A framework for assisting the innovation process by using TRIZ-based Web services

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Abstract: Innovation is a complex process which is impelled by several economic vectors, but it is also a process that involves creativity to get started and a vast knowledge diversity to be crystallized in new products (manufactured goods or services) or processes accepted in a market. Innovation is then a social activity that demands a collaborative environment where several individuals could interact to solve the inherent problems of this process. The TRIZ theory (theory of inventive problem solving) is useful to guide creativity and also for connecting the problem requirements with available knowledge in other domains. But even if TRIZ has the potential to guide problem solving activities, it has been conceived to be deployed individually. Consequently, in this paper is proposed a doctoral research that will explore, evaluate and conceive several mechanisms for offering a collective dimension to TRIZ. A capital objective in this research is to create the conditions for enabling TRIZ-based open innovation services through collaborative web services and software architecture.

Key words: TRIZ, Computer Aided Innovation, Collaborative Web applications.

1- Introduction
The rapid changes in today’s world economy (shortest product life cycle, increasing customer’s demands, more complex industrial interactions, among others) represents a challenge that could be synthesised with a single phrase: the need to manage and control the innovation process [CN1]. In this scenario traditional techniques for assisting the initial phases – the creative stages- of the innovation process reveal its limitations. Thus, a new approach is needed, one capable to launch innovation activities voluntarily. The TRIZ theory (Russian acronym for Theory of Inventive Problem Solving) is capable to assist companies when developing new products or processes (or solving the intrinsic problems of the innovation process). But even if the TRIZ theory has gained an important position in the industrial environment, like any other approach for problem solving has several limitations. The limitation explored in this paper is the absence of a collective dimension of TRIZ. The TRIZ theory was originally conceived to be exploited individually, while several research point out that the innovation process it is a social activity [MJ1], [M1], [N1]. This paper proposes a Web services-based collaborative architecture for assisting the innovation process by using TRIZ. In next section, the TRIZ theory and the main foundations of the Computer Aided Innovation (CAI) are described.

2- The Theory of Inventive Problem Solving (TRIZ) and the Computer Aided Innovation (CAI)
TRIZ, which refuses the compromise when proposing solutions, is a knowledge-based approach for problem solving. One of its basis states that universal strategies to solve problems could be extracted from available knowledge and that every person can propose innovative solutions [AL1]. An extensive description of this theory could be found it in [RD1]. The integration of TRIZ in computer software programs has facilitated the emergence of a new discipline: Computer Aided Innovation. Several technological platforms are available [I1], [II1], [CR1] and widely employed, but concerning collaborative Web services, the offer is very limited.

2.1 Computer Aided Innovation
The Computer Aided Innovation (CAI) is emerging as a strategic domain of research in computer science. Its goal is to create applications to support the innovation process. The central topic of this paper is a contribution in this direction: the design and development of a collaborative architecture in order to create a synergy between the TRIZ theory and CAI through Web services. This framework is called ItSolver. Thus, the main objective of this paper is to improve the innovation process by integrating the TRIZ tools in a collaborative Web. In our proposal each Web service represents an ItSolver functionality: to solve contradictions,
to assist solvers when representing conflicts graphically (Substance-Field analysis), to capitalize knowledge, among the most important.

2.2 Target problems to solve

According to Drucker [D1], knowledge should be transformed in innovation in order to generate value for an organization. Thus the WWW needs to impel this process and to propose tools for enabling organizational collaboration when solving the inherent problems of this transformation. The ItSolver is a proposal in this direction: to mobilize knowledge and direct creativity to generate value. The ItSolver focuses in the resolution of a particular kind of problems: inventive problems and ill-defined problems. For the moment, the Itsolver focuses in the first class of problems. Inventive problems could be described as a contradiction between two useful parameters, subsystems, conditions or characteristic in the same system. The importance to solve this kind of problems resides in the originality and productivity of the proposed solutions. According to Altshuller [AL1] the most effective way to innovate is to overcome or surmount contradictions –even partially–. Hence the Itsolver objective is to provide a Web platform that enables troubleshooting based on a collaborative approach using the TRIZ theory. In the next section, the fundamentals of the collaborative Web and its architecture based on Web services are described.

3- Collaborative architecture

A Web service is a software component that is accessible by means of messages sent using standard web protocols, notations and naming conventions, including the XML protocol. The notorious success that the application of the Web service technology has achieved in different domains such as B2B e-Commerce, SCM and EAI where it is perceived as a promising technology for designing and building effective collaboration systems. Our approach uses Web services technology that reduces the integration costs and creates the required infrastructure for automation, obtaining a quality of service that could not be achieved otherwise. The representation for a CAI based collaborative web application using TRIZ theory is done with a logical view which is one of the four architectural views proposed by Kruchten [K1]. Using the classes diagram in Unified Model Language (UML) the figure 1 presents the logical view of the architectural proposal.

The collaborative architecture has a layered design. Each layer has a defined function explained as follows:

**Presentation Layer:** Composed by project solving and collaboration packages, in this tier is defined the graphic user interface components responsible for displaying information related with the creating, editing, deleting and solving projects. Collaboration view package include components needed for sending invitations, accept invitation and collaborate on project solving with other users. This tier communicates with controller tier.

**Control layer:** Takes input from the view request and figures out what the information means and then communicates with service tier to get and store data. This layer groups classes for project management, collaboration and project solving classes.

**Service layer:** This layer acts as a brokering service between control and model layers for information interchange; it works as an abstraction for data. Algorithms for CBR and solving problems using TRIZ methodology are located at this layer, also rules related with project management and classes for collaboration mechanism are found too.

**Model layer:** Represents the data in order to store and retrieve it from database. This layer is based on Data Access Patter (DAO) to make easy the database operation (insert, delete, select). Database is used to store and retrieve projects and the cases for CBR.

According to the emphasis on automation, our collaborative architecture can be accessed in two modes of interaction, either as a proxy server or as an Internet portal. In the first mode, the architecture can interoperate with other systems or software agents by using the Web services APIs. In the second mode, our architecture acts as an Internet portal that provides to the users a range of options among the Web services available. Furthermore, our proposal follows the Service-Oriented Architecture (SOA) architectural paradigm for creating and managing “business services” that can access these functions, assets, and pieces of information with a common interface regardless of the location or technical makeup of the function or piece of data

4 – Core processes

ItSolver system is a CAI collaborative Web that allows users to solve inventive problems. The ItSolver exploits the most utilized (and easy to use) TRIZ concepts and tools. This decision was guided by a premise: to reduce complexity in order to increase user’s adoption. Besides, this could facilitate the assimilation when learning about the TRIZ theory. The application of the TRIZ tools involved in this research is separated in components that are connected according the problem requirements.

The solving problem process starts with a general description of the project. Then, TRIZ essential concepts like resources, Ideal Final Result (IFR also called More Desirable Result), contradictions and ideality, should be analyzed with one single purpose: to generate, infer, complete and collect information about the problem situation. Once these stages
4.1 General description
In this section a name is assigned to the project and an initial classification according to the nature of the project is selected. Then a deeper description of the system where the problem exists should be elaborated. Once this initial section is completed, users need to generate information for problem solving by deploying some TRIZ concepts: resources, Ideal Final Result, contradictions or Substance-Field analysis. Constraints must be described with the aim to transform it in evaluation criterion.

4.2 Resources
In this section, the available resources in the system must be identified. According to TRIZ, every system in evolution has available reserves that could be mobilized to improve its performance or for solving its intrinsic problems. A resource can be anything in or around the system that is not being used to its maximum potential, such as unoccupied space, information, substance properties and wastes among other elements. ItSolve encourage the effective use of resources through an algorithm called Resources Oriented Search, which is not covered in this article.

4.3 Ideal Final Result (IFR)
IFR is a tool that has its foundation over a TRIZ capital concept: Ideality. Ideality is an evolution pattern which states that every system evolves to one direction: to an increasing degree of proficiency. Ideality is not a privative TRIZ concept, but in this case, this psychological concept has been transformed in a tool that can concentrate reflexion and reasoning in one direction. The IFR is often a powerful means for generating potential solution. The formulation of the IFR is useful to select conceptual solutions, but first is necessary to convert it in evaluation parameters.

4.4 Contradictions
Frequently, when solving problems that have contradictory requirements, trade-off is the most employed principle to generate solutions. Contradictions are typically revealed in situations like these: (1) when trying to improve a system for any known method, another useful characteristic gets damaged or deteriorates negatively; (2) a system needs operate at two opposite/exclusive states (A’) and (A) for achieving performance; (3) reduction/elimination of a negative state, parameter or characteristic produces a significant reduction or elimination in a positive one. This kind of problems could be solved with several TRIZ tools (i.e contradiction matrix, separation principles). Those tools have been synthesized from a vast knowledge capitalization effort.

4.5 Substance-Field Analysis (Su-Fi)
The Substances-Field (Su-Fi) analysis is a modelling approach useful to represent processes/functions and describe physical phenomena in a system. This formalism assists and helps designers to clearly identify what transformations or changes (solutions) are necessary to improve technical systems. The model can be represented graphically with circles representing the field and the substances and some symbols that represent the relationships among the substances and the field(s). The minimal model useful to describe a function is composed of two substances and one field (triangular representation). Once the Su-Fi model is completed, a set of strategies for problem solving called the 76 standard solutions could be applied.

4.6 Constraints
Constraints must be identified when exploring the problem space. They are useful for identifying the bottlenecks in the system and also for establishing evaluation parameters.

4.7 Capitalization knowledge through the Case-Based Reasoning (CBR)
In this module is deployed the Case-Based Reasoning process. Its application is possible because all information collected in the past stages can be arranged in a vector. Coming from AI, CBR is a very useful approach to manage knowledge. The main idea in CBR is that similar problems have similar solutions. Basically in the CBR process users try to solve a new problem by establishing similar patterns between the initial problem and some previous experiences (solved problems). Then the CBR process uses and adapts earlier successful (or failed) solutions in order to solve the new problem. This process is at the core of everyday human problem solving. The CBR method is a cyclic process involving at least five stages: represent, retrieve, reuse, revise and retain [AK1], [CN1]. The integration of the CBR process is very useful to generate a knowledge memory in the ItSolver.

4.8 Collaborative work
The collaborative approach of ItSolver is based on the usage of a dashboard, where users can share invitations to participate in a specific project. In the dashboard it is also possible to have access to the different TRIZ tools or components of the web service, to download documents that explain a module utilization, to open a communication channel, among other tools. Users can also see all the projects where he/she is participating.

4.8.1 Dashboard
In this section, users can see updates to their projects and also the innovation projects they are working on. It makes easy the collaborative work. The figure 2 shows the dashboard.
4.8.2 My Projects

In this section, there is a list of projects managed by a specific user. In this module this user can invite other people to collaborate. The name of the project and the project status are shown and the option of the invite is activated. The figure 3 shows “MyProjects”.

5 – Related works

In this section are succinctly described some related research to this doctoral proposal.

Noa Dörr, et al, in [DB1] describes a Web-based platform for knowledge management that facilitates collaborative work and that performs specific knowledge management tasks. This platform provides support to knowledge sharing, communication within and across different types of organizations such as teams, departments, or inter-organizational networks. It also assists idea management and knowledge diffusion as strategy for facilitating the innovation processes. The system proposes then a platform for knowledge and innovation management and a basic framework to develop, capture, share, preserve, apply, and evaluate knowledge.

Noa Dörr, et al, describes an ideal platform based on three central concepts that provide the core of a holistic knowledge management approach and the fundament of a modern innovation management: documentation, organization, and collaboration.

Min-Hwan Ok, et al, in [MK1] underline that most of developments on Computer-Aided Engineering (CAE) have been focused on a single and well defined field, such as dynamic analysis, structural analysis, or fatigue analysis for example. Their interests are to pursue higher accuracy in simulations approaching to measured values in the experimentation. The author states that it is essential to facilitate collaboration and information sharing when solving problems. The author suggests a way to collaborate on CAE with teams. Authors are seeking for a practical method to derive a system for Virtual Engineering.

Chesbrough, et al, in [CV1] define the open innovation paradigm as a R&D approach in an open system. Open innovation suggests that valuable ideas can come from inside or outside the companies and thus that companies needs to take advance of this “technology”. Open innovation has a collaborative process for problem solving, but it does not have a memory. Consequently, this kind of systems can not to store and reuse past solved problems in order to infer new solutions. In contrast ItSolver provides a TRIZ based collaborative process to solve problems and includes a CBR module that enables the retrieval similar cases for solving new problems.

6. Conclusions

This paper schematizes a TRIZ-based web service and a software architecture that is oriented to facilitate and to drive forward an open innovation process. The collaborative environment utilizes some TRIZ basic concepts that are useful to drive creativity and to link problem requirements with well tested engineering models. This collaborative web named ItSolver has been divided in components that are useful to face different kind of problems. It is important to underline the presence of a special module that has been conceived to capitalize the experiences derived from problem solving activities. This module imitates the core process of the Case-Base Reasoning, which enable organizational learning. The implementation of this collaborative web stills under development.

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7- References


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