status. Consequently, as strategic recommendation one may state: invest in the production and marketing for this technology. Previous technologies were employed, but the peak core and beverage temperatures realized had been inadequate due to secondary limitations (or problems) associated with the technology in question (e.g., cost to manufacture, weight, safety). Therefore, several S-curves were initiated but each declined prior to the emergence of the technology.

Conclusion

TRIZ instruments for prediction bring along updated, adopted and enhanced patterns and lines of evolution; new ways to apply knowledge about laws of technical systems evolution; problem solving techniques applied for predictions. Prediction instruments produce qualitative outcome with some quasi-quantitative results. This paper suggests a connection among various methods possible to be used in technology management and forecasting. One method is mainly used in TRIZ problem solving and for increasing creativity in technological management applications. The preoccupation for studying this connection and its application for the business management emanates from the preoccupation of the authors to improve the benefits of TRIZ as a forecasting tool.

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