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History, Current Situation and Development Prospect of the TRIZ

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Abstract

This paper briefly presents the history of development of the TRIZ namely the Theory of the Solution of Inventive Problems, introduces the current situation of the theoretical research and the application of the TRIZ, and propounds the emphasis and direction of the research and application of the TRIZ in China, which will contribute to the enhance the efficiency and benefits in Computer Aided Manufacturing.

1. Introduction

TRIZ, short for "Teoriya Resheniya Izobreatatelskikh Zadatch", which is the Latin transliteration for the Russian phrase "теории решения изобретательских задач", means "Theory of the Solution of Inventive Problems" [1]. It dated back to 1946 and was started by the former Soviet inventor and scientist, Genrich S. Altshuler [2], with a group of research workers led by him, through a series of researches and summaries on more than 2.5 million patents all around the world.

The original TRIZ was only applied to the fields such as manufacturing and quality engineering. Since the TRIZ was opened to public in 1990s, researchers from all around the world have made some supplement and improvement to the traditional TRIZ. Some world-class companies has made use of the TRIZ to product innovation

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research, such as Motorola, Boeing, Chrysler, Ford, General Electric, and has well-achieved on new technology development, quality check and manufacturing costs saving [3]. At present, the researches and applications of the TRIZ are spreading from traditional technical areas such as product developing to some non-technical areas, such as business administration, politics, education and so on.

2. The development history of the TRIZ

The development of the TRIZ can be generally divided into the following stages [4]:

(1) The primary stage (1946-1955).

In 1946 during his working in the Soviet Navy Patent Office, Genrich S. Altshuler led a series of researches to a large amount of patents and discovered that the product improvement, technological changes and the process of innovation in any field were the same as the biological systems, in which the periodical rule of maturing and decline existed. The idea laid a foundation of the TRIZ.

(2) The beginning stage (1956-1985)

In 1956, the paper "About a technology of creativity" by Altshuler and Shapiro [5] first introduced the TRIZ method and the technical evolution rules, which had formed the basic theory of the TRIZ in reality with their ideological framework. In the following nearly 30 years, Altshuler established some basic concepts and analysis tools of the TRIZ through his series of works.

(3) The developing stage (1986-1991)

After the year around 1985, with some experts migrating to the Europe and the US, the TRIZ began to be noticed and spread by scholars and engineering staffs, which has contributed much to its development. In 1989, Altshuler convened the dozens of TRIZ experts at that time, and organized the International TRIZ Association in Petrozavodsk, with Altshuler as the chairman of the first term. Nowadays, the association possesses more than 30 membership organizations in over 10 countries around the world, and has thousands of experts. During this period, the research on the TRIZ had been gradually accepted in the worldwide range especially in the European and American developed countries, which promised the rise of the research on the TRIZ all around the world.

(4) The mature stage (1992-now)

After the collapse of the Soviet Union in 1992, researches on the TRIZ around the world grew rapidly. Ended to 1998 when the father of the TRIZ Altshuler died, the TRIZ founded by him has formed a complete system. In 2003, Mann, Zlotin, Zusman etc with aiming at the state that the TRIZ had been unable to meet the current product development situation, came up with 48 engineering parameters based on the original 39 ones, and also added 37 combined innovation principles, which made the TRIZ more practical [6]. In the following years, the scholars of the TRIZ has researched and discussed the application of the TRIZ theories and methods in more fields, and reached the viewpoint that TRIZ can be taken as a collaboration tool in the production environment to solve the factor of the human. The emphasis of the research in this period is to lucubrate the problems caused by the product practice of the TRIZ and to continually broaden its application area.

Among the stages above, the first three ones are the Soviet researching periods, in which the theoretical achievements are called " the classical TRIZ", while the forth is mainly the western developed countries researching period, of which the achievements are called "the modern TRIZ".

3. Major contents and principles of the TRIZ

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3.1 The definition and core ideas

According to the definition given by Dr. Savransky [7], TRIZ is a kind of knowledge-based, human-oriented and systemized solution for the inventive problems. The core ideas of the modern TRIZ are mainly reflected in three aspects. Firstly, as to whether a simple or a complex technical system, the development of the core techniques will follow the objective laws to evolve, namely possessing an objective rule and schema. Besides, the solutions of the various kinds of technical problems and collisions push forward to the evolution progress. In the end, the ideal state of the technical system is to realize the most functions with the least resources possible.

3.2. The major contents of the TRIZ

The modern TRIZ theoretical system mainly includes the following aspects:

(1) The innovative thinking methods and problem analysis methods

The TRIZ provides the scientific methods such as the multi-screen method to systematically analyze problems; as to the analysis to complex problems, a scientific problem analysis modeling method, the object-field analysis method, is provided to help to rapidly confirm the core problem, and to find the fundamental contradiction.

(2) Technical system evolution laws

Aiming at the regular patterns of the evolution of technical systems, the TRIZ has concluded eight basis evolution laws after analyses to a large amount of patents. To use these evolution laws can analyze and confirm the technical status of the current products, predict the future trend, and develop new competitive products.

(3) Solution principles of technical contradictions

Different inventions always follow same laws. The TRIZ concludes these same laws into 40 innovation principles. Aimed at specific technical contradictions, solutions can be sought based on these innovation principles combined with the engineering practice.

(4) The standard solutions for innovation problems

Aimed at the different characteristics of the object-field model of specific problems, we have corresponding model processing methods for each, including the repair, transition of the models and the addition of the objects and the fields.

(5) Algorithm for Inventive Problems Solving (ARIZ)

It is mainly aimed at the technical systems whose problem situations are complex and contradictions with related components are indeterminate. It is a non-computational logical progress such as transformation and redefinition of the original problems, to realize the gradual deep analyses of the problems, the transformation of the problems, and up to the solution of the problems.

(6) Knowledge bases based on engineering principles

Knowledge bases based on analysis results of millions of inventive patents from areas such as physics, chemistry, and geometry and so on can provide abundant scheme sources for the technical innovation.

3.3 The progress of the TRIZ solution

The progress of the TRIZ solution is as follows:

Step1 Analysis, including analyzing the product functions, confirming the ideal solutions, analyzing the available resources and confirming the collision areas. If the key to the analysis stage has been discovered, we can directly jump to the implementation stage.

Step2 To discover the solution with the TRIZ tools based on knowledge. In many application cases of the TRIZ, the following three tools may be adopted at the same time.

(1) Principles, being the usual law which obtaining the collisions should follow. During the

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progress of the principles application, there are two kinds of collisions namely the technical collisions and the physical collisions. The physical collisions are the core collisions of the problem, and also the sharpest collisions, which must be solved; the existence of the technical collisions always implicates the physical collisions, and can be transformed into them.

(2) Forecast is also called the technical prediction. The TRIZ has confirmed eight patterns of the technical system evolution. After confirming the pattern, the design of the system, the subsystem and the components should advance to a higher level direction.

(3) Effects, meaning to apply the related laws in the current field or other relative fields to solve the problems in the design.

Step3 Evaluation, compare the keys achieved in this stage with the ideal solutions, to ensure that the improvements have not only met the users' demand, but also boosted the product innovation. If the evaluation was considered feasible, continue to define new problems until coming up with the ideal solutions of all problems and come into effect; otherwise, go back to the former step.

3.4 The TRIZ solution tools of the innovation design problems

(1) Contradiction matrix and innovation principles

In the 40×40 contradiction matrix, the first row represents the 39 technical parameters for improvement, and the first column represents the 39 technical parameters which cause the deterioration. The cross of the rows and columns forms the technical contradictions, with the codes of the recommended innovation principles to solve the technical contradictions. After a technical contradiction has been confirmed aimed at the specific problems, choose the engineering parameters according to the descriptions of the contradictions, and use the innovation principles according to the locations of the engineering parameters in the matrix to eliminate contradictions. The modern TRIZ has made improvements to Altshuler's classical TRIZ method, expanded the number of the universal technical parameters from 39 to 48, and has also added 37 new innovation principles [8].

(2) Object-field model and 76 standard solutions

The technical system is the realization of the functions, while the object-field model is the tool for analyzing the system functions. According to the model, the analyses to the system functions can be conducted, such as whether the functions are complete, whether any harmful functions exist and so on. On the basis of the model analyses, the TRIZ has given out 76 standard solutions to solve the function defect problem of the technical systems. The standard solutions are divided into five categories: ① to construct or destruct the objects and fields; ② to develop the objects and fields; ③ Transform into supersystems or microsystems; ④ to check and measure; ⑤ to describe how to introduce the objects or fields. The modern TRIZ has made some improvements aiming at the defects in the object-field model in the classical TRIZ, which came up with the new object-filed triad analysis method.

(3) Algorithm for Inventive Problems Solving (ARIZ)

ARIZ, short for the phrase "Algorithm for Inventive Problems Solving" in Russian language, is an important tool of the TRIZ. It is as complete algorithm to solve the innovation problems. Many concepts of the TRIZ are integrated in ARIZ [5]. The algorithm adopts a series of logical progresses to routines the original problems, and constantly refines the problems until find out the solution. During the development progress, new versions of the ARIZ were launched in succession to improve the former version. Now some early versions of the ARIZ have been no longer used. The ARIZ has

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various versions and lengthy solution steps, and may face the problem that the produced solutions have no choosability. Generally, only 1% problems can use the ARIZ. The modern TRIZ has developed eight solution algorithms to simplify the steps of the classical TRIZ.

(4) Scientific technology and knowledge effect base

What are called "effect" are some natural laws of different science fields. The patent research indicates that many innovation projects come from the application of those natural effects which have not been applied in some specific engineering fields. In TRIZ method, effects are regarded as a "black box" system, without inner constructions, and cannot be further broken down, but only have an influence on some specific inputs. Because of the researchers not being aware of the knowledge fields outside their own major, this new kind of organization pattern can greatly shorten the search time for the required effects, as to raise the efficiency of the use of the effect base. With the development of the time, the modern TRIZ will also request the effect base to be expanded with knowledge from fields such as biology and computer science and so on.

4. Prospect of the development trend

Since the TRIZ was popularized and large-scaled researched in European and American developed countries, the modern TRIZ has made some expansion and improvement on the classical TRIZ to meet the requirement of the innovation in the fiercely competitive market economy environment. Nowadays the research on the TRIZ mainly focuses on the enhancement of the basic researches on TRIZ itself and how to develop and integrate each kind of software tools about TRIZ. The following six aspects of topics are focused on.

(1) How to describe the object-field model with more adaptable symbol systems to realize the innovation design of multifunctional products.

(2) How to further complete the standard parameters, the contradiction matrix and the solution principles.

(3) How to make rational popularization and application of the TRIZ to solve technical contradictions and collisions to wider its benefit area.

(4) How to realize the higher and deeper level of the softwarization of the TRIZ, and to develop targeted series of software systems which can suit special fields and meet special purpose.

(5) How to bring principles and methods of fields such as information technology, biotechnology, social science and so on, into the knowledge base to further expand the connotation of the TRIZ.

(6) How to bond the TRIZ with other new techniques to make a larger effect.

At present, the research on the TRIZ in China is in the stage of development with relevant papers increasing year by year. However, it still has some defects, mainly display in the following aspects: firstly the theoretical researches are more confined to the traditional classical TRIZ than the modern TRIZ which has been expanded and improved, and not any relevant achievement has come into being presently yet; besides, despite the benefits through the application by some world-class enterprises, it is still hardly ever applied in China.

Contraposing the situation above, the research in China should set about in the following sides:

(1) Focus on the frontier of the international research, take an active part in getting aware of the theoretical achievements of the modern TRIZ, and explore new thoughts to improve the TRIZ methods.

(2) Combine the TRIZ methods with tools such as artificial neural network, supported vector machine, the Genetic Algorithm and so on, to broaden the ideas of the TRIZ application.

(3) Devote more efforts to the research and

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development of TRIZ software systems, take the TRIZ expert system as the carrier to popularize the TRIZ theories and methods and make it adopted by small-and-medium-sized enterprises with lower cost, in order to popularize the application of the TRIZ.

5. Conclusions

After the progress in the past more than half a century, the TRIZ has developed into a mature theory and method system. The research and practice of the TRIZ has been rapidly popularized and developed, and became a theory and method basis of the computer aided manufacturing technology and the innovation problem solution. In recent years, the theories and methods are continuous in update and improvement, but the application aspect still needs increasing input to the development of the software of the TRIZ, in order to popularize its application and to promote the development of the TRIZ.

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