COMPORTAMENTO ORGANIZACIONAL

THE TRANSACTIVE MEMORY SYSTEM AND GROUP LEARNING

SISTEMA DE MEMÓRIA TRANSITIVA E APRENDIZAGEM GRUPAL

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ABSTRACT

The objective of this article lies in the understanding of the learning process that occurs in cross-functional groups in automotive companies in light of the Transactive Memory System (TMS). The specific objectives describe the working methodology applied for the operation of multifunctional groups and its relation to learning; the main factors that facilitate group learning and the moments which there was evidence of group learning.The research methodology used is qualitative and exploratory approaches due to the fact those approaches has been less explored in the academic environment.Two different organizations were investigated: the first one is a multinational which works with a strategy of offering complete innovation product, and the other with strategy of offering incremental innovative products for the automotive industry. The results indicated that the fact TMS acts as an important facilitator of group learning.

KEYWORDS

Group Learning. Automotive Companies. Cross-Functional Groups. Transactive Memory System.

RESUMO

O objetivo deste artigo é entender o processo de aprendizagem que ocorre nos grupos multifuncionais de empresas do ramo automotivo, à luz do Sistema de Memória Transitiva (SMT). Os objetivos específicos procuraram entender e descrever a metodologia de funcionamento utilizada para a operação dos grupos multifuncionais e sua relação com a aprendizagem, os principais fatores que facilitam a aprendizagem grupal e os momentos pelos quais houve evidências de aprendizagem grupal. A metodologia de pesquisa utilizada é de ordem qualitativa e exploratória, já que o tema tem sido pouco explorado no âmbito acadêmico. Foram investigadas duas organizações distintas: a primeira trata-se de uma multinacional que trabalha com uma estratégia de ofertar produtos de inovação completa e outra com estratégia de ofertar produtos de inovação incremental para o ramo automotivo. Os resultados indicaram que o SMT de fato age como um importante instrumento facilitador da aprendizagem grupal.

PALAVRAS-CHAVE

Aprendizagem Grupal. Empresas Automotivas. Grupos Multifuncionais. Sistema de Memória Transitiva.

INTRODUCTION

In a society guided by information and an economy based on providing services, knowledge is an important intangible asset that companies must acquire and exploit in order to achieve superior organizational performance (PAWLOWSKY; FORSLIN; REINHARDT, 2001). Faced with the intensification of global competition and with the exponential growth in means of communication, manufacturers around the world that are committed to maintaining their competitiveness in the market must strengthen their ability to deploy and exploit their intangible assets to the maximum. If the people who comprise organizations are able to learn more quickly, they will enable their companies to achieve a higher level of development (MACNEIL, 2001). Learning emerges as a phenomenon that arouses interest in order to guarantee the efficiency of organizations. Understanding the processes by which organizations learn and how they can be managed becomes indispensable, for both researchers and for the professionals who work in management (EDMONDSON, 2002).

Some terms related to organizational learning found in the literature include: codification and modification of routines, acquisition of learning useful to the organization, increase of organizational capacity for taking productive action, capacity for interpretation, development of knowledge

with respect to the action-result relationship, detection and correction of errors.

Although the literature shows the importance of examining learning in organizations starting from different levels, this article proposes special focus on the group level. According to Weick and Roberts (1993), the analysis of the group perspective involves inter-related attitudes that have the individual as their base. This analysis should not be concerned only with the existing divisions of the relations of the individual with the group and vice-versa, but also understand when each influences and/or is influenced by the other (NODARI, 2009).

Cross-functional groups in automotive companies are charged with the development of new production processes and providing services to their major customers (automobile manufacturers). They are also responsible for the efficient control of resources indispensable to the organization, such as people, technologies and information. They are capable of generating the interaction of these resources among themselves and the processes, in addition to promoting integration among diverse sectors inside the company.

According to Edmondson and Nembhard (2009), it is common for organizations to utilize cross-functional groups in the execution of certain development projects, as they generally manage projects. To make up these groups, several professionals from distinct areas are selected based on their unique capability to contribute to a particular project. The dynamics of the group process will depend mainly on the nature of the project. For example, some members can perform functions in specific phases, later they are transferred to other projects for which their expertise is required.

The variety of organizational activities becomes fundamental for individuals to be able to work with different people on various projects. This flexible arrangement allows groups to be able to be composed of the most appropriate specialists. The existence of cross-functional groups in the context of business of supplying automotive parts is crucial for the survival of Brazilian automotive companies.

The utilization of memory storage and sharing systems in the group learning process, as explained by Edmondson, Dillon and Roloff (2007), covers a specific area that emphasizes Task Mastery and studies how team members learn to perform interdependent tasks. It sees group learning as the result of communication and coordination that promotes knowledge sharing by the group members about the team itself, tasks, resources and context. More specifically, group learning is conceptualized here as the task mastery and how well a group learned to perform it, making it a typical measurement of performance.

Edmondson, Dillon and Roloff (2007) examines how groups leverage the knowledge of their members and their abilities to increase the quality and quantity of knowledge available for performing tasks, being substantially concerned about analyzing processes such as codifying, storing, retaining and communicating information in the teams, in addition to emphasizing the concepts and constructions concerning collective cognition using terms such as: Shared Mental Models; Transactive Memory System (TMS); Social Cognition, among others. It is important to highlight the fact that such concepts and constructions are similar, treating cognitive systems at the group level as a form of codifying, storing, retaining and communicating knowledge.

According to Ellis, Porter and Wolverton (2008), the memory sharing system was originally conceived to describe how some individuals placed in groups, in their closest relationships, divide and combine their work load. Instead of disorganizing their internal memory in an attempt to keep pertinent information, each member assumes the responsibility for specific work-related parts starting from the information most relevant to his own work. Any pertinent information (for example, information related to someone's expertise) is thus submitted to or retrieved from that individual. TMS is understood to be a form of enabling partners to process information more efficiently and effectively.

Considering the aspects mentioned in this introduction, it is believed that the proposed topic is important and relevant not only from the academic point of view, but also from the business one. Due to the necessity to delimit the focus of the study, the following line of questioning was established: Which processes permeate the learning that occurs in cross-functional groups in auto parts supply companies in light of the Transactive Memory System (TMS)? Seeking an answer to this inquiry, the overall objective of this study lies in the understanding of the group learning processes that occurs in work situations in cross-functional groups in automotive companies in light of TMS. To achieve this, the following specific objectives were established: (1) to identify and describe the methodology used in the operation of cross-functional groups and its relationship with learning; (2) to identify, describe and discuss the factors that facilitate learning in cross-functional groups; (3) to identify, describe and discuss the moments at which there is evidence of learning in the cross-functional groups studied.

LEARNING AT THE GROUP LEVEL

The theoretical and empirical production in learning at the group level, especially in the international scope, has grown greatly since the 1990s. The factors that caused this fact were indicated by Wilson, Goodman and Cronin (2007) and by Edmondson, Dillon and Roloff (2007). For these authors, the increasing number of studies that examine group learning has been guided by at least two basic factors: the first of these is revealed in the desire about discovering the real reasons for which some groups show themselves to be more effective in learning in the most varied work situations and the second arises from the discussion concerning the crucial role exercised by groups in organizational learning. It is relevant to also highlight that these empirical studies are supported by a variety of terms and concepts, in addition to using different research methodologies.

According to Wilson, Goodman and Cronin (2007), at the same time at which such heterogeneity shows itself to be fertile, it can also generate confusion. In this way, the main challenge has been, essentially, to characterize what constitutes a social group. These authors (WILSON; GOODMAN; CRONIN, 2007) argue that a unified vision about the concept would help to advance the understanding of this important phenomenon. In spite of the emphasis on the importance of a more homogeneous definition, defending the convergence to a single concept, the view of Edmondson, Dillon and Roloff (2007) reveals that this conceptual diversity reflects the current stage of theoretical development concern-

ing the topic, still nascent when dealing with establishing a single understanding for such conceptualization.

According to Edmondson (2002) and Wilson, Goodman and Cronin (2007), the definitions of group learning have varied considerably, revealing the existence of conceptual ambiguities. Such discrepancies led Mohammed and Dumville (2001) to affirm that the literature about the topic suffers from insufficient cohesiveness. These authors argue that the establishment of greater consensus regarding the theoretical framework about the topic may be useful for the emergence of a greater number of empirical studies, helping to evaluate the scarcity of data related to group learning in organizations. Wilson, Goodman and Cronin (2007) consider empirical studies about group learning to be in the initial stage of maturity.

In spite of these difficulties, the relevance of the groups inside organizations is a theme that has been addressed by several authors. According to Fiol and Lyles (1985), organizations increasingly depend on groups to finish every day and operational tasks and also to achieve more strategic objectives, in which the most critical decisions are taken. This directly involves the capacity of the organization to learn, improving its obtained results by means of collective knowledge as a form of guaranteeing its competitive ability (EDMONDSON, 1996).

Increasingly, important tasks are directed to work groups (OSTERMAN, 1994). For some researchers in the area of organizational behavior, such as Fiol and Lyles (1985) and Edmondson (2002), the composition of work groups is the essential factor enabling organizations to learn. According to Wilson, Goodman and Cronin (2007), it is through work groups that organizational efficiency is achieved. Understanding "if" and "how" groups learn is, therefore, essential for predicting the performance of an organization.

The authors Edmondson, Dillon and Roloff (2007) call attention to the fact that in many modern organizations groups act mainly on project execution, on innovation strategies, on service provision and on execution of other key tasks that will influence organizational performance. The capacity for renewal, both learning what and learning how, with the aim of achieving organizational objectives, enables a company to maintain or even increase its efficiency in the face of the emergence of new challenges in productivity. For Edmondson, Dillon and Roloff (2007), meso-cross-functionalities can be defined as work groups existing in the context of an organization made up of professionally diverse members who share responsibilities for the development of products or services.

Consulting some significant works that review the literature of group learning (EDMONDSON; DILLON; ROLOFF, 2007; SESSA; LONDON, 2008a, 2008b; WILSON; GOODMAN; CRONIN, 2007), it is possible to identify a set of studies developed from different theoretical and methodological orientations that result in findings that are diverse and structurally different. The examination of such studies shows that there is little consensus concerning the definition of the term "group learning," as shown in Table 1, below:

According to the concepts presented above, the definition of group learning proposed by Wilson, Goodman and Cronin (2007) implicitly refers to the cognitivist approach. In this case, group learning is es-

TABLE 1 – Definitions of Group Learning

REFERENCE	DEFINITION
Argote, Gruenfeld and Naquin (1999, p. 354)	"The activities through which individuals acquire, share, and combine knowledge through experience with one another."
Edmondson (2002, p. 129)	"A process in which a team takes action, obtains and reflects on feedback, and makes changes to adapt or improve."
Soule and Edmondson (2002, p. 18)	"The acquisition and application of knowledge that enables a team to address team tasks and issues for which solutions were not previously obvious."
Ellis et al. (2003, p. 822)	A relatively permanent change in the team's collective level of knowledge and skill produced by the shared experience of team members.
Gibson and Vermeulen (2003, p. 203–204)	"The exploration of knowledge through experimentation, the combination of insights through reflective communication, and the explication and specification of what has been learned through codification."
London, Polzer and Omoregie (2005, p. 114)	"The extent to which members seek opportunities to develop new skills and knowledge, welcome challenging assignments, are willing to take risks on new ideas, and work on tasks that require considerable skill and knowledge."
Wilson, Goodman and Cronin (2007, p. 1043)	"A change in the group's repertoire of potential behavior."
Sessa and London (2008a, p. 7) Sessa and London (2008b, p. 555)	"We define group continuous learning as a deepening and broadening of the group's capabilities in (a) (re)structuring to meet changing conditions, (b) adding and using new skills, knowledge, and behaviors, and (c) becoming an increasingly sophisticated system through feedback and reflection about its own actions and consequences."

Source: Updated from Wilson, Goodman and Cronin (2007).

sentially a manifestation of the acquisition of information from the internal and external environment to the group. This happens when a knowledge-holding member shares information with other individuals such that the group is able to obtain answers resulting from the most varied work situations. Conversely, for Sessa and London (2008a), group learning can be understood from three basic approaches that highlight its nature which (1) is adaptive; (2) generates new abilities and forms of applying that which was learned; (3) and is transformative.

It is possible to say that the revision of the principal definitions reveals little consensus, since some focus on individual learning that happens inside groups, whereas others on collaborative knowledge at the group level. For Wilson, Goodman and Cronin (2007), some studies that focus on group learning are confusing, as they do not manage to make a distinction between individual learning in the context of the group and collective learning.

According to Edmondson, Dillon and Roloff (2007), the perspective denominated by them as "Task Mastery" is that which is most utilized in TMS, as it emphasizes task mastery by groups and studies how their members learn to perform interdependent tasks. It focuses on group learning as a result of communication and coordination that promote the sharing of knowledge by group members about the group itself, tasks, resources and context.

The studies developed from this perspective examine how groups leverage the knowledge and abilities of their members,

seeking to increase the quality and quantity of knowledge available for executing tasks. Studies in this area are essentially concerned with analyzing processes such as codifying, storing, retaining and communicating information in groups. According to Wilson, Goodman and Cronin (2007), such processes are essential to group learning, having in view that when certain knowledge is embedded in the form of procedures or in the roles played by the group, it tends to endure, in spite of member substitution. From the time at which knowledge is shared, it is necessary that it be stored by the group in order for it to be recovered and applied in the future. In this way, the authors present a framework based on the basic processes of learning at the group level, which are: sharing, storing and recovering.

Sharing is the process by which new knowledge, routines and behaviors are distributed among the members of the group. It permits the group to come to have the understanding that the knowledge is the group's and not just the individual members' separately. Such a process can be identified by three stages: when a member changes his skillset to incorporate new knowledge – thereby changing the skillset for the group; when the acquisition of knowledge occurs by other members of the group; when members of the group have specific knowledge and are conscious that other group members share that same knowledge. Upon reaching this third stage, the group comes to have a new skillset (KINCELER; TODESCO, 2010).

Storage determines how the knowledge learned by the group is retained and held in memory repositories or in shared locations for use such that the learning persists over time (DIXON, 1993, 1999; WILSON; GOODMAN; CRONIN, 2007). It is considered here that there are a variety of repositories and diverse types of knowledge (tacit and explicit) that involve learning at the group level.

Recovery occurs from the moment at which the members of the group find and access the stored knowledge for inspection or future use (WILSON; GOODMAN; CRONIN, 2007). According to Kinceler and Todesco (2010, p. 4-5) "the knowledge is validated by the group when the storage occurs successfully and when, upon being accessed for implementation, it is available."

It can be affirmed that TMS is mainly used to predict task performance. It should also be pointed out that a large part of the research done following the "Task Mastery" perspective involves experiments developed in the laboratory, which are not presented, given their insufficient relevance to the study related here, which sought to understand the processes of group learning in the natural environment where they happen.

However, the process of sharing is the most crucial, as it is through it that learning shall be triggered (KINCELER; TODESCO, 2010).

TRANSACTIVE MEMORY SYSTEM (TMS)

According to Ellis, Porter and Wolverton (2008), the transactive memory system was originally conceived to describe how individuals, in their closest relationships, share their combined workload. Instead of disorganizing their internal memory in an attempt to maintain all pertinent information, each partner assumes the responsibility for specific parts of the most relevant information. Any pertinent information, for example information related to someone's expertise,

is then referred to or recovered from that individual. TMS is labeled as a form of enabling partners to process information in a more efficient and effective manner.

The concept of TMS has been adopted by organizational researchers to describe how the members of groups combine their individual memory capacities in a synergistic manner, starting from approximate relationships between individuals. The sharing of memory permits different members of a group to process information such that they remember the given information that is directly related to their area of expertise.

Through TSM, group members are able to trust the expertise of their partners, enabling the team to access a larger set of information related to the task, avoiding a waste of cognitive effort. A transactive memory system exists when the members of the team possess a shared understanding and unrestricted access to the knowledge and abilities of the other group members, actively using them together with specialized knowledge, having the objective of performing a determined task (ELLIS; PORTER; WOLVERTON, 2008, p. 93), or even taking decisions that involve, also, greater risk.

According to Ellis, Porter and Wolverton (2008), to the extent that the interest of organizational researchers increased, two different interpretations about this concept were developed. The first states that a group of researchers principally concentrated on specialization, coordination and credibility which are considered the emerging cognitive manifestations of shared memory. Specialization refers to the level of memory differentiation inside the group, coordination refers to the perceptions of the newcomers to the team about its ability to work together efficiently and credibility is related to the members' belief about the reliability of their partners' knowledge.

A second group of researchers concentrated on updates to directories, allocation of information and coordination of memory recovery, which are considered to be independent behavioral indicators of shared memory and fall under the category of action processes. Through a update directory, group members become conscious of their respective areas of expertise and "who knows what" by sharing or soliciting information from their teammates.

Through allocation of information, information is communicated to the group member who covers a relevant area of expertise, enabling other members to pass information to one another without keeping anything in their individual memory. Through the coordination of memory recovery, team members utilize their "directories" soliciting known information to be realized inside the areas of expertise of a teammate.

According to Edmondson, Dillon and Roloff (2007), the first papers developed within the perspective of memory sharing concerned the relation between group training, TMS and task performance. The authors identified studies whose research objectives were to analyze in what manner simple tasks, such as assembling transistor radios, could explain the differences in the process of memory sharing, task coordination and task credibility, including factors such as motivation, group cohesion and social identity. The discoveries demonstrated that in groups in which training was conducted jointly (with all the members of the group) there was the development of intense memory sharing and a stronger social identity among their members.

METHODOLOGICAL ASPECTS

It is important to stress that, at this moment, part of the theoretical framework, of the results obtained, as well as the methodology used deal with excerpts from a doctorate thesis. The study encompasses a qualitative perspective which aids the interpretation and understanding of the processes that permeate administration, especially when understanding of the phenomena "from the perspective of the subject, that is, of the participants of the situation being studied" (GODOY, 1995, p. 58) is sought.

According to Merriam (2002), the result of a qualitative investigation should be richly descriptive. Words and figures are used in place of numbers to communicate that which the researcher learned about a determined phenomenon. There will probably be a rich description about the context, the participation of those involved and other activities. In order to develop this description, the researcher will use document citation, field notes, and interviews with the participants, video tapes, electronic communication, or a combination of all these elements.

In this way, this study is descriptive and interpretive, as it sought to analyze, understand and expound upon the main characteristics of the phenomenon of learning in the participants of cross-functional groups inside the specific context of an automotive parts supplier. It is also considered exploratory, as the phenomenon of learning in work groups, although present in the reality of Brazilian organizations, has been a topic that reveals little accumulated and systematized knowledge.

Considering that the study will start from a contextual-interpretive perspective, the proposed method was a qualitative case study in order to observe, explore, interpret, understand and discuss aspects related to the processes of learning in cross-functional groups in an automotive organization.

According to Godoy (2006, p. 124), interpretative case studies should contain unique characteristics, such as a rich description of the phenomenon being studied, data standardization and organization by means of conceptual categories "able to illustrate, confirm or disconfirm theoretical suppositions." Both Godoy (1995, p. 25) and Yin (2001, p. 32) attest that a qualitative case study "is an empirical investigation that involves a contemporaneous phenomenon within a real-life context, especially when the limits between the phenomenon and the context are not clearly defined."

Merriam (1998, p. 29) states that this type of investigation also includes some "particular, descriptive and heuristic" characteristics. *Particular*, as they are focused on one particular situation or event; *descriptive*, as they represent a complete and literal description of that which is being studied; and *heuristic* for permitting new meanings, leading the researcher to rethink the investigated phenomenon.

Collection of the Data

For Triviños (1987), the interview carried out by means of a script of questions is one of the decisive instruments for studying the processes and products in which the investigator is interested. According to Alencar (2000) and Godoy (2006), the greatest advantage of this form of data collection is that it enables the interviewee to state his opinions, points of view and arguments, permitting the researcher to understand

the meanings that the interviewees attribute to the questions and situations related to the topic of interest. The objective of the interview is to "collect descriptive data in the language of the subject himself, which enables to investigator to develop an idea about the matter in which the subjects interpret aspects of the world" (GODOY, 1995, p. 134).

It should be remembered that, in a broad study, in the scope of this thesis, with the goal of achieving the objectives proposed, members of cross-functional groups of two distinct organizations were interviewed, comprised of three groups per company, totaling nineteen interviewees, ten in Company Alpha and nine in Company Beta. The interviews were done in the months of March and April 2012, amounting to a total of 600 minutes of electronic audio. The average time taken by each interview was approximately 31 minutes, they were subsequently transcribed, generating about 200 pages of material.

However, in order to achieve the requirements of this study, we chose to analyze only the data obtained from the cross-functional groups of **Company Beta**, as in this organization there was evidence of the intensive use of TMS, differently from Company Alpha. The transcribed material was sent back to the company for the interviewees to read and analyze it, attesting to its veracity and authorizing the use of the data. All participants had complete freedom to disagree with the transcribed statements or even to abstain from participating in the research project.

According to Godoy (1995) observation has an essential role in qualitative case studies. It is by means of this technique that the investigator will learn appearances, events and/or behaviors. Non-participant observations occurs when the researcher acts only as an attentive spectator (GODOY, 2006, p. 133), collecting data and not participating in the context in which he is placed, using a script of observations for support.

In this way, non-participant observation happens at moments in which cross-functional groups meet. It was sought to verify the overall context of the social process in these meetings, such as the definition of the individual and group goals, the justifications for the non-achievement of them, conflicts and discussions between the participants, the role of the project manager and his defense and persuasion strategies. In addition, there was the opportunity to verify productive processes, physical and architectonic structure of the company and other visible artifacts that could corroborate the results of this article giving form to the strategy of triangulation of the study presented here.

Analysis of the Data

As King (1998) defends, faced with multiple qualitative research modalities, one of the main advantages that justifies the use of analysis by templates comes from the fact that this technique is more flexible, permitting the researcher to adapt it to better meet his own needs.

When used within a phenomenological approach, analysis by templates is, in practice, very similar to interpretative phenomenological interpretative analysis, in which the development of the conceptual themes comes from broader conglomerates and its possible identification into "main categories" subdivided into "constituent categories" (subcategories). Sub-

stantially, what distinguishes analysis by templates from other interpretative phenomenological approaches is the *a priori* use of codes, which can be used in a "balanced manner" in case study situations, and can be understood as the flexibility itself that such a strategy permits.

Furthermore, King states that the initial template can be constructed from the "academic literature" (KING, 1998, p. 259), that is, from the theoretical framework itself proposed by the researcher, being that this is the strategy used in this study, as, through the theoretical framework, a set of codes or words were obtained that can represent the conglomerates of theoretical ideas, thus giving rise to fifteen initial analytical categories, subdivided hierarchically into a level of subcategories, thus confirming what King (1998, p. 261) suggests, in which the "categories should be subdivided into one, two, three or four smaller ordered levels."

Analyzing the interview data for the current study, starting from the initial template made up of fifteen categories, by means of analytical codes, the next step was to identify patterns of responses that were capable of aggregating information to the conglomerates (categories). This first attempt at data analysis enabled the initial template to reduce the number of categories, leading it to its completion. According to the repetitions that occur, more similarity patterns arise, making the template increasingly less redundant and more robust, as Merriam (1998) suggests.

In the scope of this thesis, starting from the first attempt to categorize via analysis by templates, resulting in fifteen categories, passing through the process of repetitions, the final template resulted in five relevant categories, namely: (1) group composition; (2) operation of the groups and the learning processes found there; (3) aspects that impede the operation and learning at the group level; (4) aspects that facilitate the operation and learning at the group level; (5) evidence of learning. Nevertheless, in order to achieve the objectives proposed in this article, the second, fourth and fifth categories were most valuable.

RESULTS AND DISCUSSION

The methodology of group operation in Company Beta was dominated by Stage-Gate®, broadly spread and applied in leading group work. It has distinct characteristics and tries to harmoniously fit in according to the profile of the work of this company and the objectives defined by its groups. It was developed by Cooper (1993) and is a process for managing projects that are led by a cross-functional team.

Each of the stages is developed as a form of obtaining the information necessary for a project to proceed to the next stage, passing through a decision point (gate), which precedes each stage. The gates serve as quality control verification points, in which members of a cross-functional group obtain a decision concerning the continuation or termination of the project (COOPER, 1993).

According to Cooper (1993), after conceiving the idea for the project, the gates are defined ahead of time and specify a set of activities to be achieved for the stage in analysis, employing a series of criteria or outputs. In the case of Company Beta, the evaluation in the gates is conducted by the manager responsible for the project, taking into consideration the following stages of development, as shown in Figure 1, namely:

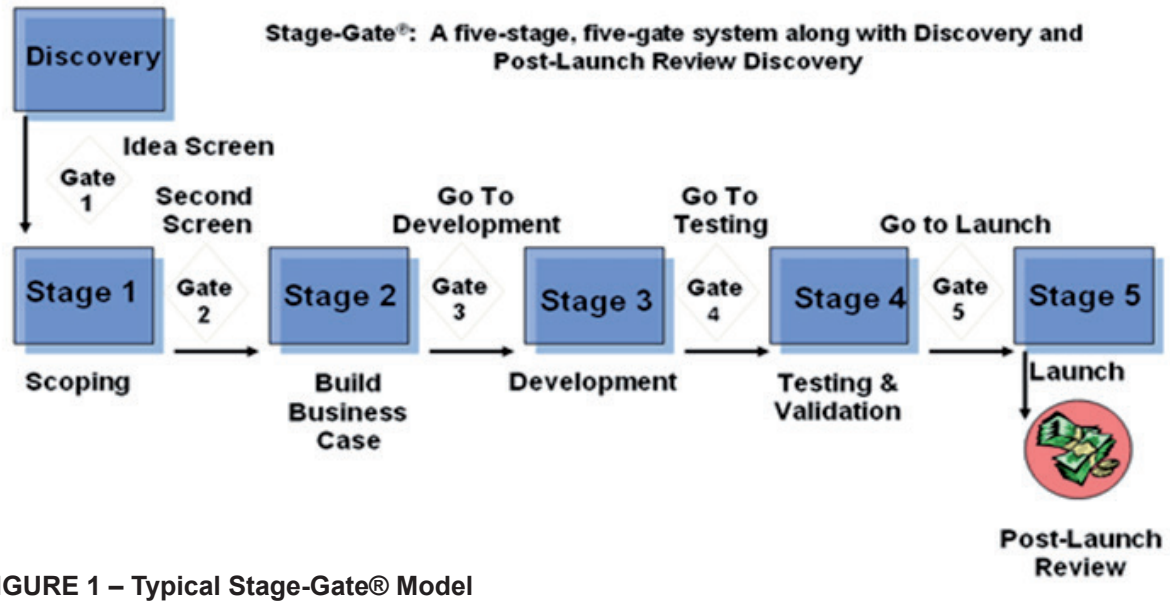

FIGURE 1 – Typical Stage-Gate® Model
Source: COOPER, 1993.

Company Beta is the fact that such a method permits the cross-functional group to visualize all the phases of the project, from the conception of the idea to the product launch, its patenting, if that is the case. This model can also justify the motive for a cross-functional group not working on only one project, as, at a determined verification gate, there is a 70% chance of termination of the idea occurring, according to one of the researchers in Company Beta.

Perhaps this is also an important indication of the occurrence of group learning. According to notes taken on visits to Company Beta, there are several elements that can favor learning, such as: broad range of project research; widespread occurrence of non-successes in diverse project and in their most varied phases of development, which cannot be understood as failures or errors, given that many times the technology available at the moment is not sufficient to put certain ideas into practice; systematic and simultaneous verification meetings with other groups' projects, involving a greater number of people, which by itself promotes greater information sharing and more intensive use of cutting-edge technology, given that the work is mainly with innovative product projects.

The Stage-Gate® method, due to its holistic organization, enables a cross-functional group to see all the phases of a project, providing greater internal control, mainly at the moments that require the use of greater subjectivity and reflection or even at those times that involve sharing of information and taking decisions about the continuation or termination at particular stage. In several of the interviewees' statements these ideas are present.

According to the field observations, due to this systematization that focuses on the greater control used in phases of product development, it is possible for a cross-functional group to work less with the trial and error perspective, albeit knowing about its existence. Nevertheless, there is awareness of its real capacity to generate new knowledge, given that it is strictly linked to the members' reflection and

consequently the group's learning. However, it must be remembered that this deals with innovative projects, with a high aggregated value, which logically involves a large budget. Thus, there are indications, as shown by the statements below, that the Stage-Gate® methodology also constitutes a form of controlling per-project financial expenditures by taking decisions rationally, at the expense of greater reflection and subjectivity.

This more streamlined system and the restriction of subjectivity, aspects verified through observation and by the content of some interviews, are typical of the Stage-Gate® methodology, allowing the group members to work more individually, concentrating on their particular work goals, clashing with the idea that a diverse environment can be more favorable to exchanging experiences, knowledge and heated debates (EDMONDSON, 1996). The data from interviewees BETA 13 and BETA 14 constitute this situation.

However, this lack of greater subjectivity can be ameliorated by the existence of a repository of information acquired by the group at certain moments (gates) in the project life cycle, which for some reason was not taken advantage of. Thus, it appears that the information is not wasted or lost. The repository comes to function as an artificial transactive memory system (TMS), as the studies of Wilson, Goodman and Cronin (2007) identified, whose primary function is to enable the access and use (application) of ideas and information in problematic situations during the stages of the project. It can also serve as an inspirational source to guarantee the upkeep of the group's project portfolio, as shown in Figure 2, inspired by Rozenfeld et al. (2006).

The aspects presented in Figure 2 can be confirmed by interviewee BETA 14. According to him, his project group works with an information system (software) that serves as an idea repository. In addition to this, ac-

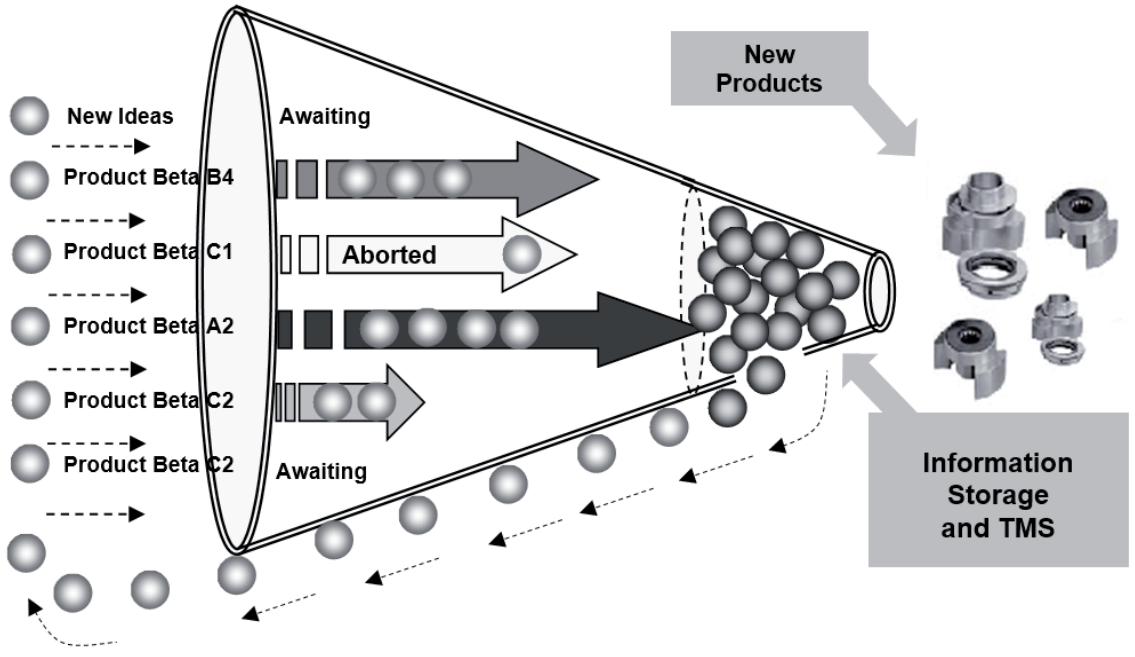

FIGURE 2 – Project portfolio
Source: Prepared by the author from Rozenfeld et al. (2006).

cording to notes from observations made outside the offices of Company Beta, it was possible to confirm the existence of totems spread throughout the plant, directly connected to the intranet, whose access enables sharing information contained in the organization TMS. Facts such as this reinforce the interest of the company to take systematic advantage of the ideas and information generated by its groups, mainly those coming from projects that had been aborted.

The principal contribution of TMS to group learning is open to question. According to observations performed and non-recorded testimony, in fact, the process of group learning precedes the input of information into repositories that make up TMS, as its simple storage, even if codified and well-structured, cannot by itself find the links necessary with the tacit human idea, even if it has already been placed in the first stages of the Stage-Gate® method.

Very probably, the great merit of TMS used in Company Beta is the reduction of time used in project development stages and in the verification gates, as well as the accumulation of knowledge through errors, given that seventy percent of projects are aborted at some stage of their development. Suppose, for example, a group of individuals trying to remember prior technical or strategic details used in some other project that, for some reason, have not been used. Imagine, now, how useful it would be for a cross-functional group to have a system that enabled quicker and more precise confirmation of some aspects of a more technical order, or even some information that could be valuable concerning the sue of different materials. How much time would be saved with structural calculations, chemical analyses and other factors that could be in a product development process.

As such, it appears that TMS can be a learning-accelerating agent, but it does not possess the faculty of promoting group reflection prior to recalling that a determined idea is archived in artificial repositories. It is not that a more flexible work method should be more effective than the Stage-Gate® method employed at Company Beta.

In the light of group learning, the results show that the Stage-Gate® method applied in Company Beta and the TMS used by it, recall the idea of restricting processes of subjectivity through which cross-functional groups pass. It's not that such processes do not occur, but they are all attached to verification gates, as if their occurrence necessarily had a date to happen.

Perhaps, as a form of reducing such a collateral effect from TMS/Stage-Gate®, note that Company Beta seeks to architectonically maintain a spacious and open physical appearance. In the observations performed during visits to this company, care with respect to internal physical transparency was confirmed, proven by cleanliness of the laboratories, the modernity of the restaurant, the arrangement of the totems placed in strategic locations inside the plant, by the coffee machines strategically situated at heavily-trafficked internal intersections, where people come and go from one of five functional blocks.

At several moments there is the impression of walking through a mall hallway, where the shop windows are the research laboratories themselves intended for product development. The snack area actually resembles a mini food court, with soda machines and coffee available to anyone walking through it.

Everyone who walked through there

wore light lab coats, carrying electronic tablets and notebooks. Some indicated a feeling of satisfaction, whereas others hurried with their mechanical measurement instruments, appearing worried about something. Some researchers, during their breaks, remained seated at wooden tables, discussing and exchanging ideas with colleagues.

As for the environment in the research laboratories, without exception, the floor was light, as well as the as well as the ceiling and the walls were all glass. Such architectonic characteristics recall Dixon (1999) and her concept about organizational corridors that, according to her, should be characterized as spaces in which individuals can exchange information more freely and openly.

At Company Beta, the importance of hallways was, in fact, taken into consideration, as they are informal, neutral and accessible places, free of office walls, of closed doors and of divisors with blinds. According to one of the interviewees, the philosophical concept itself of the architecture of the place is a subliminal message for the people who work there to constantly seek to innovation. It can be seen that the informal flow of information existing in the organizational environment was strategically architected. This positioning is different from what happens at Company Alpha, where the circulation of information does not always happen spontaneously, even though there is internal effort for this to occur.

The edifice constructed of semicircular rings sought, in essence, to integrate itself into the scenery, maintaining the original topographical design of the terrain, sitting upon a huge rock. Located in a reserve of the Mata Atlântica, the architecture provides natural light and complete internal visibility in the five functional levels.

In addition to the architectonic aspect favorable to the creation of collective meanings, the members of the cross-functional groups of Company Beta also work simultaneously with other members spread throughout ten technological centers on three different continents.

These foreign members are consequently placed into another cultural reality, in which they can cause, at times, some communication problems. Meetings always occur by means of video conference, enabling everyone to participate. Thus, the informal aspect results in constant questioning with the objective of confirming the ideas shared, bringing new information.

The archives and other documentation pertinent to the virtual meetings are previously sent by electronic mail, thus enabling all to have access to the subjects covered.

The international sharing of information is done more frequently with the Technology Center (TC) located in Stuttgart, Germany, this being the foremost of all, as it is from the German headquarters that all R&D organizational directives originate. According to data from the organization, the CT in Brazil contributes with an average of twelve patents per year, among them several automotive parts responsible for the operation of the largest innovations in the automotive sector. Therefore, it is apparent that, at the same time, Company Beta seeks to ease some restrictive factors seen in its TMS/Stage-Gate®, adopting other forms that serve as a factor of taking advantage of ideas created by its people.

FINAL CONSIDERATIONS

As for the processes observed in the work groups in Company Beta, it appears that the work methodology adopted by

this company – Stage-Gate® – strongly represents the perspective on group learning called "Task Mastery" (EDMONDSON; DILLON; ROLOFF, 2007) in which a strong emphasis on performing interdependent tasks is highlighted, facing learning as a result obtained from communication, coordination and sharing of knowledge, if only by means of a transactive memory system (WILSON; GOODMAN; CRONIN, 2007), also justifying the fact that its members work much more with a perspective of transposing group limits, given that they involve coordination of objectives, schedules and common material resources (EDMONDSON; DILLON; ROLOFF, 2007).

It can be stated that such elements constitute the everyday work of cross-functional groups in Company Beta, because as stated in Cooper (1993), projects led within a Stage-Gate® system cover a portfolio of projects with interdependent stages. As explained in Edmondson and Nembhard (2009), a group in isolation or a subject alone would never reach the level of creating a prototype or patent, as each of them works on interdependent stages that, upon being concluded, bring together knowledge acquired that will be transferred to other groups until the last stage of the chain is completed in the form of a product/prototype/patent.

Thus, the verification gates can be understood as meetings to determine if a certain stage is ready for another group to lead it or abort the project, according to the rise of technical/market inconsistencies. Because of this, there are strong indications that between a stage and a gate there is the accumulation of knowledge, as prescribed by the "Task Mastery" perspective (EDMONDSON; DILLON; ROLOFF, 2007). In addition, gates can be understood as the transactive memory systems themselves indicated by Wilson, Goodman and Cronin (2007), as they deal with knowledge embedded in procedural form, on papers and minutes, having as basic assumptions sharing, storage and subsequent recovery.

In part, these theoretical elements help explain the motives for which the interviewees in Company Beta did not demonstrate any concern or pressure for the fact that up to seventy percent of their projects were terminated, as the greatest gain for the collective is not in the project itself, but in the acquisition of knowledge coming from the project termination. What is noteworthy is that in the Stage-Gate® methodology there is a considerable conceptual ambiguity, given that organizational theories that do justice to scrap, waste, terminations, reworkings or other elements that, at first glance, bring losses are rare.

However, Edmondson and Nembhard (2009) help us better understand such circumstances in the scope of project development. The authors state that in order to reach the state of the art in innovation, it is possible that the group need enter into a realm made up of large ambiguities and uncertainties, becoming essential ingredients for the development of products, processes and services. In this way, the concept of trial and error cannot be confused with the concept of trial and failure. Mistakes are part of Company Beta's strategy for generating new knowledge, mainly when ideas are terminated and also for being directly linked to breakthroughs, that is, to innovative products with market reference. Failures do not appear to have such a positive connotation, as there has been some reference or accumulation of knowledge on

top of certain projects in which errors had been supplanted by embedded knowledge, characterizing a strategy of innovative increments or re-adaptations/nationalization of foreign parts into the domestic market. In this case, the organization would be much more open to errors – of technical/technological content – than to failures – of strictly human content.

Seeking to reduce failures or learning from errors, it is possible to infer that situations of this order are related to what Wilson, Goodman and Cronin (2007) state concerning the transactive memory system and social cognition. Such elements are used as a form of predicting the performance of interdependent tasks and re-utilizing information acquired in unsuccessful projects, as shown in Figure 2, Company Beta Project Portfolio. The main virtue of this study lies in the fact of having discovered that TMS acts as an important knowledge-generating factor in cross-functional groups in automotive companies. However, the limitation of this article involves some questions that could not be investigated due to lack of time and space, such as a deeper analysis of the information systems that Company Beta uses, (Easy and DMT) and their role inside TMS.

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