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Research on Innovative Design of Multifunctional Tables and Chairs based on TRIZ Conflict Resolution Principle

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Abstract

In order to provide a design innovation process based on logic, it was studies how to use TRlZ theory and tools in industrial design. According to the concept of innovation level in TRIZ, the level of difficulty of industrial design was pointed out. By using the previous findings of comparative study about the conflict theory, the separation principle, the principle of invention, TRlZ, ideality. substance field analysis and the effect library and other tools in TRIZ, the applicability of these tools in industrial design was analyzed. Then an industrial design innovation process model was set up by combining TRIZ conceptual design process with general industrial design process. At last, the model was used to design the shape and transformation mechanism of a kind of multifunctional desks and chairs, also its validity was verified.

Keywords

TRIZ; Multifunctional Desks and Chairs; Separation Principle.

1. Overview of TRIZ Theory

TRIZ is the Russian abbreviation of "theory of solving invention problems".It is a theoretical system formed by the research institute led by the former Soviet expert Archie Schuler, on the basis of analyzing nearly 2.5 million high-level invention patents in the world and integrating the principles and rules of multidisciplinary fields. In 1946, Archie Schuler, a naval patent investigator of the Soviet Union, was keenly aware of the existence of some common models for solving problems in these patents because he read a large number of documents during his work. [1] Every creative patent basically solves the problems of contradictions, and the basic principles for solving these contradictions are repeatedly used, often after several years. Based on this, archischuler reasoned that the scientific principles and laws sought in the process of solving invention problems are objective, and the basic problems and contradictions faced by a large number of inventions are the same. The same technological innovation principles and corresponding problem solutions will be repeatedly applied in subsequent discoveries, only in different technical fields. Therefore, the existing knowledge can be refined and reorganized to form a systematic theory, which can be used to guide the invention and innovation of the later. If later inventors can have the knowledge of early solutions, their innovation work will be easier.”. Archie Schuler wrote down his questions in his notes at that time.

The TRIZ theoretical system takes dialectics, system theory and epistemology as the philosophical guidance, the analysis and research results of natural science, system science and thinking science as the foundation and pillar, and the evolution law of technology system as the theoretical basis and core idea, including various analysis methods, problem-solving tools and algorithm processes required to solve engineering contradiction problems and complex invention problems. [1]

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TRIZ theory helps to solve complex invention problems characterized by technical conflicts and physical contradictions.

2. Technical Conflict Resolution and Resolution Process

2.1 Determination of Technical Conflict

Function is an understanding of the product from the perspective of technical realization, and an abstract description of the changes of parameters or states of the product when it is input and output under specific constraints. [1]When carrying out the innovative design of products, first of all, starting from the functions of products, through the analysis of functions, the ideal functions and harmful functions of current products are pointed out, that is, the existing technical conflicts are determined. The so-called technology conflict refers to a certain role in the system, which simultaneously produces two kinds of effects that are beneficial and harmful to the design purpose.

2.2 Product Design Process based on TRIZ Conflict Resolution Principle

The process of product design based on TRIZ conflict resolution principle is to solve the technical conflict existing in the improvement of product function and appearance, [1] Fig. 1

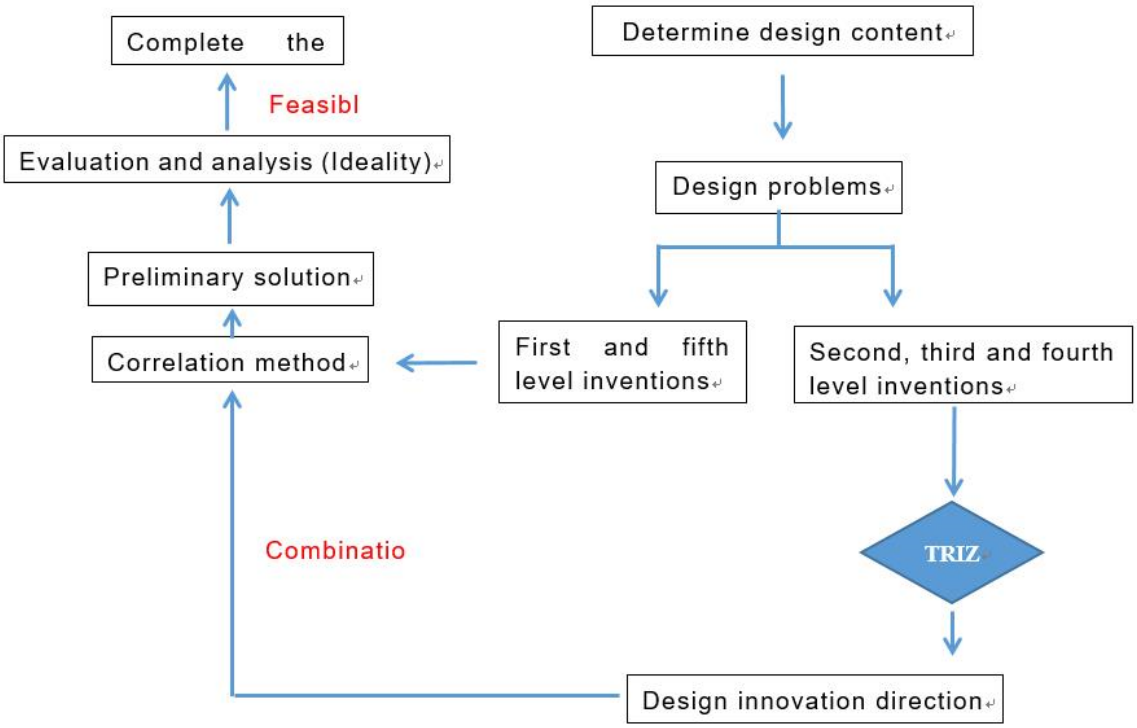

Fig 1. Product design process based on TRIZ conflict resolution principle

Firstly, the function of the product is analyzed to find out the ideal function and harmful function, and determine the technical conflict; Determine its invention level; Then 39 engineering parameters corresponding to TRIZ theory are used to describe the determined technical conflict, and the corresponding invention principle is obtained by searching the conflict resolution matrix; Inspired by the principles of invention, designers can get corresponding solutions to technical conflicts based on experience and inspiration.

3. Design of Multifunctional Tables and Chairs

The teacher's desks and chairs are fixed when the college students are in the level classroom, which is convenient for the students to listen to the class but not convenient for the students to communicate with each other, such as group discussion and group meeting. Our task is to use TRIZ theory to design

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a desk and chair fixed on the ground, which has the basic functions of existing products and is convenient for front and rear students to communicate face to face. [1]

3.1 Determination of Invention Level

List of invention grades, see Table 1.

Table 1. List of invention grades

Invention level	Main features	Example
Rationalization proposal for the first invention level (accounting for 35% of the total)	Original condition	A project with a general engineering parameter.
	Problem source	The problem is clear and easy to solve.
	Scope of knowledge required for problem solving	Basic professional training.
	Degree of difficulty	There is no contradiction in the subject
	Transformation law	Significant changes have taken place in the corresponding engineering parameters.
	Changes after problem solving	There are obvious changes in the corresponding characteristics.
The second invention level is moderate new innovation (accounting for 45% of the total)	Original condition	With several general engineering parameters and structural model.
	Problem source	The problems existing in the system are not clear.
	Scope of knowledge required for problem solving	Traditional professional training.
	Degree of difficulty	Standard questions
	Transformation law	Select common standard models.
	Changes after problem solving	The function and structure of the original system are solved under the condition that the principle of action is unchanged.
Third invention level patents (accounting for 16% of the total)	Original condition	Heaps of workload, only functional model topics.
	Problem source	It is usually derived from knowledge in other hierarchies.
	Scope of knowledge required for problem solving	Innovative ideas of development and integration.
	Degree of difficulty	Non-standard issues.
	Transformation law	Solving invention problems with integrated methods.
	Changes after problem solving	In the case of changing the principle of action, the use of the system becomes a valuable and highly effective invention.
The fourth invention level comprehensive important patent (accounting for 3% of the total)	Original condition	There are many uncertain factors, and structural and functional models are unprecedented topics.

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	Problem source	From different fields of knowledge.
	Scope of knowledge required for problem solving	Profound knowledge and ability to break away from traditional concepts.
	Degree of difficulty	Complex problem.
	Transformation law	Using effect knowledge base to solve invention problems.
	Changes after problem solving	"Advanced invention" that makes the system produce extremely high efficiency and will obviously lead to the change of similar technical systems.
New discoveries of the fifth invention level (1% of the total)	Original condition	There are no original goals and no existing models.
	Problem source	Neither source nor purpose is clear.
	Scope of knowledge required for problem solving	Apply the knowledge of all mankind.
	Degree of difficulty	Unique and abnormal problems.
	Transformation law	Major breakthroughs in science and technology.
	Changes after problem solving	"Outstanding invention" that will cause sudden changes in the system and lead to social and cultural changes.

There are many similar solutions for multi-functional tables and chairs.

3.2 Conflicts and Solutions

TRIZ theory divides the contradiction into two categories: technical contradiction and physical contradiction.

1. Three common situations of technical contradiction:

(1) Introducing a useful function into one subsystem leads to a harmful function in another subsystem.

(2) Eliminate one harmful function and cause the useful function of another subsystem to decline.

(3) The enhancement of useful functions or the decline of harmful functions makes another subsystem too complex.

2. Two common situations of physical contradiction:

(1) The enhancement of useful functions in a subsystem leads to the enhancement of harmful functions of the subsystem.

(2) The decrease of harmful functions in a subsystem will lead to the decrease of useful functions of the subsystem.

This design is a desk and chair fixed on the ground. It has the basic functions of existing products and is convenient for front and rear students to communicate face to face. Because the desks have the function of communicating in front and back rows, the excessive communication function will lead to the inability to listen carefully, so the type of contradiction is physical contradiction.

Physical conflict 1: we want it to be fixed to avoid loss, and we also want it to be active to achieve multi-function. The solution is as follows: using the principle of integral and partial separation, the support is fixed, and the support surface is designed as a movable structure. The problem is solved.

Physical conflict 2: both support surface a (or b) and chair surface a (or b) are desired. In short, a certain support surface should meet the height requirements of both the desktop and the chair surface,

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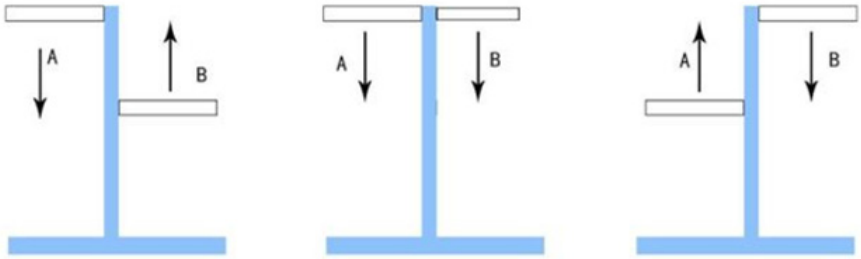
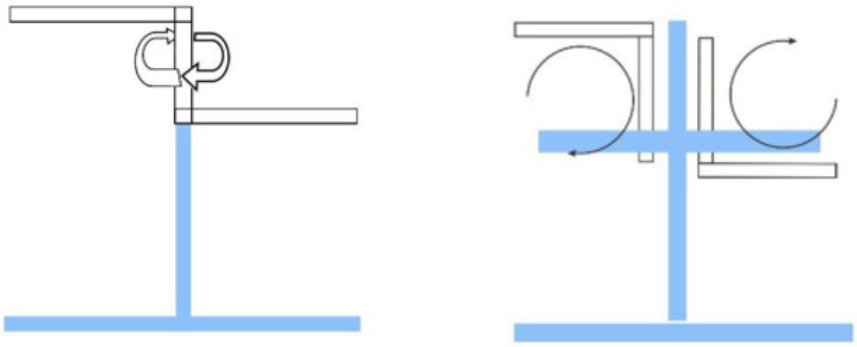
and there is a conflict between the height and the height. The solution of physical conflict 2 is as follows: the support surface cannot be high and low at the same time, and it is difficult to obtain a specific solution by using the time separation principle. At this time, you can refer to the correspondence table between the separation principle and the invention principle. The time separation principle corresponds to Articles 9, 10, 11, 15, 16, 18, 19, 20, 21, 29, 34 and 37 of the invention principle. Considering the specific situation, it is found that the inventive principles 15 (dynamic principle) and 29 (air pressure and hydraulic structure principle) are valuable here, and three schemes are designed accordingly, Fig. 2



Scheme 1 invention principle 29: pneumatic or hydraulic structure



Scheme 2: schematic diagram of solution to physical conflict 2 inventive principle 15: dynamic

Scheme 3: schematic diagram of solution to physical conflict 2 inventive principle 15: dynamic

Fig 2. Three design options

Scheme 1 adopts the principle of pneumatic lift chair to realize the height change of support surfaces a and B.Scheme 2 rotates around the vertical axis to realize the position exchange of tables and chairs. Scheme 3 rotates around the horizontal axis to realize the table and chair surface conversion.

3.3 Ideality Screening

The ideal is calculated as follows:

$$I = \sum B_e / (\sum E_x + \sum H_a) \quad (1)$$

I—Ideality

$\sum B_e$—Function and benefit

$\sum E_x$—Cost

$\sum H_a$—Harm

Scheme 1 is not easy to manufacture using a pneumatic hydraulic scheme, and there are hidden dangers such as air leakage, leakage and even explosion, and its $\sum E_x$ and $\sum H_a$ values are large.

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Scenario 2 still does not meet the needs of face-to-face communication, $\sum B_e$ value is small, exclude, herefore, scheme 3 with the highest ideality is selected, Fig. 3

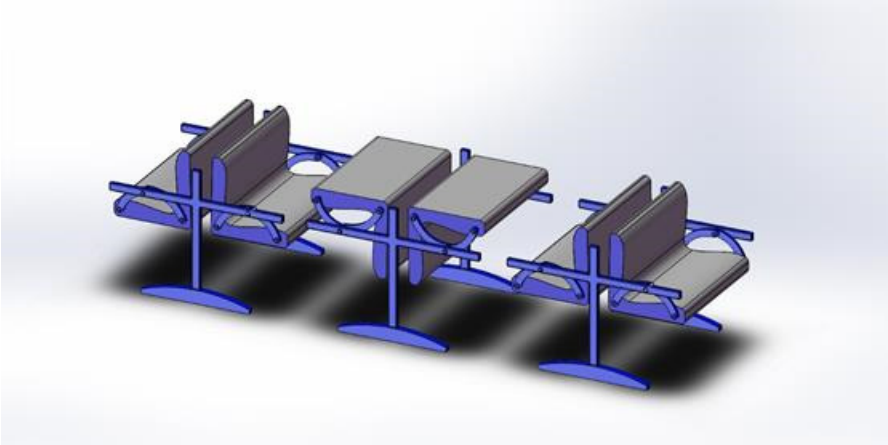

Fig 3. 3D solid

4. Conclusion

The product design method integrating TRIZ theory is mainly driven by user requirements, and solves the problem of user requirements for products through demand transformation and the selection and design of specific implementation methods. This method makes up for the deficiency of a single design method to a certain extent, and has the advantages of clear hierarchy and complete system. It can guide designers to quickly make correct design decisions and implementation scheme selection according to user needs in the process of product design, and improve product design efficiency and quality.

Acknowledgments

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