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COMBINING SURVEYING PATENT INFORMATION, REAPPEARING PROBLEM AND DISCOVERING BREAKTHROUGH FOR DESIGN-AROUND

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ABSTRACT
This research is to make an idea combining surveying patent information, reappearing problem and discovering breakthrough for design-around. Many researchers have made their efforts to develop faster and more precise approach to analyze the patent information. The idea, which introduces a keyword recognition approach based on a specific keyword bank and its corresponding TRIZ parameters and inventive principles, is proposed for resolving that situation. After analogizing the original problem of the objective patent by the keyword bank, a scenario of the problem could be showed clearly and new other candidates of solution could be found through the TRIZ contradiction matrix, and then those candidates would be beneficial to design-around and even lead an innovation. Further, this research constructed a computer tool for making the proposed idea practical, and it could assist designers to inspire new ideas for their design-around projects. So far the test database of the proposed tool involves the Taiwanese patent information of assisting-rising chairs. A demonstrative design case has been successfully developed through the computer tool, and it would pass the infringement test.

Keywords: patent, TRIZ, design-around

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1 INTRODUCTION

The acceleration in technology and business development nowadays has increased the cases of patent application and authorization. Patent right has become an important marker for companies' profits as well as advantages. Company possessing core know-how for a specific domain would gain more profits through patenting the know-how to protect its right. Nonetheless, what would happen if that significant technique or approach has already been patented by others?

"Design-around" means that a design task to avoid patent infringement, it is a feasible strategy and should be included into the process of new product development. For designers, design-around not only reduces the amount of time required for product development, but also gives companies with lagged behind technology or companies entering into the domain much delayed a chance to compete with the market's leaders. Design-around is therefore very important. Researchers discovered that when developing design-around, the patent survey process, in general, could be a very time consuming job. The objectives of this research are to find relevant information, to determine the design-around target, to acquire an effective solution, and to generate new design.

To reach the aforementioned objectives, this research considered some requirements should be concerned and they are: (1) establishing an approach that starts from surveying the objective patent, *i.e.* the target should be design-around, to be restoring, (2) reappearing the original problems as well as the solutions of the objective patent, and (3) seeking for other solutions while developing design-around for the objective patent. An approach which can be satisfied with the above-mentioned requirements would be proposed. Further, an automatic computer tool based on the above-mentioned approach would also be constricted for new product development.

2 LITERATURE REVIEWS

Facing an increasing number of patents, companies focused on research and development should take the actions of their competitors into consideration instead of limiting their time and effort on developing their own technology. In this case, companies can use patent survey to gain insights into the competition of similar types of technology. Moreover, companies can also use patent information to understand the status of their competitors' technology and market value (Aston and Sen, 1988; 1989; Breitzman et al., 2002).

In the recent research, ontology, composed of concepts and lexical association of words, is the most commonly applied approach for patent information survey and analysis (Taduri et al., 2011). There are four most frequently adopted approaches in ontological studies: linguistic features, dictionary approach, linguistic approaches and statistical analysis. Studies related to these four approaches are summarized below, and whether they are applicable for this research is discussed in the following as well.

- The Linguistic features: The linguistic features approach is about analyzing the location of keywords or the frequency of prompt texts in the articles for assessing the level of association of the words (Guo et al. 2005). Moreover, features of this approach can also be integrated into the automatic reading computer tools (Trappey et al. 2009). Important words can be found through determining the location of the language features in the document. The location is important; it reveals how significant the word is, so the researchers can assign a location weight accordingly (Hu and Wu, 2006). In this research, the researchers have found that the major keywords of an article are usually at the beginning or the end of each sentence. Therefore, keywords of an article can be quickly determined by the location (Hu et al., 2006). On the other hand, this research considered that detailed descriptions of patent do not fit into the category of this research because the technical content of detailed patent descriptions not only includes terminology and the corresponding codes of each component, but also is much more complicated.
- The dictionary approach: In this approach, the inputted content or keywords of a document is compared to an established word bank to find out keywords of an article (Li and Xing, 1998). Through obtaining as well as reorganizing the keyword database, the designers can summarize critical information related to the patent (Trappey and Trappey, 2008). The use of keyword database in coordination with the medical language system for information search can provide more accurate and critical information (Hsiao et al., 2009).

- The linguistic approach: This approach is for comparing work written in specific language. In considering of cultural differences as well as different writing rules, it is necessary to comprehend specific keywords and paragraphs in order to find the required information quickly. This approach has been shown to be quite effective for examining works written in English because the structure of English writing. As a result, the search results are more likely to be noun phrases with meaning (Ercan and Cicekli, 2008). A shortcoming of this approach is that it can only be applied on complete as well as grammatically correct sentences. For undefined keywords, it would be hard to gather correct information.
- The statistical analysis approach: This approach analyzes documents by calculating word frequency. If the frequency exceeds the threshold value, then the word is considered as a keyword (Li et al., 2009). For the statistical analysis approach, it is unnecessary to establish a word bank or a linguistic database for capturing important professional glossary or terminology (Barzilay and Elhadad, 1997). This approach has been used for evaluating American patents. The results provide useful information related to the life cycle of that patented product, which is useful for trend forecasting (Mogee, 1991). One can also select important noun phrases from several articles to create a lexical chain, and then distill those phrases with scores greater than the threshold value. The extracted phrases will be the key content of those articles (Brunn et al. 2001). Nonetheless, without using the word bank, meaningless words may be captured, which is an error.

In this research, the dictionary approach was considered to be conducive to string comparison of patent information. In addition, this research tried to use TRIZ (Russian acronym for "Theory of Inventive Problem Solving") to return the original condition of a patent, including the problem and its solution. In fact, this Russian problem-solving theory indeed performed well in innovative design (Clausing and Frey, 2005; Jugulum and Frey, 2007). Further, TRIZ and its own tool were also often taken to technique or patent analysis (Tong et al., 2006; Yoon and Kim, 2011). Concretely, several works in this research are:

- Use the dictionary approach and TRIZ to obtain information related to problem-solving techniques or approaches of the objective patent. In other words, analogizing TRIZ inventive principles can help designers gain relevant insights.
- Similarly, the dictionary approach and TRIZ allow designers to back-calculate possible TRIZ engineering parameters via reappearing the patent's analogous TRIZ problems, in other words, the designers can be aware of the original problem of the objective patent.
- Search the TRIZ contradiction matrix using possible TRIZ engineering parameters and find other inventive principles statistically. These inventive principles may be a promising design-around solution for generating new design that is concretely different from the original patent.
- Feasibility of the above-mentioned approach will be verified by an actual design example. The researchers have also worked on developing a set of automatic computer tools for elevating the efficacy of design-around.

3 RESEARCH APPROACH AND CONTRIBUTION

This research employed word association and TRIZ (Savransky, 2000; Chang and Chen, 2004; Fey and Rivin, 2005) on string comparison (specifically for Chinese Traditional) of patent information for analogizing and reappearing TRIZ inventive principles and contradiction problems that the inventor of the original patent had encountered. Then TRIZ contradiction matrix was backward deducted to obtain tangible inventive principles for developing design-around for that original patent. This research proposed a feasible three-stage approach that can be used for design-around among Taiwanese patents (their related patent information were composed in Chinese Traditional), and it was disclosed in the followings.

3.1 Patent Information Survey

When conducting the design-around process, a designer has to first determine the to be design-around domain before reviewing relevant patents before obtaining information related to the to-be design-around objective patent first. Two procedures are in the following.

- Search for possible to-be objective patents for design-around: The patent searching tool developed by this research was employed for conducting a patent search in the patent database of

Taiwan Intellectual Property Office. A specific domain was determined first before conducting the search. Relevant information was downloaded and organized to create the patent database for this research. By doing so, irrelevant patents can be eliminated, which makes the evaluating and verification of information related to the to-be design-around objective patent more convenient.

- Evaluating and varying the to-be design-around objective patent: For the patent information analysis to be effective and accurate, this research requested the designer to apply statistically determined word frequency for finding the association between the surveyed word and patent information. Next, this knowledge was employed to determine whether that specific piece of information related to the patent is worth reading. The proposed approach enables the designer to speed up the searching process for objective patents with higher association, because a greater frequency suggests a greater association

3.2 Reappearing and Resolving TRIZ Problems

To reappear contradiction problems quickly, this research proposed to first establish a keyword database based on the forty inventive principles and thirty-nine engineering parameters of TRIZ. Next, this database was used to compare with the patent information. The proposed approach should help the designer analogize patent problems with TRIZ contradiction problem as well as patent invention with TRIZ inventive principles. Two procedures are in the following.

- Comparing patent's technological keywords: For analogizing and reappearing TRIZ inventive principles corresponded to the patent, a keyword database was first established based on TRIZ's forty inventive principles. New vocabulary can be added into the word bank if required. Moreover, different inventive principles can have different corresponded vocabulary. For example, in the engineering design domain, related Chinese verbs for inventive principle "#01 Segmentation" include "分割," "分開," "分解 ," "拆解," etc.
- Recovering the original problem and backward deducting the original problem: To analogize the corresponding TRIZ contradiction problem of the objective patent, a keyword database was established based on the thirty-nine TRIZ engineering parameters. A major difference between the keyword database of the thirty-nine engineering parameters of TRIZ and the keyword database established based on the aforementioned forty inventive principles is that the engineering parameter has the following two attributes: "to be prevented from worsening" and "to be improved". This research paired up the words with a set of auxiliary words to help the designer identifying the "to be improved" and "to be prevented from worsening" engineering parameters. The keyword database associated with the thirty-nine engineering parameters was paired with the default auxiliary vocabulary for the "to be improved" and "to be prevented from worsening". For example, the "to be prevented from worsening" vocabulary was paired with the Chinese vocabularies "造成," "然而" and "以致," while the "to be improved" vocabulary was paired with "雖然," "改善" and "僅需." This auxiliary word bank for identification can be used to collect domain words with metaphor or implications. Meanwhile, if analogizing is conducted paragraph-based, then the more keywords found in a paragraph, the more important the paragraph is. The frequency is calculated as the sum of the number of engineering parameter corresponded words and the "to be prevented from worsening" corresponded words, as well as the sum of the engineering parameter corresponded words and the "to be improved" words. If the former is larger than the latter, then the engineering parameters are very likely to be the "to be prevented from worsening" ones, or otherwise, the engineering parameters are the "to be improved" ones. Currently the proposed approach only could be applied on Taiwanese patent information because of the linguistic structure of Chinese.

3.3 Discovering and Breakthrough

Continuing from the aforementioned procedures, the step described here is about using analogizing results for developing design-around. Using the TRIZ problems composed of analogizing engineering parameters, other TRIZ inventive principles can be obtained from backward deduction. Consequently, new design for the same purpose but based on a completely different approach can be generated. Two procedures are in the following.

- Obtaining design-around cues: It is about getting the most probable TRIZ engineering parameters from backward deduction of the original problem. This set of engineering parameters can be used

to search the TRIZ contradiction cell to get inventive principles other than the inventive principles adopted by the original objective patent. In general, each TRIZ contradiction cell contains one to four usable inventive principles. That is, one can get as maximum as three new clues for design-around.

- Developing the prototype of patent design around: The designer can start product development after obtaining solutions and clues for design-around.

The above-mentioned approach can be illustrated as Figure 1, which also shows a corresponding functional pages of a proposed computer tool in this research (three functional pages are "Patent Information Survey," "Reappearing the TRIZ Problems and Inventive Principles," and "Discovering and Breakthrough," and they will be introduced in the following)

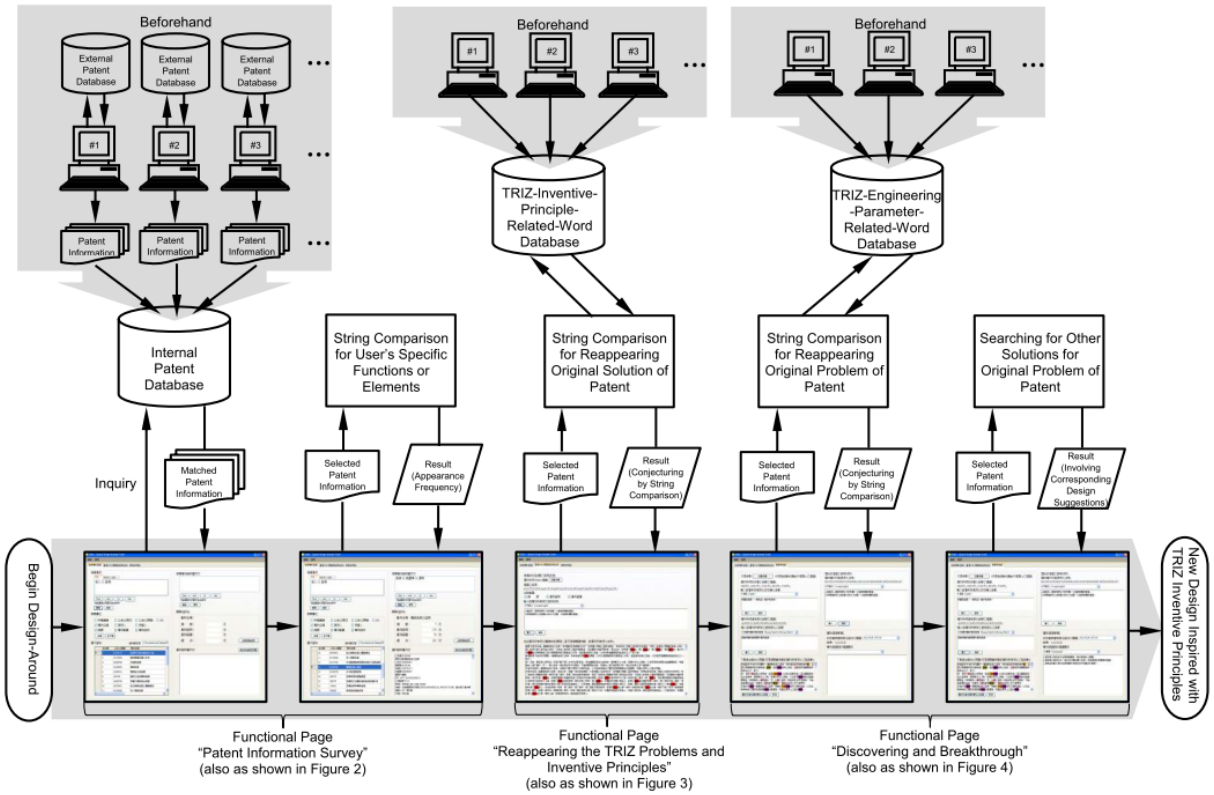

Figure 1. Proposed approach and corresponding functional pages of proposed computer tool

4 A NEW COMPUTER TOOL FOR DESIGN-AROUND

To ensure that design-around is integrated into the product design process, as well as to enable the renewal of the entire design process automatic, a computer tool was developed. The proposed computer tool is compatible to MS-Windows, and was coded by MS-Visual Basic. To verify the effectiveness of the actual operation of the proposed computer tool, this research presented an actual operational demonstration using a design-around case about "assisting-rising-movements-chair for elderly or lower-limb challenged." It is deserved to be mentioned that the proposed computer tool and all entire internal database are constructed for the Taiwanese patents (*i.e.* for documents in Chinese traditional).

Once entering the computer tool, a user can see that the work environment is composed of three functional pages as the above-mention: Patent Information Survey (as the Chinese page tag labeled "檢索專利資訊"), Reappearing the TRIZ Problems and Inventive Principles (as the Chinese page tag labeled "重現 TRIZ 問題與發明法則"), and Discovering and Breakthrough (as the Chinese page tag labeled "探索與突破").

4.1 Functional Page "Patent Information Survey"

In this functional page, it is necessary to first import the pre-established "Specific Industry/Technology Patent Information Database," which includes patent information related to the rising assistance equipment in Taiwan. This information was saved in MS-Access database. The importing operation

can be done via the menu option “File” (as the Chinese function button labeled “檔案” on the upper part of the window) for importing information into the MS-Access database, shown in Figure 2.

Figure 2. Functional page “Patent Information Survey” with demonstration

The user can enter the type of information of the objective patent, which can be TW (Taiwanese patents), USPTO (US patents), or EPO (European patents), as well as keywords into the search box. Keywords for search can be combined using Boolean logical operators, such as AND, OR, and NOT.

In Figure 2, keywords “elderly” (as the Chinese words “老人”) and “chair” (as the Chinese words “座椅”) for search were entered into the text box at the upper left of the window on trial. The user can select feasible items for the search among the application number (as the Chinese “申請編號”), title (as the Chinese “專利名稱”), abstract (as the Chinese “摘要”), issued/published date (as the Chinese “公告/公開日”), inventor (as the Chinese “發明人”), claim (as the Chinese “專利範圍”), issued/published number (as the Chinese “公告/公開號”), assignee (as the Chinese “申請人”), description (as the Chinese “專利說明”) and IPC (International Patent Classification) by the checkbox. After clicking the button “Search” (as the Chinese button labeled “查詢”), the qualified patents will be listed in inner bottom left window).

In the actual operational demonstration, an appropriate patent, M329384 and entitled “Assisting-Rising-Movement Chair” (as the Chinese title “輔助起身之座椅”), was picked for design-around on trial. Technology-related keywords and Boolean logical operators can be entered into the box at the upper right of the window. In the Taiwanese assisting-rising chairs’ market for elderly and people with lower-limb problems, hydraulic cylinder, gas spring, and connecting bars are the most commonly used mechanic components. Therefore, in the demonstration, the string of keywords entered here are “rising OR gas spring OR connecting bar” (as the Chinese Boolean string “起身 OR 氣壓棒 OR 連桿”). Then, As shown in the middle of the right hand side of the Figure 2, appearing frequency of those keywords in abstract, description and claim is 7, 176 and 59 respectively, and the total is 242. The content of the patent information extracted from the original patent document is shown at the inner bottom right window. The user can determine the level of association between key technology and objective patent based on the appearing frequency of keywords.

4.2 Functional Page “Reappearing the TRIZ Problems and Inventive Principles”

The patent M329384 “Assisting-Rising-Movement Chair” is presented as an example here once again. In Figure 3, once the range for comparison is set (the user can assign the any range among the abstract, description and claim by the checkbox), and clicking the button “Automatic Evaluate” (as the Chinese button labeled “自動判讀”), the potentially corresponding TRIZ inventive principles are No. 8, No. 7,

No. 24, No. 35, No. 4, No. 12, No. 3, No. 30, No. 17, No. 23 and No. 22 ranked by the appearing frequency of the related words. The most potentially corresponding candidate of TRIZ inventive principle is No. 8 “Counterweight” (as the Chinese “平衡力”) because of 215 times of appearing frequency, and its description is disclosed in the inner window located in the middle part of the functional page. Furthermore, the content of the selected range are disclosed in the inner bottom window, and the matching keywords entered in the previous functional page are highlighted by colored ground. Here the highlighted keywords are “connecting bar” (as the Chinese “連桿”).

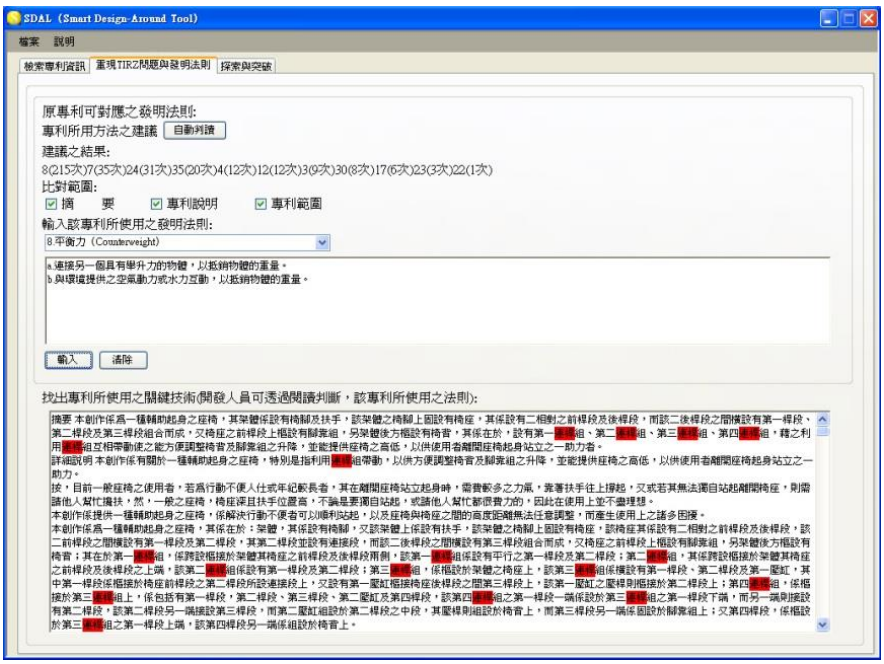

Figure 3. Functional page “Reappearing the TRIZ Problems and Inventive Principles” with demonstration

4.3 Functional Page “Discovering and Breakthrough”

Obtained in the previous functional page “Reappearing TRIZ Problems and Inventive Principles”, the estimated TRIZ engineering parameters corresponded to the original patent problem are placed in this functional page called “Discovering and Breakthrough”. Similar, by using the built-in keyword database to analogize patent information, contradiction problems of the original patent can be estimated, and then reach the most corresponding TRIZ inventive principle from the candidates.

With the TRIZ engineering parameters-based keyword database for analogizing, the proposed approach can be employed to estimate contradiction problems of the original patent and to acquire the “to-be prevented from worsening” and the “to-be improved” parameters. In Figure 4, the patent M329384 “Assisting-Rising-Movement Chair” is still used as the demonstration. After clicking the button “Automatic Evaluate” (as the Chinese button labeled “自動判讀”), as shown in the upper part of Figure 4, the top five “to be improved” parameters are “No. 9 Speed,” “No. 19 Energy Spent by Moving Object,” “No. 11 Tension/Pressure,” “No. 4 Length of Non-Moving Object,” and “No. 7 Volume of Moving Object.” Whereas the top five “to be prevented from worsening” parameters are “No. 19 Energy Spent by Moving Object,” “No. 11 Tension/Pressure,” “No. 34 Repairability,” “No. 10 Force,” and “No. 5 Area of Moving Object.” In Figure 4, the corresponding descriptions of “No. 9 Speed” and “No. 19 Energy Spent by Moving Object” are disclosed in the inner windows respectively. Furthermore, the matching keywords of the content of the selected range are highlighted with different colored ground.

From the previous functional page, the most potentially corresponding candidate of TRIZ inventive principle is No. 8 “Counterweight.” According to the idea of the proposed approach, this inventive principle must be one of the solutions for the original design problem in the patent M329384. The other inventive principles from backward deduction of the original design problem can be regarded as the solutions for design-around. At the meantime, the original design problem could be one of the

combinations composed of each the "to-be prevented from worsening" parameter and each the "to-be improved" parameter. The proposed computer tool can automatically prepare some candidates in advance for the user. To find out the appropriate parameter combination, the user can view and pick up a best one by the scroll bar "Suggestions for the Combination of the To Be Improved Parameter and the To Be Prevented from Worsening Parameter" located on the middle right part of Figure 4 (as the Chinese button labeled "欲改善與避免惡化組合之建議"). Here supposed combination composed of the "to be improved" parameter "No. 9 Speed" and the "to be prevented from worsening" parameter "No. 19 Energy Spent by Moving Object" was picked up.

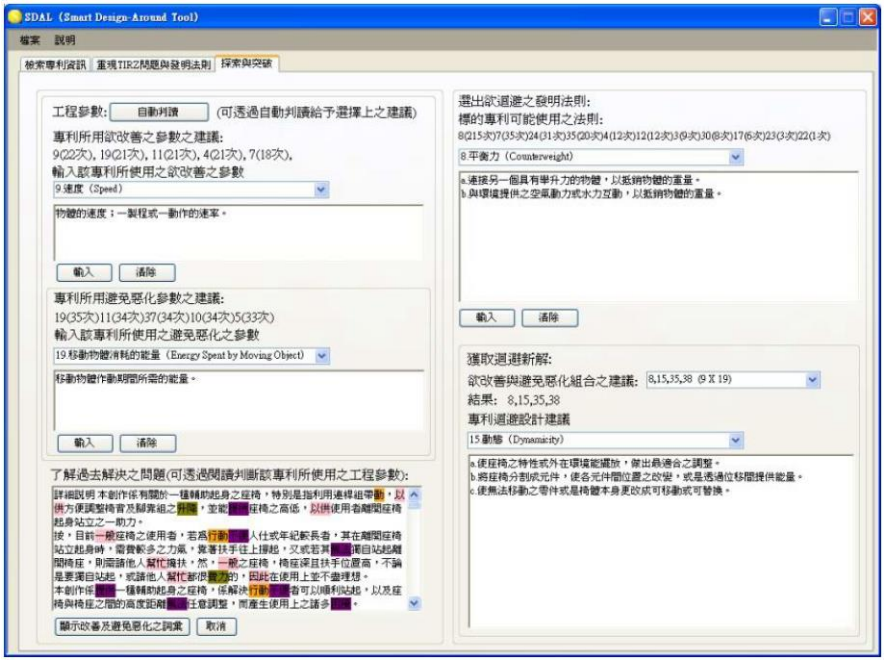

Figure 4. Functional page "Discovering and Breakthrough" with demonstration

In this combination, the inventive principle "No. 8 Counterweight" used by the original objective patent was included, and it should not be applied to design-around. Other suggested inventive principles, including "No. 15 Dynamicity," "No. 35 Transformation of Physical or Chemical States of an Object," and "No. 38 Use Strong Oxidizers" would inspire the user for design-around. Using the next scroll bar, the user can select these inventive principles and view the corresponding description in the next inner window. The description of the each inventive principle was recomposed according to general chair and its related product design, and it would be conducive to the user.

In Figure 4, the inventive principle "No. 15 Dynamicity" indicates that the user may try as the comments as followings: a. to make the features of the chair adjustable according to the requirement; b. to allow the chair can be disassembled into different components and allow the position of the each component can be adjustable, or to generate power by making the components move; c. to modify the originally unmovable components or the chair itself to be movable or replaceable.

The demonstrative design, as shown in Figure 5, was inspired based on the comment b: When a person wants to stand up from the new chair, his feet can be placed on the movable peddle located at the front while his hands holding the handle. Next, he needs to move his upper body slightly forward to shift the weight of his body by the rotatable seat. In other words, the weight of the person is used as the force lifting him and letting him to stand up. The prototype is still in improvement and will be filed for new patent.

5 CONCLUSIONS

The proposed approach and computer tool had been verified by a demonstrative case that they can indeed assist designers in make design-around under low risk. The conclusions are presented below:

- The keyword database proposed by this study is based on TRIZ inventive principles and engineering parameters. Sampling was conducted for the default industrial technology, and in the demonstrative case, the sampling accuracy and association would indeed have an effect on

problems reappearing or even discovering and breakthrough later on. Therefore, keyword databases have to be set up carefully and updated continuously using the computer database approach in order to achieve the best analogizing result.

- In addition, the collection of assorted patent information for the self-built patent database at the very beginning is important. In this research, patent information of the database was collected by the design team for a long time, and the information was reviewed and categorized. More complete information provides more insurance in design-around.

Figure 5. Demonstrative design inspired by the comment b of inventive principle "No. 15 Dynamicity"

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