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Paradoxes and organizational learning in continuous improvement approaches: using the TRIZ principles for developing problem solving performance in a Michelin plant

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Abstract. Continuous improvement approaches advocate the development of organizational learning to support the system of problem solving. For this, companies use different strategies for implementing of continuous improvement. A survey has been conducted showing that these strategies can have a paradoxical impact on the performance of problem solving. How can we explain the difficulties faced by companies in the development of problem solving? The classical learning model used by the majority of companies generates contradictions called "empirical". To provide an innovative contribution to the problem-solving learning problematic, TRIZ theory and paradox theory are used to characterize a problem model (in the form of paradoxes and organizational tensions) and a solution model (in the form of paradoxical practices). Finally, a case study in the form of experimentation in one of the Michelin factories is realized. The specific problem is modeled using TRIZ and the paradoxical approach. An organizational innovation called "problem solving pull (PSP ©)" has been developed. This specific solution made it possible to eliminate some of the tensions and make the problem-solving learning system more dynamic.

Keywords: Paradoxes Management, Problem Solving, Learning Organizational

1 Introduction

For more than 30 years, continuous improvement initiatives (CII) such as Lean Management have been very successful in improving industrial performance. CII advocate the development of problem solving by operational teams. However, companies do not always achieve the expected results [1] [2]. Several studies have identified sustainability difficulties [3] [4] [5]. *If more and more organizations are deploying of problem-solving practices, how can we explain the difficulties faced by companies? What are the contradictions that justify these difficulties?*

To answer these first questions, we conducted a survey of operational teams in several companies. The contradictions that come from the speeches of production

agents and managers will be exposed. Their impacts on the learning process of problem solving will be formalized.

Learning about problem solving is seen as a process of change management [5]. Change is a major theme in the universe of organization. In order to better understand the current problem of organizations in the face of change management, the literature has seen the concept of ambivalence [6]. Ambivalence suggests that people may be simultaneously in favor of and against change [7]. This is why the paradoxical approach seems particularly enlightening in formulating our research problem. *What are the organizational paradoxes in processes of problem-solving learning? What are the opposing trends that generate underlying organizational tensions within the operational teams?*

To answer these questions, our work will provide a brief study of the modeling of the problem of organizational change proposed by Perret (2003) [8]. We will use this model for our problem as a set of ambivalent behaviors according to the organizational contradictions and their interactions. The TRIZ will be used to reformulate this model [9].

Advocating for paradoxical management to respond to these challenges is however insufficient if we do not enter into a reflection on its implementation. Identify practices and the processes that underpin them; identifying the organizational mechanisms upon which these processes of change can be based are equally important steps. *What are the paradoxical organizational practices?*

Thus, we propose to use a model of solutions that characterizes a grid of paradoxical organizational practices analysis proposed by scientific literature. In order to formalize a frame of reference for the analysis of our scientific problematic, we will base ourselves on the paradigm of thought resulting from the TRIZ [9].

Finally, we will propose to use our paradoxical approach on a study case. This last part will propose a modeling of our approach with the help of the TRIZ Theory [9] on a specific problematic related to the processes of problem solving. A specific implementation condition will illustrate our study using a specific solution called "Problem Solving Pull" adapted to our organizational study case.

2 Formulation of specific problem to learning problem solving

A survey on the performance of CII was conducted [5]. We collected responses from 37 companies. 20% of companies have fewer than 50 employees, 44% of these companies have fewer than 100 employees and 36% have fewer than 200 employees. The companies surveyed are divided into several sectors of activity: the manufacture of equipment for the automotive sector, the manufacture of industrial equipment, and outsourcing of the aerospace and mechanical sector. The survey was conducted from September 2015 to February 2017. The selection of the sample was based on SMEs having started a continuous improvement process for at least three years. The sample of interviewees is 370 people, 40% of whom are agents of production and 60% of managers.

2.1 The empirical contradictions within continuous improvement initiatives

This study confirms the problem of sustainability of problem-solving approaches within the CII. It identified four generic difficulties that explain the barriers within companies to "learn by solving problems". These difficulties have been translated into the following empirical contradictions (C1-4):

- C1: Continuous improvement generates problems and affects their resolution (75% of the people interviewed);
- C2: Continuous improvement is not used as a source of acquisition of new skills for problem solving (64% of the people interviewed);
- C3: The visual management spaces is not exploited as an axis of progress for the problem solving organization (77% of the people interviewed);
- C4: Organizational strategy is unfavorable for learning of problem solving (78% of people interviewed).

The results of this analysis are justified by the fact that 90% of companies use traditional learning approaches. These models develop a diffusion of continuous improvement approaches in a mechanistic way. This strategy prevents the individual and collective learning of problem solving. Indeed, traditional approaches to learning continuous improvement approaches go through two phases of diagnosis (figure 1). The first diagnosis concerns the organization of problem solving (A). The second diagnosis is dedicated to problem-solving skills (B)

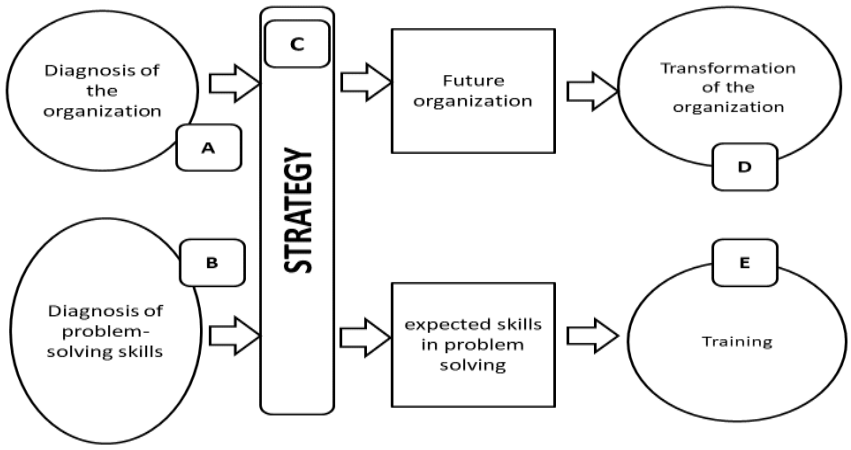


Fig. 1. Classical model of learning of problem solving.

2.2 The impacts on learning of problem solving

Argyris and Schön describe three loops of learning of problem-solving [10]. The simple loop consists of adapting to changes in the environment. Individuals respond to results by a simple feedback loop connecting the detected error to action strategies

(figure 2). The double-loop induces a change in the values of use strategies. The double loop refers to the two feedback loops that link the observed effects of the action to values and paradigms. Thus, individuals perform a double-loop learning when their investigation generates changes in the values of the use theory (figure 2). Argyris and Schön have also highlighted a third type of learning to emphasize the possibility of learning about one's own way of learning. It can lead to the formation of new learning strategies, learning itself becoming a learning object (figure 2). This figure also shows the location of the impact of the empirical contradictions within the learning loops.

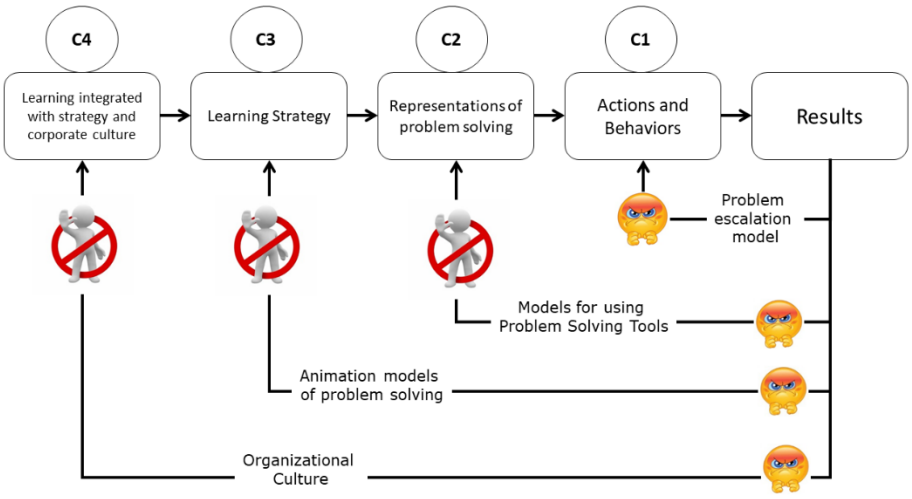


Fig. 2. The impact of contradictions on single-double-triple loop learning.

3 Formulation of the problem model

Perret [8] proposes a framework of analysis in which two logics of contradictory actions coexist by recognizing reciprocal interactions between the action and the context. The first logic is the logic of demarcation. For this author, the intentional change aims to act on an organizational context and seeks to transform it. For the second logic, which the author calls logic of support, the intentional change can only act according to a given organizational context to which he must conform and adapt. For the logic of demarcation, the action of the leader is characterized by two essential elements: distinctive nature and deliberate behavior. This logic confronts leaders with resistance to change. For the logic of support, the action of the leader is characterized by two essential elements: cohesive nature and emergent behavior. This second logic constrains the leaders with the risks of losing the intentionality of their actions. Table (1) shows the conflicts and tensions that arise from the coexistence of these two logics.

Table 1. Ambivalent behavior of the change according to Perret [8].

	Logic of demarcation	Logic of support
The nature of the action of change	difference	Identity
The dynamics of the action of change	Revolution	Evolution
The modalities of the change management	Autority	Autonomy

The figure (3) illustrates the paradoxical paradigm of the antagonistic pair (demarcation logic / support logic).

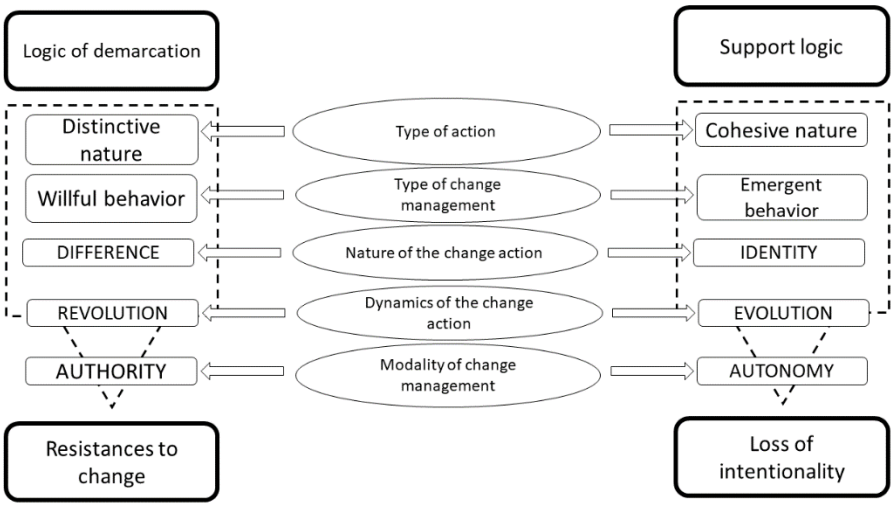


Fig. 3. Problem model of change management for learning of problem solving.

4 A model of solutions in the form of paradoxical organizational practices

Josserand and Perret [11] say that an organization practices a paradoxical management if it is able to reconcile the constraints perceived usually as opposed. The paradoxical organizational practices are characterized by the ability to master a self-equilibrium. Josserand and Perret [11] identifies six types of practices according to two dimensions [Table 2]. The first dimension corresponds to a mode of articulation of the dualities of the antagonistic couples. The analyzed practices can play on a temporal or spatial articulation of the two lemmas of the paradox. The second dimension is that of the logic overcoming the paradox: differentiation, dialogue and disappearance.

Table 2. Organizational practices and solution model from Josserand and Perret [11].

		Logic ….		
		of differentiation	of dialogue	of disappearance
Organizational practices	Diachronic dimension (time)	Sequential practices	Stratification oscillation	Framing
	Synchronic dimension (space)	Subdivision	Local construction	

In this article, in connection with our problematic, we will focus on describing the change of frame of reference in a logic of disappearance. This organizational practice will be experienced in our case studies.

4.1 The logic of disappearance and framing

In the logic of disappearance, the paradox no longer exists: the individuals no longer live in a situation of double constraints; they have integrated the two contradictory dimensions. The disappearance of the paradox can be explained by the transition from one logical level to another. In the reframing, a new element is introduced in a situation that allows the logical jump, which allows to get out of the contradiction [12] [13]. It is frequent that the change of logical level is made possible by the intrusion into our world of a new object, a third element that enriches or disturbs our representation of reality. An object, a concept or a person then allows the reconciliation of the two opposites [14].

4.2 Change of reference frame in a logic of disappearance

The practice of reframing is based on a cognitive leap. The reframing presents a difficulty related to the inability to project outside the frames [16]. Barriers generate this difficulty.

The first typology of barriers is linked to the often-insufficient knowledge of managers to leave the framework. The imperfection of the knowledge of the real pushes the organization towards the cognitive biases described by Lambert [15]: focusing on certain solutions, illusion of control. Eby and Adams [16] stress the importance of informal and regular meetings. These meetings are opportunities for sharing experiences.

The second barrier is psychological type. The question of reframing is then about techniques to ensure that people can receive knowledge that is useful to them in the context they are facing. Behavioral concerns are central to Argyris' methods of promoting organizational learning [10].

The last barrier that constrains the possibilities of reframing is that related to the organizational culture. Knowledge can be irreconcilable with culture or organizational routines. These routines enclose the company in a single thought. The managers

defend these routines without questioning. The structure of the organization leads to a routine of choices that further reinforces uniformity. It becomes impossible to change the perceptions of a situation or a problem. The individual can also express defensive routines in the form of resistance to change [6] [16]. For this, it is necessary to introduce a kind of logic of questioning in the company. One of the essential vectors of renewal lies in a permanent contact between the managers with operational agents.

We propose to use the formalism resulting from the TRIZ to formulate our model of solutions in connection with the specific problematic and the model of problem (figure 4).

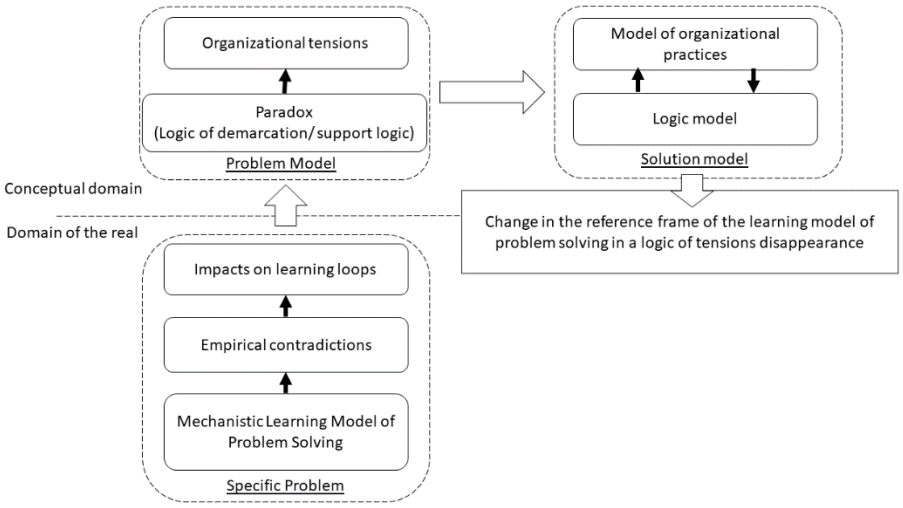


Fig. 4. Modeling of the research problem by TRIZ.

To illustrate our approach, we will use a case study that will allow us to explain our approach in the search for an organizational innovation of learning of problem solving.

5 Case study and experimentation of the paradoxical approach

We conducted an experiment with our paradoxical approach on a Michelin production factory located in Le Puy en Velay between December 2016 and October 2017. The approach was tested on two-production workshops with 12 production agents associated with their manager.

5.1 Background of the experiment

Michelin is a leading group in the design, industrialization and production of pneumatic products. For years, this company has developed a program of

development of empowerment and autonomy for its production agents. The company wants to develop the concept of the learning organization to strengthen its initial program. The central service has created problem-solving tools as well as training and support for operational staff in the use of these tools.

5.2 Formulation of the problem of learning problem solving

To test our paradoxical approach, we modeled our problem using TRIZ. The system studied is the learning of problem solving of production agents. In order to discover the organizational paradoxes and the associated tensions, we used two typological models, the level of maturity of the current system and the approach by the Vepoles, which are respectively, represented by the figures (5) and (6). The names of the parties are as follows:

- SE (Energy source) = operating standards (quality, inventories, security)
- CC_RdP (Engine) = Skills and knowledge in problem solving
- O_RdP (Transmission) = Problem solving tools
- F_RdP (Control) = Training for problem solving tools
- AP (Work) = Production Agent
- Pb (Object) = Problem (operating deviations)

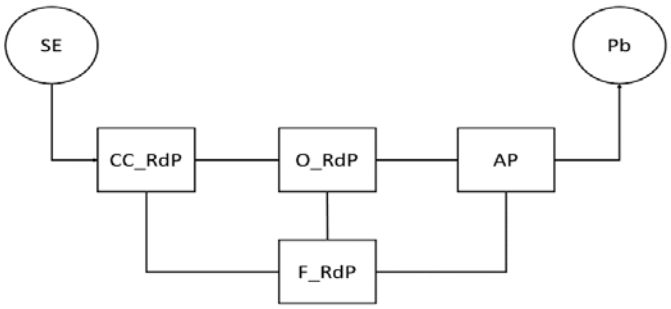


Fig. 5. Current system of problem solving learning.

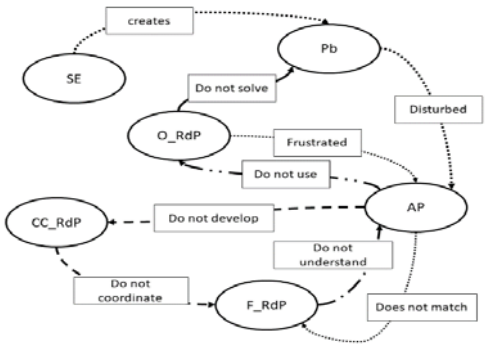


Fig. 6. Vepole model of the specific problem.

It follows from this first diagnosis with the agents of production and their manager that the system of learning of the resolution of problems contains organizational tensions, which are {authority / autonomy}, and {revolution / evolution}. Subsequently using semi-structured interviews, we were able to capture a series of ambivalent discourses that confirm these paradoxes. Below are some examples of these speeches:

- Authority / autonomy: "*I am trained to use these tools to develop my problem solving skills, but I do not use them because it is too administrative and complicated to complete. I fill them a posteriori or I forget to fill them because I do not have time*"- "*I solve my problems not to penalize production but I do not develop my skills or I do not know if the solutions are effectives*"
- Revolution / evolution: "*I have followed training on problem solving tools that I do not use and I'm told you do not solve problems then? –* "*I solve problems, it's my daily work and so I do not need problem-solving tools*"

These two analyzes validate the fact that within these two production workshops, the current system of learning of problem solving is not effective because it contains organizational paradoxes that generate tensions. Indeed, the organization wants to develop the autonomy of the production agents by an evolution of their skill in problem solving. This declared objective is linked to a logic of support. However, in fact and reality, we find that the organization generates a strong contradiction. The company uses a logic of demarcation (prescribed and administrative tools, strong control over the actions of problem solving, nonsense training for agents, etc.) which is paradoxically with the logic of support it advocates.

5.3 Proposition of an organizational innovation in the form of paradoxical practice

In order to present a solution to develop an effective system of learning of problem solving, we have developed a model of evolution specific to this study case by increasing its level of ideality. This model proposes to reduce the irregularities of evolution of the parts by the integration of a logic of framing. The aim is to increase the degree of dynamism of the control system of learning (Figure 7).

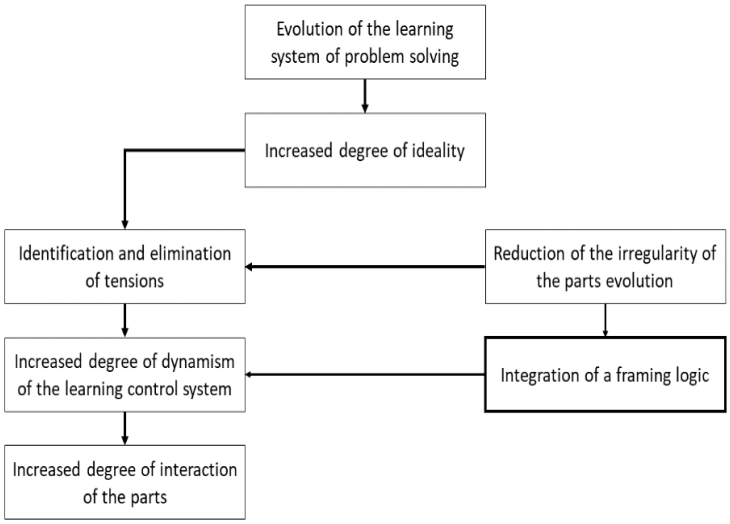


Fig. 7. Evolution of the learning system of the problem solving

We propose an innovative framing logic for the development of problem solving for production agents (figure 8). This logic is named "Problem Solving Pull © (PSP)". This is about needs of learning for problem solving. In fact, learning dimensions must take into account individual, collective, managerial and organizational realities. The diagnosis of individual and collective learning requires an evaluation of lived experiences: the actual work of problem solving [A], the work of team between individuals and managerial practices used by leaders [B]. These experiences are used later to guide the strategies of training [C] and finally to improve the learning organization of problem solving [D].

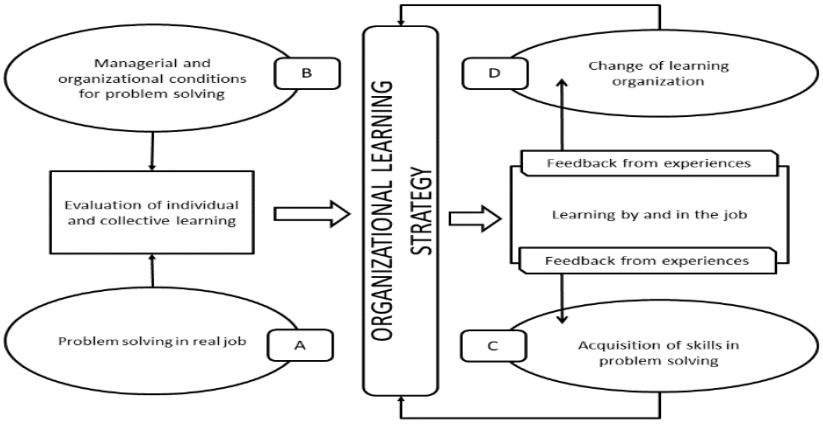


Fig. 8. Organizational Innovation (Problem Solving Pull)

6 Conclusion

This research work had several objectives. First, it was a question of identifying the empirical contradictions, which justify the difficulties of the companies to perpetuate the learning of problem solving of the operational teams. We have shown that these contradictions stem from a set of organizational paradoxes (opposing tendencies that generate tensions within the agents of production). The scientific literature resulting from the paradoxes theories associated with TRIZ helped us to formulate a model of the problem as well as a generic solution model. These models were tested on a concrete case and creates an organizational innovation. The new logic has helped to evolve the current system towards more dynamic control of the learning. We have developed a new logic (PSP) that helps to remove tensions by increasing the degree of dynamism of the production agents (AP) learning control system (figure 9). To implement this logic, frequent feedback of experiences is recorded. These feedbacks are integrated into managerial routines led by managers. A maturity grid (GM) problem solving capabilities (dimensions to be assessed, maturity levels) was built. GM is associated with a system of questioning (Q). The goal is to position the individual maturity of the production agents in problem solving. The level of maturity will allow developing the knowledge and skills (CC_RdP). This new model allows the identification of training and coaching needs (F_RdP) in the field of individuals to improve learning of problem solving tools (O_RdP).

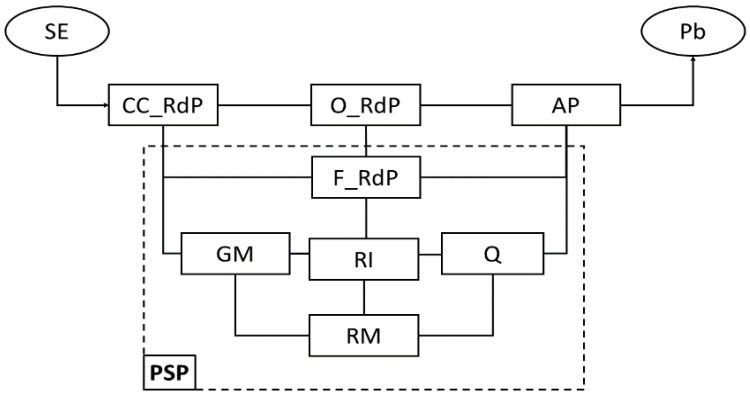


Fig. 9. Integration of the PSP into the learning control system of problem solving

Linking the paradoxes of management from management sciences with TRIZ should allow us to test other innovative organizational practices. Research is in perspective regarding the application of our paradoxical approach in other companies with problems related to the change management like company 4.0.

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