



Research Article

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**The dynamic effect achieve of reducing air concept in high-speed railway tunnel based TRIZ theory**

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**ABSTRACT**

*"Independent innovation, the method first" is the key to catch up developed countries by leaps and bounds in China economic development. Represented by TRIZ innovative approach has made innovative methods and can be relied upon to achieve an objective way. With computer-aided design CAD and computer-aided innovation CAI, innovative activities can achieve economies of scale and innovation of the procedures to a certain extent. As a pilot Innovative approaches provinces, Sichuan Province accumulated a wealth of technological innovation and management experience with the practice of the past 3 years. In this paper, with the Sichuan Bureau of China Railway high-speed railway tunnel aerodynamic effects of technical problems successfully applied TRIZ method for reference, we drew a detailed summary of its successful experience in managing technology innovation and applications to other regional significance.*

**Key words:** Innovation system, TRIZ theory; the concept of realization, Sichuan experience.

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**INTRODUCTION**

The evolution of human development and history of science and technology show that: great historical leap and important scientific and technological progress are closely related with the innovative thinking, methods innovations, and tools innovation. The early 21st century not only is the important strategic opportunities of China's economic and social development, but also an important strategic opportunity of the development of science and technology. In this context in 2006, President Hu Jintao announced the goal of China National Conference on Science and Technology Development of the next 15 years is: to build an innovative country by 2020, so that scientific and technological development can act as a strong support for economic and social development[1,2]. "Independent innovation, the method first," Innovation is the fundamental source of innovation, innovative approach is an important part to build an innovative country, therefore, the promotion and application of innovative methods are the inevitable works to build an innovative country.

All along, people are eager to find the norm innovate way, that is pursuing the path of innovation and stability under the direction of reliable, innovative and effective implementation[3]. Compared with the traditional innovation techniques, TRIZ (Sui Chi) theory is a totally different and innovative ways to enhance its innovation to the methodology. it get the height of innovation in finding solutions to guide their thinking process to find simple and effective Solution as soon as possible, as early as possible eliminate the complex and inefficient in order to find more effective solutions. It get innovative design provides for product direction, orders and operability.

In 2007, the Ministry of Science, Development and Reform Commission, Ministry of Education and the China Association for Science launched a series of innovative ways together; the Ministry of Science approved Heilongjiang, Sichuan, and Jiangsu province as pilot innovative approaches to technology[4].

Sichuan works as (mainly TRIZ theory) one of the Pilot major provinces, it has a necessity and reality of conditions:

Strong industrial base, private capital is abundant, simple folk, creative thinking, active and a series of favorable factors make outstanding innovation in Sichuan Province lately 3 years innovative experiences outstanding.

### TRIZ INNOVATION THEORY APPROACH

The prospects and trends of technological innovation has pointed out a variety of resources concentrated effort, innovative approach is to teach us how to achieve the objective way. The history of innovative approaches has been complicated, different today. The innovative approaches have about 300. Commonly used traditional Innovation methods is: trial and error, brainstorming, integrated camera method, shortcomings cited approach, point cited the invention method, imaginary constitutes law, Thinking Gordon, asked the question, analogy invention method, the legitimate exchange of information, lateral thinking, Five S Method on the card thinking method, superposition method, prototype heuristics, rational transplantation, Lenovo Expansion Act, a symbol of the analog method, etc.

Overall: technological innovation in the traditional classification of the basic methods can be divided into two major categories of qualitative and quantitative. Qualitative analysis method is mainly through theoretical analysis to encode and organize all kinds of information, more directly reflects the transformation of scientific and technological achievements and problems in the implementation process and experience, this method is characterized by strong theory, the policy requires a considerable Research background, strong intuitive to conclude the process, do not use mathematical and statistical knowledge. It is more suitable for science and technology policy formulation and implementation of departmental research applications.

Quantitative analysis refers to the use of number of indicators for evaluation. Quantitative indicators can be divided into objective indicators and subjective indicators. The so-called objective indicators that can used is some objective indicators to quantify; subjective indicators of assessment, assessment often involves the subjective feelings of clients, then you need to measure subjective indicators, The more is the degree of scale.

TRIZ, the "Theory of Inventive Problem Solving, "the Russian acronym for the English transcription readable Teoriya Resheniya Izobreatatelskikh Zadatch, abbreviated as TRIZ. Inventor from the former Soviet Union, Altshuller founded in 1946, so which Altshuller TRIZ is also known as father of the theory.

#### *TRIZ and Innovation Law Theory*

TRIZ theory contains many systems, scientific and full operability of the invention of creative thinking and problem analysis. TRIZ theory system includes the following sections:

#### 1. TRIZ eight laws of technical evolution systems

Altshuller's technical system evolution was known as the "three theory of evolution". with the natural sciences and the biological evolution of Darwin Spencer's Social Darwinism shoulder. TRIZ's eight laws of evolution systems are: ① S-curve technology systems laws of evolution; ② law to improve the ideal degree; ③ none balanced subsystem laws of evolution; ④ dynamics and control laws of evolution; ⑤ further increase the integration Simplify the rules; ⑥ subsystem coordination laws of evolution; ⑦ to micro-level and field of application of laws of evolution; ⑧ reduce manual into the laws of evolution.

#### 2. The ideal final result

To solve the problem in the beginning, TRIZ theory first set aside a variety of objective constraints, by the definition of ideal final result, where the ideal solution to a clear direction and position, to ensure the problem-solving process in along the goal and get the ultimate ideal solution, which involves innovative methods to avoid the traditional drawbacks of the lack of goals to improve the efficiency of innovative design. The ideal final result has four characteristics: ① to maintain the advantages of the original system; ② eliminate the deficiencies of the original system; ③ none more system complex; ④ none introduce new defects.

#### 3.40 inventive principles and 39 engineering parameters and Altshuller contradiction matrix

Altshuller analysis and summary a large number of patent researches and extract the most important and widespread use of the 40 inventive principles in TRIZ. then use these conflicts and conflict resolution principles to improve the composition of a 39 parameters and 39 parameters constitute the matrix degradation, the horizontal axis expressed the hope that improvement of the parameters, the vertical axis to improve the technical characteristics that cause a deterioration of the parameters, the number of vertical and horizontal Axis at the intersection of each parameter that is used to solve the system of conflicts principle used.

#### 4. Inventive problem solving algorithm (ARIZ)

ARIZ is the process of inventive problem solving methods and the theory should follow the steps, ARIZ is based on

the law of technical system evolution of a complete problem-solving procedure proposed for a non-standard problem solving algorithm.

ARIZ theoretical basis of the following three principles form: ① ARIZ works by identifying and resolving problematic technical contradictions; ② when using ARIZ to solve the problem, problem solvers of the inertia thinking factors must be controlled; ③ ARIZ also continue to be widely To-date knowledge base of support.

With the ARIZ software applications, a bureau of the researchers in conjunction with iron-related research institutions access to domestic and foreign patent databases and software layered screening, reduce high-speed railway tunnel aerodynamic effects of the problem for the following specific aspects of reconstruction (main): Question 1: How to Vehicles approaching the tunnel at high speed reduces aerodynamic effect? Question 2: How to reduce the friction caused by high speed air flow? Question 3: How to reduce high-speed car piston wind? Question 4: How to reduce noise near the mouth of the tunnel? Question 5: how to consider the structural design of tunnel?

*TRIZ innovative approaches to issues related to module design*

(1) Question 1: the structure of the tunnel when high-speed vehicles approaching?

To reduce the high-speed transient when the car approached the tunnel pressure, increasing the tunnel section, is an effective way, but the tunnel profile can not be unlimited increase

Definition of technical contradiction: stress, pressure vs. the size of stationary object

35.30.13.2	29.2.40.20	5.35.14.2	2.0.15.30	8.10.10.37
	7.17.4.35		13.4.0	8.10.19.35
17.7.10.40		35.8.2.14		17.10.4
	7.14.17.4		29.30.4.34	28.10
41.42.43.44.45.46				19.30.35.2
	41.42.43.44.45.46		29.4.30.34	1.10.35.36
		41.42.43.44.45.46		15.35.36.37
	7.29.34			2.10.37
1.10.36.37	15.9.12.37	2.36.10.37	41.42.43.44.45.46	13.20.15.19
10.15.36.37	6.35.10	35.24	13.20.15.12	41.42.43.44.45.46
	14.4.15.22	7.2.35	6.35.36	36.35.21
39	20.10.19.39	34.20.35.40	35.15.34.18	35.10.37.40
9.40.20	10.15.14.7	9.14.17.15	33.15.20.18	10.35.21.16
	10.2.19.30		8.13.26.14	10.18.3.14
		35.34.30	3.35.5	19.2.16
35.30	34.39.40.10	35.6.4	2.20.36.30	35.10.3.21
	2.13.10		10.13.19	26.19.6
	35.13.10		0.15.35	16.26.21.2
				36.37

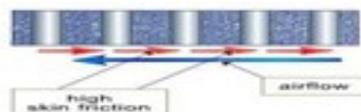


**Pre-action principle:**

- A. Pre-impose the necessary changes to the objects;**
- B. Pre-placement of objects, making it the most convenient location in the beginning without wasting time**

(2) Question 2: How to reduce high-speed air tunnel friction block?

Input module problem solution: functional input: (How to) lower friction



Inspiration: the design of the tunnel wall, drawing the patented micro air blast structure to reduce the friction lining block wall reverse flow.

(3) Question 3: Tunnel high-speed truck piston structure decreases wind?

How to understand the technical contradictions implicit from the Pistons from the wind tunnel?

High-speed vehicle traffic in the tunnel, the car in front of the air being compressed, and the train entered the tunnel after the end of a certain negative pressure, the formation of the so-called "piston style." then, Speed, wind tunnel effect that is shortened, so that the exhaust air cannot be as timely and smoothly as open air along the air side of the formation of the flow around the train Week

Technical contradictions define the problem: the role of stationary object time vs. Stability, Digestion piston air

quality principle of local technical contradiction.

(4) Question 4: How to reduce noise near the mouth of the tunnel?

Solution modules: (How to) reduce noise



Inspiration: consider partial tunnel lining wall sandwich structure, built-in sound active secondary market, according to the source of the frequency, amplitude, phase offset noise more effectively

(5) Question 5: how to consider the structural design of tunnel?

The technical definition of tunnel lining contradiction: the area of stationary object vs. the object of the harmful factors



**Segmentation theory:**

**A. Put an object into independent parts;**

**B. The object take part into some easy assembly and disassembly ones;**

How to change airflow lining for harm into?

How to split lining to reduce aerodynamic effect?

Two innovative structural design principles of the Enlightenment lining

"Split", "change harm into" the principle of "elimination of fluid pressure pulse," a reflection of the program:

Inspiration: learning where "destructive coherent" variation harm into ideas, split lining, the lining have "devastating for coherent wind tunnel" functional design.

Segmentation, variable harm into the design of the lining of the implementation: the tunnel lining is divided into the two outer layers 1; equidistant at intervals on each opening 4,5, 4 tilt outward opening (arrow shows Car driving directions); high-speed vehicles to enter the tunnel, the airflow direction is mainly two: car head forward and outward; piston wind back the flow of cars. Merry respectively by these two openings 4, 5 in the lining laminated together, coherence, thereby reducing the dynamic effects of air inside the tunnel.

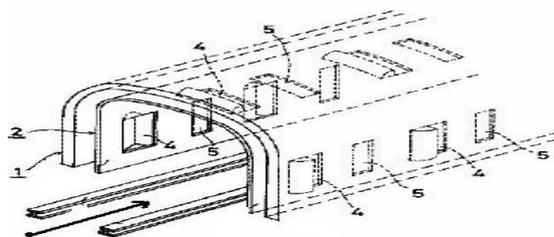


Fig.1 Schematic diagram of the preliminary design of lining

*Steps to achieve the final operation*

TRIZ theory and related applications Pro /Innovator (Computer Aided Innovation CAI) system, the success of a bureau of China Railway high-speed railway tunnel concept to solve the implementation issues, based on the above

process, so quick to find an effective method of technical improvements and changes, the main Are: ① additional horn front-end tunnel with ventilation holes in the buffer section; ② tunnel wall lining laminated to consider the second sound field active noise reduction built; ③ consider the micro-blast tunnel wall structure to reduce friction; ④ tunnel port Additional controlled air curtain design; consider the wind tunnel vents road steering, exhaust noise damping device design; ⑤ key consideration single-hole high-speed railway tunnel lane structure; ⑥ tunnel lining is divided into inner and outer two Layer, the inner and outer openings with appropriate structure.

Such as the central region less developed regions, in order to achieve "leapfrog" development, "carry catch-up" concept implementation, the application of innovative methods and the implementation of relevant policies and implementation is critical, the focus should select the environment and awareness of innovative enterprises, May exist for specific innovative projects to focus on integration of support, to be achieved outstanding results point to an area after the roll-out work and innovative practices continue to accumulate in the growth of total capacity and economies of scale.

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