PROPOSAL FOR THE USE OF THE INFORMATION CONTAINED IN THE PATENTS SYSTEM IN THE ENGINEERING TEACHING

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Abstract. *The present work aims to demonstrate the viability of the use of information contained in the patents system in the Engineering teaching. Some approaches are proposed that strength the focus of the engineering project, the solution of technical problems with innovation and creativity, as well as the protection of the solution and eventual exploitation. In this proposal the Patent System is used in three different approaches: The first of them is the state of the art identification, when the student identifies how similar or of the same nature problems were solved, as well as which solutions are already protected by the System, avoiding duplicity of efforts. The second approach refers to the use of the Patent System with TRIZ Method (Theory of the Inventive Solution of Problems) as a tool for the solution of problems using the methodology of the systematic innovation and creativity. The third approach refers to the invention concept and inventive step definitions in the engineering project, in the identification of matter capable of being protected as a result of the proposed problem solution, and choose and development of final course project aiming a patent elaboration. The teaching methodology here proposed also deals with aspects of commercial exploitation of the patent and formatting of a technology-based company to be incubated.*

Keywords*: engineering teaching, patent information, TRIZ, innovation, creative problem solving.*

1. INTRODUCTION

In general, the industrial property system in Brazil has not been used by the Academy: Nor to knowledge protection, neither as a source of technological information, as observed by Nunes *et al.* (2007), although about two thirds of all technical publications, which achieve more than a 1.5 million documents per year, are only revealed through the patent system. This fact should make them desirable in the development of any creative activity in the technical area, because besides providing novel techniques, they eliminate possible matches, with economy of time and financial resources. It can be said that the patent is practically unknown in the academic world, and it is not used in engineering training in Brazil.

Lopez *et al.* (2005) make a brief explanation of how the TRIZ Method can be implemented in teaching and research in Physics in undergraduate courses. In 2006, the Bradford University implemented TRIZ courses and reports the good results of this initiative. Filmore (2006) formatted a two hours TRIZ course for undergraduate and master's level students using a software support. He considers the result positive, but concluded that the time was too short. Shih-Liang (2007) based on a successful TRIZ implementation in Wayne, Connecticut and Florida Atlantic Universities, has proposed a tool to improve the course of engineering design using free software and literature. But because of the non-uniformity of the available didactic, it does not allow replication of the experience in various *campi*. Nunes *et al.* (2008) suggest a way of using the industrial property system in engineering courses through the introduction of an elective discipline in the course of mechanical engineering, focusing on rising of the state of the art.

2. PROPOSAL TO INTRODUCE INDUSTRIAL PROPERTY IN ENGINEERING TEACHING

The main idea for the introduction of industrial property in the engineering teaching is based on the false need that for using the system it would require that students first learn the industrial property system fundamentals, which range from the history of patents, the legal framework, through the formalities of the patent document. In such approach, the examples are very far from the reality of these students, who cannot foresee using this information in their lives or are not presented to any prospect of applying this information in training or working life as an engineer. This way of introducing this knowledge becomes a burden for the students, who are already overwhelmed with the increasing content of the traditional disciplines.

In fact, the introduction of this subject in engineering courses treating the most common problems is much simpler than it seems, because there is no need to burden students with information of little use for the solution of a problem. By offering an effective tool for aid them in academic and professional activities, it contributes effectively offering new and unique information on doing their projects, either at the end of the course when the undergraduate, or in the development of their research in post-graduate (masters or doctorate) or any other academic activity.

The fact is that it is quickly evident to the students that those who hold this knowledge are in great advantage over others who know nothing about the subject, thus a differential increasingly important in the life of the engineer with any level of training. This perspective has been shown to be sufficient for the good acceptance of the subject by students in engineering courses.

This study aims to demonstrate the feasibility of the use of information contained in the patent system in engineering teaching, based on a methodology that strengthens the approach of the engineering project, independent of any tools or methodologies used to project in the course. The only requirement is that the methodology allows the introduction of three stages or steps where the information of the patent system is used.

The first step can be called an informational stage (or informational project, as suggested by Back (1983)), where the information contained in the patent system is used to determine the state of the art. Then there is a conception stage, where the solutions are developed for the problem. At this stage the patent information is used as a possible source of solutions to the problem or as a source of inspiration for new solutions. We then introduce the methodology TRIZ - Theory of Inventive Problem Solving, which is used as methodology to support the conceptual project, and can be linked or not to any other project tool. The final step treats the aspects of the protection of project results, when it is analyzed in the formal aspects: The patentability, preparation of patent report, and formal and legal issues. In this step issues concerning the commercial exploitation of results are also introduced through creation and incubation of technology-based companies.

2.1. Informational Step

In this step, also called the informational stage, the surveys are conducted to all information relevant to the development of the project and to raising the state of the art. Traditionally, the most used sources are technical books, technical articles, industrial catalogs and engineering databases (COMPENDEX), and very rarely, the technical information contained in patent databases. Besides specific technical information, applicable technical standards are also searched, and more recently the information related to legal issues, such as environmental legislation, was introduced.

In Brazil, the use of patents in the research of technical information for engineering projects, particularly at universities, is virtually nonexistent (the use of the patent system by universities represents 0.6% of total deposits of residents), although this source is responsible for 70% of all technical information published in the world. The proposed methodology allows the introduction of this information on engineering teaching counting with an elective discipline with the task of supporting the project's development. This course would be taught in conjunction with the traditional(s) discipline (s) dealing with the final dissertation, where students of last years of engineering course would be asked to provide an engineering design approach to their final course works, with no interference in the contents that had already been decided with their advisors.

Nowadays, most patents databases are found online for free, allowing access to documents by Internet. Access to these databases is not restricted, facilitating the patents search worldwide. Among the many national patent offices that have published their databases for free, it can be cited the U.S. Office (USPTO), the Brazilian Office (INPI), the European Office (EPO, which includes more than 80 countries and their Espacenet database has more than 60 million documents) and the Japanese Office (JPO). In 2006, Google launched the page www.google.com/patents, where the full text of U.S. patents can be accessed, as well as perform advanced searches using various criteria (e.g., inventor, filling date, the patent number).

Within this methodology the procedures that enable the use of information industrial property system are formatted directly using textual basis of patents search engines. In particular, the European Patent Office database is used, accessed at http://ep.espacenet.com . This database was chosen because it allows the use of a search strategy similar to those used in sites for general information access like Google, Wikipedia, etc., to which most users are used to.

At first, the search is to define clearly and explicitly the object being sought. In examining the object of search, it is important to get the words and phrases that best describe them, as the success of the search depends on the use of words and phrases contained in patents.

As usually the interested people (students of the last periods of the engineering courses) have good skills on handling search engines, they can therefore be introduced to more advanced techniques on text searching, suitable for these environments, enabling greater efficiency in search and consequently in the results. This context is ideal for the introduction of knowledge concerning to the structure of patent documents, as the students begin focusing their interests in the patent documents and understanding that its structure facilitates the search of much information of interest.

Then, it is shown through examples that the search text is not sufficient to obtain the desired information, and then it is introduced another way of search using the index system used in the industrial property system which is the patents classification. So, the methodology proposes that the International Classification of Patents is introduced, outlining its structure, ways of access and classification strategy. It should be said that the proposal is not to train classification of patents technicians but to give students the necessary knowledge to use the patents information.

Students continue using the textual search engines, but now with a tool available from the World Industrial Property Organization called TACSY, accessed from http://www.wipo.int/tacsy/, which allows search by word in the system of

International Patent Classification - IPC, so they can use it in another way to search. Now the textual searches are conducted in TACSY, which locates the classification in the International Patent Classification.

With the acquired knowledge about the classification system, with a few exercises the student can perform patent search in databases simultaneously using the text and classification search, which improve significantly the results, and avoid information not relevant to their purposes.

Finally, the students become informed of the citation search, a useful way of search since it allows the knowing of how the invention was interpreted by the patents examiner and which technologies were considered relevant. This helps to understand the thoughts of the examiner on the subject, and how he/she understood and defined the technology under their examination. Conducting a citation search you can gradually identify the evolution of a technology, the used terminology, alternative search terms, and even terms that are unique to a specific invention.

By comparison, both classification search and text search assume that the person knows the terminology, synonyms and equivalent technology, which in this context may not be true, and usually is not, causing loss in quality in the search. The citation search allows students to improve their understanding of the state of the art and adjust their search strategies in accordance with the terminology used in that technology segment.

2.2. Conception Step

The second approach refers to the use of the Patents Systems as source of solutions and/or of inspiration for the solution of the problems, where the student uses the fundamental knowledge of the Patents System obtained in the informational stage in the solutions of some parts of his/her project and also as inspiration source for the creative process. Therefore the self-confidence handling of the Patents System is highly desirable for the implementation of the proposed methodology.

It was chosen for this conception stage, the Theory of the Inventive Solution of Problems – TRIZ, of Altshuller, because besides being a method that had been developed based in the patents system, it is a group of knowledge based tools that facilitates the use of the Patents System a lot, since this is one of the most complete sources of technological information, as evidenced in the works of Marmor (1979) and Thomson (2007). These works demonstrate, as previously mentioned, that the information revealed by the Patents System represent two thirds of all of the technological information published in the world, only available in the Industrial property system, that nowadays publishes more than 1,5 million documents a year WIPO (2008). This fact by itself already justifies the inserting of it in the engineering teaching.

TRIZ was developed by Genrich Altshuller (1984) as a result of a study, where more than 200.000 successful patents in the world were analyzed. In this analysis creativity patterns and inventive content of the patents were observed, concluding that the inventive activity of these patents corresponded to the solution of one or more technical contradictions (situation in the which where the improvement of a certain parameter means the depreciation of another parameter) and, also, that the technical systems develop obeying certain evolutionary patterns or predictable evolutionary lines.

In his research, Altshuller discovered that more than 90% of the engineering problems had already been solved previously, and they used the same fundamental principles. He also verified that some solutions used in a specific area had already been used in some inventions of other technological areas. Based in the results of these studies, the TRIZ methodology was created. It is based on the concepts of the ideality, contradictions and resource, and is composed of several tools based in knowledge and in the evolution of the technical systems, that can be used together or separately, depending on the problems characteristics.

The ideality can be understood as the evolution of a system in the direction of an ideal system. Technical contradictions can be understood as conflicting requirements regarding a same system where the requirement improvement implicates in the depreciation of other. The resources of a system can be defined as any elements of the system or of his boundaries that were not used yet for the execution of useful functions to the system Carvalho (2001).

The great advantage of the TRIZ methodology is the fact of propitiating a systematic process to define and to solve any kind of problem. It is very different from the traditional try and failing approach as a solution method, which is unviable with the increase of the problem complexity. The Fig. 1 displays an outline of like TRIZ works to solve a problem.

In a very brief way, the solution of a problem using TRIZ can be much more understood through the following steps: 1 - to identify the specific problem; 2 - to formulate the problem using the TRIZ methodology; 3 - to look for available similar solutions in the documents of patents; 4 - to adapt them to obtain the specific solution of the problem.

The resources offered in the informational stage are now adapted in way of making it possible the handling of the patent document under the optics of the technological content originated from of the inventive process. There is a difficulty related to the search of the patents information to fulfill the requirements of the TRIZ methodology, since the patent documents are indexed using the Classification of Patents, that classifies them in agreement with the technical domains in which they are inserted. Although this procedure is effective for the purposes of the search for innovation and/or anteriority, is inadequate for the direct use in the TRIZ methodology.

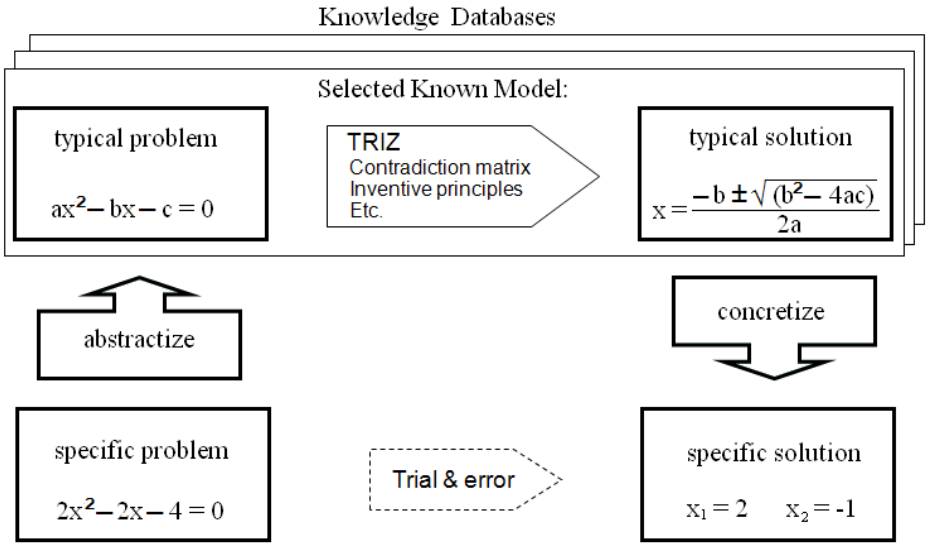

Figure 1. Scheme TRIZ to solve Problem

The inventors that use TRIZ are not interested in researching the inventions in the defined similar areas for the conventional classification only, but they would like to extend their search fields so that it was possible the search of patents of other technological fields, one of the main characteristics of TRIZ.

In that sense, the patent documents should also be classified using the 40 Inventive Principles with the Table of Contradictions so the inventors could be oriented directly for more effective solutions, saving time and effort.

This difficulty has been the motivation of several researches in the sense of proposing alternatives to classify and/or re-classify the documents contained in the patents database for their use in TRIZ. Because of the great volume of documents and the largest complexity of this new classification, the viable solution for that work indicates the use of automatic systems of classification as introduced in the works of Krier *et al.* (2002), Liang *et al.* (2003), Fall *et al.* (2003) and H.T. Loh *et al.* (2006).

In 2006 was released the eighth edition of the International Patent Classification – IPC (www.wipo.int/classifications), bringing important modifications related to the previous editions, that in some sense allows its use to assist the needs of TRIZ, but with a significant increase of the complexity on the searching strategies by classification. In this new version two classification levels were introduced: A basic level that it is addressed to give information in general; and a more elaborated level, containing more detailed subdivisions that allow a larger documents filtering.

To minimize this difficulty, it was chosen the American Office Patent Database, accessed in www.uspto.gov, as it has a very advanced and robust search mechanism, that makes it possible the combined search in several fields of the patents, as title, summary, classification, etc., allowing the use of Boolean and proximity operators. The American Office's patents database allows the search of the bibliographical data of the documents in two useful ways to our purposes: Text format information of the integral documents and also TIFF format. There is also the possibility of the search of the integral document in the PDF format.

Altshuller also classified the inventions in five levels based in the degree of complexity of the presented solution, as shown in the Table 1, where it is defined each invention level, as well as the quantitative mean of the solutions considered for each found solution. It also presented statistics of the distribution of those levels in the patents universe, later updated by several authors, showed in Table 2.

Table 1. Levels of Inventions

Levels of Invention	**Definition**	**Nº of Solutions Considered**
1	Small changes in an existing system, usually well-known and readly accessible	1 to 10
2	Improvement – existing system improved, usually with some compromise	10 to 100
3	Invention inside paradigm – a concept for a new generation of a existing system	100 to 1.000
4	Invention outside paradigm – a new concept for performing the primary function of an existing system	1000 to 100.000
5	Discovery – pioneering invenion of an essentially new system	more than 100.000

The present proposal intends to work only with inventions of the levels 1 and 2, because of the restrictions presented by the classification patent system and due to the lack of an efficient tool for its reclassification using the criteria of TRIZ. Besides, those two levels together represent about 94% of all the patents filled in the world, therefore perfectly adaptable to the level of teaching in the graduation, the main focus of this work.

Table 2. Levels of Invention Distribution

Levels of Invention	Original Distribution	Updated Distribution
1	32.0%	68.0%
2	45.0%	27.1%
3	19.0%	4.3%
4	< 4.0%	0.26%
5	< 0.3%	0.06%

It is important to observe that the proposed methodology is sufficiently robust to cover all of the existent invention levels and the suggested restriction only rests in the availability of time of an elective discipline. In case of interest on further content, it would be necessary only to enlarge of the course mark for about 200hrs/class, with the support of specialized softwares.

So, we will concentrate in the necessary knowledge to assist to the demands of the 1 and 2 levels of complexity, that allows the use of the traditional patent classification system, in the IPC's eighth version, to aid in the search of the information for direct use in the parts of the methodology where such information are necessary.

The methodology of teaching of TRIZ will not be approached, because besides the existence of abundant literature on the subject, there is all original work of Genrich Altshuller and their derived and/or associated methodologies.

The TRIZ methodology is introduced in the stage of project conception, through the use of their tool as in the diagram of the Figure 2 illustrating the basic structure. The Patterns of Evolution of Technological System are one of the foundations of TRIZ. The Patents System offers some important information since one of their characteristics is carry future information and can contribute to determining such patterns. Among the several analytical tools that compose TRIZ, it can be included: the Contradictions Analysis, Algorithm for the Inventive Problems Solving (ARIZ), Substance Field Analysis and Required Functions Analysis. In the group of knowledge based tools, stand out the 40 Inventive Principles, 76 Standard Solutions, and Effects of Knowledge Base. By applying those resources a solution or a set of solutions is reached for the problem that not rarely produces an invention. That methodology is applied in 20 hours of theoretical classes and 20 hours of exercises classes.

The students are only urged to use the TRIZ methodology in case if they feel safe, as they have to assist the pedagogic demands for the conclusion of their graduation. An alternative was created for the choice of a parallel project to practice the methodology.

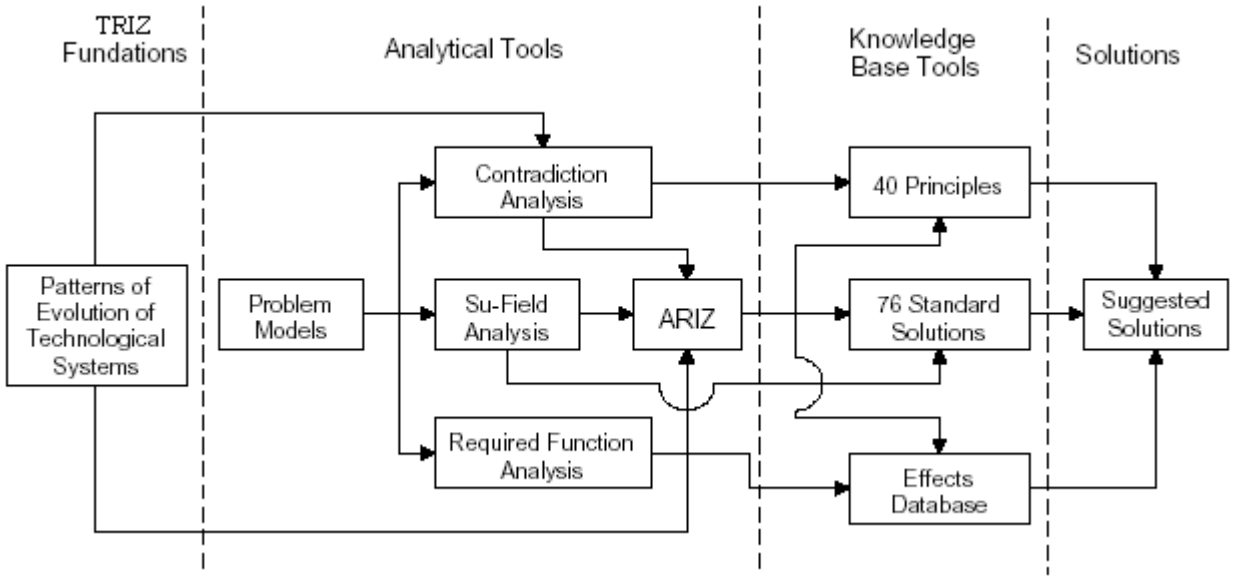

Figure 2. Scheme TRIZ to solve a Problem

2.3. Knowledge protection step

This step corresponds to the third approach proposed by the methodology, where more formal aspects of the Industrial property system are verified, in respect to patentability. Independent of the results reached in the previous stage, all students participate in a basic course of industrial property, because in this stage the students retake the contact with the Patents System in the traditional way, once the objective of this stage is the protection of the results reached in the solution of the problem (final course works or researches for the masters degree) through the elaboration of a patent application.

The fundamental concepts are introduced for submission of the patent application: The novelty, non-obviousness utility, and industrial applicability. The novelty concept is already accomplished once the state of the art was known in the informational stage, only remained a last verification in case it has elapsed a long time between this stage and the previous.

The industrial applicability concept is more or less evident once it is part of the requirements of the project, so it should be possible to manufacture the project.

The third requirement treats of the evaluation of the inventive activity, which in a very basic way means everything that is not a juxtaposition of means or process known in the technique, that does not produce a new or unexpected technical effect, and that it is not evident for a technician in the subject. Obviously, this is not a closed definition because it depends on the degree of the technician's knowledge in the subject that analyzes the request, although with the continuous analysis this concept is visible and it is very rarely evaluated in a mistaken way.

Also an objective course about writing patents is supplied, where the students learn how to elaborate a patent document, where the characteristics of the descriptive report are approached; elaboration of the patent drawings, that introduces different peculiarities of engineering drawings, and the claims, one of the most important parts of the application because it delimits the protected matter. An important characteristic of this proposal is the introduction of a procedure for the generation of one or more technical articles corresponding to the patent result of the research, that can be elaborated easily based on the same information used for elaboration of the report of patent application.

In Brazil there is a preference for the publication of technical articles rather to patents applications. This is due to the mistaken idea that such activities are mutually exclusive. Actually the united elaboration of the patent document and technical article now proposed is viable through a very simple procedure of correspondence, since both documents present very similar structure, and the differences presented are treated conveniently and incorporate to each document.

In this step teaching relative to the legal subjects that involve the procedure of a patent application is also supplied: necessary documentation and the deposit procedures in Brazilian Patent Office (INPI). Besides, it is analyzed which is the best protection form, as the convenience of the maintenance or not of a filling, the periods of each stage of the procedure and also of the validity of the privilege, the costs involved in the deposit and in the maintenance.

Subjects relative to the patent rights are also discussed, as employer and employee rights. Also are treated aspects relative to the commercial exploitation of an eventual patent, sale and cession, advantages and disadvantages of each one, applicable legislation, the ways of payments and the usual remuneration.

Still in this approach, it is foreseen the formatting of a technological basis company that will be incubated to make possible the commercial exploitation of an eventual patent resulted of the project developed in the Academy.

3. CONCLUSIONS

The use of the information contained in the patent system as complementing information in the graduation works (final of course) and in researches in masters' degree level (master's degree) in mechanical engineering course seems to be a promising way of introducing such important resources.

In INPI courses for university and research centers' students, it is demonstrated great interest in the use of patent information as the students notice that such information can bring useful knowledge to the development of their projects, academic or not. The possibility to obtain a patent application was observed to be strongly motivating too.

Some difficulty in the search of solutions in fields other than mechanics was observed, pointing to the need of a solution for the indexation of the patent documents for the Principles of TRIZ.

It was also observed that there was the need of at least a complementing course with strong practical content and with specific computational tools support. We understood that the best way for introducing this approach is in a support discipline to the final course work. In the case of master's or doctor's degree it would be better if teaching the subject in specific course as "special topics" where the students would develop their works in parallel with industrial property and TRIZ.

The formal aspects related to the protection and the elaboration of a patent report can be perfectly developed in courses or workshops developed by the Innovation Office of the University (NIT), avoiding spending the graduation's available time with subjects that although important are not essential to the creative process.

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