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Definition of System Innovation Degree and its Measuring Method

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Abstract

In classic TRIZ, Genrich S. Altshuller proposed five levels of innovation (LOI), but in practice, people usually are confused on how to evaluate the degree of an innovation when the solutions are within the same innovation level which is vertical and qualitative designed.

To distinguish the difference of the innovations who belong to the same innovation level, authors propose a new concept, in horizontal and quantificational way, S*ystem Innovation Degree* (SID), and a proposal for measuring the SID with the support of International Patent Classification (IPC).

Finally, with a case study, the paper shows how the SID and its measuring method work.

Keywords: Levels of system innovation, International Patent Classification, Method to evaluate the degree of an innovation.

1. Introduction

It is well known that Genrich S. Altshuller has proposed the five levels of innovations (LOI) as following:

Level 1: Technology Transfer—a simple improvement of a technical system—requires knowledge available within the trade relevant to that system.

Level 2: Knowledge Exchange—an invention that includes the resolution of a technical contradiction—requires knowledge from different areas within the industry relevant to the system.

Level 3: Knowledge Collaboration—an invention containing a resolution of a physical contradiction—requires knowledge from other industries.

Level 4: Knowledge Innovation—a new technology is applied which contains a resolution of contradictions with better approach to Ideal Final Result—this new technology includes a breakthrough solution that requires knowledge from different fields of science.

Level 5: Innovation Networks—discovery of a new phenomenon or substances—this new knowledge provides for the development of new technologies with utilization of the new phenomena, resolving existing contradictions with better approach to the Ideal Final Result (Kraev, 2006).

With the problems of the first level, the object (device or method) does not change. At the second level, the object is changed but not substantially. At the third level, the object is changed extensively and at the fourth, it is totally changed. In the fifth level, the entire technical system is changed in which this object is used.

We know that levels of innovations proposed by Genrich S. Autshuller could be used to 1) determine the stage of a technical system in the S-curve and 2) indicate the level of innovations is high or low. But we should understand sometimes that the level of innovations is high or low doesn't means that the innovation is good or not good for the enterprises, the reason is some high level of innovation will lead high cost and long time to realized.

According to the definition of the levels of innovations proposed by Genrich S. Autshuller, People can vertically distinguish the levels in different degrees, while, if there are two or more innovations labeled in the same level, how can people evaluate the degree of these innovations objectively?

It is clear that the classic levels of innovation need to be improved by a new method which could distinguish the degrees of innovations in horizontally.

Even though some people thought that distinguishing of the different levels of innovation is more important than the distinguishing within the same level (Tan, Ru, and Babbitt, Tr., 2008), but in the most of enterprises, the innovation usually is an asymptotically process with the limited of resources or some economic factors, in another word, people usually will choose the solutions within the same level of innovation, which indicates that distinguishing the degrees within the same level is meaningful.

2. Method Propose

In order to evaluate the degree of an innovation which is within the same innovation level, we introduce a new concept which we called as System Innovation Degree (SID). It is of measurement to the innovations which locate at the same level of innovation defined by Genrich S. Altshuller.

With the help of SID concept, people could evaluate the degree of some innovations in the same level of innovations，in another word，SID could be used to evaluate the degrees of an innovation in horizontally and quantificational, which is entirely different from the 5 levels of innovation, the SID and 5 levels of innovation are shown in Fig.1.

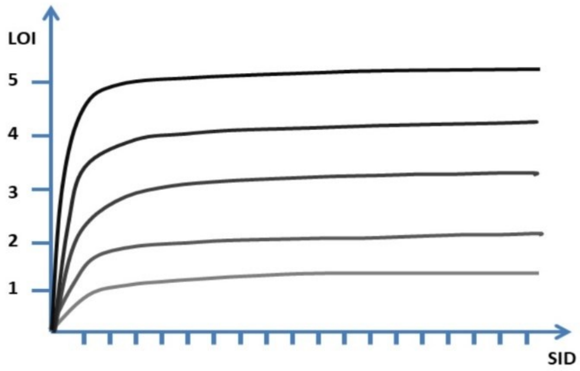

Fig. 1 Degrees and Levels of Innovations.

To the concept of SID, we should put forward a method for measuring. A lot of proposals could be used to measure the SID. Such as the ideality of the solutions, the cost of the solutions or the functionality improves of the solutions, etc. But as people known, these proposals will got the different results based on the different calculate factors (ideality), different market price (cost) or different viewpoints (functionality improves). Based on the universality, authority and consistency, we propose a reference proposal by means of IPC (International Patent Classification) to measure the SID of the solutions.

We know that the objective of the IPC is being a means for obtaining an internationally uniform classification of patent documents. It's primary purpose is to establish an effective search tool for the retrieval of patent documents by intellectual property offices and other users, in order to establish the novelty and evaluate the inventive step or no obviousness (including the assessment of technical advance and useful results or utility) of technical disclosures in patent applications (International Patent Classification Guide, Version 2013).

The layout of classification symbols in IPC is including four levels: Section, Class, Subclass and Group.

Section: This Classification represents the whole body of knowledge which may be regarded as proper to the field of patents for invention, divided into eight sections. Sections are the highest level of hierarchy of the Classification. The eight sections are titled as follows:

A HUMAN NECESSITIES
B PERFORMING OPERATIONS; TRANSPORTING
C CHEMISTRY; METALLURGY
D TEXTILES; PAPER
E FIXED CONSTRUCTIONS
F MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING
G PHYSICS
H ELECTRICITY

Subsection: Within sections, informative headings may form subsections, which are titles without classification symbols. Example: Section A (HUMAN NECESSITIES) contains the following subsections:
AGRICULTURE
FOODSTUFFS; TOBACCO
PERSONAL OR DOMESTIC ARTICLES
HEALTH; LIFE SAVINGS; AMUSEMENT

CLASS: Each section is subdivided into classes which are the second hierarchical level of the Classification.
SUBCLASS: Each class is comprised of one or more subclasses which are the third hierarchical level of the Classification.

GROUP: Each subclass is broken down into subdivisions referred to as "groups", which are either main groups (i.e., the fourth hierarchical level of the Classification) or subgroups (i.e., lower hierarchical levels dependent upon the main group level of the Classification).

COMPLETE CLASSIFICATION SYMBOL

A complete classification symbol comprises the combined symbols representing the section, class, subclass and main group or subgroup. Example is shown in Fig. 2 (International Patent Classification Guide, Version 2013):

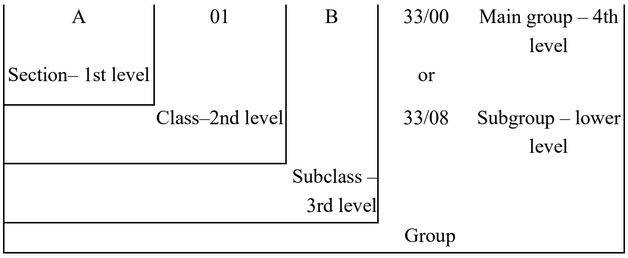

Fig. 2 Full structure of IPC class.

Based on the definition of IPC, we could determine the value of a SID for a solution using the following procedure.

First of all, we should identify the IPC number of the existing system and the solutions from the IPC. Once we finger out numbers of the existing system and the solutions, we could begin to calculate the value of SID for each solution separately in allusion to the existing system. The calculating could be done from the highest level of IPC-Section to the lowest one because the IPC is a hierarchical classification system. We could choose the subject of the existing system as the main subject, we set up this subject as number 1 in spite of this subject is belongs to A, B, C, D, E, F, E, G or H, and take the solution as the number n in clockwise; here n is countered from main subject according the IPC classification. Shown in Fig.3, thus the value of this SID of the solution in the section level equals n-1. Or $n_S = n-1$. For example, if the problem is belong to Section A, HUMAN NECESSITIES, while the solution belongs to Section E, FIXED CONSTRUCTIONS, then the value of SID of the solution in section level equals E-A , i.e. $n_S=5-1=4$. This calculating process of SID could be repeated in order for the other hierarchical levels in IPC (Section, Class, Subclass Group and subgroup). Finally, when we finished the counter in whole levels of IPC, we will get a summation: $N=n_S+n_C+n_{SC}+n_G+n_{SG}$, this summation N is the value of SID for this solution. See Fig.3 for the details.

It is similar to the levels of innovations proposed by Genrich S. Autshuller, the value of SID of a solution is large or small doesn't means the solution is better or not. A solution is better or not usually will be determined by non-technical factors in enterprise.

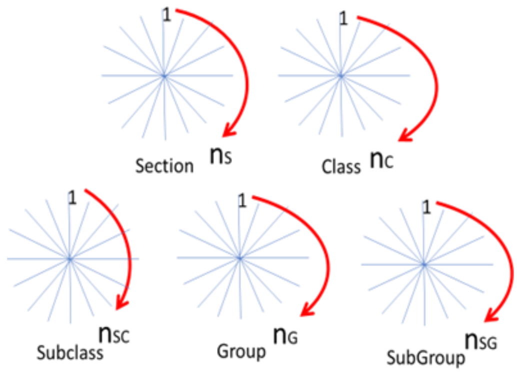

Fig. 3 Value of SID Calculating Method based on IPC.

3. A Case Study

Here, we introduce a real example to show how the SID works in the real innovation world.

Fig. 4 Wind Turbines in Working.

Project name: Wind Turbine Improvement;

Project Description: Wind turbine works the opposite of a fan. Instead of using electricity to make wind, a turbine uses wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. The electricity is sent through transmission and distribution lines to a substation, then on to homes, businesses and schools.

Project Goal: Improves the productivity of the three blades wind turbine without increasing the cost.

To simplify the process, we take the technical contradiction (TC) overcoming as our example of SID measuring. It is well known the solutions with technical contradiction overcoming are belong to level #2 in LOI proposed by Genrich S. Altshuller

After analysis, we got the first pair of TC_1, which is shown in Fig.5 .Of course, there are a series of pairs of TC, and the solving process is of analogical. It is unnecessary to go into details.

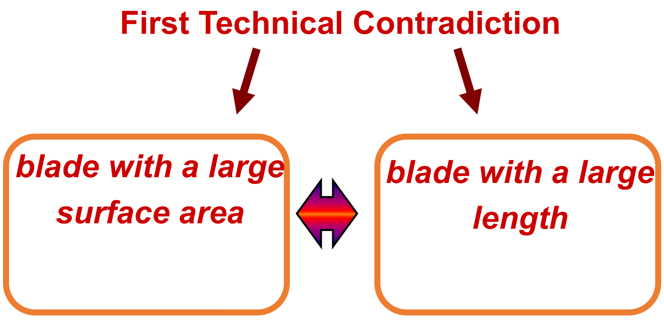

Fig. 5 The TC1 in Wind Turbine.

By means of Altshuller's Matrix, we got four recommendations, shown in Fig. 6.

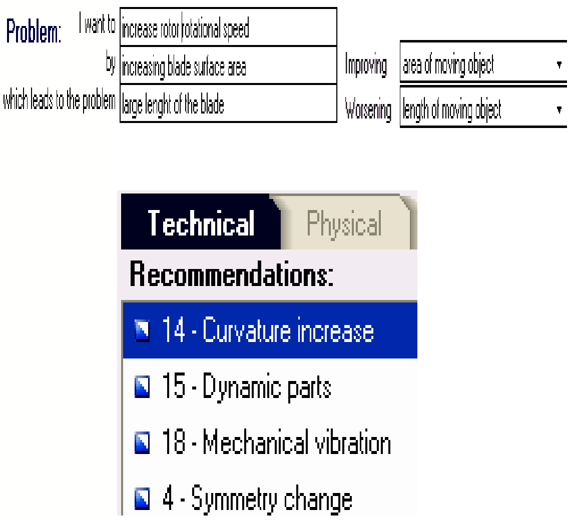

Fig. 6 Recommendations for TC1.

Based on these recommendations, finally we got the following solutions**,** shown in Fig.7 **(**Wind Turbine project, Isak Bukhman).

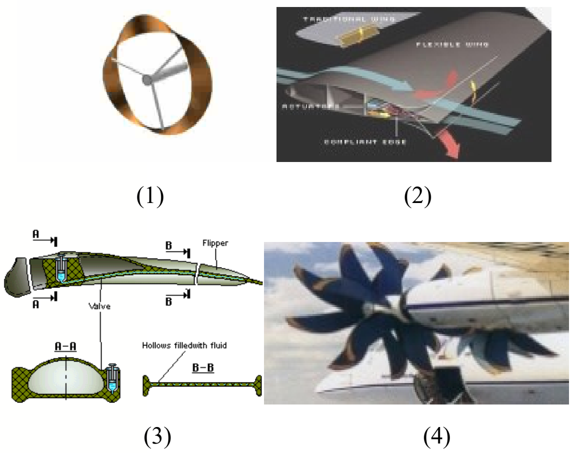

Fig. 7 Final Solutions for TCs in Wind Turbine.

(1) Blade in form of MOBIUS Belt; illuming from 14 **Curvature increase**
(2) Flexible Wing – Blade; illuming from **18 Mechanical vibration**
(3) Variable-rigidity flipper – blade; illuming from 15 **Dynamic Parts**
(4) Doubled propeller – Doubled blades; illuming from **4 Symmetry Change**

According to IPC, We can find out that the IPC Number for wind turbine is F03 D 1/00. Based on this IPC number and Table1, we can get the value of the SID for each solution by the method mentioned in this paper, the result is shown in the Table 2.

Table 1 IPC Section and Subclass number for IPC F03 D 1/00.

IPC Section and its number	IPC Subclass and its number
A-4	A-24
B-5	B-25
C-6	C-26
D-7	D-1
E-8	E-2
F-1	F-3
G-2	G-4
H-3	H-5
	–
	Z-23

Table 2 SID Value of Each Solution.

#	Solutions	Relevant IPC No.	SID	Calculating Procedure
1	Blade in form of MOBIUS Belt	B63H 1/26	94	=(5-1)+(63-03)+(5-1)+(1-1)+(26-00)
2	Flexible Wing - Blade	B64C 3/44	136	=(5-1)+(64-03)+(26-1)+(3-1)+(44-00)
3	Variable-rigidity flipper - blade	F03D 7/00	6	=(1-1)+(03-03)+(1-1)+(7-1)+(26-00)
4	Doubled propeller - Doubled blades	B64D 27/00	91	=(5-1)+(64-03)+(1-1)+(27-1)+(00-00)

Now, according the value of SID, we can easily ranking each solution which belongs to the same levels of LOI. This kind of evaluate criteria is objectively.

4. Conclusion

Traditional or Classic TRIZ proposed five levels of innovations, but it is not enough to distinguish the difference of the innovations which belong to the same levels in practice. The distinguishing of those innovations is important for enterprises sometimes.

The paper also proposed a reference method to measure the difference of innovations which belong to the same level of innovations based on IPC and hope it will be helpful to distinguish the innovation solutions impersonal.

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AUTHOR BIOGRAPHIES

Michael Yongmou Liu is CEO at GET group in P.R.C since 2007. Before then, he has 11 years of industrial experience in the aviation industries with Gas Turbine Establishment of China, 13 years of CAD/CAD/CAE experience in IT industries with IMAG Industries Co. Ltd and MSC Corp, and he has also 13 years of systematic innovation CAI experience with IMA Co., Ltd. Michael received his EMBA degree at Renmin University of China in 2001. He holds a B.S.M.E. degree from Shenyang Aerospace University and an M.S.M.E. degree from Northwest Poly-technical University. He also got MATRIZ level 3 from International TRIZ Association in 2007. He is currently the Vice President of the Society of Innovation of Chengdu China. His area of business includes Systematic Innovation, TRIZ, Computer Aided Engineering and Factory Simulation.

Bill Yuanbo Liu is a student in master degree program of accountancy at Purdue University Calumet in United States. He has a Bachelor's degree of Science in Management. In 2010, he had a patent with published number of CN101940832A. Now he is focusing on the study in application of Six Sigma.