DOI:10.6977/IJoSI.201101_1(3).0001
Tien-Lun Liu, Shao-Ting Kuo / Int. J. Systematic Innovation 2-12 (2011)

A Study of Applying TRIZ to Technological Patenting Deployment

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Abstract

Under the trend of economic globalization, the new survival competitions among enterprises are their patenting capabilities and tactics. The enterprises not merely need patent improvements in "quantity" to protect their researches, but also in "quality" to develop crucial core patents for gaining profits from intellectual property. This research explores various methods in TRIZ and studies how patent activities can be assisted effectively by the right method, then further look into how patenting strategies can be carried out in depth or in breadth. S-curve Analysis and System Operator Analysis should be used for patent trend examination. Evolutionary Trends and Knowledge/Effects may be applied to constructing technological patent roadmaps. In addition, Contradiction Analysis and Function Analysis with Attributes are beneficial for strategic patenting both in depth and in breadth. We also make several observations from the viewpoint of patenting patterns, and compare the similarities between design-around methods and TRIZ inventive principles in order to help construct an integrated patenting strategy.

Keywords: TRIZ, Patent Analysis, Patenting Deployment.

1. Introduction

Currently Taiwan's technology developments are good enough to compete in the world. The quantity of patent production is stable every year. However, the improvement in patent quality can truly realize the value of intellectual property. For example in Taiwan's electronic industry, lots of enterprises which do not have their own core patents are then suffering huge royalty payment. Therefore how to enhance enterprises' research capabilities and develop significant core patents is a very important issue nowadays. Recent researches in TRIZ applications related to patents are mostly focused on how to design around patents, but not much attention on patenting strategies. By going through patent trends analysis, we may transform the collected results into useful information such as current status and future development, etc.. In this research, we intend to discuss TRIZ methods in the area of patenting strategy and plan to provide several guidelines for enterprises to consider how to patent their researches in depth and in breadth.

2. Background and literature review

2.1. TRIZ

TRIZ is a Russian acronym, translated in English as Theory of Inventive Problem Solving (TIPS). The TRIZ theory was mainly developed by Russian scientist G. Altshuller in 1946 (Altshuller, 2000). He and his colleagues analyzed hundreds of thousands of patents and classified methodically. They concluded

the inventive principles and solving techniques involved in these patents to a systematic innovation approach.

There are various methods and tools in TRIZ, including Problem Formulation, Contradiction Matrix, 40 Inventive Principles, Functional Analysis, Separation Principles, Substance-Field, Ideal Final Result, Effects, ARIZ, etc. The advantages of the TRIZ lie in its broad technical extent. For instance, the thinking direction of a mechanical engineer tends to be confined to his or her specific domain of knowledge. Nevertheless through TRIZ, we are likely to acquire solutions from different fields of knowledge such as electrics, chemistry, biochemistry, etc. The TRIZ theory not only breaks the bottleneck of limited acquaintance but also provides a more systematic search method for technical solutions.

Although a rather complete theoretical system has formed after 60 more years of the TRIZ theory development, relevant researches continue because the innovation is an incessant task. It is especially discussed extensively after the Soviet scholars introduced it to the western countries. The domestic researches of the TRIZ are gradually and systematically developed through the establishment of relevant academies. Chinese transliterations for the TRIZ indicate that the TRIZ spirits lie in the wisdom of collection, extraction, thinking, etc. Currently, relevant developments of TRIZ researches are mainly as follows.

- Revisions and Modifications of the TRIZ theoretical system (Mann, 2002).
- Practical applications of the TRIZ to the technical problem-solving and the innovative products development (Wang, 2002; Domb, 1997; Royzen, 1997).
- TRIZ software developments such as Creax, Goldfire, IWB (I-TRIZ), etc.
- TRIZ-incorporated applications with other design theories (Liu *et al*., 2008; Andrew and Madara, 2005; Yang and Zhang, 2000; Chang and Teng, 2008).
- Extended TRIZ applications other than technical systems, such as in the service, management, software programming, etc. (Mann, 2007; Chen, 2003)

2.2. Design around

Designing around (or Inventing around) is a responsive strategy that an enterprise contests with allegations of infringement on patents. Starting from imitating of patents, it requires the sufficient understanding of elements established for the infringement so as to look for creative outcomes with market values rather than patent infringement. The vitalest part of designing around a patent is to judge whether an infringement occurs. There are three judgment principles: All Elements Rule, Doctrine of Equivalents, and File-Wrapper Estoppel. Different methods of design-around are shown in Table 1.

Table 1. Design-around methods (Nydegger and Richards, 2000)

Methods	Original Patent Attributes → Post Design-Around Attributes	Statements
Elimination	A+B+C+D →A+B+C	Circumvention of the All Elements Rule

Replacement	A+B+C1+D1 →A+B+C2+D3	Technical Attribute C1≠C2 Technical Attribute D1≠D3 Circumvention of the All Elements Rule & the Doctrine of Equivalents
Combination	A+B+C+D →A+B+E	Technical Attribute C+D≠E Circumvention of the All Elements Rule & the Doctrine of Equivalents
Decomposition	A+B+C+D1 →A+B+C+D2+D3	Technical Attribute D1≠D2+D3 Circumvention of the All Elements Rule & the Doctrine of Equivalents

The relevant researches on the TRIZ methods with the patent-related concerns mostly probe into the design-around issues. For examples, Hsu (2010) and Hung (2007) constructed an integrated design around approach by systematically incorporating patent information, the rules of patent infringement judgment, strategies of designing around patents, and innovative design methodologies. During the design-around process, they mainly used the *contradiction matrix* or *su-field analysis* to generate an engineering solution. Chang and Teng (2008) constructed the patent analysis via indexing the patent information, sifting through the scope of patent rights and evaluating the points of design-around. They then conduct the re-design for a patented safety pushpin through contradiction analysis and the *Independence Axiom* of Axiomatic Design.

Unlike designing around existing patents, our study starts from the viewpoint of patenting strategies for a novel technology or a core patent, and makes direct connections among the concepts of patenting activities and the various TRIZ methods.

2.3. Patenting strategies

The so-called patenting strategy means the allocation and deployment for the patent rights, which include patenting in regions, patenting over time, and patenting in technology space. The further explanations are described as follows:

- The strategic patenting in regions is related to the consideration of patents to be registered in different countries, where the enterprises should have plans for their business.
- The strategic patenting over time is related to the life cycle of a patent. Different types of patents have various life spans, and the corresponding products also have their own life spans. Thus, when to apply and whether to continue the claims for the patents are both relevant to this category.
- The strategic patenting in technology space is the deployment that focuses on the core of technical innovations. This category is primarily that TRIZ can play an important role.

This research is focused on the issue of technological patenting strategies, which were first systematically classified by Granstrand (1999) into six patterns as briefly described below. The illustrations of these patent strategies are shown in Fig. 1.

(1) Ad hoc blocking and inventing around: One or a few patents are used in this case to protect an

innovation in a special application. The difficulty of design around in this category is usually low.

(2) Strategic patent searching: A single patent with a large barrier in between R&D isocost curves is called a strategic patent, which may be a key technology and will cause high design-around cost.

(3) Blanketing and flooding：The relative patents are distributed as a minefield or in a less structured form. Some of these patents may be insignificant but a nuisance to slow down competitors.

(4) Fencing： This refers to the situation where a series of patents, ordered in someway, block certain directions of R&D. Fencing is typically used for a range of possibly quite different technical solutions for achieving a similar functional results.

(5) Surrounding：This is the case that a core patent from a competitor is surrounded by other less important patents, which collectively block the effective commercial use of the core patent. Then in turn we would create possibilities for cross-licensing.

(6) Combination into patent networks: This refers to a patent portfolio in which patents of various kinds and configurations are used to strengthen overall protection.

A further research was done by Ikovenko (2006) who proposed five major steps of designing and executing patent strategies from the aspect of business operation. In these steps, he advanced and developed 11 types of patent strategies. For each type of patent strategy, he also suggested several so-called TRIZ*plus* tools, which are based on classical TRIZ and developed by the research group of GEN3 Partners, Inc.. His work is summarized in Table 2.

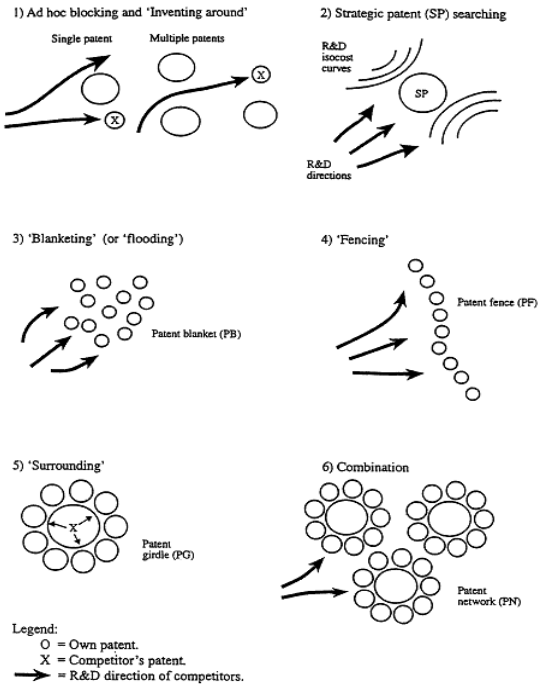

Fig. 1. Various patent strategies in technology space (Granstrand, 1999)

Table 2. Patent strategies and corresponding TRIZ*plus* tools (Ikovenko, 2006)

N	Type of Patent Strategy	TRIZ*plus* Tools
1	The Antidote Strategy	Function Analysis, Cause-Effect Chain Analysis, Trimming, Function-Oriented Search
2	The Picket Fence Strategy	S-Curve Analysis, Trends of Evolution, Function-Oriented Search, Reverse Contradiction Analysis
3	The Tall Gate Strategy	S-Curve Analysis, Trends of Evolution, MPV Analysis
4	The Submarine Strategy (old and new)	Trends of Evolution, Function-Oriented Search
5	The Counter-Attack Strategy	Function-Oriented Search, Reverse Contradiction Analysis, Semantic Tools
6	The Stealth Counter-Attack	Function-Oriented Search,

	Strategy	Reverse Contradiction Analysis, Semantic Tools
7	The Patent Busting (through Trimming)	Function Analysis, Cause-Effect Chain Analysis, Trimming
8	The Patent Busting (about the Doctrine of Equivalents and Prosecution History Estoppel)	Function Analysis, Function-Oriented Search
9	The Blanketing Strategy	Function-Oriented Search, Trends of Evolution
10	The Bargaining Chip Strategy	Trends of Evolution
11	The Cut-Your-Exposure Strategy	Function-Oriented Search

Ikovenko developed patent strategies more completely according to different practical situations, and his classification was done in a more tactical way. However, his work did not pay much attention on the issue of patenting in-depth or in-breadth with TRIZ tools, which is discussed in this research. In other words, Ikovenko considered patent strategies in a sense of bottom-up manner. Nevertheless we observe patent strategies from a top-down aspect to deploy a core technology.

For a more essential analysis without complicating our intention, this study is primarily focused on the patenting strategies in technology space based on Granstrand's classification. We then probes into the possible applications of the TRIZ, such as how to conduct patent analysis for new techniques within the industry and efficiently transform into useful reference information. Therefore, we start from a general process of patent-related events shown in Fig. 2 and then think from the standpoint of the TRIZ to see what assistance or application it can provide in these patent activities so as to conduct the patent technical deployment in breath and in depth.

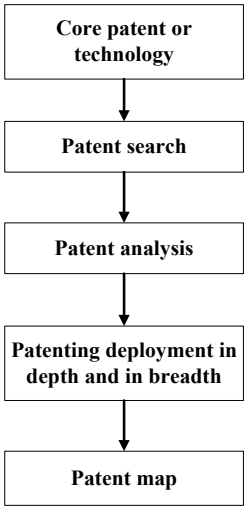

Fig. 2. A general process of patent-related activities

3. Strategies of patent analysis

After we have done patent search, two useful efforts with TRIZ are performed in the patent analysis as described below.

3.1. Patent trend analysis

The purpose that we conduct the patent trend analysis by collecting the information through the patent indexing of keywords for a certain technology is to understand its current status. The patent trend analysis involves the quantity of related patents, what countries the patents register, which company or inventor the patent belongs to, and the citation rate analysis. These pieces of information can be combined with the S-Curve analysis and the System Operator concept that are commonly used for problem definition phase in TRIZ.

(1) The S-curve is shaped as the 4 stages of Birth, Growth, Maturity and Retirement, shown in Fig. 3. The S-curve mainly helps users elaborate on the maturity of techniques or products. Its x-axis is defined as the time unit and the y-axis as the idealism of a technology or a product type. Therefore the concerned entity represented in y axis can then be examined in terms of the patent quantity, the country, the company, or the inventor for different analyses to achieve the patent trend exploration.

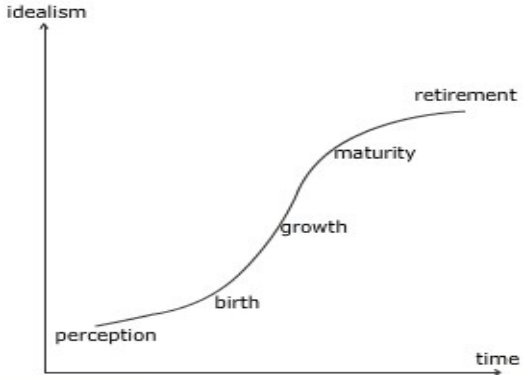

Fig. 3. S-curve characteristic

(2) The System Operator concept divides the problem of concerns into nine sections which are expressed as the "system" domain (super-system, system, sub-system) corresponding to the "time" domain (past, present, and future) as shown in Table 3.

Table 3. 9- windows representation of the System Operator

time / system	Past	Present	Future
Super-system			
System		Starting point of thinking	
Sub-system			

The purpose of the System Operator is to help that we break the psychological inertia to think in terms of time and space to consider all possible factors. Therefore, we can put the collected patents inside the 9 windows, and then trace the relations between the past and present patents of all systems as well as their super-systems or sub-systems. Meanwhile, we can also deliberate on the developments of future patents.

3.2. Technical chart analysis

The technical chart analysis is carried on after the patent trend analysis. The main purpose is to understand the technique spreading conditions in the industry to draw up the directions of future technical development, shown as Table 4.

Table 4. Technology-Effect matrix

Technique / Effect	T1	T2	T3	T4
E1	9	5	3	1
E2	7	2	1	2
E3	10	1	6	

For example in Table 4, there are 9 patents that technique T1 achieves effect E1 and there are 5 patents that technique T2 achieves effect E1. The technology with more patents means higher competition. On the other hand, the technology with fewer patents may represent opportunities to explore and deploy. Therefore, we can get a hold of the directions of the technical developments. Such survey can be further combined with Evolutionary Trends and the Knowledge/Effects in TRIZ as explained below:

(1) D. Mann (2007) divided the evolutionary patterns into 35 trend lines, such as "geometric

evolution", "smart material", "dynamization", etc., which may be put into three broad categories covering space, time, and interface situations to facilitate their usages. We can analyze the contents of a certain patent through 35 trend lines, find out the correlated trends, define individual evolutionary level, and further construct the radar plot for evolutionary potentials, which helps recognize the possible developments of the next generation techniques. As shown in the Fig. 4, for example, "controllability" and "dynamization" have lower evolutionary levels, thus are more likely to have room for developments. Through the analysis of the trend lines, we may foresee the future trends of the products, predicting the directions of the future patent deployment in advance. There has been some published articles by applying this approach to create new ideas and improve designs (Guan,2008; Zhang,2006). In addition, Shpakovsky (2006) promoted an organized methodology called "Evolution Tree" to structure technical and patent information, and then obtain innovative thoughts or solutions. He also stated that such evolutionary thinking approach provides good opportunities for circumventing others' patents or protecting the patents we own.

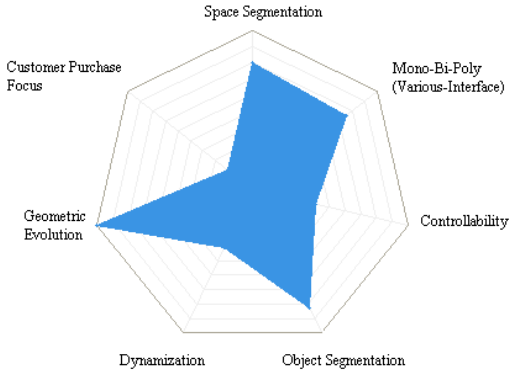

Fig. 4. Radar plot of evolutionary potentials

(2) The database of the Knowledge/Effects includes the patents and technical outcomes of physics, chemistry, biology, geometry and so on. If a research staff member needs to realize certain functions, such database may provide more options, i.e., we can search for certain techniques with certain functions. For example, we are to achieve the effects of lower temperature. We can then search the approaches for that function, such as air-cooling, water-cooling, or chemical action, through the Knowledge/Effects. Thus, it is likely to find out solutions that satisfy our needs from multi-disciplinary fields. In this way, we may generate sophisticated patents to deploy. Litvin (2005) developed a newer version of such tool called Function-Oriented Search (FOS) and derived an algorithm to perform FOS step-by-step.

4. Technological patenting strategies

As we consider patent strategies from a top-down sense, the technological strategic patenting indicates the patent deployment in depth and in breadth within technology space. The so-called "in-depth patenting" means to derive intensified patents from the fundamental patents within the same category and form a patent chain which achieves the effects of technical monopolization. As for the "in-breath patenting", it refers to discover the possible applicable fields for the fundamental patents and then acquire consequent patents in that fields. In such a way, it will benefit from the technical dominations of application development as well as the market trends. Along with these patenting concepts, we present several tactics of analysis with regard to TRIZ as follows.

4.1. Contradiction analysis for patents

For a new developed patent, we can investigate if it can be transformed into a contradiction problem for analysis. By finding what problem this patent is solving, we should identify the improving engineering parameter and the worsening engineering parameter, and then look up the Contradiction Matrix table for inventive principles. These suggested inventive principles could be the possible developments in breadth, which may build the patent strategy of *blanketing and flooding*.

Following the contradiction pattern analysis, we look for the subsequent contradictions possibly caused (i.e. contradiction chain) to intensify the solution or the optimization for this particular type of problem. Thus, we can go deep into the problems with related technical fields, and produce the derived in-depth patents, which may construct the patent strategy of *fencing* or *surrounding*. The analytic flowchart is shown as Fig. 5.

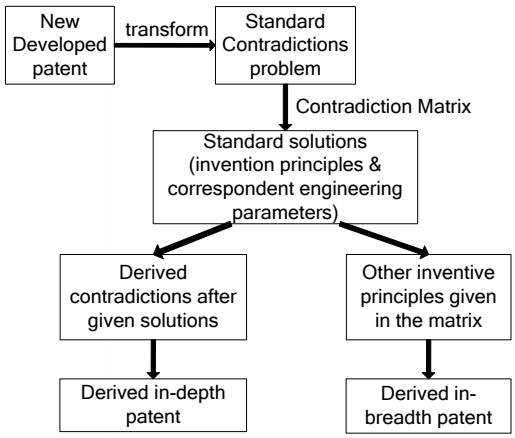

Fig. 5. Patent Contradiction Analysis

4.2. Functional analysis for patents with attributes

The functional analysis in TRIZ emphasizes on not only the useful functions but also the harmful, ineffective, excessive functional relationships. To additionally present the attributes (or parameters) among these relationships will reveal more information to help capture the critical portion of the problem. We may further observe the variations of functions and attributes from the dimension of time, such as "before the problem" and "after the problem". We take the engine oil as an example and illustrate the differences in expressions of functional modeling with or without attributes, as shown in Fig. 6.

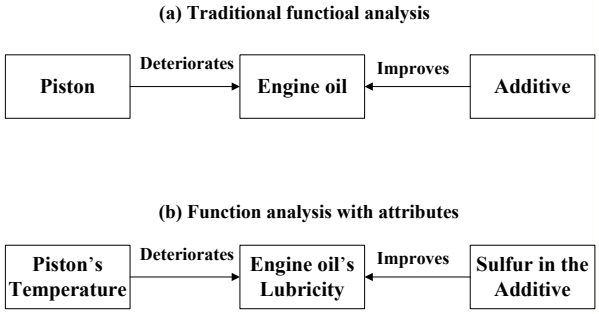

Fig. 6. Functional modeling with/without attributes

To express the patent contents in a functional analysis model, it is helpful to recognize the opportunities of derived patents. We perceive two basic indications as follows.

- The "negative" relationship in the functional analysis model may represent improving opportunities for "in-depth" patents.
- The "positive" relationship in the functional analysis model may represent applicable opportunities for "in-breadth" patents.

In the example of engine oil, the temperature variations of the piston worsen the engine oil's lubricity. Continuous improvements on the poor relations in the model can help us consider the research directions which concern in-depth deployment. On the other hand, Sulfur in the additive can improve on the deterioration

of oil lubricity. The good effect can be deemed a promotion of application to other domains, which may bring about in-breadth patents.

4.3. Patent strategy applicability

There are diverse innovative methods and tools in TRIZ. According to their characteristics, we probe into the usage occasions from the viewpoints of patenting in breadth or in depth, as well as the deployment patterns. For example, if we intend to conduct a *surrounding* patenting to hinder competitors or in-depth deployment to protect our core patents, what tools in TRIZ are better to make use of? The study concludes some preliminary observation for applicability as follows:

- The patterns of *strategic patent searching* and *fencing* more likely require patenting developments in depth.
- The patterns of *blanketing/flooding* and *surrounding* more likely require patenting developments in breadth..
- The methods of *IFR* and *trends of evolution* are more likely suitable for in-depth patenting developments.
- The methods of *contradiction matrix* and *scientific effects* are more likely suitable for in-breadth patenting developments.
- The methods of *S-Field*, *resources*, *psychological inertia* and *separation principles* are most likely neutral and depend on the situations.

4.4. Strategic analysis with design-around：

Well goes the proverb: *know both the enemy and yourself and be ever-victorious*. To protect our own patents, we should also comprehend the design-around techniques adopted by others so as to strengthen the barriers. We bear in mind for the thinking patterns of design-around while conducting the patent deployment by TRIZ. For example, similar concepts can be found among the design-around methods and 40 inventive principles. The analytic results are shown in Table 5.

Table 5. Design around vs. inventive principles

Design around technique	**Inventive principle**
Elimination	Preliminary Anti-Action、Preliminary Action、Beforehand Cushioning
Replacement	Asymmetry、Do it in Reverse、Another Dimension、Blessing in Disquise、Replacement of Mechanical System、Flexible Membranes or Thin Films、Changing the color、Parameter Changes、Phase Transitions、Rejecting and Regenerating Parts
Combination	Merging、Universality、Nested Doll、Self-Service、Homogeneity、Composite Materials
Decomposition	Segmentation、Separation

Therefore by means of relating inventive principles, it is of help to increase the design-around difficulties or establish the fencing barriers, and construct an incorporated patenting strategy.

5. Conclusion

It has been proven that TRIZ is supportive in many aspects for patent-related applications. However applying TRIZ with suitability and efficiency on the

problem is another concern. This study is carried out from a top-down sense to look into the effective usage of TRIZ on the subject of patent analysis and patent deployment in depth or in breadth. We have made several attempts to conceptualize guidelines by clarifying their relations to construct an initial basis. Beard these guidelines in mind, TRIZ users may develop patenting map with ease.

Acknowledgement

This research is funded by the National Science Council, Taiwan, R.O.C. under Grant No. NSC 98-2221-E-129-002-MY2. Authors are grateful to its financial support of this work.

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