



# Open innovation in the research and development process: an analysis of the cooperation between automotive companies and universities

## *Inovação aberta no processo de pesquisa e desenvolvimento: uma análise da cooperação entre empresas automotivas e universidades*

Ana Paula Vilas Boas Viveiros Lopes<sup>1,2</sup>  
André Ferrarese<sup>1</sup>  
Marly Monteiro de Carvalho<sup>1</sup>

**Abstract:** The growing demand for innovation and the need for reducing time and cost of new products development have changed the Brazilian automobile scenario, which has been characterized by a closed innovation model for a long time. Flex fuel technology has been a challenge for the companies in this sector, and it is the motivating factor of this study, which aimed to understand the open innovation process within the fuzzy front end context, identifying the main motivations and implementation gaps. In order to reach this goal, a longitudinal case study has been carried out in a consortium composed by nine companies and two universities. The methodology has involved some qualitative and quantitative research. The main theoretical contribution from this research is precisely the pioneering concerning the automobile assembly companies working in a collaborative way. This research has also major managerial implications. It points out the peculiarities that shall be considered in a coepetition environment, as well as makes suggestions to the managers regarding the way of working the initial innovation phases. The research portrays well the role of the Universities in this context.

**Keywords:** Open innovation; Fuzzy front end; Cooperation.

**Resumo:** *A crescente demanda por inovação e a necessidade de reduzir o tempo e o custo do desenvolvimento de novos produtos têm mudado o cenário automotivo nacional, o qual foi por muito tempo caracterizado por um modelo fechado de inovação. A tecnologia flex fuel tem sido um desafio para as empresas desse setor e é o fator motivador deste estudo, cujo principal objetivo foi compreender o processo de inovação aberta no contexto de Fuzzy Front End, identificando as principais motivações e os principais gargalos para implementação. Para atingir esse objetivo foi realizado um estudo de caso longitudinal em um consórcio composto por 9 empresas e 2 universidades. A metodologia envolveu pesquisa qualitativa e quantitativa. A principal contribuição teórica desta pesquisa é justamente o pioneirismo no que diz respeito às empresas montadoras automotivas trabalhando de forma colaborativa. Esta pesquisa também tem implicações gerenciais importantes. Ela indica as peculiaridades que devem ser consideradas quando em um ambiente de coopetição, bem como sugere aos gestores de que forma trabalhar as fases iniciais da inovação. A pesquisa retrata bem o papel das universidades nesse contexto.*

**Palavras-chave:** *Inovação aberta; Fuzzy front end; Cooperação.*

## 1 Introduction

The continuous evolution of the process of new product development has benefited the reduction of the time-to-market, i.e., the time to make the product available in the market (Tatikonda & Rosenthal, 2000). The increasing demand for innovation has taken companies to work in an open innovation context, aiming, mainly, sharing risks and costs, as well as

reducing the time (Chesbrough, 2007; Chesbrough & Crowther, 2006).

Innovation has become increasingly important to the companies' competitiveness (Nagano et al., 2014). The companies are turning their focus to the Fuzzy Front End - FFE phase from innovation management process, which may be defined as the interval between

<sup>1</sup> Laboratório de Gestão de Projetos, Departamento de Engenharia de Produção, Escola Politécnica, Universidade de São Paulo – USP, Avenida Professor Almeida Prado, travessa 2, 128, CEP 05508-900, São Paulo, SP, Brazil, e-mail: paulavilalopes@fei.edu.br; andre.ferrarese@br.mahle.com; marlymc@usp.br

<sup>2</sup> Departamento de Engenharia de Produção, Centro Universitário FEI, Avenida Humberto de Alencar Castelo Branco, 3972, CEP 09850-901, São Paulo, SP, Brazil

the idea's appearance and its development (Khurana & Rosenthal, 1997; Kim & Wilemon, 2002).

Previous research has identified the preliminary assessment of the ideas as a key factor, and some studies have proposed structured processes to deal with their low maturity in terms of product orientation (Koen et al., 2001; Reid & Brentani, 2004; Verworn et al., 2008).

Open innovation, expression coined by Chesbrough (2003a) that means, primarily, the creation and use of ideas inside and outside companies, has become an important competitive weapon in some sectors, such as information technology. However, it seems to remain poorly explored in other areas (Chesbrough, 2006; Dodgson et al., 2006; Zien & Buckler, 1997). Open innovation involves activities not yet fully structured and tested empirically. The relations within and among the companies or other organizations must be aligned with the technological environment, the skills and goals, and the social capital are extremely important to the success of these interactions (Fleming & Waguespack, 2007; Wasserman & Faust, 1994). Some researchers have pointed out how important is the level of interaction among the partners to achieve their goals (Dabholkar & Neely, 1998), while other studies have investigated the level of complementarity among them (Ariño, 2003; Brouthers et al., 1995; Ireland et al., 2002) and the main factors that lead organizations to choose projects involving collaborative partnerships (Gulati, 1998; Khanna et al., 1998).

This paper approaches these issues within the context of the automotive industry. In Brazil, this industry has always been highly important to the national production. One of the first moves towards the particularization of the Brazilian car development was the "Proálcool" program, between 1970s and 1980s. The development or the conversion from a car that used to be fueled by gas to an automobile that could adopt ethanol has required an intense engineering work. With the ethanol crisis, in the late 1980s, consumers would refuse to buy cars fueled by ethanol.

The advent of the flex fuel technology has allowed cars to be fueled with gas, ethanol or any mixture of these elements. This was enabled due to the fuel injection technology. Brazilian automotive companies are constantly seeking new concepts that may minimize the functional effects of the engines technology. Therefore, the universities' involvement is a key factor to increase competitiveness in a globalized environment, especially concerning the search for innovation.

The main purpose of this study is to understand the open innovation process in the fuzzy front end context, identifying its main motivations and the gaps in its implementation. A longitudinal case study has been carried out in a consortium of the automotive

sector. A qualitative analysis and social network mapping techniques have been used to realize the relations among the agents.

This study is divided into six sections. Section 2 provides a summary of the theoretical framework that approaches the literature about open innovation and fuzzy front end. The research method is detailed in section 3, which is followed by the presentation of the results, in section 4. Sections 5 and 6 include the discussion of the results and research conclusions.

## 2 Literature review

### 2.1 Open innovation

The term "open innovation" opposes to the concept of closed innovation, in which the innovation process (from the idea conception to the commercialization, passing through the development) occurs inside the organization. One of the pillars of the closed innovation is the profit generated by the price obtained by means of the pioneering innovation in the market.

In the open innovation model, the same process involves not only the organization's internal environment, but also its surroundings, which are, clients, vendors, competitors and universities (Chesbrough, 2003a). The open innovation has a different logic with respect to the ideas' generation and application (Chesbrough, 2003b), with an approach comprising the new notions of "outside in" and "inside out" (Chesbrough, 2011). The "outside in" approach uses innovating ideas from external sources, and uses them to create new products and services, or to improve the existing products and services; the "inside out" approach allows the companies to open their innovation ideas to other companies. Therefore, there is a permeability among companies (Dahlander & Gann, 2010).

The concept of open innovation is related to the essential competencies concept, since it promotes an integration between internal and external competencies, instead of an innovation outsourcing process (Buganza & Verganti, 2009). The innovation may be adapted or developed, and requires organizations to expand both their internal knowledge and their capacity to use the external knowledge (Kirschbaum, 2005). The company's capacity to assimilate external knowledge and abilities, applying them and converting them into value and tradable final goods, is related to their absorptive capacity (Cohen & Levinthal, 1990) and to its dynamic capabilities (Teece et al., 1997).

Open innovation may be defined as an approach in which the innovation process involves knowledge, exploration and retention mechanisms inside and outside the borders of an organization (Lichtenthaler, 2011).

In this context, the management of the intellectual property shall follow the logic of open innovation, where the ideas, the human resources and the knowledge

acquired are not the exclusive property of those who have developed them (Chesbrough, 2003b). The way how each organization uses the knowledge acquired and retains the best talents is what renders it more or less competitive in respect to its competitors.

The open innovation favors the discovery of new ways of exploring the internal innovation, and of incorporating the external innovation into the internal development (West & Gallagher, 2006).

A factor that motivates the companies to adopt the open innovation model is the belief that the use of external technologies is the key to the profitable growth, since it increases the products' financial margins (Chesbrough & Crowther, 2006). Another motivating factor of the open innovation is the sharing of internal development costs (Chesbrough, 2007).

Alike in other typologies, the borders may be diffuse, indicating that a considerable part of the companies may be in a continuum between closed innovation and open innovation. Moreover, it is important for the companies to get to know well their internal environments before adhering to the open innovation model (Jacobides & Billinger, 2006).

Innovation should not be focused on the company or in the product, but in the external experimentation possibility (Prahalad & Ramaswamy, 2003). According to these authors, the client has a fundamental role in the creative process and in the value generation.

Apparently, there is a consensus about the need for seeking external complementarity in the innovation process, especially if the process is systemic or implies rupture. The process complements the internal competencies, adding value to the organization and accelerating the time for innovations to be introduced in the market (Chesbrough & Teece, 1996; Christensen, 1997; Huston & Sakkab, 2007; Nooteboom, 1994).

However, a series of risks and threats are related to the open innovation. There is the risk of copying and violating patent and intellectual capital protection laws (Chesbrough, 2006). Another study also approaches the Not Invented Here (NIH) Syndrome, which corresponds to a negative attitude from the company employees with regards to external technology sources (Herzog & Leker, 2010). Some companies face a constant "tension" between their wish to share and their inclination to protect their innovation, which configures in five forces: partnership; knowledge; property rights; relationship with the partner; and external innovation environment (Bogers, 2011). The essential competencies may be exposed to competing companies during the open innovation process, and the company may lose its competitive advantage over its competitors (Lichtenthaler, 2011).

## 2.2 Fuzzy Front End

The expression "fuzzy front end" may be defined as the initial and the most dispersed part of the innovation management, and refers to the phases where innovating opportunities and ideas are generated and selected. Since these activities are, many times, diffused and poorly structured in the organizations, in comparison with the development stages, the expression fuzzy front end has been adopted. There are several differences between the fuzzy front end and the products' development phase (Kim & Wilemon, 2002; Koen et al., 2001).

This is the embryonic phase of the innovation process. The company must seek a holistic view of the process. It is also required to keep strong channels to check the environment changes and the emerging technologies, such as the market changes for new client demands and the competitors' moves (Carvalho, 2009). Considering that, in the fuzzy front end, the ideas are generated, this research explores the preparation of the environment, aiming to offer the conditions essential to create new concepts of products through the knowledge transfer and/or generation (Backman et al., 2007).

In accordance with the Product Development and Management Association (PDMA, 2006), three tasks are typical of this phase: strategic planning, concept generation and technical assessment. In this phase, important decisions about the features of the target market, value proposals, cost and products are made. All these decisions are made based on the product concept and design, which serve to guide the development activities (Smith & Reinertsen, 1998).

Therefore, the needs of the target market are in line with the project plan, which contains the priorities, the resources, the organizational capabilities and the parameters for the market placing time, in terms of opportunity costs (Khurana & Rosenthal, 1997; Kim & Wilemon, 2002; Poskela & Martinsuo, 2009).

The fuzzy front end phase may be considered one of the most difficult and important phases of the innovation process, due to both its direct impact on the success of new products (Cooper et al., 2001; Griffin, 1997) and to the improvement opportunities offered (Cooper et al., 2004; Khurana & Rosenthal, 1997; Nobelius & Trygg, 2002; Smith & Reinertsen, 1998). The fuzzy front end phase is characterized by the uncertainty about the information used, by the dynamic scenarios, and by the low formalization levels (Murphy & Kumar, 1997). Thus, it is in this phase that the organization's strategy is divided into proposals of projects that ease the strategic planning. It is also in this phase that the prospection is made, and that the specialists in key areas for the organization are contacted.

The interface limit made with the environment aims to ensure that the organization is an open

and multidisciplinary organization (Brem & Voigt, 2009). There are several agents in this process, which engages the boundary spanners, the gatekeepers and the decision makers (Carvalho, 2009). The boundary spanners connect the organization with its external environment. In this interface, it is hard to distinguish the role of the organization and of the individual inside the organization, since the individual, organization and environment are parts of an interaction network and knowledge exchange (Reid & Brentani, 2004). There are two types of gatekeepers in the literature: the technology and marketing gatekeepers, corresponding to the technology voice and to the market (O'Connor, 1998). The technology gatekeepers connect the organization to the external technology sources and construct an efficient channel for transferring information from external sources to the organization (Nochur & Allen, 1992). Nonetheless, they are also frequently consulted about internal technical issues, due to their technical competence. The marketing gatekeepers reflect the function of the technology gatekeepers, acting as sensors to detect and send the information to the market (Roberts, 2001). Due to their connections with the external environment, the gatekeepers normally hold the position of boundary spanners too. Nevertheless, they are capable of deparating opportunities that adhere more to the organization's features. In this article, this perspective is quite present in the perception of the environment preparation to promote new products concepts.

### 2.3 Cooperation

Cooperation is a central aspect of the open innovation. This is a topic largely studied in the literature. Many authors have pointed out to the cooperation as a way to mitigate the pressure for reducing costs and time in the process of developing new products (Amara & Landry, 2005; Morrison et al., 2000; Nieto & Santamaría, 2007). In this context, the cooperation based on an interactive process among the agents is rendered necessary (Edwards, 2000). This cooperation extends from technology transfer agreements to agreements with universities aimed at the joint exploration of a patent for the joint development of products. The cooperation may be defined as a process in which the different parts involved may constructively explore their differences and seek solutions (Gray & Wood, 1991).

As regards to cooperation, it should be mentioned that the organizations, in spite of being independent structures, are involved in social networks (Powell, 1990). These networks may be defined as inter-organizational arrangements based on systematic bonds, either formal or informal (Freeman, 1991). It is an endogenous structure that depends on the individual choices of the agents (Eguiluz et al., 2005), and that basically

consists of ties and connections, where the members represent the ties (agents) and the connections represent the interaction relationship among them (McDonald, 2007). Many studies try to understand the relationship between the collaboration and the better performance of the companies, especially between buyers and vendors (Brito & Mariotto, 2013).

The cooperation facilitates the organizations' access to the information, human resources, markets and technologies, aiming to combine abilities and increase their knowledge (Gulati et al., 2000). Moreover, it favors the expansion of the organizational borders (Richardson, 1972). Many organizations seek partnerships in collaboration networks with the purpose of obtaining economic return and competitive advantage (Barney, 1991; Hamel, 1991; Nelson & Winter, 1982; Teece, 1986; Teece et al., 1997) and also aim to improve the existing knowledge (Cohen & Levinthal, 1989; March, 1991; Nonaka & Takeuchi, 1995).

In some cases, in order to be succeeded, a company needs to cooperate even with its competitors (coopetition), which allows it to benefit from the relationship too (Brandenburger & Nalebuff, 1995). The main advantages of the cooperation among competitors are: facing the financial restrictions in research and development, obtaining economies of scale in research and development, internationalizing the technologies, and attaining a greater synergy, as well as reducing risks and uncertainties (Harabi, 2002).

There are three types of collaboration among competitors: synergy (value added through the exchange of know-how among the parties); levelling (capacity that those who receive the information have of increasing its value) and negative reverse-impact (determining how the knowledge use by the receiving party reduces its value) (Levy et al., 2003). Strategic resources are distributed in a heterogeneous way among the companies, and the companies must have an absorptive capacity and dynamic capabilities in order to be able to assimilate the external knowledge and abilities to convert them into value to the organization (Cohen & Levinthal, 1990; Nonaka & Takeuchi, 1995).

In cooperation relations, in general, it is important to build the trust, which has a direct impact over the results (Blomqvist et al., 2005; Davenport et al., 1998). The trust may be developed based on relations over the time, and acts as a sort of barrier for the opportunist behavior (Miles & Snow, 1992; Raub & Weesie, 1990; Shapiro et al., 1992). When the trust is established, the risk perception level decreases, and the positive expectations increase (Doney & Cannon, 1997). The use of contractual mechanisms to rule networks aims at providing foreseeability in relation to the agents' behavior, in search of guarantees for the knowledge and resources transfer among partaking alliances or networks (Uzzi & Gillespie, 2002).

## 2.4 Company-university-client interaction

According to the Organization for Economic Cooperation and Development (OECD, 2005), the basis of science and engineering involves university systems for specialized technical formation, and the support to basic research. This basis sustains innovation through the provision of training and scientific knowledge. There are varied types of connections that may occur between companies and universities: research partnerships, research services, academic entrepreneurship, transfer of human resources, interactions, information, commercialization of property rights, scientific publications (Perkmann & Walsh, 2007). The generated learning has also been the focus of previous research (Ariño, 2003; Gulati & Singh, 1998; Harrigan & Newman, 1990; Kogut, 1988).

The literature identifies four types of relations among the company individuals, the clients and the university (see Figure 1). Relations 1 and 2 are equivalent and deal with the interaction between a university and company or client. This interaction may occur in many ways, including a service provision relationship. Relation 3 discusses the interaction between the company and its clients, which is generally a business relationship. On the other hand, in the automotive industry environment, the relations

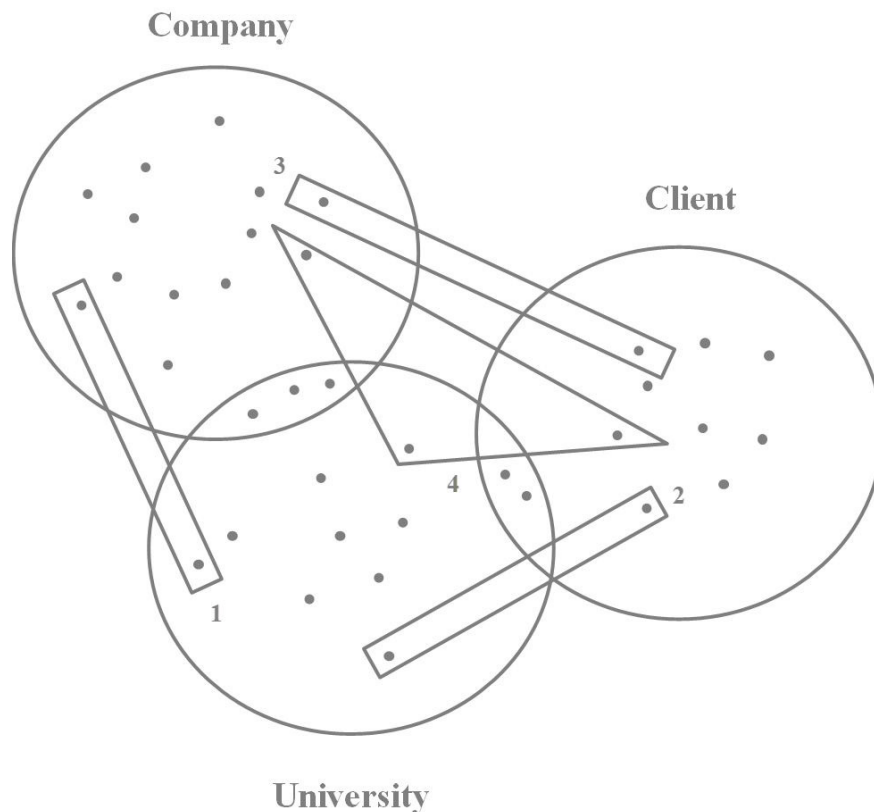
focused on the technological development are quite common, and their purpose is to explore the engine technologies concepts, yet to be implemented.

This research focuses on the relationship signaled as number 4 in Figure 1, the open and collaborative relation among company-client-university (Janowicz-Panjaitan & Noorderhaven, 2009). Provided that the individuals generate ideas by their relationships (Alegre & Chiva, 2008), all eventual relations are important to the open innovation base.

The main obstacles of the cooperation relations are: the autonomy, the initial moment of the relation, the focus on the external environment, the political struggle, the change, the learning, the people, the Black Box and the culture (Lorange et al., 1992). When assessing the different methods of searching for new concepts, studies have found out that the open innovation – and, particularly, the direct interaction with the clients – is a very powerful tool, which leads this research's consortium to be an interesting tool for its participants (Cooper & Edgett, 2008).

## 3 Research method

Aiming to understand the open innovation process in the fuzzy front end context and to identify the main motivations and their implementation gaps, this research has involved a literature review and



**Figure 1.** Relationships among company, universities and clients. Source: Elaborated by the authors.

some empiric research with a qualitative approach, as well as the analysis of social networks.

The research was based on a longitudinal case study, meeting the recommendations for this type of research (Voss et al., 2002). The unit of analysis chosen was a consortium involving nine companies and two universities, with focus on the research about tribology and on the mechanical impacts of the flex fuel technology upon the internal combustion engines. The choice of this consortium as research object was intentional, once it explores the innovation in its early stage of generating ideas, and works this through the collaboration between universities, companies and clients.

During a three-year period (2013-2015), the researchers followed the consortium formation and evolution, as well as took part in monthly meetings and seminars of the consortium, which is expected to be concluded in late 2016.

Several data collection sources have been used, such as the analysis of documents, reports, presentations, training materials and semi-structured interviews with the consortium members. Based on the literature review carried out, the interview guide has been prepared. The first part of the guide was used to characterize the sample, with information about the company’s kind, size, previous experience with tribology projects, previous experience with projects with other companies and/or universities, continent of origin and factors that led it to adhere to collaboration relations.

The second part of the guide was used to analyze issues concerning the consortium members’ contentment in relation to the following topics: satisfaction with the deadlines’ observance, satisfaction with the meetings’ agendas, satisfaction with the project management and satisfaction with the decisions made in the project.

The third part of the guide explored aspects related to open innovation, fuzzy front end and collaboration. The social networks method was used to analyze the interaction between the consortium members. It has identified the role of each member and the connections between them, as well as the intensity of such connections. In order to support the

characterization of the consortium members’ roles, the centrality and intermediation indicators have been used (Wasserman & Faust, 1994). Level of centrality is an adjacent relation of an agent, and may be subdivided into entry level (number of connections that an agent receives from others) and exit level (number of connections that an agent establishes with the others). Level of intermediation is the possibility that an agent has to mediate the communication between pairs of agents that do not interact directly. Table 1 summarizes the calculation formulas. The software used to analyze the social networks was the “Ucinet for Windows – Version 6.289” (Borgatti et al., 2002).

## 4 Results

### 4.1 Sample characterization and consortium dynamics

The consortium analyzed in this work is composed by five car builders, two auto-parts companies, one engineering services company and one oil and gas company. The car builders involved in the consortium represent over 85% of the vehicles production in Brazil (according to the Brazilian Agency of Automotive Vehicles Manufacturers ANFAVEA, 2014). The consortium is focused on the development of tribology knowledge (wear, attrition and lubrication) related to the challenges arising from the flex fuel technology. Table 2 presents the characterization of the consortium members.

Figure 2 presents the consortium members depending on their participation as universities, companies or clients. The car builder’s companies are clients of the auto-parts companies, and of the engineering services and oil and gas companies.

The main purpose of the consortium, since its beginning, is to generate knowledge about tribology through the collaboration among its participants. About the companies’ size, ten of them are large companies and one is a small company, which was expected, since the sample is basically composed by car builders and universities. Nine out of the eleven institutions have had a previous experience with

**Table 1.** Formulas to calculate centrality and intermediation.

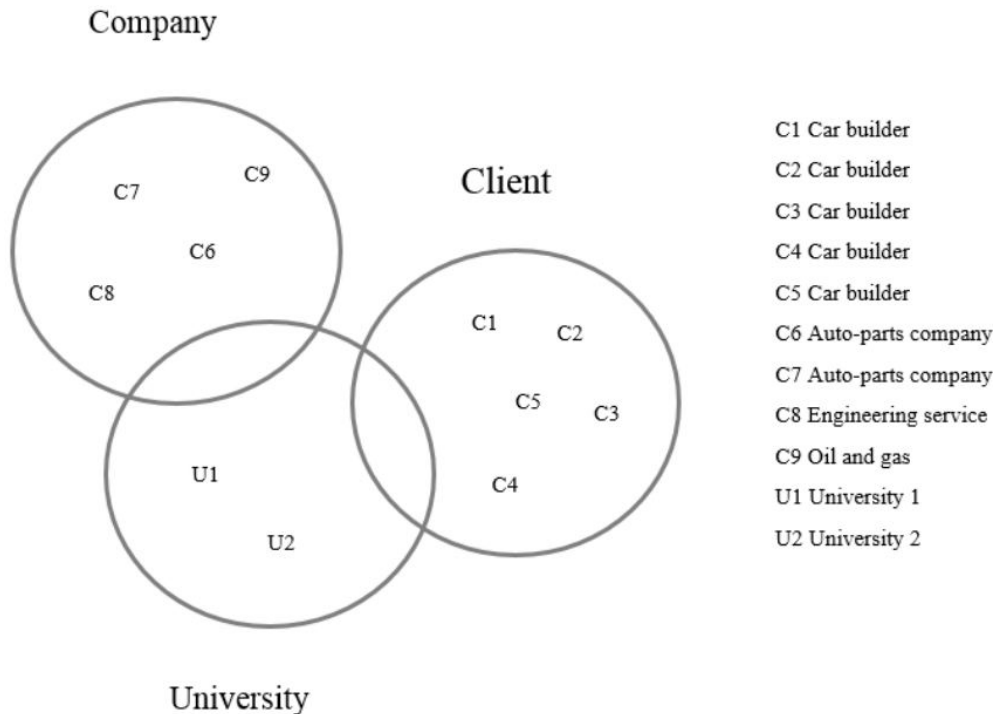
Index	Formula	Information
Centrality	$C^D(n_i) = d(n_i) / (g - 1)$	$C^D(n_i)$ → centrality $d(n_i)$ → number of links $g$ → number of actors
Intermediation	$P_p(n_i) = (I_i / (g - 1) / \sum D(n_j, n_i) / I_i$	$P_p(n_i)$ → intermediation $I_i$ → number of actors that relate to actor $i$ $d(n_j, n_i)$ → number of the actor’s $j$ ties to the actor $i$ $g$ → number of actors

Source: Adapted from Wasserman & Faust (1994).

**Table 2.** Characterization of the consortium members.

Organization	Type	Number of participants	Competence
Company 1	Car builder	2 fixed + 2 not fixed	Leadership in large engines
Company 2	Car builder	1 fixed + 5 not fixed	Cost leadership
Company 3	Car builder	1 fixed + 2 not fixed	Leadership in engines with lower fuel consumption
Company 4	Car builder	1 not fixed	Pioneering designs 100% natural projects
Company 5	Car builder	5 not fixed	Flex engines development platforms worldwide
Company 6	Auto-parts company	2 fixed + 8 not fixed	Specialist components of tribology
Company 7	Auto-parts company	1 not fixed	Foundry
Company 8	Engineering service	2 not fixed	Combustion
Company 9	Oil and gas	1 not fixed	Lubricants and lubricating systems
University 1	University	7 fixed + 5 not fixed	Tribology properties
University 2	University	1 fixed	Coverings

Source: Elaborated by the authors.

**Figure 2.** Characterization of the consortium members. Source: Elaborated by the authors.

tribology projects; and, out of these nine organizations, seven have executed these tribology projects together with other companies/universities. In relation to the institutions' origin, the results were: three in the American continent, five in MERCOSUR bloc and three in Europe.

With regard to the consortium dynamics, the communication among the participants occurs, mainly, by means of monthly meetings. These

meetings usually take place in University 1, since it is a neutral environment, especially for the car builders companies, which are competitors among themselves. In these meetings, subjects previously discussed are presented, and invited companies with some knowledge about a specific theme of the consortium make presentations. There are also trainings and courses. The topics are discussed based on the academic literature, i.e., published works that may

contribute to the research, as well as on the practical knowledge of each participant.

The primary theme of the project has been divided into five main programs, namely: tribology study; jacket – lubricant ring system study; ring – valves system study; materials study; and development of specialized workforce. All discussions held in the monthly meetings are based on the need to meet these five main programs.

#### 4.2 Satisfaction of the consortium members

Eleven interviews have been conducted. In relation to the members’ satisfaction with the deadlines’ observance, the interviewees acknowledge the group efforts to prevent the postponement of meetings and consequently, to ensure the proper chronological evolution of the consortium. Regarding the satisfaction with the meetings’ agendas, the interviewees have considered as relevant the active participation of the companies and Universities through presentations enabling knowledge generation. Still in connection with this item, they have stressed the importance of previous discussions about the best themes to be approached during the meetings.

In relation to the satisfaction with the consortium management, the participants have indicated as a major deficiency the lack of a professional fully dedicated to the following activities: elaborating minutes of meeting; elaborating and maintaining the consortium website; concentrating and disclosing information; monitoring the consortium performance concerning, particularly, the foreseen timeline and scope.

The group of issues related to the satisfaction with the decisions made in the project shows that the interviewees were not capable to clearly visualizing

how the project’s decisions flow. Furthermore, they believed that the participants’ balance should be improved, which implies the group’s desire for the institutions to have an equal development.

#### 4.3 Motivating factors and interaction company-university-client

Figure 3 shows the result of the main factors that led the companies and Universities to take part in the consortium.

Confirming what has been presented in the theory, the main initial interest of the participants was to develop and share knowledge, reducing the time spent to create new products and, thus, innovation.

It is also worth emphasizing the interest in developing and sharing technology. Across the project, it was evident that developing and sharing technology would not be possible, since it is a pre-competitive consortium focused on the generation of ideas and knowledge. However, these aspects are connected, therefore, to the preparation for future development conditions, such as generating knowledge in the universities so that they are capable of assessing and creating concepts, as well as preparing a specialized workforce.

The way how the ideas are generated in the consortium diverges a little from the way how each company or university works its ideas internally. The fact that the consortium involves direct competitors somehow renders the exposition of ideas difficult, compromising the knowledge generation and flow. As time went by, the partnership caused the trust among the partners to be established, which minimized the cooperation negative impact.

There is a consensus among the interviewees that the knowledge generated will be internally applied

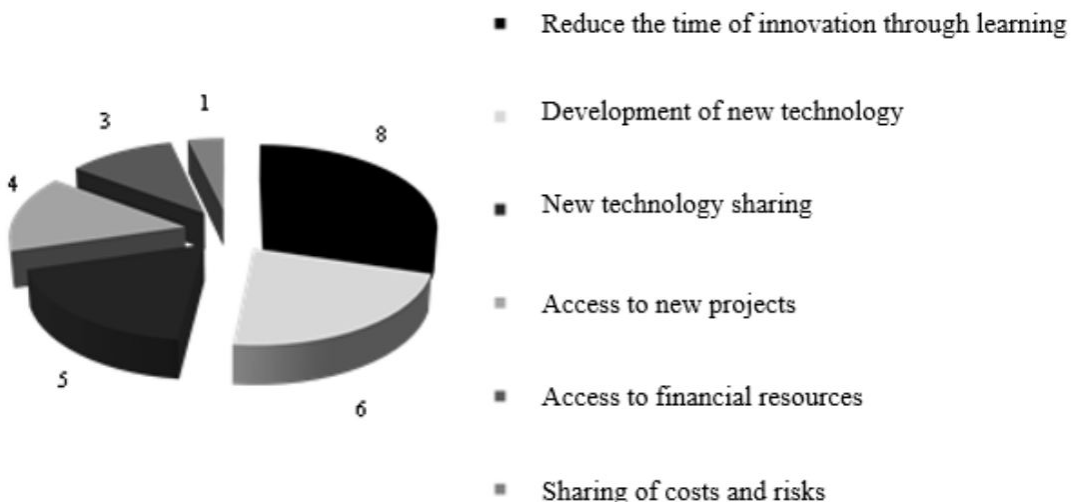


Figure 3. Motivating factors scale. Source: Elaborated by the authors.



in the companies, enabling the development of better products for the flex fuel cars' engines, such as more resistant materials, new parts, fluids and lubricants, etc.

Some interviewees have indicated they need to develop internal competencies that allow absorbing the knowledge generated, applying it in the best and most profitable way for their companies.

The network of Figure 4 shows the level of interaction existing among the consortium members, and Table 3 presents the centrality and intermediation rates of the interaction network.

The project's proposal phase was mostly motivated by company 6 (more central in the network) and by University 1, which had worked together previously

and which hold great competencies in engines tribology, and would like to optimize these competencies in the consortium. Figure 1 evidences the significant relation that company 6 with the others, which is due to the fact that it is an auto-parts company renowned for its vast tribology performance. Although company 7 is also an auto-parts company, it does not have the same level of interaction with the car builder's companies, which has not hindered its participation in the consortium.

Since the car builder's companies had not worked together before, they resisted at the beginning. However, they ended up investing in the possibility of benefiting from this relation. The engineering services

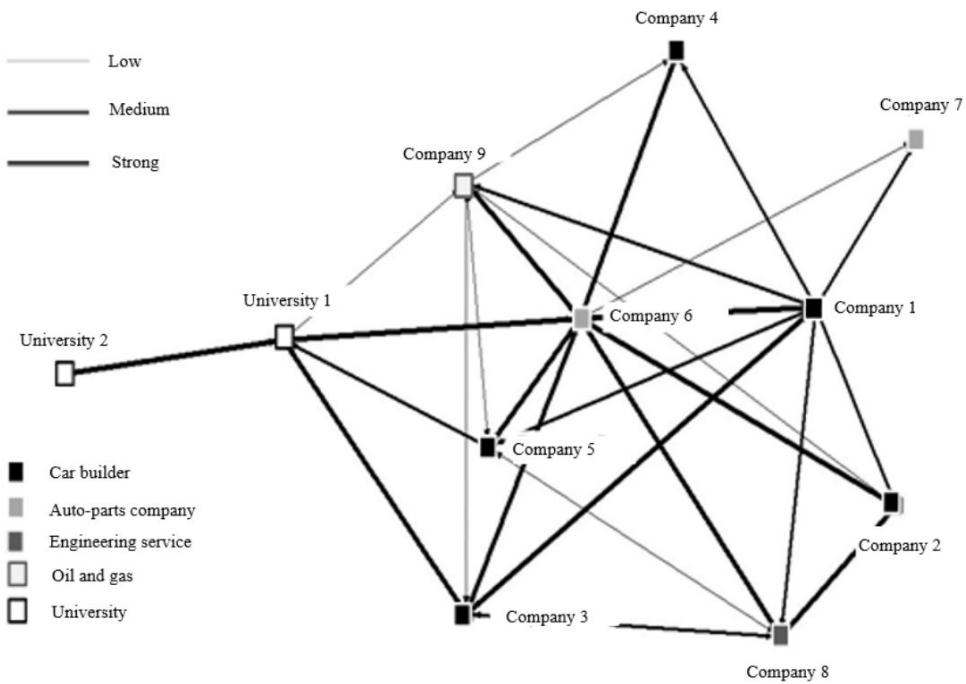


Figure 4. Interaction network among the organizations. Source: Elaborated by the authors.

Table 3. Centrality and intermediation rates.

Organization	Centrality		Intermediation
	Input	Output	
Company 1	16,000	7,000	2,750
Company 2	0,000	9,000	0,000
Company 3	10,000	9,000	4,417
Company 4	0,000	6,000	0,000
Company 5	7,000	7,000	2,750
Company 6	20,000	17,000	15,000
Company 7	0,000	3,000	0,000
Company 8	9,000	6,000	1,250
Company 9	8,000	6,000	5,250
University 1	5,000	8,000	9,583
University 2	3,000	0,000	0,000

Source: Elaborated by the authors.

and the oil and gas companies, in turn, adhered to the consortium idea readily, and considered the project as a possibility for approaching the automobile assembly companies and anticipating their needs in some manner.

With regard to the roles played by the consortium participants considering the fuzzy front end environment of ideas generation, company 6 can be characterized as the main boundary spanner of the network, due to its strong capacity of connecting with the external environment and favoring the connection among the other companies. The automobile assembly companies (1, 2, 3, 4 and 5) are the main gatekeepers, both in the technology field (they connect to the external technology sources) and in the marketing domain (they are the technology voice in the market). The universities (especially University 1) play the role of decision makers.

The network shows the unequal interaction among the companies, which is having a direct effect on their unequal development in the consortium. This is also due to the motivation of each company in the consortium. If we take the car builders companies as example, not all of them entered or remained in the consortium driven by the same factors. Company 2, for instance, entered the consortium motivated by the fact that it already had other partnerships with company 6. Actually, it was not much aware of the benefits the consortium would bring to it. For the interaction network of future partnership projects to be more effective, it would be important to define very well the purpose of each company at the beginning of the project.

The Universities played an important role both in the knowledge generation and in the dissemination of this knowledge. Under the Universities' supervision, 27 academic publications directly related to the consortium have been generated: 1 PhD thesis, 4 Master's dissertations, 9 articles published in conferences, and 13 articles published in journals.

## 5 Conclusions

Although the literature points out the costs reduction as a big motivating factor that leads the institutions to cooperate, the participants analyzed by this work seemed to be more interested in generating knowledge through the combination of abilities. This knowledge, focused on the reduction of risks and uncertainties related to the flex fuel technology challenges, favors a decrease in the time spent to introduce innovations in the market.

Since it is a pre-competitive environment, which involves the collaboration among organizations and universities within a consortium, this can mean that the companies' members promote new ideas in the innovation funnel.

The fact that seven institutions have some previous experience in collaborative projects related to the engines tribology benefits the level of interaction and the level of complementarity among the partners, and furthers the creation of trust, which has a direct influence on the course of the partnership contractual arrangements. The results indicate that, even though the project is being developed within the expected deadline, the participation of institutions has not occurred equally, which goes against one of the purposes of the group. Another aspect that requires more attention is the decisions made by the group.

One of the main difficulties faced by the companies was dealing with the new, i.e., developing the first consortium in Brazil involving automobile assembly companies that are direct competitors, working in collaboration. Another great challenge was to understand, after many discussions, that the consortium would not develop intellectual property, since it is focused on the generation of idea and knowledge. Which each company will do with the knowledge generated is what can make the difference as to the attainment of competitive advantage.

## References

- Alegre, J., & Chiva, R. (2008). Assessing the impact of organizational learning capability on product innovation performance: an empirical test. *Technovation*, 28(6), 315-326. <http://dx.doi.org/10.1016/j.technovation.2007.09.003>.
- Amara, N., & Landry, R. (2005). Sources of information as determinants of novelty of innovation in manufacturing firms: evidence from the 1999 Statistics Canada Innovation Survey. *Technovation*, 25(3), 245-259. [http://dx.doi.org/10.1016/S0166-4972\(03\)00113-5](http://dx.doi.org/10.1016/S0166-4972(03)00113-5).
- Ariño, A. (2003). Measures of strategic alliance performance: an analysis of construct validity. *Journal of International Business Studies*, 34(1), 66-79. <http://dx.doi.org/10.1057/palgrave.jibs.8400005>.
- Associação Nacional dos Fabricantes de Veículos Automotores – ANFAVEA. (2014). São Paulo: ANFAVEA. Recuperado em 29 de setembro de 2014, de [www.anfavea.com.br](http://www.anfavea.com.br)
- Backman, M., Borjesson, S., & Setterberg, S. (2007). Working with concepts in the fuzzy front end: exploring the context for innovation for different types of concepts at Volvo cars. *R & D Management*, 37(1), 17-28. <http://dx.doi.org/10.1111/j.1467-9310.2007.00455.x>.
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120. <http://dx.doi.org/10.1177/014920639101700108>.
- Blomqvist, K., Hurmelinna, P., & Seppänen, R. (2005). Playing the collaboration game right: balancing trust and contracting. *Technovation*, 25(5), 497-504. <http://dx.doi.org/10.1016/j.technovation.2004.09.001>.
- Bogers, M. (2011). The open innovation paradox: knowledge sharing and protection in R&D collaborations. *European*

- Journal of Innovation Management*, 14(1), 93-117. <http://dx.doi.org/10.1108/14601061111104715>.
- Borgatti, S., Everett, M., & Freeman, L. (2002). *Ucinet for Windows: software for social network analysis*. Harvard: Analytic Technologies.
- Brandenburger, A. M., & Nalebuff, B. (1995). The right game: use game theory to shape strategy. *Harvard Business Review*, 73(4), 57-71.
- Brem, A., & Voigt, K.-I. (2009). Integration of market pull and technology push in the corporate front end and innovation management: insights from the German software industry. *Technovation*, 29(5), 351-367. <http://dx.doi.org/10.1016/j.technovation.2008.06.003>.
- Brito, E. P. Z., & Mariotto, G. (2013). Benefícios da cooperação entre compradores e fornecedores: Um estudo no setor de tecnologia de informação e comunicação. *Revista Brasileira de Gestão e Negócios*, 15(47), 241-261.
- Brouthers, K. D., Brouthers, L. E., & Wilkinson, T. J. (1995). Benefícios da cooperação entre compradores e fornecedores: Um estudo no setor de tecnologia de informação e comunicação. *Long Range Planning*, 28(3), 18-25.
- Buganza, T., & Verganti, R. (2009). Benefícios da cooperação entre compradores e fornecedores: Um estudo no setor de tecnologia de informação e comunicação. *European Journal of Innovation Management*, 12(3), 306-325. <http://dx.doi.org/10.1108/14601060910974200>.
- Carvalho, M. M. (2009). *Inovação: estratégias e comunidades de conhecimento*. São Paulo: Atlas.
- Chesbrough, H. W. (2003a). The era of open innovation. *MIT Sloan Management*, 44(3), 35-41.
- Chesbrough, H. W. (2003b). The logic of open innovation: managing intellectual property. *California Management Review*, 45(3), 33-58. <http://dx.doi.org/10.2307/41166175>.
- Chesbrough, H. W. (2006). *Open business model: how to thrive in the new innovation landscape*. Boston: Harvard Business School Press.
- Chesbrough, H. W. (2007). Why companies should have open business models. *MIT Sloan Management Review*, 48(2), 22-28.
- Chesbrough, H. W. (2011). Bringing open innovation to services. *MIT Sloan Management Review*, 52(2), 85-90.
- Chesbrough, H. W., & Crowther, A. K. (2006). Beyond high tech: early adopters of open innovation in other industries. *R & D Management*, 36(3), 229-236. <http://dx.doi.org/10.1111/j.1467-9310.2006.00428.x>.
- Chesbrough, H. W., & Teece, D. J. (1996). When is virtual virtuous? Organizing for innovation. *Harvard Business Review*, 74(1), 65-73.
- Christensen, C. M. (1997). Making strategy: learning by doing. *Harvard Business Review*, 75(6), 141-146. PMID:10174795.
- Cohen, W. M., & Levinthal, D. A. A. (1989). Innovation and learning: the two faces of R-And-D. *The Economic Journal*, 99(397), 569-596. <http://dx.doi.org/10.2307/2233763>.
- Cohen, W. M., & Levinthal, D. A. A. (1990). Absorptive-capacity – a new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152. <http://dx.doi.org/10.2307/2393553>.
- Cooper, R. G., & Edgett, S. J. (2008). Overcoming the crunch in resources for new product development. *Research-Technology Management*, 51(2), 47-58.
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2001). Portfolio management for new product development: results of an industry practices study. *R & D Management*, 31(4), 361-380. <http://dx.doi.org/10.1111/1467-9310.00225>.
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2004). Benchmarking best NPD practices-II. *Research-Technology Management*, 47(3), 50-59.
- Dabholkar, P. A., & Neely, S. M. (1998). Managing interdependency : a taxonomy for business-to-business relationships. *Journal of Business and Industrial Marketing*, 13(6), 439-460. <http://dx.doi.org/10.1108/08858629810246797>.
- Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, 39(6), 699-709. <http://dx.doi.org/10.1016/j.respol.2010.01.013>.
- Davenport, S., Davies, J., & Grimes, C. (1998). Collaborative research programmes: building trust from difference. *Technovation*, 19(1), 31-40. [http://dx.doi.org/10.1016/S0166-4972\(98\)00083-2](http://dx.doi.org/10.1016/S0166-4972(98)00083-2).
- Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R & D Management*, 36(3), 333-346. <http://dx.doi.org/10.1111/j.1467-9310.2006.00429.x>.
- Doney, P. M., & Cannon, J. P. (1997). An examination of the nature of trust in buyer-seller relationships. *JMR, Journal of Marketing Research*, 61(2), 35-51.
- Edwards, T. (2000). Innovation and organizational change: developments towards an interactive process perspective. *Technology Analysis and Strategic Management*, 12(4), 445-464. <http://dx.doi.org/10.1080/713698496>.
- Eguiluz, V. M., Zimmermann, M. G., Cela-Conde, C. J., & Miguel, M. S. (2005). Cooperation and the emergence of role differentiation in the dynamics of social networks. *American Journal of Sociology*, 110(4), 977-1008. <http://dx.doi.org/10.1086/428716>.
- Fleming, L., & Waguespack, D. M. (2007). Brokerage, boundary spanning, and leadership in open innovation communities. *Organization Science*, 18(2), 165-180. <http://dx.doi.org/10.1287/orsc.1060.0242>.
- Freeman, L. (1991). Networks of innovators: a synthesis of research issues. *Research Policy*, 20(5), 499-514. [http://dx.doi.org/10.1016/0048-7333\(91\)90072-X](http://dx.doi.org/10.1016/0048-7333(91)90072-X).

- Gray, B., & Wood, D. J. (1991). Collaborative alliances: moving from practice to theory. *The Journal of Applied Behavioral Science*, 27(1), 3-22. <http://dx.doi.org/10.1177/0021886391271001>.
- Griffin, A. (1997). PDMA Research on new product development practices: updating trends and benchmarking best practices. *Journal of Product Innovation Management*, 14(6), 429-458. [http://dx.doi.org/10.1016/S0737-6782\(97\)00061-1](http://dx.doi.org/10.1016/S0737-6782(97)00061-1).
- Gulati, R., Nohria, N., & Zaheer, A. (2000). Strategic network. *Strategic Management Journal*, 21(3), 203-215. [http://dx.doi.org/10.1002/\(SICI\)1097-0266\(200003\)21:3<203::AID-SMJ102>3.0.CO;2-K](http://dx.doi.org/10.1002/(SICI)1097-0266(200003)21:3<203::AID-SMJ102>3.0.CO;2-K).
- Gulati, R., & Singh, H. (1998). The architecture of cooperation: managing coordination costs and appropriation concerns in strategic alliances. *Administrative Science Quarterly*, 43(4), 781-814. <http://dx.doi.org/10.2307/2393616>.
- Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, 19(4), 293-317. [http://dx.doi.org/10.1002/\(SICI\)1097-0266\(199804\)19:4<293::AID-SMJ982>3.0.CO;2-M](http://dx.doi.org/10.1002/(SICI)1097-0266(199804)19:4<293::AID-SMJ982>3.0.CO;2-M).
- Hamel, G. (1991). Competition for competence and interpartner learning within international strategic alliances. *Strategic Management Journal*, 12(S1), 83-103. <http://dx.doi.org/10.1002/smj.4250120908>.
- Harabi, N. (2002). The impact of vertical R&D cooperation on firm innovation: an empirical investigation. *Economics of Innovation and New Technology*, 11(2), 93-108. <http://dx.doi.org/10.1080/10438590210900>.
- Harrigan, K. R., & Newman, W. H. (1990). Bases of interorganization co-operation: propensity, power, persistence. *Journal of Management Studies*, 27(4), 417-434. <http://dx.doi.org/10.1111/j.1467-6486.1990.tb00255.x>.
- Herzog, P., & Leker, J. (2010). Open and closed innovation: different innovation cultures for different strategies. *International Journal of Technology Management*, 52(3-4), 322-343. <http://dx.doi.org/10.1504/IJTM.2010.035979>.
- Huston, L., & Sakkab, N. (2007). Connect and develop: inside procter & gamble's new model for innovation. *Harvard Business Review*, 84(3), 58-66. PMID:17348170.
- Ireland, R. D., Hitt, M. A., & Vaidyanath, D. (2002). Alliance management as a source of competitive advantage. *Journal of Management*, 28(3), 413-446. <http://dx.doi.org/10.1177/014920630202800308>.
- Jacobides, M. G., & Billinger, S. (2006). Designing the Boundaries of the Firm: From "Make, Buy, or Ally" to the Dynamic Benefits of Vertical Architecture. *Organization Science*, 17(2), 249-261. <http://dx.doi.org/10.1287/orsc.1050.0167>.
- Janowicz-Panjaitan, M., & Noorderhaven, N. G. (2009). Trust, calculation, and interorganizational learning of tacit knowledge: an organizational roles perspective. *Organization Studies*, 30(10), 1021-1044. <http://dx.doi.org/10.1177/0170840609337933>.
- Khanna, T., Gulati, R., & Nohria, N. (1998). The dynamics of learning alliances: competition, cooperation, and relative scope. *Strategic Management Journal*, 19(3), 193-210. [http://dx.doi.org/10.1002/\(SICI\)1097-0266\(199803\)19:3<193::AID-SMJ949>3.0.CO;2-C](http://dx.doi.org/10.1002/(SICI)1097-0266(199803)19:3<193::AID-SMJ949>3.0.CO;2-C).
- Khurana, A., & Rosenthal, S. R. (1997). Integrating the fuzzy front end of new product development. *Sloan Management Review*, 38(2), 103-120.
- Kim, J., & Wilemon, D. (2002). Focusing the fuzzy front-end in new product development. *R&D Management*, 32(4), 269-279. <http://dx.doi.org/10.1111/1467-9310.00259>.
- Kirschbaum, R. (2005). Open innovation in practice. *Research-Technology Management*, 48(4), 24-28.
- Koen, P., Ajamian, G. M., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S., Johnson, A., Puri, P., Seibert, R., Burkart, R., Clamen, A., Davidson, J., D'amores, R., Elkins, C., Herald, K., Incorvia, M., Johnson, A., Karol, R., Seibert, R., Slavejkov, A., & Wagner, K. (2001). Providing clarity and a common language to the "Fuzzy Front End". *Research-Technology Management*, 44(2), 46-55.
- Kogut, B. (1988). Joint ventures – theoretical and empirical perspectives. *Strategic Management Journal*, 9(4), 319-332. <http://dx.doi.org/10.1002/smj.4250090403>.
- Levy, M., Loebbecke, C., & Powell, P. (2003). SMEs, co-competition and knowledge sharing: the role of information systems I. *European Journal of Information Systems*, 12(1), 3-17. <http://dx.doi.org/10.1057/palgrave.ejis.3000439>.
- Lichtenthaler, U. (2011). Open innovation: past research, current debates, and future directions. *The Academy of Management Perspectives*, 25(1), 75-93. <http://dx.doi.org/10.5465/AMP.2011.59198451>.
- Lorange, P., Roos, J., & Bronn, P. S. (1992). Building successful strategic alliances. *Long Range Planning*, 25(6), 10-17. [http://dx.doi.org/10.1016/0024-6301\(92\)90164-W](http://dx.doi.org/10.1016/0024-6301(92)90164-W).
- March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71-87. <http://dx.doi.org/10.1287/orsc.2.1.71>.
- McDonald, D. B. (2007). Predicting fate from early connectivity in a social network. *Proceedings of the National Academy of Sciences of the United States of America*, 104(26), 10910-10914. PMID:17576933. <http://dx.doi.org/10.1073/pnas.0701159104>.
- Miles, R. E., & Snow, C. C. (1992). Causes of failures in network organizations. *California Management Review*, 34(4), 53-72. <http://dx.doi.org/10.2307/41166703>.
- Morrison, P. D., Roberts, J. H., & Von Hippel, E. (2000). Determinants of user innovation and innovation sharing in a local market. *Management Science*, 46(12), 1513-1527. <http://dx.doi.org/10.1287/mnsc.46.12.1513.12076>.
- Murphy, S. A., & Kumar, V. (1997). The front end of new product development: a Canadian survey. *R & D Management*, 27(1), 5-15. <http://dx.doi.org/10.1111/1467-9310.00038>.

- Nagano, M. S., Stefanovitz, J. P., & Vick, T. E. (2014). Caracterização de processos e desafios de empresas industriais brasileiras na gestão da inovação. *Revista Brasileira de Gestão e Negócios*, 16(51), 163-179.
- Nelson, R. R., & Winter, S. (1982). *An evolutionary theory of economic change*. Cambridge: Harvard University Press.
- Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, 27(6-7), 367-377. <http://dx.doi.org/10.1016/j.technovation.2006.10.001>.
- Nobelius, D., & Trygg, L. (2002). Stop chasing the front end process: management of the early phases in product development projects. *International Journal of Project Management*, 20(5), 331-340. [http://dx.doi.org/10.1016/S0263-7863\(01\)00030-8](http://dx.doi.org/10.1016/S0263-7863(01)00030-8).
- Nochur, K. S., & Allen, T. J. (1992). Do nominated boundary spanners become effective technological gatekeepers? *IEEE Transactions on Engineering Management*, 39(3), 265-269. <http://dx.doi.org/10.1109/17.156560>.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: how japanese companies create the dynamics of innovation?* New York: Oxford University Press.
- Nooteboom, B. (1994). Innovation and diffusion in small firms: theory and evidence. *Small Business Economics*, 6(5), 327-347. <http://dx.doi.org/10.1007/BF01065137>.
- O'Connor, G. C. (1998). Market learning and radical innovation: a cross case comparison of eight radical innovation projects. *Journal of Product Innovation Management*, 15(2), 151-166. <http://dx.doi.org/10.1111/1540-5885.1520151>.
- Organisation for Economic Co-operation and Development – OECD. (2005). *Manual de Oslo: diretrizes para coleta e interpretação de dados sobre inovação*. Rio de Janeiro: Finep.
- Perkmann, M., & Walsh, K. (2007). University-industry relationships and open innovation: towards a research agenda. *International Journal of Management Reviews*, 9(4), 259-280. <http://dx.doi.org/10.1111/j.1468-2370.2007.00225.x>.
- Poskela, J., & Martinsuo, M. (2009). Management control and strategic renewal in the front-end phase of the innovation process. *Journal of Product Innovation Management*, 26(6), 671-684. <http://dx.doi.org/10.1111/j.1540-5885.2009.00692.x>.
- Powell, W. W. (1990). Neither market nor hierarchy: networks forms of organizations. *Research in Organizational Behavior*, 12, 295-336.
- Prahalad, C. K., & Ramaswamy, V. (2003). The new frontier of experience innovation. *MIT Sloan Management Review*, 44(4), 12-18.
- Product Development Management Association – PDMA. (2006). *Body of knowledge*. Chicago: PDMA. Recuperado em 10 de outubro de 2014, de <http://bok.pdma.org>
- Raub, W., & Weesie, J. (1990). Reputation and efficiency in social interactions: an example of network effects. *American Journal of Sociology*, 96(3), 626-654. <http://dx.doi.org/10.1086/229574>.
- Reid, S. E., & Brentani, U. (2004). The Fuzzy Front End of new product development for discontinuous innovations: a theoretical model. *Journal of Product Innovation Management*, 21(3), 170-184. <http://dx.doi.org/10.1111/j.0737-6782.2004.00068.x>.
- Richardson, G. B. (1972). The organization of industry. *The Economic Journal*, 82(327), 883-896. <http://dx.doi.org/10.2307/2230256>.
- Roberts, E. B. (2001). Benchmarking global strategic management of technology. *Research-Technology Management*, 44(2), 25-36.
- Shapiro, D. L., Sheppard, B. H., & Cheraskin, L. (1992). Business on a Handshake. *Negotiation Journal*, 8(4), 365-377. <http://dx.doi.org/10.1111/j.1571-9979.1992.tb00679.x>.
- Smith, P. G., & Reinertsen, D. G. (1998). Faster to market: developing products quicker takes managers who can keep everyone on course. *Mechanical Engineering*, 120(12), 68-70.
- Tatikonda, M. V., & Rosenthal, S. R. (2000). Technology novelty, project complexity, and product development project execution success: a deeper look at task uncertainty in product innovation. *IEEE Transactions on Engineering Management*, 47(1), 74-87. <http://dx.doi.org/10.1109/17.820727>.
- Teece, D. J. (1986). Profiting from technological innovation: implications for integration, collaboration, licensing and public-policy. *Research Policy*, 15(6), 285-305. [http://dx.doi.org/10.1016/0048-7333\(86\)90027-2](http://dx.doi.org/10.1016/0048-7333(86)90027-2).
- Teece, D. J., Pisano, G. P., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533. [http://dx.doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7<509::AID-SMJ882>3.0.CO;2-Z](http://dx.doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z).
- Uzzi, B., & Gillespie, J. J. (2002). Knowledge spillover in corporate financing networks: embeddedness and the firm's debt performance. *Strategic Management Journal*, 23(7), 595-618. <http://dx.doi.org/10.1002/smj.241>.
- Verworn, B., Herstatt, C., & Nagahira, A. (2008). The fuzzy front end of Japanese new product development projects : impact on success and differences between incremental and radical projects. *R & D Management*, 38(1), 1-19. <http://dx.doi.org/10.1111/j.1467-9310.2007.00492.x>.
- Voss, C. A., Tsiriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management*, 22(2), 195-219. <http://dx.doi.org/10.1108/01443570210414329>.
- Wasserman, S., & Faust, K. (1994). *Social network analysis: methods and applications*. Cambridge: Cambridge University Press. <http://dx.doi.org/10.1017/CBO9780511815478>.

- West, J., & Gallagher, S. (2006). Challenges of open innovation: the paradox of firm investment in open-source software. *R & D Management*, 36(3), 319-331. <http://dx.doi.org/10.1111/j.1467-9310.2006.00436.x>.
- Zien, K. A., & Buckler, S. A. (1997). From experience dreams to market: crafting a culture of innovation. *Journal of Product Innovation Management*, 14(4), 274-287. [http://dx.doi.org/10.1016/S0737-6782\(97\)00029-5](http://dx.doi.org/10.1016/S0737-6782(97)00029-5).