Knowledge based approach for identifying TRIZ contradictions

Tiziano Montecchi*
University of Bergamo, Italy

Davide Russo†
University of Bergamo, Italy

Ying Liu‡
National University of Singapore, Singapore

Abstract

Solving ill-defined problems is a complex activity governed by the search for knowledge. The contribution of this article consists of an algorithm for problem analysis and a discussion on the role the knowledge plays in such an analysis.

The authors propose, (1) an algorithm guiding the user to move from an indefinite problem situation to obtain a clearer problem formulation, following a process inspired to the ARIZ approach for fixing physical contradictions, and (2) some strategies and tools for selecting, acquiring and finally modeling necessary information to improve the effectiveness in building the contradiction model.

All those strategies have been implemented in a knowledge management tool called KOM, working as an automatic patent searching engine based on functional oriented search. An exemplary application is presented to explain how KOM is integrated in the problem definition process.

Keywords: contradictions; TRIZ; knowledge; function; patents.

1 Introduction

In the early phase of a design process, the problem space has to be narrowed down in order to transit from an initial situation to a goal state (Newell and Simon 1972). According to Newell and Simon's theory, this space should contain complete information about the initial state of the task (problem), information about the transformation function to move from the problem state to the solution, and information about the goal.

The most widespread classification divides problems into *well-defined* and *ill-structured* (Jonassen 1997). Well-defined problems have a definite solution process including a well-known initial state, a defined goal, and they require application of concepts, rules and principles from specific knowledge domains to reach a solution (Jonassen 1997). Unfortunately, in everyday life it is more frequent to encounter ill-structured problems, in which one or several aspects of the situation are not well specified, the goals are unclear, and there is insufficient information for the problem statement to solve them (Chi, Feltovich et al. 1981).

A deeper classification was developed by Getzels (Getzels 1964; Getzels 1979; Getzels 1982). He introduced 10 common types of problems combining problems features such as "*the problem is known*", "*it exists but remains to be identified or discovered*", "*it does not yet exist but is invented or conceived*", with methodology features such as "standard methods to solve problem that are known to designer and/or others", "*they are not known*", "*it becomes known once the problem is formulated*".

Problems can also be classified according to similarities in the cognitive process that are required to develop skills for problem solving. In this direction we can cite the work of Jonassen (Jonassen 2003) that has identified: *puzzles, algorithm, story problems, decision making, troubleshooting, diagnosis-solution problems, rule-solving problems, strategic performance, systems analysis, design problems*, and *dilemma*.

Also people from the TRIZ community like Ivanov and Barkan (Ivanov and Barkan 2006) have tried to classify problems in four typologies: *manufacturing process problems* (glitches, stops, non-rhythmical character and ineffectiveness of the main technological process. Inability to keep manufacturing process within established parameters; increase in number of rejects, unfavorable impact on environment), *design problems* (low productivity of the existing technical system, high energy consumption, large overall dimensions – mass, unreliability, short life and complexity of structure). The design problems include two further sub-problems development of the existing systems and the creation of new systems. *Science and research problems* (lack of information about physical and chemical processes, disparity between expected and real results, emergence of a previously unknown phenomenon or event) and *emergency problems*.

The growth of interest in ill-defined problems, and consequently in design problem methodologies, has been radically changing the role of the designer, from a creative person highly skilled in the art, into an expert in design methods and knowledge management techniques.

To complete the overview on problem classification, it is useful to cite also the problem classification proposed by Altshuller (Altshuller 1998). Also this classification is based on the types of information required to solve it. According to him, problems can be classified in two categories, technical problems and inventive problems. We face **technical problems** when the designer knows where to find the information needed to solve them and how to use such information. Solving this kind of problems leads to a quantitative change of the technique. While, we face **inventive problems** every time the designer needs solving instruments not yet known in technical literature to achieve a qualitative change of technique. Two main conditions define an inventive situation:

- Vagueness of the initial problem. The formulation is so vague that it contains a lot of different problems.
- Contradiction. When we try to find a solution using the prior art, some conflict situations arise. These conflicts are called technical contradictions. In fact, technical systems are whole entities so, any attempt to improve a part (function, characteristic) of the system by known techniques leads to a not acceptable worsening of other parts (functions, characteristics) of the system.

The method and suggestions proposed in this article aimed to address all problems that belong to the class of inventive problems, giving to designers a strategy and tools for better reformulating the problem situation into technical and physical contradictions.

In the next section an overview on the main methods to solve inventive problems is given, focusing on the TRIZ resolution of the inventive problem based on the concept of contradiction.

*e-mail: tiziano.montecchi@unibg.it
†e-mail: davide.russo@unibg.it
‡e-mail: mpeliuy@nus.edu.sg

Section 3 proposes an algorithm to derive contradictions from inventive problems and an integration of this algorithm with the knowledge management techniques developed by the authors is presented in Section 4.

2 An overview on TRIZ contradictions

An **inventive situation** is a typical case where the problem does not allow us to use known solving techniques to find a solution, but an invention is needed. A very representative problem to describe inventive problems is told by Altshuller himself.
Example: *For testing a new type of parachute, a small copy of it is used for the simulation. This model is placed in a transparent tube in which a stream of water flows. In this test it is essential to record the motion of vortices of water around all parts of the model (cell and suspension lines) by a camera. How to make the vortices visible? We tried to cover the model with a soluble paint, but paint was thinned faster and we had to stop testing very often. What to do?*

The formulation is so vague that it contains a lot of different problems, i.e. changing the paint, the way to paint or the investigation system. The inventive situation consists of a description of the technical system highlighting the deficiencies: the absence of a certain characteristic or vice versa the presence of an undesired characteristic (harmful). Many of the difficulties that arise in solving inventive problems are influenced by attempts to resolve the initial situation without consciously moving from the "pile" of problems of the initial situation to a real problem. At present, inventive problems can be solved with a lot of methods that can be classified according to three different approaches.

Psychological methods: stimulate personal creativity avoiding mental archetypes in order to generate bright and original solutions. Among this kind of methods we mention the most known Brainstorming (Osborne 1953) and all its variants (e.g. counter brainstorming). Lateral thinking (De Bono 1970) and other tools, such as STC (Altshuller 1996) or Why-How method (Bytheway 2005), that analyze problems from multiple points of view, changing the observer, or trying to identify him/herself with the problem, or trying to analyze the problem by analogies (Gick and Holyoak 1980), synectics (Gordon 1961) to stimulate not obvious relations.

Methods to systematize the selection of options: increase the number of alternatives to evaluate, excluding systematic reiteration and the constant return to the same ideas characterizing the non-oriented searches. For this class of methods, we mention Morphological Analysis (Zwicky 1948) and its variants, the huge number of checklists that guides to consider possible changes, such as scamper (Eberle 1996) or ASIT (Horowitz 2003), or attribute listing (Crawford 1979), or Creating Workforce Innovation (Morgan 1993), or methods to sort solving approaches such as mental maps (Buzan 1996). Largely, also the functional analysis proposed by Miles (Miles 1972) falls in this group.

Methods based on the technique evolution: reduce and, in many cases, completely eliminate the selection of options using an approach based on the objective laws of systems evolution. The knowledge of regularities makes it possible to sharply restrict the search area by replacing intuition with scientific predictions. In practice, the only representation of this class of methods is the TRIZ theory.

According to TRIZ, all systems develop themselves as result of the accumulation of contradictions within the system. The amount of contradictions increases and their solution is possible through a breakthrough, i.e. an idea that comes up, a totally new conception. Consequently, finding solutions to inventive problems, or more in general improving technical systems, must include the identification and resolution of hidden contradictions within systems. The transition from the indefinite inventive situation to the problem and its model is described by Altshuller (Altshuller 1998) through three different types of contradictions.

Administrative contradiction. *Something is required to make, to receive some result, to avoid the undesirable phenomenon, but it is not known how to achieve the result.*
Let's take the example of parachute problem, this is an administrative contradiction, in other terms it is not a problem but rather an inventive situation. Usually, an inventive situation is formulated like something is required to make (for achieving some result or avoiding the undesirable phenomenon), but it is not known how to do it. This type of contradiction does not show a direction to the answer.

Technical contradiction. *An action is simultaneously useful and harmful or it causes Useful Function(s) and Harmful Function(s); the introduction (or amplification) of the useful action or the recession (or easing) of the harmful effect leads to deterioration of some subsystems or the whole system, e.g., an inadmissible complexity of the system.*
The administrative contradiction has to be turned in a technical contradiction, so transforming a given problematic situation into a technical problem. This helps to reduce the vagueness of the inventive situation. Savransky's classified all ways a technical contradictions occurs (Savransky 2000):

- the creation (intensification) of the useful function in one subsystem causes the creation of new harmful function or the intensification of the existing harmful function in another subsystem;
- the elimination (reduction) of the harmful function in one subsystem causes the deterioration of the useful function in another subsystem;
- the intensification of the useful function or reduction of the harmful function in one subsystem causes the unacceptable complication of other subsystem or even the whole technique.

In our parachute example, we can formulate the technical contradiction as in the following:
Example: *To increase the time of video shooting is necessary to increase significantly the quantity of paint placed on the parachute, but in this way we inevitably alter the measurement and the shape of the model.*

Physical contradiction. *A given subsystem (element) should have the property "P" to execute necessary function and the property "-P" to satisfy the conditions of a problem. Where "-P" could be defined both as the absence of P and the opposite of P.*
The physical contradiction implies inconsistent requirements to a physical condition of the same element of a technical system. Each technical contradiction can be expressed in terms of a physical contradiction that represents the final reformulation of an inventive problem. Physical contradictions occur when:

- The intensification of the useful function in a subsystem causes the simultaneously intensification of the existing harmful function in the same key subsystem.
- The reduction of the harmful function in a subsystem causes the simultaneously reduction of the useful function in the same key subsystem.

For the example of the parachute the physical contradiction is reported in the following.
Example: *On suspension lines there must be an infinite amount of paint (to increase the time of video shooting) and there should not be absolutely (not to alter the measurement).*

Problem analysis has always had a pivot role inside the TRIZ community. The transition from administrative contradiction (situation) to technical contradiction (problem) is hard task (Altshuller 1998; Savransky 2000) due to two main reasons:

- Vagueness of the initial situation, among all different problems related to a situation is difficult to choose and define the problem to face.
- Technical contradictions are often hidden inside problem conditions.

In fact, in ARIZ, the most representative and acknowledged tool of the TRIZ theory, the "step 0" dedicated to the problem reformulation has been modified many times until its final elimination. The first version of ARIZ dates back to 1956, but only in the 1964 version, did a section devoted to "clarifying and verifying the problem statement" appear. It remained unchanged until 1968, when the section related to problem analysis was expanded and supported by techniques for overcoming psychological barriers (Size Time Cost - STC tool, etc.). In this version the correct problem identification was almost half the entire algorithm.

The versions belonging to the 1970s (ARIZ 71, ARIZ 75, ARIZ 77) had the problem formulation and analysis phase as large and distinct, until obtaining the 1977 version, by successive and gradual changes. ARIZ 77 was based on a single step composed of nine sub-sections, including techniques for reducing psychological inertia, comparison techniques based on existing systems on the market and patents knowledge.

Since this version, the problem formulation stage remained unchanged in the following versions (82-A, B, C, D and 85-A) until version 85-B where it suddenly disappeared. The section on analysis and reformulation of the problem was eliminated, even though it was considered necessary and useful, because it was probably judged too poor in rigor compared to the other steps. Also Altshuller, the founder and creator of the TRIZ theory, was not able to find a structured procedure for the formulation of the problem (Zlotin and Zusman 1999). This lack, in a context of a well-structured and guided theory, could not pass unnoticed and without any consequences. In fact, in following years, many TRIZ specialists have tried to bridge this gap. Immediately after 1985, the suspension of ARIZ developments by Altshuller and the need for a structured step guiding the formulation of the problem was perceived and thus proposed by many of his disciples (Terninko, Zusman et al. 1998; Khomenko, De Guio et al. 2007). So, further versions of ARIZ, containing a section on the analysis of the problem, were developed (such as ARIZ-KE-89/90, ARIZ-SMVA 91, ARIZ92, Ariz.-96SS). In more recent years, the arrival of the first computer programs has supported the development of this phase, trying to guide the user in the first phase of problem analysis, especially in information retrieval and problem formulation (Ideation, Invention Machine and Iwint).

Before to introduce also our methods for supporting problem formulation in terms of contradictions (section 4), a new algorithmic method to formulate a problem as a physical contradiction is proposed in the next section.

3 An algorithm to move from an inventive problem to its contradiction

As above mentioned, solving an inventive problem means to identify and eliminate the technical contradiction. Sometimes, the technical contradiction within a problem is clearly evident, other times it seems that a problem does not contain any technical contradiction because it is hidden within the problem conditions.

The conceived algorithm consists of four phases, supporting step by step the user from the definition of the initial situation to the formulation of the physical contradiction. In fact, the physical contradiction represents the most precise way to formulate an inventive problem, because it contains a precise specification of which direction should be taken and which parameters have to be used to model the solution. A schematic representation of the four phases is reported in Figure 1.

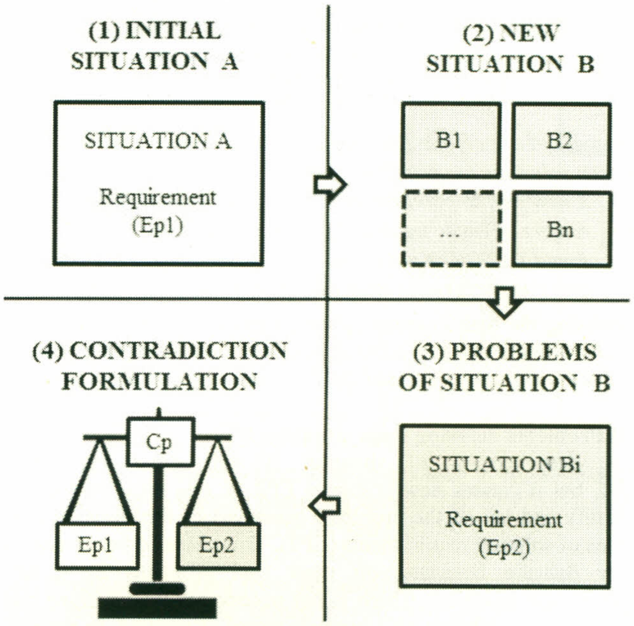

Figure 1. A schematic representation of the algorithm for problem reformulation.

(1) Initial situation A
The phase 1 aims to clearly define which main requirement the solution must have. This requirement has been called Evaluation Parameter (EP1) and it represents the desired improvement (or creation) of a useful function or the decrease (or elimination) of a harmful function.
Example: *For the situation of the parachute, the* ***EP1*** *can be defined as: The time of video shooting has to be long.*

Defining EP1 is not a simple task due to the complexity of the initial situation and its vagueness. Often, an initial situation contains more goals according to the level of details of the description. Thus, given an initial inventive situation, it is strategic to identify as many points of view as possible. For this reason, it is useful to know that our problem definition depends on the different perspectives from which the initial situation is described. In particular, from a same inventive situation we can derive different goals according to the level of abstraction of their descriptions. Let's think about the parachute example: if we consider a more abstract definition of the goal, our EP1- *The time of video shooting has to be long,* could be changed in a new EP1- *clear visualization of vortexes* so opening the solution space to other methods of investigation replacing the visual method. Before moving to the next step, the user has to choose only one of these directions according with TRIZ evolution laws.

(2) New situation B
Once our goal is identified, we need to find a direction to move from the current problem situation (as-is) to a new situation (to-be) where EP1 is satisfied. People skilled in the art, often identify this direction(s) using their background and experience. This knowledge can also be gained by studying the prior art (encyclopedias, handbooks, and textbooks or patents or scientific papers and technical reports or monographs and reviews, etc.),

setting ad-hoc test campaigns, using software (3D CAD/CAM simulation). However, for acquiring the proper knowledge about a specific problem it is useful to remind that an inventive situation often contains multiple problems, thus many contradictions. At a first glance, for a non-TRIZ expert, this could seem a drawback but, actually, the more contradictions we identify, the more directions of solution we have. Now the problem situation could be written in the following way:

System A does not achieve a required function (EP1)
It has to evolve to a new system B
to achieve the required function (EP1)

Example: *To increase the time of video shooting (EP1) a lot of known solutions are possible:*

- *A new way to paint the model using the existing paint.*
- *A more effective paint to coat the model.*
- *Avoid the use of paint and build a new device for shooting that can acquire the movement of transparent water.*

Choosing the first situation, where *something has to be changed in the way the existing paint is used*, the new situation B can be defined by an expert as: *add more paint on the parachute model.*

(3) Problems deriving from situation B

The new system of situation B will solve our initial EP1, but it creates new problems EP2. In this step, we have to identify and list all the problems generated by the situation B in terms of solution requirements (EP2). This phase of the process is very delicate because you must find problems in a new problematic situation, which is not necessarily well defined and not always possible to be accurately tested or verified. In general, we can say that the more knowledge we have about the problem and the more accurate and indisputable will be the final reformulation.

Example: *If we add more paint to the model (situation B) the measurement will be affected due to the alteration of the vortices or because of rising costs of test campaigns.*

(4) Contradiction Formulation

In the last phase of the process, among all requirements/problems (EP2) extracted from situation B, we select only those which are in conflict with the requirement (EP1) of the situation A. Now the technical contradiction could be written in the following way:

System A does not achieve a required function (EP1); It has to evolve in a new system B to achieve EP1,
but,
System B will no longer achieve another requirement (Ep2) that system A was able to do.

Example: *The technical contradiction is the following:*
System A does not realize a time of video shooting long enough; adding more paint we realize a longer time video
But the measurement will be affected due to the alteration of the vortices.

Finally we have to transform this technical contradiction in a physical contradiction. According to the definition at Section 2, we have to find the property "P" to execute necessary function and the property "-P" to satisfy the conditions of a problem. Such a property is called Control Parameter (CP). Here the final template for physical contradictions

PhC#1: the CP has to be high to satisfy EP1,
but doing that EP2 is not satisfied.

PhC#2: the CP has to be low to satisfy EP2,
but doing that EP1 is not satisfied.

Example: *The physical contradiction is the following:*
PhC#1 the quantity of paint has to be high for long time video shooting but doing that the vortices alteration is high.
PhC#2 the quantity of paint has to be low for a small vortices alteration but doing that the time video shooting is short.

4 Using knowledge to support contradictions extraction and formulation

Results of the process to derive contradictions can be highly improved if supported by proper tools for knowledge management. Thus, in this section we discuss the role that knowledge plays in each step of the method, providing suggestions about which are the proper information to acquire, how to do it and from which source. In particular, the authors focus their attention on automatic search strategies to extract desired information from patent documents.

(1) Initial situation A

The supporting tools for this phase should provide as many perspectives as possible of the initial problem in order to have a complete overview of the situation and multiple levels of detail. For better understanding this concept, we can consider a specific case.

Example: *We want to shell walnuts to be sold, to do that, it is essential to keep intact their kernels. How can we extract the kernel keeping it intact? We tried to crack the walnut by a traditional levers nutcracker, this works for most of the walnuts, but in some cases the force generated is excessive and kernel is broken. What to do?*

The authors have explored and proposed different solutions both exploiting the laws of evolution (Russo, Regazzoni et al. 2011), and combining different methods such as linguistic triggers, Why-How methods and Inventive Standards from TRIZ (Russo and Montecchi 2011; Russo and Montecchi 2011). Regardless of the suggested tools, their aim is always to generate a wide range of directions of intervention at a general level, described in functional term. In this case the application of KOM method splits the initial situation into several EP(s), as shown in Figure 2.

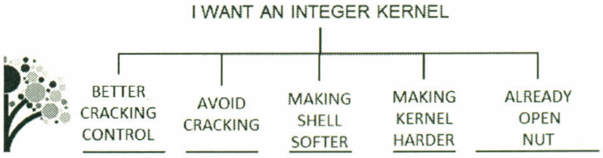

Figure 2. Different directions of intervention generated by KOM method.

(2) New situation B

In this step we have to identify an already known system to solve the situation A (EP1). If we do not know any already existent solution or if we want the opportunity to choose among more systems, it is recommended to gain an exhaustive knowledge on all the possible known solutions belonging to the prior art. It is evident that in this step knowledge plays an important role. Authors suggest using the knowledge contained into patent database. Our approach is based on a functional based search method called Knowledge Organizing Module (KOM). The authors have developed this searching system (Russo and Montecchi 2011), that is able to automatically search in a patent database decomposing an action in a Function + Behaviour + Physical (or Chemical) Effect according to the FBS design ontology (Gero 1990). KOM requires an function as input and it automatically generates a list of queries based on combinations of functional concepts at different detail levels, e.g. mince, crack, divide, open, etc. The outputs are patents that can be organized in form of a hierarchical tree where the knowledge is organized from the general level to the specific level (Behaviours, Physical Effects and Structures) according to the FBS ontology.

Patent search can be done inside and outside our field of interest (Montecchi and Russo 2011). Searching outside allows us to have more options for choosing the known system for situation B, finding those solutions that even a domain expert does not know because not yet used in his/her field. Thanks to the different levels of abstraction and a dedicated algorithm, KOM is able to explore different domains with the aim to identify patents using different Physical Effects to accomplish the same goal. Moreover KOM can be used also to retrieve a homogeneous pool of patents to be processed in order to extract systems that use different Structures to accomplish the same goal.
Example: *Figure 3 shows an example of "how we can automatically find all different ways of cracking", by using different physical effects. For every branch a list of patents is automatically provided.*

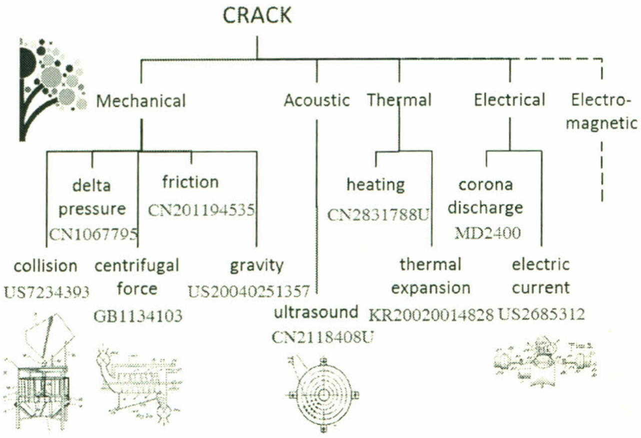

Figure 3. Known solutions based on different physical effects to crack a walnut. Results generated by KOM searching inside patents of the nutcracker domain.

If we extend this search of known systems outside the nutcracker domain, KOM can identify other fields:

- *Cracking shells in general: devices for cracking shellfish or shell eggs or gas tank shell, etc.*
- *Cracking object in general: machine for cracking tablets or stones, devices for grinding rice or grain, etc.*

KOM has found also some examples of physical effects, not yet exploited at the state-of-the-art of the nutcracker but, already developed in other fields, *e.g. JP2005312315: using vibrations for eggs cracking.*

Similarly, KOM could be used to generate a different situation B, at a more abstract level as in example: *"Finding a new way of opening walnuts". See Figure 4.*

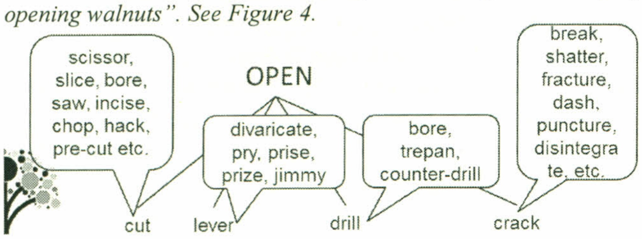

Figure 4. Alternative situations of opening walnuts.

Finally KOM can be used to suggest the new situation B at the structure level. Just processing the pool of patents suggested at the bottom of every single branch of the diagram (Fig. 2), we can understand, if there are known solutions that have already tried to achieve our EP1. Simple text mining tools, such as those developed by Cascini and Russo (Cascini and Russo 2007) can automatically search comparative and superlative adjectives to identify known systems satisfying EP1.
Example: *Figure 5 shows three ways of using levers for mechanically cracking a nut.*
EP976355: "The nutcracker device according to the invention may comprise ... and second stop means limiting the minimum distance between said elements".
US4944219: "This nutcracker is provided by more than two levers, so in this way the cracker force and inertia can be controlled easier".

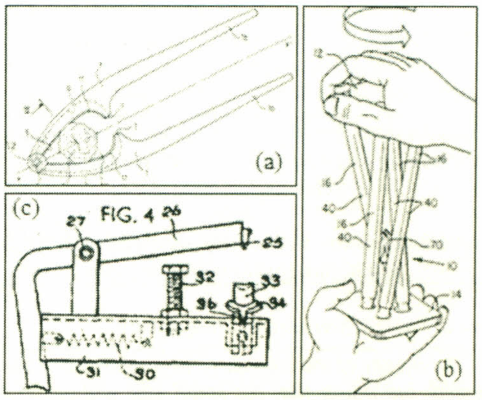

Figure 5. Examples of different structures used to crack walnuts by compression without damaging kernels. (a): *EP976355*, (b): *US4944219, (c): GB1152001*

(3) Problems deriving from situation B
After having chosen the known system, now we have to identify problems (EP2) related to this situation B. We can do that, analyzing/studying the literature, in particular, also in this case we suggest acquiring this kind of knowledge from patent documents (especially the field of description) because they often describe problems that the invention has solved. In order to know as many problems as possible, we suggest collecting all patents belonging to the same field of the known system chosen for the new situation B. From these patents we can understand which problems affect the state-of-the-art, identifying both general problems related to how to achieve a goal by a certain function (low effectiveness, side effects, low productivity, etc.) and very specific problems depending on the specific structures used (size, weight, manufacturing problems, etc.). At the same time, it is important also the collection of patents that describes systems achieving the same goal in different fields. These patents are more supportive for understanding general problems, in fact structures are extremely dependent on the application fields. For both the collections of patents, KOM is a useful support since it is able to individuate and classify (according to their fields) the entire pool of all the patents that allow us to achieve a same goal. Once we have the collection of pertinent patents we can also use text mining techniques to automatically extract problems (EP2) from texts by the recognition of predefined linguistic patterns that imply technical problems (Cascini and Russo 2007; Liang, Tan et al. 2008).
Example: *For "keeping the kernel undamaged" (EP1) we have chosen the known solution "nutcracker having a stop" (system B), but doing that this new system "cannot crack small walnuts" (EP2). This new problem (EP2) is described inside the patent: CN201814442U: "Therefore, the people have invented various walnut pliers according to actual nut, but the walnut pliers size in market is fixed, mainly designs in view of some big walnuts, but regarding the present great variety, a nutritional value higher small walnut, carya and so on cannot give dual attention".*

(4) Contradiction Formulation
The identification of the CP can be done identifying the physical laws governing EP1 and EP2, or by exploiting with text mining

techniques the patent documents. In the first case, we study the natural laws or phenomena governing the two requirements EP1 and EP2 looking for the common characteristic that at the same time must assume a certain value (P) and its opposite value (not-P or anti-P). Scientific and technical literature can support us to accomplish this task and in particular, we suggest to use physical effects databases (CREAX; Goldfire Innovator; Gorin 1973; TRIZ Korea Inc.) because they contain formula, explanations and practical examples about physical (chemical, geometrical, etc.) laws and phenomena. Also patents may contain information at this level of knowledge, and we can extract the CP reading documents related to the requirements EP1 and EP2.

Example: *From the previous step (3) we have obtained EP2, so now the technical contradiction can be formulated like:*

The initial nutcracker does not keep the kernel undamaged (EP1); evolving to a nutcracker having a stop (system B) the kernel is undamaged (EP1),
But
The small size walnuts cannot be cracked (EP2) while the initial nutcracker was able to do.

The physical formulation assumes this form:

PhC#1: the height of the stop as to be high to keep the kernel undamaged, but doing that the small size walnuts cannot be cracked.
PhC#2: the height of the stop as to be low to crack the small size walnuts, but doing that the kernel is undamaged.

Moreover, some attempts are done in trying to automatize the extraction of control parameters (CP) by means of text mining techniques (Zanni-Merk, Cavallucci et al. 2009). These text mining techniques are based on linguistic markers that can locate the control parameter (CP). In particular, a parameter can be retrieved using verbs that introduce a concept of change such as, *"change, generate, enable, create, enhance, improve, stabilize, maintain, emit"* and also considering, for each specific verb, the syntactic role of the parameter.

CP, EP1 and EP2, allow the designer to obtain a very precise model of the initial problem situation. This formulation of the problem has reduced the initial vagueness, easing the generation of effective solutions.

5 Conclusion

This article presents a method to derive TRIZ contradictions from an indefinite problem situation. This method is composed by a 4 step algorithm to guide and systematize the designer in formulating technical and physical contradictions where its powerful is highly improved integrating knowledge management techniques. The integration between the steps of the algorithm and knowledge management techniques is presented in form of suggestions that support the process of selecting, acquiring and finally modeling the necessary knowledge to build a contradiction. The authors suggest different ways for the acquisition of knowledge, focusing their attention on systems for automatic information extraction from documental literature. In particular, they point out the fundamental functioning principles of KOM system, a dedicated tool for automatic patent searching based on their research activity. One of the peculiarities of the patent searches they propose is related to how patents are exploited. In fact, at difference from common patent analysis, for our task patents are used as a knowledge base from which contextual/domain information are extracted and then decontextualized to turn them into general knowledge for modeling a problem belonging to any domain.

Finally, the authors believe that a future implementation of automatic techniques for text mining and semantic analysis inside KOM system could be the starting point to work inside patent texts with the aim of extracting information related to the structure of systems.

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