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The system dynamics approach and the methodology for multicriteria decision aid as tools for organizational learning

Rudolf ROSAS FLUNGER
Booz· Allen and Hamilton
Praia de Botafogo 300, 5to Andar
22259-900 Rio de Janeiro, RJ, Brazil
Phone ++ 55 (21) 237 8409 Fax ++ 55 (21) 553 0103
e-mail: flunger_rudolf@bah.com

Abstract
The general objective of the present work is to demonstrate that the joint utilization of the system dynamics approach and the methodology of multicriteria decision aid enable the organizational learning process improving therefore the decision processes in the organizations.
A scientific approach was developed based on real experiences grouped according two categories: laboratory experiences and real world organizations. The laboratory experiences are simulations done with university students. It was created a controlled experimental environment to use the ''Beer Distribution Game''. The original rules to evaluate the learning process were modified to prove our hypothesis. The real world organizations experiences are based on a pharmaceutical company that is passing a transformation process.
From these experiences we concluded that the joint utilization of the proposed tools present specifics advantages as:
The system dynamics approach helps the formalization and communication of knowledge due to the perception of causal links, exchanges and the simulation tools
The system dynamics simulations make evident the counterintuitive feedback impact in complex systems.
The methodology of multicriteria decision aid allows to make evident and to address scientifically the desires and beliefs of organizational agents (stakeholders) in order to formalize them into the organizational strategy and objectives.
Key words: organizational learning, system dynamics approach, methodology of multicriteria decision aid, *Beer Game*, pharmaceutical companies, Venezuela.

Introduction

The present work is a brief summary of a doctoral dissertation presented at the LAMSADE, Université PARIS IX – Dauphine (ROSAS FLUNGER 1999). This research is the result of a dedicated effort looking to improve the decision processes in organizations. A long several years of professional and academic practice, the system dynamics approach (SDS) (WOLSTENHOLME 1990), and the multicriteria decision analysis (MCDA) (POMEROL & BARBA ROMERO 1993, ROY 1985) emerged as especially effective tools to improve the decision processes in organizations. The combined use of the two techniques uses the problem understanding advantages brought by the system dynamics approach (SDS) and the objectiveness to support the decision process of the multicriteria decision analysis (MCDA).

The paper is structured in 4 pieces: The presentation of the research problem, the conceptual framework, the experiences and the research conclusions. The first part set the scope, objectives and drivers of the research. The second sets the theoretical basis. Afterward, the experiences context are described, the decision framework explained, an analysis identifying and evaluating the evolution of the articulated knowledge is described and finally the relationship between the knowledge in use and the resulting performance of the organization under study is analyzed. At the end, a set of conclusion related to the types of knowledge identified and the impact of the suggested techniques are made.

1. Organizational Learning problem definition

Organizational learning has been studied from different perspective and through all related fields: sociology, cognitive sciences, organizational behavior, and others (HUBER 1996, MIDLER 1992). Specific concepts have been defined like, knowledge, organizational memory, deuterolearning, and organizational cognition. However, major issues still requiring further research (ARGYRIS & SCHON 1996 pp. 200-2001):

- At what level of aggregations does it make sense to talk about productive organizational learning?
- What does it means productive learning?
- How to manage the inherent barriers for organizational learning in real world organizations?
- What kind of interventions can enable the organizational learning process?

From a decision aid sciences perspective[1] the organizations can be conceived as entities who's behavior is driven by the decision processes of its stakeholders (MARCH 1994). Adding the decision perspective to the organizational learning problem brings three major research directions:

- The organizational action as a result of a decision process based in the articulation of available knowledge
- Knowledge acquisition process inside the organization and types of knowledge articulated in the organizational decision process
- Organizational memory, problem representation and language

These issues should be address in two dimensions:

- Aggregation level at which knowledge is articulated to solve an organizational problem
- Impact of knowledge on the different decision attributes

In order to build real world interventions that enable organizational learning, a set of experimental tools can be assembled from the system dynamics approach (SDS) and the multicriteria decision analysis (MCDA). From the SDS it can be taken the simulation and representation tools to understand the decision context (WOLSTENHOLME 1990). From the MCDA, the criteria building and aggregation procedures can be taken to enable the final steps of the decision process[2] (POMEROL & BARBA ROMERO 1993, ROY 1985).

From this context, we proposed to focus in three major issues:

- What elements of the organizational decision process can be address with the experimental tools?
- What types of knowledge can be better addressed with the use of the proposed experimental tools?
- How the experimental tools can be used as memorization instruments for the knowledge issue from the organizational learning process?

2. Conceptual framework

The research was based on three major conceptual definitions:

- Decision process in the organizations
- Types of knowledge articulated by decision makers in the organizations
- Organizational Learning concept

The decision process is build upon two dimensions: a problem solving axis and a consensus-building axis (see Figure 1 : Axis of the decision process in organizations):

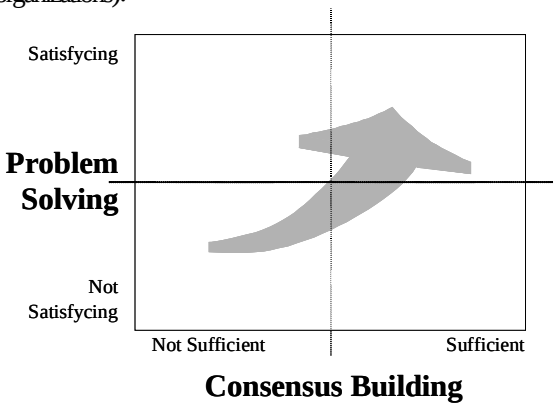

Figure 1 : Axis of the decision process in organizations

One axis corresponds to the problem solving heuristic (POMEROL 1997). The problem solving process is focus on finding a satisfycing solution to the objective decision problem (ROY 1992). However, if the selected solution is not accepted by the organization it will not be implemented at an organizational level. Therefore, a second axis exists that drives the problem solving heuristic to a consensus building process looking to build ownership on the solution. According to the position of the outcome in the decision matrix, the decision process could be satisfycing but not organizational, recognized by the organization but not effective or effective and organizational enough to be implementable as an organizational action (ROSAS FLUNGER 1999 pp. 106-114).
The second major conceptual definition is the classification of the knowledge articulated in a Management Situation[3]. Three types of knowledge can be identified (HATCHUEL & WEIL 1992):

- Know-How (Savoir-faire): Is the knowledge that expresses a transformation procedure through known actions. Can be represented through a collection of procedural instructions that can be easily codified in a computer language
- Understanding (Savoir-comprendre): Is the knowledge set articulated to understand why a situation perceived doesn't correspond with a desire situation. I typical example can be the maintenance engineering context when a dysfunctional situation is perceived and its causes identified.
- Combination knowledge (Savoir-combiner): Is the set of knowledge articulated to combine resources and objectives in a project approach. Is knowledge of the entrepreneur that is able to organize its resources and objectives to achieve a business system.

Finally, we defined organizational learning as the durable modification of the elements of the decision process of stakeholders in a management situation oriented to the implementation of organizational actions with a problem-solving objective. The concept is based in a concrete set of assumptions (ROSAS FLUNGER 1999 PP. 138-141):

- Learning is a process
- Learning is based on a modification the objectives, representations and rational of stakeholders
- Modifications should be saved in the " organizational memory" in order to become durable
- Modifications happens at individual level of stakeholders
- Stakeholders are evaluated by the outcome of their actions (management situation)
- Learning is expressed through an organizational action
- The process started is perceived problem
- The learning process has the intention to solve a problem

3. Experiences

3.1. Laboratory experiences

3.1.1. Experience description

The Laboratory experiences are a modified version of the " Beer Distribution Game" (STERMAN 1994, 1982). As part of operations research courses in two engineering schools in Venezuela a supply chain system with 5 echelons was simulated with more than 100 students (4 experiences with more than 25 students each). The students were grouped in teams acting as the retailers, distributors and wholesalers. The moderators (professors) served as the clients and the plant of the system. Each team was evaluating comparatively against the group. Grades based on team position and chain position against other chains was measured. In consequence, the students were stimulated to compete between them but at the same time they had the responsibility of improving the overall chain performance. Major differences with the original Beer Game are:

- The demand curve is not a step over a constant order volume but a cyclical demand
- The students were allowed to talk. At the beginning of the experiences the silences paradigm prevailed as the experiences were made in a formal evaluation context. Once the students realized it was possible to talk, the important issue was the effectiveness of the communication and the team dynamics allowing an efficient resolution of the game challenge

3.1.2. Decision framework

The Beer Game demands from the student's three main decision processes:

- Organization: The students have to organize themselves in the teams to be able to meet the time pressure of the experience. The teams have very short time to place the orders and make the deliveries. In consequence, an internal organization is imperative to be efficient performing the game activities. Two level of organization are required in the game: team and game organization. First the teams have to allocate internally the task of the game. Secondly, once the teams have discovered they can communicate through the chain they have to define a communication model to solve the information delay issue. For the internal team organization three main options are available: functional, mix and no organization. At the chain level also three models are available: non communication, representative and integral models depending on the level and stakeholders involved in the communication processes
- Stock policy: The teams have to define a stock policy that drives the order process. The students were allowed to use all their resources (books, etc) to define the policy. They were formally asked in the experience protocol to make explicit their stock policy.
- Order placement: At each game step the teams have to define the quantities in the orders and the quantities in the deliveries.

3.1.3. Knowledge assessment

Each identified decision articulated a different type of knowledge:

- Organization: Understand the task and objectives of the game as well as resources and constraint are the major issues. The task can only be achieved articulating the combination knowledge (savoir-combiner). All the teams were not able to define or to implement a clear organizational model.
- Stock policy: To understand the feedback processes in information and physical flows of the game is the major issue for this decision. Understanding type of knowledge (savor-comprendre) is articulated for this decision. Build the causal loops and identify the critical parameters are the inherent task and knowledge required. A clear evolution of the knowledge involved was perceived through the different moments of the game. At the beginning a first policy was set up without considering any communication with the chain. Once it was realized communication was allowed, a second stock policy was defined. Finally, once stabilized the orders the teams moved from a cooperative environment to a more competitive one to try to get better grades than the others. (See Figure 2 : Evolution of deviation average of orders from retailers, wholesalers and distributors with polynomial approximation (95%)
- Order placement: Defining the quantities be ordered and delivered is a procedural task based on knowing how to apply the defined stock policy. Correspond to a typical know how (savoir-faire) context.

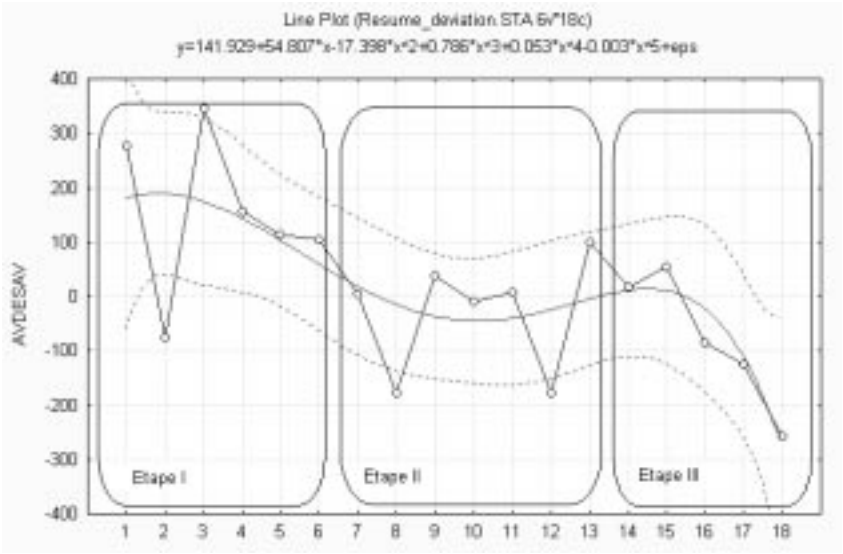

Figure 2 : Evolution of deviation average of orders from retailers, wholesalers and distributors with polynomial approximation (95%)

3.2. Real world organization

3.2.1. Experience description

A family owned pharmaceutical industry in Venezuela was defining its strategic intent. After several decades of success as a niche player, good levels of profitability and financial stability the next generation of owners was questioning the sustainability of its business system. An organizational Learning initiative was designed and implemented targeting to:

- Create a common vision in a recently hired new management team
- Develop an adapted business system sustainable in the new market conditions of Venezuela

The intervention was designed as a set of workshop were high level causal models were defined and MCDA tools were deployed to support the required decisions.

3.2.2. Decision framework

During the initiatives 4 decision were identified as been the most critical:

- Product classification: A management decision on product portfolio was required in the laboratory. A significant number of product, especially the two most important were classified and sold as pharmaceutical products when it was possible through simple initiatives to transform them in over the counter (OTC) products. The change would also impact all commercialization chain moving it to the common mass market. It was not a simple classification exercise but a management decision to be taken.
- Performance assessment: A full set of performance indicators was defined to be able to evaluate the performance of the laboratory and an assessment process was launched requiring a measurement effort in all areas of the company
- Mission and vision definition: In workshops with the top management of the firm and the owners the new vision and mission of the company was defined.
- Objectives definition: The mission and vision were articulated in detailed performance targets with clear measures

3.2.3. Knowledge assessment

The identified decisions were based on specific knowledge:

- Product classification: Articulated the know-how of rules and laws that defines the current product portfolio according to industry standards. The MCDA tools were used to support the criteria

definition and assessment to identify current portfolio positioning. The type of knowledge use was know-how

- Performance assessment: Articulated a set of knowledge targeting the understanding of the current performance of the company. The type of knowledge as understanding (savoir-comprendre). The main issue is to understand why the current performance is at the perceived levels
- Mission and vision definition: using all knowledge developed about the firm, a clear understanding of available resources (coming form the performance evaluation) the new company goals were defined. This was the result of combining available competences with feasible objectives. The type of knowledge articulated was combination (savoir-combiner)
- Objectives definition: Based on the vision and mission the detailed resources and detailed objectives should be defined and articulated to achieve the desired goals. The type of knowledge in use are combination knowledge (savoir-combiner)

4. Conclusions

The beer game allowed to understand the proposed organizational learning concepts but not the effective use of the experimental tools. In the experience, it was clearly enough what types of knowledge were articulated on each decision. However, the time pressure and dynamics of the beer game does not allow to use simulation models neither MCDA procedures.

The conclusions driven from the experience were:

- Organizational models with clear allocation of responsibilities increased the performance of the teams
- Open but organized communications were critical to achieve high performance levels
- The use of explicit stock policies increased the performance levels
- The performance level were proportionally related to the learning velocity of the teams for the understanding knowledge related to the definition of the stock policy and also to the velocity on developing the know-how (order placement)

The pharmaceutical company experience allowed to use the experimental tools in a real world environment. The conclusions from the experience were:

- The clear allocation of responsibilities as well as the understanding of the allocated task increase the organizations performance
- The openness generated by the joint workshops, were the top management interacted, making the identified decisions through the support of the experimental tools increase the organizations performance
- The MCDA allowed to improve the transparency and fairness of the performance evaluation process improving the consensus building axis of the decision process
- The utilization of simulation models and causal diagrams improved the identification of critical issues improving the development of understanding knowledge (savoir-comprendre) and increasing the effectiveness of the problem solving axis of the decision process

Further development must be made as the sample of the research is restraint to a single example (pharmaceutical laboratory) but gives important insights in the implementation of the 2 suggested techniques.

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[1] For a further discussion on the relevance of the concept decision sciences and decision aid sciences ROY 1992

[2] For further details on the steps of the decision process SIMON 1997.

[3] For a definition of management situation GIRIN 1990