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Patents in the framework of TRIZ

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Abstract – This paper uses a few patents for illustrating some key concepts used in TRIZ. TRIZ can be defined as a: "human-oriented knowledge-based systematic methodology of inventive problem solving." [4].
Keywords: TRIZ, contradiction, path of evolution, SuF analysis, inventive principle, separation principle, effects.

I. BASICS

"Patents reveal solutions to technical problems and they represent an inexhaustible source of information: more than 80 percent of man's technical knowledge is described in patent literature." - Statement of the European Patent Office [4].

Studying patterns in the way Altshuller, the "father" of TRIZ did, about fifty years ago when he started his career as a promising young inventor, means using a certain frame of work different from the usual one, based on classification.

Analyzing around 400,000 patents, Altshuller recognized that systems do not evolve randomly, but along demonstrable principles called "patterns of evolution" which principles are general in nature and can be applied to any system or product. He also made the observation that many inventive technical problems from various fields of engineering are solved by the same generic approaches.

Specialists in TRIZ had already analyzed almost 2 million patents from all around the globe, which represent 10% of the total number of issued patents.

The table 1 illustrates the classification system used by Altshuller [1] when classifying and studying world-wide patents.

The results of the study of patents must be put in a certain pattern abstract form in order to produce uniform results, so they contain reusable information. TRIZ specialists proposed [4] a Patent Abstract Form which mainly contains the following items:

A. Legal information
B. Abstract of extracted knowledge
C. State of the art
D. Elements and functions of the prototype system
E. Resolved conflict
- e1. type of contradiction
- e2. structure of problem

F. Invented system
- f1. contradiction

f1.1. principle of solution
f1.2. reduction rule
- f2. effect(phenomena)

f2.1 natural
f2.2 technical
- f3. heuristics

f3.1 engineering principle
f3.2 separation principle
f3.3 standard transformation
f3.4 prescript
- f4. trend/path of evolution
- f5. special cases

Using TRIZ for the study of patents one needs to be conversant with the 8 patterns of evolution [2] followed by every technical system or technological process as it is shown in the table 2:

Table 1

Level	System changing	Variants number	Used knowledge	Inventions pool
1. Standard solution	Trade-off, quantitative changes	A few	Someone profession	32%
2. Change of a system	Qualitative change	Tens	One industry	45%
3. Solution across industries	Radically changed system	Hundreds	Many industries	19%
4. Solution across sciences	New system created	Thousands, tens of thousands	Many sciences	4%
5. Discovery	New discovery	Hundreds of thousands, millions	New knowledge created	0.3%

A certain phraseology must be clarified in order to better understand certain aspects on which TRIZ users focus when studying technical inventive problems. Some such terms are:

AC - *administrative contradiction*: something is required but we don't know how to obtain the result

TC - *technical contradiction*: an action is simultaneously useful and harmful

PC - *physical contradiction*: a system should have both property A and non-A

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Table 2

Pattern	Example	
Technology follows a life cycle of birth, growth, maturity, and decline.	Stage 1. A system does not yet exist, but important conditions for its emergence are being developed. Stage 2. A new system appears due to high-level invention, but development is slow. Stage 3. Society recognizes value of the new system. Stage 4. Resources for original system concept end. Stage 5. Next generation of system emerges to replace original system. Stage 6. Some limited use of the original system may coexist with the new system.	1. Early experiments like "cat's whisker", the crystal detector, etc. 2. Late 40s - W. Sheckley, J. Bardeen, W. Brattain, inventors of the point-contact transistor. 3. Companies invest in producing the new device and replacing the vacuum tubes where possible. Financial resources available. 4. New components based on the new concept but with new materials and design; need for more complex function and smaller device. 5. J. Kilby and R. Noyce - inventors of integrated circuit. 6. Despite the explosive development of IC industry, the classical transistor is still used in certain electronic circuits.
Increasing Ideality.	ENIAC computer in 1946 weighed several tons, took a whole room, and did computational functions. In modern laptops weighing a few pounds capability exist for text processing, mathematical calculations, communications, graphics, video, sound, etc.	
Uneven development of subsystems resulting in contradictions.	Subsystems have different life cycle curves. Primitive subsystems hold back development of total system. A common mistake is to focus on improving wrong subsystem.	
Increasing dynamism and controllability.	Early automobiles were controlled by engine speed. Then manual gearbox, followed by automatic transmissions, and continuously variable transmissions (CVT).	
Increasing complexity, followed by simplicity through integration.	Stereo music systems have evolved from adding separate components such as speakers, AM/FM radio, cassette player, CD player, etc. to integrated "boom box."	
Matching and mismatching of parts.	Early automobiles used leaf springs to absorb vibration. These were an assembly of unrelated or mismatched parts borrowed from horse carriages and whatever else was available. Later fine tuning allowed adjustments of the parts so that they mated into a matched system - the shock absorber. Purposely mismatch parts to create additional resources from the differences. An example of this might be using a bimetal spring that changed spring rates when a current is applied. Automatic matching and mismatching as needed. For example a computer controlled active suspension system.	
Transition from macro systems to microsystems using energy fields to achieve better performance or control.	Development of cooking systems from wood burning stove to electric and then to microwave ovens.	
Decreasing human involvement with increasing automation.	Development of clothes washing from washboard to washing machine with ringer, automatic washing machine then automatic washing machine with automatic bleach and softener dispensers.	

Structure (topology) of a problem - obtained from the representation of contradictions together with the hierarchical structure; generic problem structures are:

- point: have contradictions within a single subsystem or have no contradictions at all.
- pair: have a single technical contradiction between functions in two subsystems.
- linear: have chains of engineering contradictions
- network: have a loop of several dependent contradictions
- star: have a set of independent technical or mathematical contradictions with a common root (usually a physical contradiction)

Inventive principles: the 40 principles revealed by G. Altshuller based on the observation that technical contradictions contained in a large number of problems from different domains used the same typical principle for removing them (he also identified 39 engineering parameters representing very general features of TS and TP and placed them in a so- called Matrix of Contradiction)

Separation Principles: a system of heuristics that serves as a basis for solving physical contradictions; four types of separations are used:

- separation in space: possible when a requirement exists in one place and is absent in another
- separation in time: possible when a requirement exists at one period and is absent at another time interval

- separation upon condition: possible if a requirement exists under one condition and is absent under another
- separation between parts and whole: possible when a requirement exists at the key subsystem level but does not exist at the sub-system, system or super system level

Standard Solutions: are based on a formalism called *SuF (Substance-Field)* [3] analysis (Fig.1 - The complete basic Su-Field model); from the two general categories of inventive problems standard and non-standard, the former can be solved using rules based on Su-Field Models and on the Patterns of Evolution of TS (which determine the modifications the system has to undergo).

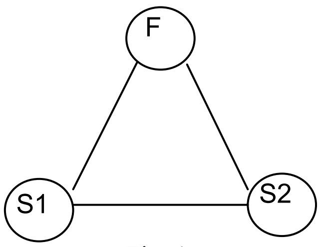

Fig. 1

Su-Field modeling helps focusing on the main system elements and identifying the problem as one belonging to a particular group. Deviations from complete Su-Field triangles reflect the existence of some problem in the group. Su-Field analysis presents a general formula that shows the direction of solving the problem. Three types of situations exist when completing the model: the desired effect may not occur; a harmful effect may occur; insufficient desired effect occurs.

Standard Solutions: developed by G. Altshuller in 1985, consists of 76 Standard Solutions separated in five classes.

- Class 1: solutions for building and destroying Su-Field Models.
- Class 2: solutions directed toward improving Su-Field Models
- Class 3: rules for transitioning to either a super-system or to the micro-level; they are based on Pattern of Evolution.
- Class 4: help solving the specific problems related to measurement and detection.
- Class 5: rules for applying the Standard Solutions.

Effects and Phenomena: standard solutions include methods but also physical effects (they do not refer to a concrete physical effect but to the type of effect, and for this reason they do not wear out; strong inventive solutions may be obtained sometimes by using natural effects that have rarely or never been used before in a specific area; knowledge of less known effects in physics, chemistry or geometry may be necessary)

Technical effects: transformation of energy or substance from input to output under certain conditions; it can affect quantitatively or qualitatively the input parameter.

Large data bases with effects and phenomena were built containing about 10,000 effects described in scientific literature (compare with around 100 known by an ordinary engineer). They are organized on a functional principle: they contain a list of functions commonly encountered in practice and a corresponding list of effects that may be employed to achieve these functions. [4]

II. CASE STUDIES

We will present some patents collected from the USPTO (United States Patent and Trademark Office) collection [5] based on their area of application in the field of the telecommunication system and underline some aspects of them using TRIZ philosophy and terminology.

Case 1:
Multi-frequency light source - USPA 20060193032, August 31, 2006

The text says: "a multi-frequency light producing method and apparatus multiplies the number of optical channels present in an incident wavelength division multiplexed (WDM) signal light source by four-wave mixing (FWM) the WDM signal with at least one pump lightwave at least one time." Further on in text contradictions to be solved are set: "*For a system employing a large number of wavelengths, using a different light source such as a laser diode to generate each optical wavelength can be expensive and consume a large amount of electric power*." then effects are used in solving contradictions: "*Four-wave mixing (FWM) is a phenomenon wherein three optical lightwaves of different frequencies (wavelengths), propagating in a nonlinear medium interact with one another due to the nonlinear optical effect of the conversion medium. This interaction generates additional optical signal having different frequencies from the three original signals*." Using Physical and Technical Effects helps inventors to obtain high level even revolutionary solutions on the path to ideality [2].

Case 2:
Auxiliary power conservation for telecommunications site - USPA 20060182262, August 17, 2006

The abstract says: "a method and/or system is provided for managing power in a telecommunications site having an auxiliary power supply that selectively powers the site when an outage is experienced in connection with a primary power supply for the site. The method includes: detecting a power outage to the primary power supply; determining the duration for the detected outage; selecting a power conservation protocol based on the determined duration of the outage; switching to the auxiliary power supply and implementing the selected power conservation protocol." Further on in the text the state of the art is detailed: " Previously, the industry has used: multiple commercial power feeds, a battery reserve, local power generation equipment expensive to implement, particularly when the demand for their deployment or use is relatively infrequent." All these technical systems: "may not be practical where the location prohibits the noise often associated with running generators; the auxiliary power supply has a limited capacity with respect to the amount and/or duration of power it can supply to its site; the degree to which power consumption can be conserved during back-up emergency situations largely determines how much back-up or emergency power capacity a site should be provisioned with." Here comes the reduction to a single technical contradiction: "*One option is to switch off all but the very essential site functions when a site begins operating on back-up or emergency power, unfortunately: "limiting the level and/or quality of services provided by the site; there is a desire to maximize power conservation when operating a site on auxiliary power, while still providing a suitable level and/or quality of service*."

Here is an example of the use of one of the 40 Inventive Principles - Principle of Extraction (extracting the harmless functions from the system):" after the primary power has been lost and a site switches operations to auxiliary power, some site functions are turned off or otherwise not supplied power."less important or extraneous non-core functions." Efforts are made to increase the dynamism of the system: "To further extend the longevity of the auxiliary power supply, additional site functions may be shed as the reserve power supply is consumed or depleted." so maintaining the natural evolution path.

Case 3:

Fire-resistant power and/or telecommunication cable - USPA 20060148939, July 6, 2006.

In the abstract it is stated that: "a cable capable of withstanding extreme temperature conditions...remain in operation during a defined length of time on being subjected to high levels of heat and/or directly to flames." The Administrative Contradiction is established: "*is essential to maximize the ability of a cable to retard the propagation of flames, and also to withstand fire."* After stating that: "a cable is constituted in general terms by at least one conductor part extending inside at least one insulator part" the physical contradiction appears: "amongst *the best insulating materials and/or protection materials used in cable-making, many of them are unfortunately also highly flammable*."

The state of the art of the technique is presented further on: " The technique that has been in the most widespread use until now consists of implementing halogen compounds in the form of a halogen by-product dispersed in a polymer matrix." Safety constraints are also present: " present regulations are tending to ban the use of substances of that type, essentially because of their toxicity and because of their potential corrosivity, whether at the time the material is being fabricated, or while it is being decomposed by fire." Trying to solve the folowing aspect "ever increasing recourse is being made to fire-retardant fillers that do not contain halogen, and in particular to metal hydroxides" a new technical contradiction is about to rise: " technical solutions of that type present the drawback of requiring large quantities of filler in order to achieve a satisfactory level of effectiveness, whether in terms of ability to retard flame propagation, or in terms of resistance to fire." And here is the solution based on using Standard Solutions: " the solution to the technical problem posed consists in that the cable includes at least one constituent part based on a fire-resistant material of composition that comprises a synthetic polymer and a fire-retardant filler, comprising an inorganic compound associated with a hydrocarbon compound selected from the group of asphaltenes, each constituent part being selected from an insulating covering and a protective sheath. *The presence of the inorganic compound within the fire-retardant filler conventionally makes it possible to increase the fire resistance of the material. To compensate for this presence also having the drawback of strongly degrading the mechanical properties of the corresponding material, it is associated simply with a compound based on malthene*."

An extended study of a patent will follow a more complex scheme like the one presented in Fig. 2.

III. CONCLUSIONS

The study of patents is of fundamental importance for TRIZ and not only, because patents represent the primary source of knowledge and the methodic study of this fund can bring up new heuristics. Due to the fact that this kind of study is very difficult and not very productive (one new heuristic per 10,000 patents [4]) new methods of study, perhaps based on artificial intelligence are needed.

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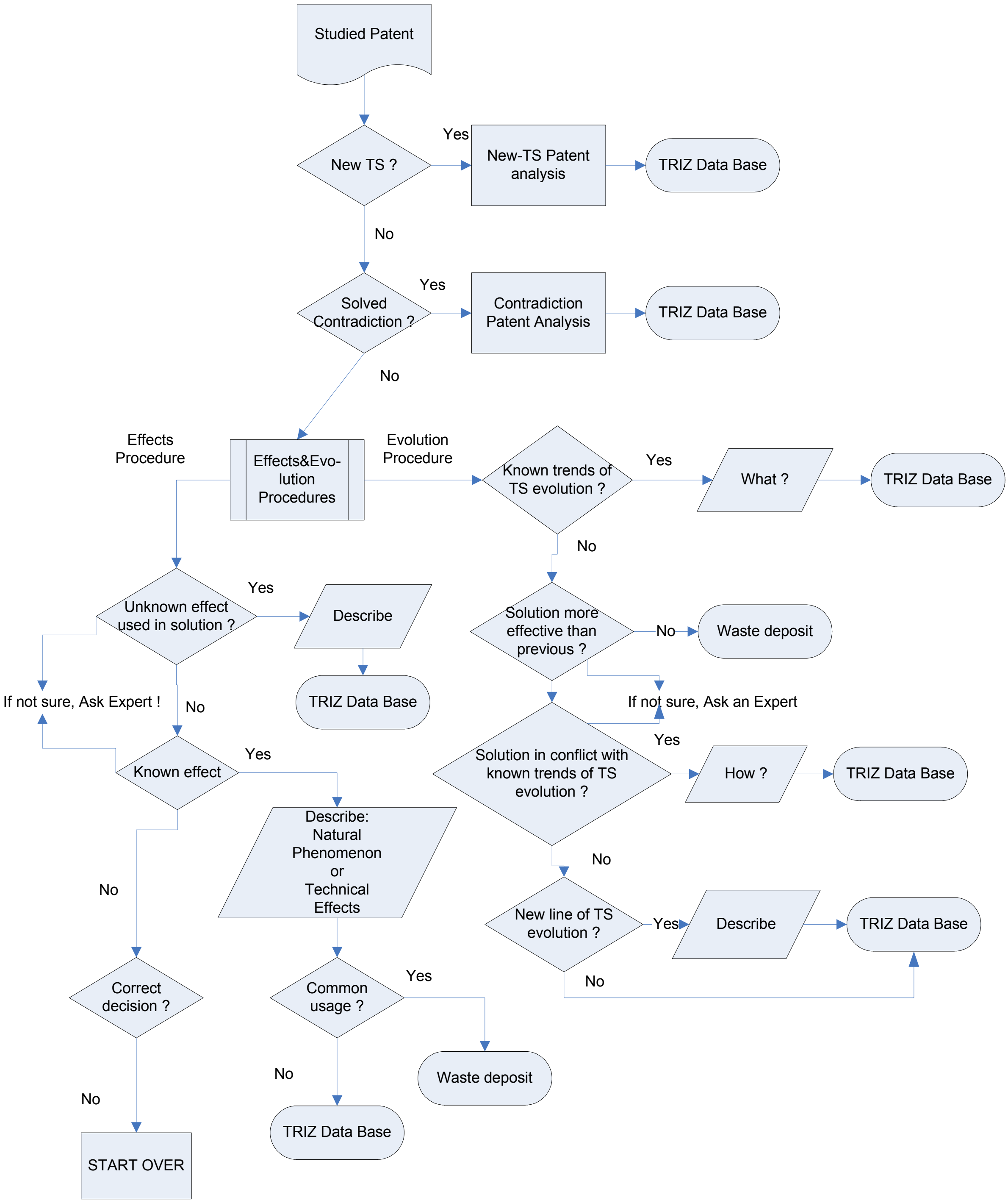
Studied Patent
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Yes
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Solution more effective than previous ?
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If not sure, Ask Expert !
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Solution in conflict with known trends of TS evolution ?
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Waste deposit
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No
TRIZ Data Base
START OVER

Fig. 2