THEORY OF INVENTIVE PROBLEM SOLVING APPLIED TO BUSINESS PROCESS MANAGEMENT PROJECTS (BPM-TRIZ)

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Abstract. *Many companies look for business process management as a way to put into practice their strategic goals, thus expecting to antecipate and adequate themselves for potential enviroment changes. However, it is possible to find a set of innovation barriers when the process management methodology is executed, such as the existence of conflictant project goals, the inherited level of business processes variancy and the specialist's psychological inertia. Those barriers often decrease the level of efficiency and quality of projects, by the application of completly intuitive methods, and by the development of compromisse solutions. It is proposed in this article that the Theory of Inventive Problem Solving (TRIZ) be applied to business process management projects, specifically to the proposal and impementation stages. The main goal is to reduce or even eliminate the innovation barrier's effects on such projects. Inventive principles can be used as a guidance to reach the ideal final result, and inventive solutions complying to conflitant goals can be developed in a systematic way. Necessary analogies are proposed and validated, on a business process development project, to adapt the TRIZ method on a non-technical environment. Preliminary results are presented, and partial conclusions are stated.*

Keywords*: TRIZ, business process, process management.*

1. Introduction

Considering that nowadays there are new and more aggressive competitors, the dissemination of both knowledge and technologies, and the refinement of customer's requirements, companies capable of adapting themselves faster and better to the changing environment are more likely to survive. Such environment quite often pushes those companies to review their own strategic goals, or, in another words, "where it should be" if one considers the context and its own forces (Piemonte, 2002a).

Having once reviewed their strategic goals, companies will probably adjust their processes, organization, human and technical resources. Business process management is a systematic approach to help any organization to make significant changes in the way it does business, assuring its existence and success on short and medium terms (Mendes and Trabasso, 2003).

However, according to Piemonte (2002b), studies present that, most of times, strategic goals are far from being properly elaborated, well stated, or correctly implemented, which makes it difficult to implement necessary changes.

Taking into account such a problem, it is proposed on this paper the utilization of Theory of Inventive Problem Solving (TRIZ) for business process management projects. The TRIZ would be used for obtaining better and faster results. To make it possible, a work methodology that adapts TRIZ method for a business process management context is proposed and presented.

A theoretical background that states the core concepts is firstly introduced. There concepts include: business process, process management projects, and TRIZ. Following, the proposed work methodology is tackled. Finally, preliminary results are commented.

2. Theoretical Background

The following definitions are useful to better understand the proposed work methodology.

2.1. Business process

According to Rozenfeld (1999), business process is a set of activities performed inside the organization that should be focused on one kind of business, which is usually intended for one specific customer or market share, and with well-defined suppliers. Such process uses enterprise's resources and technologies to manipulate associated informations, developing added-value products or services.

Enterprise's resources are usually reported to be the techniques, methods, tools, information technology systems, human resources as well as all the knowledge used to perform the business process. The organization is not just defined by its structural aspects, but also by its agents, or in other words, collaborators having specific attributes, i.e.

qualifications, motivations, knowledge, among others. This concept is illustrated on Fig. 1, according to Rozenfeld (1999).

Figure 1. Business process concept (Rozenfeld, 1999).

2.2. Process Management Projects

According to Mendes and Trabasso (2003), process management projects are essential to make a company's business development possible, cheaper, faster and better. Those projects focus on reducing the process variance, increasing process confidence as well as increasing customers' satisfaction, which simplifies or just eliminates activities which do not add value.

According to Hunt (1996), process management projects are composed by four main steps:

1. **Information Gathering:** process information is gathered by reading source information without interacting with other people; interviewing process "experts" about the process under analysis; or performing "experts" workshops;
2. **Process Analysis – AS-IS Model:** the aim here is to perform a process assessment. The main outputs of this step are the AS-IS model, which is the actual work flow, and the main process problems to be solved;
3. **Process Proposal – TO-BE Model:** improvements are proposed, according to the performed process analysis. By this way, a new process work flow is developed, and its implementation planning created;
4. **Process Implementation – TO-DO Model:** the proposed improvements are implemented by either the definition or revision of normative procedures, performing try-outs and implementing new information technical systems. A follow-up activity is also performed which identifies and implements necessary process adjustments. Figure 2 illustrates these four steps, according to Fan (2002).

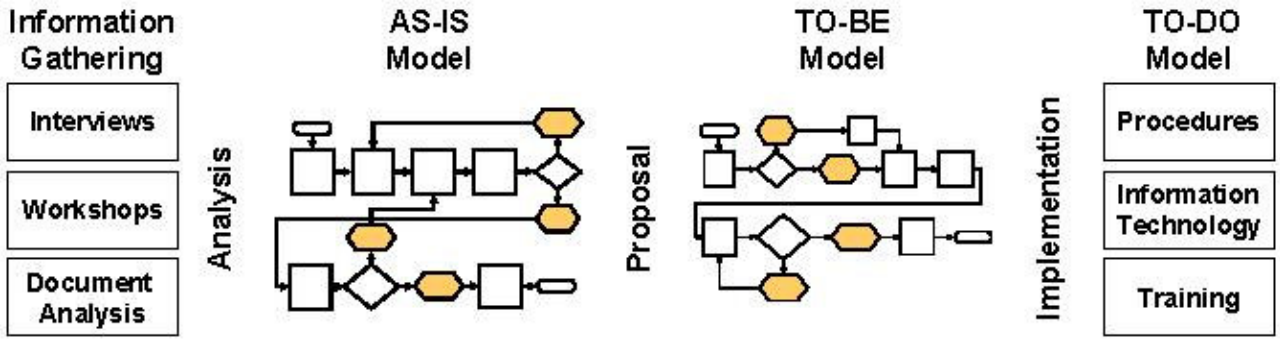

Figure 2. Process management projects (Fan, 2002).

On the other hand, some barriers can often be found when the above methodology is applied which affects the project efficiency and its final quality. Among those barriers, the most important are:

- **Intuitive methods:** according to Livotov and Ruchti (2001), the majority of the decisions are still been done using intuition and personnel experience. The utilization of intuitive methods, such as "brainstorming" and

"check-lists", can make the project more expensive and longer than it was originally planned, because a lot of meetings to find out the best solution are required (Ferreira and Forcellini, 2000);

- **Psychological Inertia:** according to Ferreira and Forcellini (2000), it concerns the phenomenon of searching for solutions inside the knowledge field of the project team members. This can bring to an endless "try-and-error" cycle, a searching for the right solution on a wrong knowledge field;
- **Motivation:** process management projects are initiated with a very motivated and engaged team. However, they are soon placed as secondary activities, supplanted by more urgent matters as time goes by. All of the spent efforts are wasted and the project is abandoned (Mendes *et al.*, 2002).
- **Poor problem definition:** strategic goals and project requirements are rarely unambiguous. Thus, the project team is taken for proposing and implementing a process that does not comply to the strategic original goals, but instead to a compromise solution (Fan, 2002);
- **Variability of people in process workflow:** the process management exercise aims at developing a single, unique and exact TO-BE model. It may harmonize the input of many views and sources of information. However, it is assumed that there is "a" way of doing things that could be documented and everyone in the process will follow the defined model. Empirical experience suggests that it is not so in reality (Fan, 2002).

2.3. Theory of Inventive Problem Solving (TRIZ)

Theory of Inventive Problem Solving (TRIZ) has been developed by Genrich Altshuller, a Russian Inventor, based on certified inventions or patents. According to Altshuller (2000), the more innovative one invention was, more "trial-and-error" cycles was necessary to discover it as no systematic approach was used. His goal was to figure out a more efficient methodology than the existent ones. As a result of his work, a set of tools were developed. Two of them are going to be described: the Contradiction Matrix and ARIZ.

Altshuller classified an inventive problem as the one that presents a technical contradiction – a compromise solution, so to speak. He studied more than 40,000 patents and observed that their technical contradictions had a common pattern. If typical contradictions exist, then typical principles for removing must also exist. Indeed, statistical investigation of inventions reveals forty effective inventive principles for resolving technical contradictions. Many inventions are based upon their utilization – either separately, or in combination. They were placed in a matrix, the **Contradiction Matrix**, which associates 39 engineering parameters with 40 inventive principles.

Altshuller has also developed the **Algorithm for Solving Inventive Problems (ARIZ),** which is a process having a sequentially structured set of actions. According to the author, ARIZ does not ignore the individual personality of the one using it. On the contrary, ARIZ stimulates the maximum utilization of and inventor's specific strengths. The inventor acts in accordance with his knowledge, experience and creative ability. The algorithm only saves the inventor from performing wrong steps. Moreover, different inventors, when utilizing TRIZ, can reveal different solutions to the same problem. ARIZ has a structure that leads inventors toward the most powerful solution for their given problem.

Ferreira and Forcellini (2000), as illustrated on Fig. 3, adapted ARIZ in five steps.

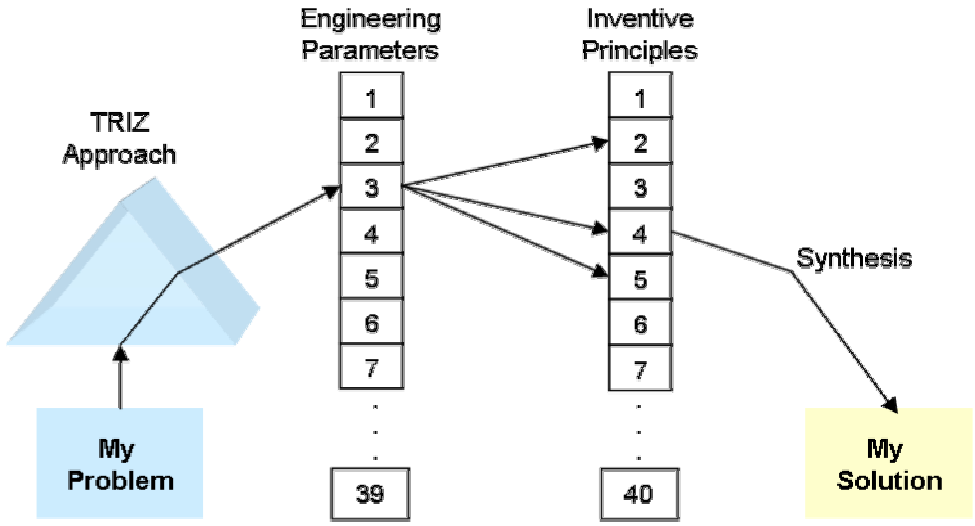

Figure 3. TRIZ adapted methodology (Ferreira and Forcellini, 2000).

This adapted method simplifies the use of TRIZ main tools, ARIZ and Contradiction Matrix, as follows:

- **Define the problem:** this step identifies the operational environment, the project requirements, the main functions, and also determines the Ideal Final Result (IFR);

- **Model the problem:** the problem shall be re-formulated according to the TRIZ approach, describing the project requirements as a set of technical contradictions;
- **Analyze the problem:** the technical contradictions shall be defined as a conflict between two of the 39 available engineering parameters;
- **Solve the problem:** the engineering parameters shall be used in the Contradiction Matrix to search inventive principles that suggest and guide to possible inventive solutions;
- **Synthesis of the solution:** the inventors shall use their creativity, technical knowledge and experience to adapt one or more inventive principles making possible to develop inventive solutions to reach the Ideal Final Result (IFR).

Having stated the main concepts used herein, it is possible now to presented a proposed work methodology as follows.

3. Proposed work methodology

A TRIZ application to Business Process Management projects (BPM-TRIZ) is proposed here, in particular on its third and fourth steps – process proposal and process implementation respectively.

However, since TRIZ methodology was originally developed for technical problems, analogies are necessary and actually proposed to apply TRIZ on a non-technical methodology, like the process management one. Analogies are fundamental cognitive mechanisms to retrieve existing knowledge and to apply this knowledge to new problems (Schild, Herstatt and Lüthje, 2004). These are shown in Tab. 1.

Table 1. Proposed analogies for ARIZ steps.

ARIZ steps	**Proposed Analogies**
Define the problem	Creating an analogy between marketing requirements to the enterprise's strategic goals.
Model the problem	Identifying process management project requirements and establishing the technical contradictions, according to the enterprise's strategic goals.
Analyze the problem	Associating process main characteristics, which describe the previously defined technical contradictions, to engineering parameters.
Solve the problem	There is no necessary analogy.
Synthesis of the solution	Adapting inventive principles once developed for product development, to the process development environment.

The aim of BPM-TRIZ is to reduce or even eliminate the effects of the process management projects barriers. It is expected that results increase the process management project's quality and efficiency, creating processes that comply with the enterprise's goals and consume fewer resources than the process management methodology. Some hypotheses have been stated as presented in Tab. 2.

Table 2. Expected results of BPM-TRIZ.

Barriers	**Expected BPM-TRIZ results**
Intuitive methods	Applying ARIZ makes it possible to "do it right in the first time", because it is based on a systematic process.
Motivation	ARIZ stimulates the maximum utilization of an inventor's specific strengths, increasing the level of motivation of the specialists.
Poor problem definition	Technical Contradiction indicates the obstacle that must be removed, and the Inventive Principles can be used to create the Ideal Final Result.
Variability of people in process workflow	It will be possible to use a set of inventive principles, creating a set of potential solutions, covering the natural variance that exists on business processes.
Psychological Inertia	ARIZ makes it possible to figure out the Ideal Final Result (IFR) that guides to the problem's solution field, avoiding then the "trial-and-error" cycle.

Although TRIZ method was originally developed for a product development environment, a number of authors (Mann and Domb, 1999; Livotov and Ruchti, 2001; Rea, 2001a; Rea, 2001b; Marsh, Waters and Marsh, 2004) provided evidences that it is possible to obtain high-quality results applying TRIZ in non-technical environments.

As an attempt to validate the analogies proposed here, BPM-TRIZ has been applied in a business process development project, as described bellow.

4. Preliminary results

BPM-TRIZ method has been applied on a requirements management process. As explicated on the proposed work methodology, information gathering and process analysis have been previously performed at this stage. BPM-TRIZ was applied only at the third and fourth steps – process proposal and process implementation, and the preliminary results are presented as follows:

- **Defining the problem:** the process has to be developed according to an Integrated Product Development operational environment, considering multi-functional teams, customers, risk-sharing partners and suppliers. As proposed, the process development project requirements were developed from the enterprise's strategic goals deployment. Required process functions are: identify customer needs, deploy the customer needs into marketing requirements, validate the marketing requirements and verity them as regards the product development. The ideal final result is to have a product developed according to the customer needs, as efficient as possible;
- **Modeling the problem:** relationships among project requirements were identified, making it possible to identify the existent technical contradictions, which are labeled as "-" in Tab. 3.

Table 3. Identified technical contradictions.

		PR1	PR2	PR3	PR4	PR5	PR6	PR7
PR1	The process shall guarantee an efficient deployment of marketing needs to marketing requirements		-	-	+	+	-	-
PR2	The process shall guarantee the development of a complete set o marketing requirements	-		-	+	+	+	-
PR3	The process shall guarantee the development of a unambigous set o marketing requirements	-	-		+	+	+	-
PR4	The process shall guarantee an efficient communication betweem customers and developers	+	+	+		+	+	-
PR5	The process shall guarantee the development of the product according to the marketing requirements	+	+	+	+		+	+
PR6	The process shall guarantee an acceptable product maturiry in the earlierst product development phases	-	+	+	+	+		+
PR7	The process shall guarantee an efficient product development	-	-	-	-	+	+	

- **Analyzing the problem:** as proposed before, analogies between process main characteristics and engineering parameters were performed as listed in Tab. 4. The fifth project requirement was not used to search inventive principles because it has no technical conflict among the others requirements.

Table 4. Analogies performed between process characteristics and engineering parameters.

Project Requirements (PR)	**Process Main Characteristics**	**TRIZ Engineering Parameters**	**Technical Contradiction**
PR1	Efficiency	(25) Loss of time	Characteristic to be improved
PR2	Completeness	(26) Amount of substance	Characteristic to be improved
PR3	Correctness	(33) Convenience of use	Characteristic to be improved
PR4	Communication	(24) Loss of an information	Characteristic that is getting worse
PR6	Maturity	(29) Manufacturability	Characteristic that is getting worse
PR7	Efficiency	(39) Speed, power	Characteristic that is getting worse

- **Solving the problem:** using the previously identified technical contradictions, it was possible to search in the Contradiction Matrix a set of inventive principles as shown in Tab. 5.

Table 5. Inventive principles that were extracted from the Contradiction Matrix.

IP	Inventive Principles (IP)	Contradiction Matrix Orientations
1	Segmentation	(a) Divide an object into independent parts; (b) Make an object sectional (for easy assembly and disassembly); (c) Increase the degree of an object's segmentation
24	Mediator	(a) Use an intermediary object to transfer or carry out an action; (b) Temporarily connect the original object to one that is easily removed.
26	Copying	(a) A simplified and inexpensive copy should be used in place of a fragile original or an object that is inconvenient to operate; (b) If a visible optical copy is used, replace it with infrared or ultraviolet copies; (c) Replace an object (or system of objects) with their optical image. The image can then be reduced or enlarged.
27	Dispose	(a) Replace an expensive object with a cheap one, compromising other properties (i.e., longevity)
28	Replacement of Mechanical System	(a) Replace a mechanical system with an optical, acoustic, thermal or olfactory system; (b) Use an electric, magnetic, or electromagnetic field to interact with an object; (c) Replace fields that are stationary to mobile, fixed with ones changing over time, random with structured ones; (d) Use fields in conjunction with ferromagnetic particles.
32	Changing the Color	(a) Change the color of an object or its environment; (b) Change the degree of translucency of an object or its environment; (c) Use color additives to observe an object or process, which is difficult to see; (d) If such additives are already used, employ luminescent traces or trace atoms.
35	Transformation of Properties	(a) Change the physical state of the system; (b) Change the concentration or density; (c) Change the degree or flexibility; (d) Change the temperature or volume.

- **Synthesis of the solution**: using team's creativity, technical knowledge and experience it was possible to perform the necessary analogies to develop inventive solutions that can be implemented and thus solve the existent technical contradictions as described in Tab. 6.

Table 6. Analogies performed to adapt inventive principles to the presented problem.

PIS	Proposed Inventive Solutions (PIS)	IP	Inventive Principles (IP)
1	The set of requirements shall be segmented in categories, making it easier to manage and communicate them, reducing the necessary project's control.	1	Segmentation
2	One neutral person shall be responsible for organizing, managing and communicating others about the set of marketing requirements.	24	Mediator
3	A read-only copy shall be distributed to the development team just before the product development phase, and just before and after requirements reviews meetings.	26	Copying
4	A requirements baseline shall be created for every single development phase, or just before significant requirements change. After that, the previously created baseline shall be disposed for the development team.	27	Dispose
5	Replace physical data sheets with intranet based data sheets, increasing the level of communication.	28	Replacement of Mechanical System
6	Process indicators shall be used to keep the project manager always updated with the product development status.	32	Changing the Color
7	A requirement shall be harder to modify once an agreement between enterprise and customer has been done.	35	Transformation of Properties
8	A requirement shall be easier to modify in the earlier phases of the product development process.	35	Transformation of Properties

Once the inventive solutions have been proposed, it was necessary to verify their appropriateness or quality. The way of carrying out this task was to check the proposed inventive solutions (PIS) against the project requirements (PR). Table 7 presents the performed verification.

Table 7. Project's verification matrix.

Verification Matrix	RP1	RP2	RP3	RP4	RP5	RP6	RP7
PIS1	✔		✔	✔			✔
PIS2	✔			✔			✔
PIS3	✔			✔	✔		✔
PIS4		✔	✔	✔	✔	✔	✔
PIS5	✔			✔			✔
PIS6	✔	✔	✔	✔	✔	✔	✔
PIS7		✔	✔		✔	✔	✔
PIS8	✔	✔					✔

Even though all requirements have been accomplished, it can be noticed that the project requirements numbered one, four and seven, which are "efficiency" requirements, have higher level of compliance than the remaining.

Thus, technical contradiction "quality vs. efficiency" can be solved as the second proposed inventive solution is implemented. Such solution eliminates non-official agreements, creates an unique requirements database and increases the level of communication as one neutral person is responsible for this task, as shown on Table 6. It is a simple innovation that could be implemented using analogies in a systematic way.

As the inventive proposed solutions derived from the BPM-TRIZ method are presently been implemented, it is not possible to completely verify the usefulness of the proposed work methodology. However, preliminary conclusions can be presented as follows.

5. Conclusions

Having once developed proposed inventive solutions to solve a non-technical problem, it is possible to validate the analogies proposed for BPM-TRIZ. Preliminary results comply with the project requirements, and consequentially with the enterprise's strategic goals.

Creativity was used in a systematic way as well as innovative solutions were created to solve technical contradictions. However, since it was required to the project team the use of analogies, creative and experienced team members were essential to perform the project.

The major advantage of applying TRIZ methodology can be observed in the earliest phase of a business process management phase, the project preparation. Developing project requirements, identifying technical contradictions and stating the ideal final result makes it easier to understand the problem as well as increase the efficiency of the project's execution.

Necessary modifications to the BPM-TRIZ method have to done, in order to focus on the project preparation. The sooner a problem is analyzed, project requirements are developed and technical contradictions are extracted, the more the ideal final result is likely to be achieved.

Finally, implementation of the method has to be fully performed to verify if the expected BPM-TRIZ results will be achieved, and to ratify the quality and efficiency growth.

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7. References

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