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Procedures and Models for Organizing and Analysing Problems in Inventive Design

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Abstract
One of the first tasks designers are facing is the gathering of all potentially interesting information for understanding an initial situation. Its main objective is the drawing of a problem statement and the understanding of all future difficulties their project will face with. In this paper, we consider the problem of highlighting challenges within an inventively oriented design process, based on expert questioning procedures. Our intentions are to obtain a list of clearly formulated contradictions in the sense of TRIZ. In addition, we wish to minimize expert's time solicitations while guaranteeing that the highlighted inventive challenges have been exhaustively identified.

Keywords:
Problem statement, Inventive Design, TRIZ, Contradictions.

1 INTRODUCTION

1.1 Orientations of a design process

Prior to be engaged in a design process, the understanding of an initial situation is a crucial stage often poorly exploited by designers. If neglected, there is a high risk that a project evolves towards poorly effective outcomes since somewhere else; a similar task might have been already solved by another team. A second situation is that design efforts might have been connected to a goal of secondary importance in a given field of activities since the goals of primary importance have been missed. When designing an inventive way, this issue is even more critical. In our research, the problem of guiding the design process in a direction consistent with the laws of TRIZ has already been exposed in a previous publication [1]. The topic to be discussed in this article concerns the mapping of known problem and partial solutions as a preamble to the synthesis of contradictions of a specific field. Other articles have already dealt with the ontology building of our main concepts and their interactions [2] and the choice of a reduced set of contradictions in order to impact appropriately on the initial problem network [3]; they are to be considered as a continuation of this article.

1.2 Knowledge and graphical representations

A significant amount of knowledge recording modes are nowadays available to companies so that the experience of their experts is both captured and formalized graphically [4]. Such representations are sometimes helpful to highlight deficiencies in the model represented and are sometimes initiating proposals for solutions [5]. Other models are known to better understanding the complexity of specific situations [6]. Our approach is also a proposal for knowledge recording and representing but can be differentiated in the sense that our aims are turned towards the assistance of contradictions formulation of a given field. The contradiction model is to be understood within the meaning of TRIZ, as it has already been exposed in several other publications [7] [8].

1.3 Optimizing versus inventive design

The paradigm in which our contribution lies resides within a particular category: inventing. Invention results from a human thinking act leading to a physical embodiment (an artefact) non-existent before. This "invention" reaches its status by the fact that one of its components proposes an original solution to a problem so far unresolved. TRIZ [9] distinguishes inventions problems whose solution requires overcoming a contradiction (technical or physical) from those not requiring the resolution of such a contradiction. TRIZ considers the former and does not consider the latter, which are optimization problems, in opposition to Inventive Problems. The rest of this article relates implicitly to inventions that cannot be obtained under the procedures known within the theory of optimization.

To conclude on this subject, optimizing and inventive design are complementary and respond to different logics of problem-solving. Used in conjunction with optimization, invention makes possible to exceed actual design limits. Our postulate is that invention is an unavoidable path when optimizing has exhausted its area of potential solutions and when we can no longer be satisfied with best possible compromises [10].

2 LIMITS OF EXISTING PROCESSES FOR PROBLEM STATEMENT

In the state of the art of existing techniques and approaches for assisting with processes a problem statement, we can find four categories of findings.

The operational research community has achieved many interesting results in the definition of problems in an axiomatic way. Among others, CSP or Nonlinear Analysis clearly define and constitute a mathematical orientation for addressing such kind of problems [11]. The abundance of findings is this area reveals also the deepness of such a field and several authors have highlighted that one of the boundary of this research was the presence of a man's brain and perception as an unknown land where mathematics are of poor impact. Design indeed is a lot about a human act [12] and our purpose in this approach is neither to deal with existing data compiled in databases (rarely exhaustively representing a wide part of a domain knowledge) nor to reproduce human brains but to interface with a know-how in an expert knowledge only tacitly present in his mind. For instance, an obvious limitation we forecast within our needs in using the findings of this community resides in the fuzzy capacity of their models to both acquire knowledge in a generic way and in a detailed way covering a dynamically moving wideness of known things in a mono or multi-domain perspective.

Conceptual mapping techniques and their modes of representation of unstructured knowledge [13] constitute a complete field of research activity from both education sciences and artificial intelligence. As a result we can observe various techniques like web-pads or mind-maps of specific domains [14] established within this community. Although the approach has been proven to be useful for education purposes and tested in pedagogical situations, such models still have to prove their relevance in industry where the speed and the contradictory aspect of several experts beliefs needs to be taken into consideration.

A novel community, namely working on Computer Aided Innovation Software, can also be considered. Their findings are diverse depending on the company's philosophy behind. For instance, the most known is certainly the Invention Machine's Goldfire Innovator product and its "cause and effect" model. The graphical aspect is ergonomic and its interpretation and use rather simple. Nevertheless the simplicity of highlighting a "core problem" obviously limits such claims to a reduced typology of situations (relatively simple ones). Moreover, we were not able to find in their product the possibility neither to implement a new rule for graph interpretation nor to link what the model claims to be a "core problem" to any set of contradictions prior to entering the solving aspect of the study.

Finally, within TRIZ ongoing researches, several models for initial situation analysis have been proposed [15][16]. Among these results, the OTSM framework has proposed some promising directions, but without a complete, thoroughly described ontology of concepts [17][7]. While we have appreciated the originality of some of these findings, we shall register our contribution within this field of activities with the aim of further describing (also sometimes differing from OTSM) a complete framework of knowledge acquisition, representation and manipulation, useful within inventive problem solving concerns.

3 DESCRIPTION OF THE PROPOSED MODEL

3.1 Key terms of our approach

In this section we will summarize and illustrate the main definitions associated with the key terms used in our process. For a better understanding of the concepts and their interrelations, readers may refer to figure 5 of the paper in the case study section.

Problems

A problem is expressed as a sentence (<subject> + <verb> + <complement>) reduced to its essentials. A single idea is to be contained in its definition. In the network and beyond its syntax form, a problem (in the sense we give to it) describes a situation where an obstacle prevents a progress, an advance or achieving what has to be done.

Generic aspect of a problem

As remarked in the definition of a problem, its expression must first have reached its maximum decomposition. This type of decomposition aims to remove ambiguities which may occur during a too generic description containing an unknown number of sub-problems which could then not be traced with partial solutions related to them.

Partial Solutions

In its simplest form (To <Verb in its infinitive form > + <Complement>) expresses a result known in the domain and verified by experience. It may materialize a tacit or explicit knowledge of one or more members of the design team upon their past experience, a patent filled by the company or a competitor or any partial solution known in the field of competence of the members of the design team.

Uncertainty in partial solutions: We want to remind here that a partial solution is supposed to bring the least possible uncertainty about assertions of its effects on the problem it is attached to. Confusion can occur between a "solution concept" (which is the result of an assumption made by a member) and a partial solution, which has been validated by experience, tests, calculations or results known and verified. This distinction is important because any ambiguity inserted in the network would lower the relevance of working hypotheses taken from the interpretation of this network.

Contradictions

A Contradiction (figure 1) includes 3 types of components: the elements, the parameters, the values.

Elements

The Elements are constituents of a system. From a syntax viewpoint, they may be names or groups of names or nouns (for example: the hammer drives the nail, E = hammer). The nature of the elements can change any time based on the description which is given upon a certain viewpoint. Thus "the hammer drives the nail" may become "the anvil pushes the nail" when expressed by another expert. In the second case, E = anvil. For a third expert "The man pushes the nail". In this case E = man. It is important, when identical situations are described with divergent points to organize a consensus in forcing the reformulation within the meaning of fundamental physics and the systemic decomposition that has been previously made when starting the study.

Parameters

Parameters describe elements by assigning them a specificity, which reflects an explicit knowledge of the area observed. They are mainly names, objects or adverbs. The form of expression is diverse, sometimes contradictory when expressed by different experts. We distinguish two categories of parameters:

- Active Parameters (AP): On which the designer has the power to modify its state (the designer can make the choice to design an anvil having a light volume or small one, in this case volume = AP). This type of formulation has generally two directions that can potentially result in positive impacts on the object or its super system.
- Evaluating Parameters (EP): The nature of these parameters can be observed in their ability to evaluate both positive and negative results of a designer's choice. The consequence of designing an anvil having an important mass is that its ease of driving is improved (in this case ease of driving = EP). This type of parameter has often a logical sense of progress (its positive direction seems obvious) while the other seems absurd.

Values

Values are mostly adjectives used to describe a parameter (the volume of the anvil should be heavy; in this case V = heavy). Note that the fundamental aspect of the concept of contradiction, when expressed at a physical level, is the qualitative difference of values of a parameter: if the meaning induced by the adjective associated with the V leads to positive aspects, then it is essential (in order to complete a contradiction) to investigate adjectives qualifying V's antonyms to highlight the contradictory aspects of the analysis and then to validate it or not. We choose, as a first step for practical reasons, to limit the values of V pairs consisting of an adjective and its antonym. Thus, a heavy anvil volume leads to an ease of driving while a light anvil volume results in an ease of manipulation; in this case the pair chosen for V is heavy / light.

$TC_{n.m}$	Active Parameter AP_n	
	Va	V$\bar{a}$
Evaluating Parameter EPx	☺	☹
Evaluating Parameter EPy	☹	☺

Figure 1: Generic table of a contradiction (from TRIZ viewpoint)

3.2 Construction of a network of problems / partial solutions

The main foreseeable problem has been pointed out by [18]. It states that consultation with experts is effective because it allows the problem space and the solution to be negotiated interactively, whereas computer-based systems simply offer passive data. Our process of building a network of problems / partial solutions is iterative and passes through a set questions and answers between the facilitator and the members of a design team. The entry point of the questioning can be the problem that, according to the participants, appears as the most critical from the expert awareness. This mode of entrance into the network may seem arbitrary. Nevertheless we do not intend here to describe a single problem but to enter in the problem space to be formalized through a specific one (one of the sub-problems among others) and to discover its immediate surroundings (immediately related problems) until a satisfactory level of space coverage is reached. Here, the notion of "problem space" has to be understood as the sum of interconnected problems sufficient to completely describe the initial problematic, while each problem have to be taken as equivalent explanations clarifying a specific part of the overall problematic.

In order to be complete, a problem space must be composed by partial solutions. The sum of partial solutions can also be called a "partial solution space", interacting with problem space.

The ending point of the domain clarification is generally observed when participants (experts) have expressed what they had to say on the subject (parts of their knowledge regarding the problematic situation) and when it can be observed, several times, that any new input (new problems or new partial solution) seems similar to previous ones already expressed. A saturation of problem elicitation by expert is therefore reached, symptomatic of a space where most of what we wanted to represent has been revealed.

The next paragraph will describe how the networks may be graphically constituted (see table 1) and iterated within time, therefore offering the possibility to add, remove or change any data on its appearance.

3.3 Maintenance and monitoring of the network data

It is acknowledged that companies give little time for problem formalization in the early stages of a project. Therefore, our goal is to get and maintain as many information as we can in a minimum allowed time for the project. In various past situations we encountered in companies, it was hardly possible to go beyond 3 to 4 meetings for problem networks constitution. The topic we deal with in this paragraph is therefore the activity of maintaining a network of problems / partial solutions through a series of 3 to 4 consecutive sessions.

All elements (problems, partial solutions, links) placed in the network during the first meeting are in black / solid only when validated by all participants. Before any validation (when a conflict between two or more participants appears), the feature is the same colour but a dotted line.

When the first meeting ends and before the second one, any additional suggestion by a member of the design team is allowed to integrate the network but the colour of this proposal should be the colour of the second meeting using a dotted line. During the second meeting, we therefore begin working on (if one or more members have worked on the model) black / solid lines (for what has already been approved at previous meetings), afterwards with the dots in another colour (the second day) placed in the network between meetings by one or more participants. The task for the second day will summarize therefore the transition from dotted elements to strong lines (validated by the group) and / or additions of new elements whose state can vary from strong lines to dotted ones according with the fact they have been co-validated by the design members.

3.4 Standards situations

From Problems to Partial solutions

Any problem, stated in the problem space and in relation to one or more experiences having led to an acknowledged result gives rise to a partial solution. The nature of the relationship between the problem space and the partial solutions space can be interpreted as "one can".

> *Example: PB1: Thermal expansion generates an uneven roll's profile →"One can"→ PS1: Create a concave roll in cold situations.*

From Partial solutions to Problems

Any partial solution provoking no subsequent problem virtually suppresses the existence of this problem.

When the implementation of a partial solution creates new problems, a link between the spaces of partial solutions to problem space is created. This link can be interpreted as "but then".

> *Example: PS1: One can create a concave roll in cold situations→"but then"→ PB2: Strip deviation is observed at start-ups.*

Links between Problems

A chain of several successive problems can be created. Such a sequence means that the appearance of a problem is generated by others. This type of representation is to be used with precaution since if a problem disappears; it means that all subsequent problems will disappear as well. Such statements are subject to precautions before being placed in the network of problems.

> *Example: PB1: Rolls are deformed by thermal expansion →"and thereafter"→ thermal expansion generates an uneven roll's profile.*

Links between Partial solutions

A chain of several partial solutions, succeeding each other is to be considered with precaution. A partial solution following another signifies that the previous one had not solved the whole problem. If not, the new partial solution probably solves another problem either already presents in the network or needing to be formalized.

> *Example: PS1: One can create a concave roll in cold situations →"and thereafter"→ PS2: One can create a convex roll in hot situations.*

Note: Such situations can underline the necessity to disclose problems (if they were not mentioned by experts before). Our example can, for instance, underline the necessity to disclose the following relation: "PS1: One can create a concave roll in cold situations→"but then"→ PB3: There is a necessity to have a stock of rolls".

3.5 Particular Cases

AND operators

To be validated, at least two partial solutions need to be associated for partially solving a problem (if one of them is removed, the rest of the links aren't true anymore). In this case lines joining problems and partial solutions are converging in the equivalent of an "AND" cell.

Note that this situation can be reversely used between problems and partial solutions.

OR operators

A partial solution is generating alternatively a problem or another (but not both problems at the same time). In such cases a line coming out of this partial solution enters in an "OR" cell and its output is connected to the alternative generated problems.

Problems only partially solved

A partial solution only partially solving a problem, but not creating new problems: In this case a batch line (axis line) is created and indicates that this partial solution only partially solves the problem (the problem remains despite the existence of a partial solution to reduce its effects).

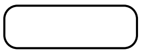
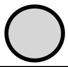
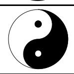
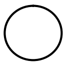
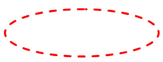
Graphical representations	Definitions
	Problem
	Partial solution
$PB_n \rightarrow PS_n$	“one can” link type
$PS_n \rightarrow PB_n$	“but then” link type
$PB_n \dashrightarrow PS_n$	Signify that the problem is only partially influenced by this partial solution
from Pb or Ps – & – to Pb or Ps	“AND” cell
from Pb or Ps – >1 – to Pb or Ps	“OR” cell
	Contradiction
	Active Parameter
	Evaluating parameter
$\xrightarrow{a}$	Value (adjective) of an Active Parameter
$\xrightarrow{\bar{a}}$	Opposite Value (adjective’s antonym) of an Active Parameter
	Signify that this group forms a contradiction

Table 1: Graphical representations and their definitions

4 SYNTHESIZING CONTRADICTIONS OF A GIVEN DOMAIN

4.1 Knowledge location

As we have already mentioned in the introduction, the necessary sources to conduct a mapping of the problem space are twofold:

- They can be included within textual corpuses (compiled in various documents as patent, internal reports, lists of requirements, …)
- They can be tacitly or explicitly in experts mind but not written somewhere.

The first case will not be discussed in this article but will be the purpose of a further contribution. Regarding the second case, the first task is to organize the exchange between experts in order to extract elements from their knowledge appropriately fitting in our networks formalism. Their respective knowledge will be therefore thoroughly recorded and co-validated by members of the design team. During these questions, the networks of problems and partial solutions are jointly constructed.

4.2 Links between problems / partial solutions networks and contradictions network

In our industrial experience when applying such networks, it is often apparent that each problem (when formulated as described above) may be linked to one (or several) evaluating parameters. The partial solutions, in their case, may be linked (or give rise) to one or several action parameters. By organizing a formal relationship, when possible, among problems, partial solutions and parameters, we obtain a set of links between the networks of our explored domain.

But encouraging the emergence and the gathering of parameters, we achieve an important step in problem formulation. The next paragraph will synthesize some of our procedures.

Our common goals in the synthesis of contradictions of an area are as follows:

- To transform key problems in the contradiction format since we know that TRIZ uses contradictions as a base for starting its heuristics for its tools and techniques deployment. To reveal all relevant contradictions arising from the key problems thus remains a primary objective.
- To choose, among a coherent and consistent set of contradictions, the smallest amount of single contradictions having the highest impact on the problem network within the context of corporate objectives (to remove a maximum of key problems).

In order to preserve the coherence with TRIZ fundamentals, let us keep in mind that a contradiction is an obstacle that stands out ahead of the artefact on the laws of evolution its is supposed to follow. The identified contradictions must record their possible links with laws if these links were expressed during the study. Otherwise, using hypotheses of evolution’s formulation may facilitate the identification of these links [1].

4.3 The sources enabling the emergence of parameters

There are three sources that facilitate the emergence of parameters prior to the synthesis of contradictions.

- Multi-screens (figure 2), especially the transitions from past-present in the system screens / super-system and subsystem.

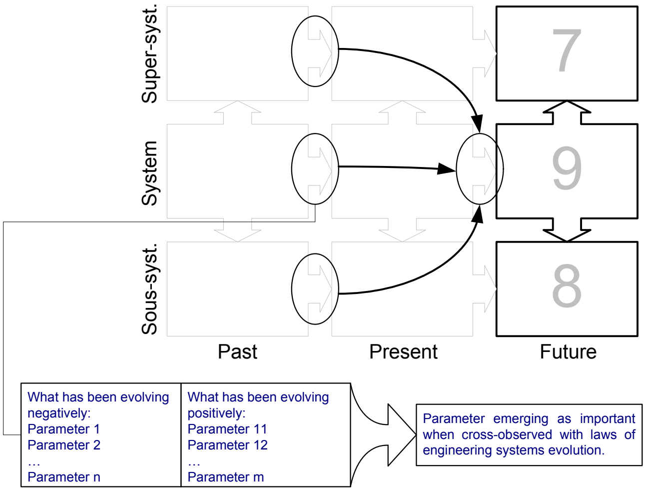


Figure 2 : Location of parameters extracted from multiscreen scheme analysis

- Discussions in relation with the laws of engineering systems evolution (see figure 3), at this point the advantage is to be able to directly record links between parameters and laws observed.

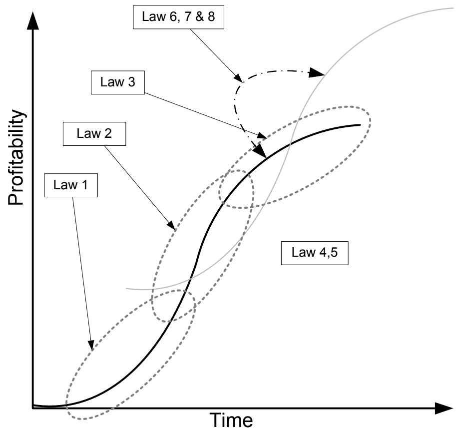


Figure 3: Summary of Altshuller's laws location along « S » curve scheme

- The ENV template (figure 4) from OTSM-TRIZ) [7][17] reveals the missing parameters when ensuring the poly-contradictions model's completeness.

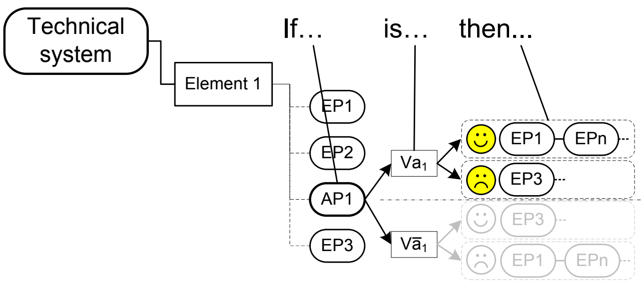


Figure 4: Template for ENV diagram completion (after OTSM)

Let us note that there is a high probability that the nature of knowledge expressed by experts will not appear the template proposed figure X. Indeed, few experts are used to formulate both sides of a contradiction since traditionally a single side of a contradiction is expressed. Nevertheless through this single side formulation, we propose to enter in our formalism, with the aim of a systematically questioning in a reverse way experts to highlight the opposite side of the contradiction. In case of impossibility of finding an inverse positive situation, there might not be any contradiction attached to this AP. In other cases we can either reveal a new EP or a link with an existing one.

4.4 Links between contradictions to form a network

We have observed, within solving processes, that when contradictions having the same active parameter were considered, solutions concepts generated by design members were likely guiding the thinking process to similar categories of ideas. This creates a limitation in the scope covered by solutions. In a reverse way, when a similar couple of EP is considered, a solution concept impacts unexpected contradictions since we did not engage the solving process through these ones. As a consequence and in order to be able to compute and observe the consequence of a specific solution concept (for instance useful in R&D decision making) links between contradictions have the same pair of EP can be created and sorted upon the fact that their root problems are sorted the same way.

5 CASE STUDY: CONTINUOUS ANNEALING PROBLEM

5.1 Problem statement and decisions

Steel material hardens after cold rolling due to the dislocation tangling generated by plastic deformation. Annealing is therefore carried out to soften the material. The continuous annealing process comprises heating, holding of the material at an elevated temperature (soaking), and cooling of the material. Heating facilitates the movement of iron atoms, resulting in the disappearance of tangled dislocations and the formation and growth of new grains of various sizes, which depend on the heating and soaking conditions. These phenomena make hardened steel crystals recover and re-crystallize to be softened.

This type of annealing involves uncoiling, and welding strips together, passing the welded strips continuously through a heating furnace, and then dividing and re-joining the strips.

The total length of the strip in the line is approximately 2,000m while its travel speed is about 200 to 700 m/min for a strip of 0.15mm in thickness (a maximum speed of 1,000 m/min. is still possible). To operate such lines, speed control, tension control, and tracking control of the strip are necessary, in addition to a high level of automatic temperature and atmosphere control.

Our company partner has observed for already several years that among these parameters an optimum situation is reachable but strip defect are observed and provoke line interruption regularly.

Line interruptions are provoked mainly due to thermal situation within the furnace.

The observed thermal expansion of rolls (transporting the strip) is unevenly distributed along its volume resulting in two different situations:

- Lateral strip movement due to non-perpendicular velocity of the strip to roll axis. As a result, the strip is hitting the furnace and gets degraded.
- The formation of thermal folds, depending directly on strip traction, provoke the necessity to stop the process, remove either partially or completely the damaged strip and start over the production line.

5.2 Partnership process as it has been engaged

The partnership consisted in proposing a technologically validated solution to these recurrent problems, taking into consideration all existing attempts (both partial successes and failures) already tested and their competitor's known solutions (mostly observable through patents).

To conduct this partnership we have divided the sessions allowed for the project in four parts:

- Questioning their experts during four sessions of about 5 hours in order to compile their problems and partial solutions using our network formalism.
- Highlighting a key problem and decompose this key problem in a set of contradictions.
- Treat a reduced set of contradictions and list a limited amount of solution concepts using TRIZ tools for solving them inventively.
- Engage a technical description and calculations proofs that to highlight that a specific solution concept is worthwhile investing R&D funds for its deployment.

Figure 5 partially illustrates the interaction between networks and summarizes the whole process in a global graphical representation.

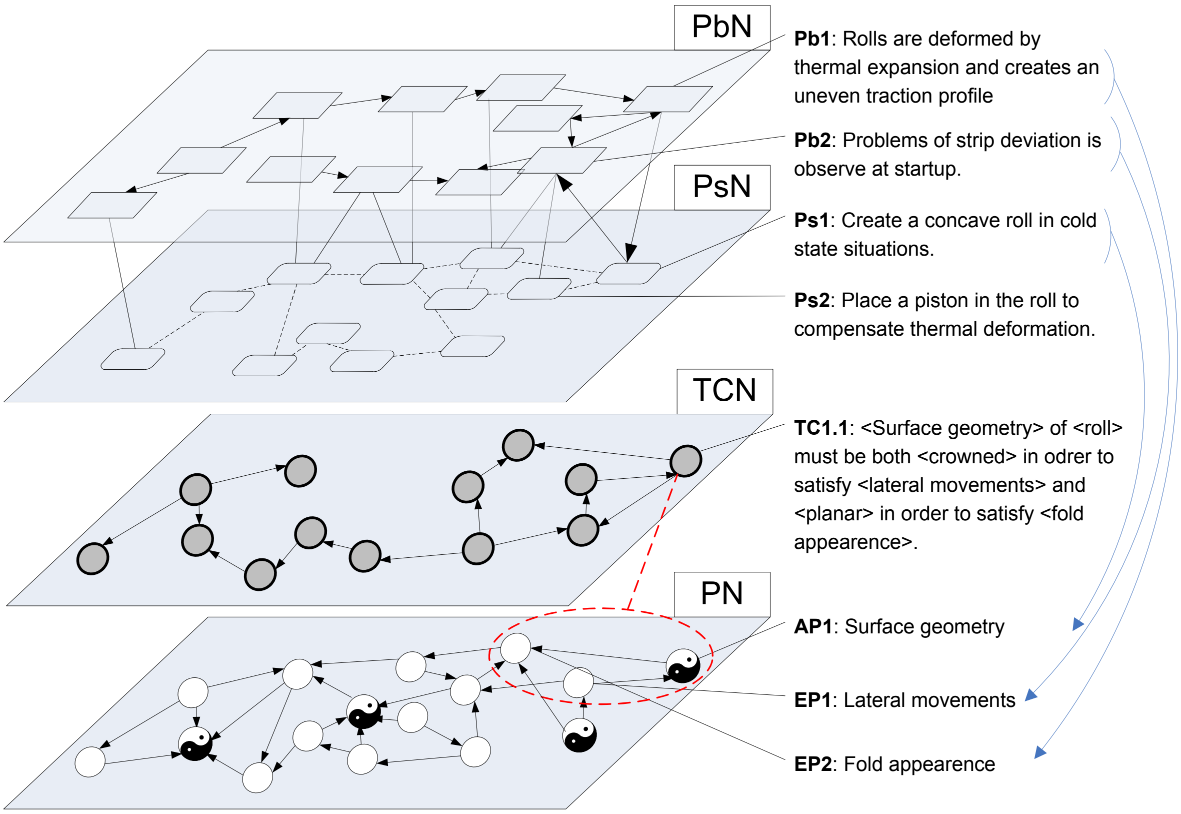


Figure 5: Partial graphical representation of the example used for illustrating our approach

5.3 Conclusion regarding the case study

Our proposed approach has been evaluated by participants after a final meeting with R&D decision makers and research managers. Among others, several points have been expressed by participants of the workshops:

The detailed aspect of the problem analysis has been well appreciated and appeared as new compared to traditional project processes commonly practiced within the company. It has been also evaluated as a good capitalization of actual knowledge of experts.

The original "profile" of solution concepts has also been pointed out with a twofold aspect:

- A reduced amount of solution concepts compared to classical already organized brainstorming on this problem.
- The novelty of these solution concepts since at least one fourth of them have never been found by any workshop in the past related to this problem. The "simplicity" of several solutions, so as their aspect (new, not expensive, easy to test, easy to manufacture) has been highly appreciated.

In brief, the case results have convinced the team that our approach can reduce the population of useless R&D attempts through a better mastering of an overall problematic. But even if some solutions have been proven to be simple, cost effective and technologically feasible, they still need to be validated through an “on line” experiment while being fully technically developed. This perspective has been drawn by decision makers and will start in a near future. This has mainly the aim to finalize the study by a more detailed return of investment balance to convince, now, managers about the financial effectiveness of obtained solution concepts from our model, when appropriately introduced within company’s practices and thoroughly conducted by trained animators.

6 DISCUSSIONS ON THE PROPOSED MODEL

6.1 Strong points and novelty of the proposed approach

From an inventive design perspective, it has never been clearly proposed to link the problem statement with contradiction formalism. Here, we have proposed and tested that problems, when formulated and recorded in their simplest form, can easily be linked with EPs in the same way as partial solutions may be linked with APs. We have been led toward this assumption when observing that experts were tacitly evoking parameters of an “evaluating nature” when qualifying their expressed problems so as parameters of an “active nature” when evoking partial solutions. As a result, we can draw the assumption that a large part of the relations between problem and contradiction networks can be automatically built during the sessions. These links are crucial for R&D decisions since, when entering in a solving mode, contradictions are considered and solved. As a result, solution concepts and problems are linked through contradictions and ease the visualization of how those solution concepts may impact Initial problem statement. At this stage we can only emit “working hypothesis” since what is proposed is only an automatic interpretation of what has been complied during problem statement and problem solving stages, but these working hypothesis are traceable and therefore increase the confidence of an R&D decision makers choices.

6.2 Limits and short term perspectives related to our model

The limits of our model are similar to what many other researchers have already pointed [19]. The time required to record all data for a relevant use is consequent and suppose significant efforts (at least time) from the company experts. Time spent for capturing their know-how and translating it into exploitable data directly raises the question of the use of such a model in an industry, constantly in search of time saving. We have also observed that many TRIZ experts intuitively converge to a reduced set of contradictions in a very limited time. Hence, one of our ongoing perspectives resides in the comparison of intuitive expert techniques (fast ones) and systematic and procedural ones as proposed through this article. It will also be interesting to evaluate the relevance of an intuitive expert choice and clearly state its value. This research will be performed in order to evaluate the relevance of our model and understand what separates or associate our results with expert practices.

7 CONCLUSIONS AND PROSPECTS

An ever growing amount of industries are affected by the need to formalize their innovation strategy. In this context, tools from the quality area have shown their limits so as approaches assisting creativity derived from Brainstorming. One of our research results is to have highlighted several limits of TRIZ and identified some potential areas of its development. We conclude now that it is timely appropriate to investigate the problematic of software support for experts practices in an inventive design context. We have built prototypes of such tools enabling designers to go beyond the current limits of TRIZ. The purpose of this software prototype structures experts approaches in the frame of inventively considering complex situation in design of artefacts evolution. The procedures having being built, when tested on real industrial situations, have also proved their usefulness in assisting R&D decisions. For improving the exhaustive aspects and the speed of gathering knowledge, we have also investigated specific text mining procedures to find and collect data contained in documents related to the covered field (patents, specifications, papers,…) in order to populate our graphical representation and assist the formulation of key problems of a given domain within the meaning of TRIZ. Our aim, when a complete system will be completed, is to be able to claim that all problems mapping a specific situation in a specific domain being co-constructed and co-validated, may assist decision makers in their choice to engage relevant inventive activities in accordance with context of their corporate objectives. The traceability and relevance of these choices, controlled by our approach, will then be based on a coherent analysis rather than an intuitive one.

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