

# Modularity and Relational Mechanisms of Governance: An Analysis of Modular Consortium and Industrial Condominium

Mario Sacomano Neto

Federal University of São Carlos  
msacomano@ufscar.br

Sílvio Roberto Ignácio Pires

Methodist University of Piracicaba  
sripires@unimep.br

Eliciane Maria da Silva

Methodist University of Piracicaba  
eimsilva@unimep.br

**ABSTRACT:** This article analyzed the main mechanisms in inter-firm governance present in a modular consortium as well as in an automotive industry industrial condominium, operating in Brazil.. The data collection was carried out through interviews (in loco) in both automakers and suppliers. Modular consortium and industrial condominium not only involve collaborative agreements in manufacturing with suppliers but also embrace managerial aspects such as: trust, long-term contracts, reciprocity, reputation, channels of interdependence and formal and informal mechanisms of control. These contemporary forms of governance have generated new ways of organizing production and coordination in operations, based on cooperation, integration and inter-firm process control. For such, governance based on company inter-relationship usually operates seeking cooperative agreements so that it would permit quick access to information and technological innovations. These governance approaches contain structures to support exchange, resource interdependence, mutual lines of communication, economies of scale for research and joint production.

**Keywords:** *inter-firm governance; relational mechanisms; Brazilian automotive industry; modular consortium; industrial condominium.*

## 1. INTRODUCTION

The Brazilian automotive industry produced 3.638 million vehicles in 2010 and occupied the fifth position in the global production ranking, behind Japan, China, the United States, Germany and Korea. Since the decade of 1990, several automakers have introduced new production arrangements in Brazil, such as the modular consortium and the industrial condominiums, characterized by high levels of inter-firm cooperation, mainly with systems and/or modules suppliers. This fact led to a major change in the role and in the labor division of tier suppliers, as the relationships with the automaker are now strongly based on cooperative routines between firms. The interdependence and cooperation among the companies that are part of these arrangements are noticed in long-term contracts, complex coordination mechanisms, qualitatively different information, trust and problem solving mechanisms, among other inherent aspects of relationships and transactions.

This paper rescued two important issues which made it possible to understand the current configurations in the automotive sector: growing role and importance of the BRIC countries (Brazil, Russia, India and China) and production modularity. Currently, the BRIC countries are considered to be attractive due mainly to their fast growing in the automotive market and relatively lower production costs. That would make these countries interesting places to launch not only new manufacturing and assembly systems but also new experiments concerning inter-firm relationship. Recent studies, done by Price Waterhouse Coopers (2009), show that BRIC countries will be responsible for 63% of overall growth in the automotive industry until 2015. Among them, Brazil is currently the fifth largest automotive manufacturer in the world and its production reached 3.182 million vehicles in 2009 and 3.638 million in 2010. Brazil is behind Japan, China, Korea and the United States in the global vehicle production, occupying the fifth position in 2010.

These trends in product design and production modularity are unprecedented in the automotive industry worldwide. In both cases studied, subsystems or modules are provided outside the main assembly line, therefore, reducing stiffness, costs and difficulties brought about by the diversity in vehicles production. The concept of modularity was first applied to the vehicle design,

later it extended to the process design and the supply chain organization (GOMES & DAHAB, 2010). However, as pointed out by Fredriksson (2006), the efficiency in the modular assembly has depended on a series of coordination mechanisms, such as the use of plans, standardization of the practices and mutual adjustment. Mutual adjustment is a way of coordination with continuous change in information and frequent interaction.

As mentioned by Tiwana (2008), modularity reduces the control of the processes, but not the results. The control of performance can be done either formally (contracts and operative agreements) or informally (through trust and reciprocity), as mentioned by Uzzi (1997) and Powell (1990). Therefore, two research questions motivated this study: (a) what are the relational mechanisms of inter-firm governance derived from the process of modularity and design? (b) How does the control of inter-firm production processes in modularity systems happen? Hence, the study begins with the prerogative that both relational (MESQUITA et al., 2008; TIWANA, 2008; FERGUSON et al., 2005) process and performance control mechanisms (FERGUSON, 2005; MARCH, SCHULZ & ZHOU, 2000) need to be developed in the relationship between suppliers and manufacturer in a modular plant and in an industrial condominium.

In this way, this article analyzed the main mechanisms in inter-firm governance present in a modular consortium as well as in an automotive industry industrial condominium, operating in Brazil. The article can contribute to understanding forms of governance and inter-firm coordination in contemporary supply chain configurations in the automotive industry. It also discusses the trend and some key managerial effects to use modules and system concepts in the design and assembly of vehicles. The results highlight that these new approaches of governance combine (total or partial) assembly outsourcing and, simultaneously, the development of robust structures to coordinate the partners in the supply chain, mainly with the key suppliers.

## 2. INTER-FIRM GOVERNANCE STRUCTURES

Governance refers to the degree of hierarchy, leadership and command (or, alternatively, collaboration and cooperation) present in the relationship among organizations, according

to Suzigan et al. (2002). However, Storper and Harrison (1991, p.408) have defined governance as the “organization that holds power so that it can affect the development of the system”. On the other hand, structures of governance are looking forward to having leadership capacity and command as well as ways of collaboration and cooperation among organizations.

If organizations want to coordinate a certain productive system it is necessary, hypothetically, different ways of governance: (1) through market mechanisms, where price is the central variable; (2) through interactive processes, denominated by Williamson (1985) as a hybrid form, where cooperation, reciprocity and trust are central (FERGUNSON et. al., 2005; UZZI, 1997; POWELL, 1990); and (3) through vertical integration, where a company can exert greater governance on a certain group of actors (customers or suppliers). This study has focused the so called hybrid ways, or relational ways of governance, as recognized in the literature (MESQUITA et al., 2008; FERGUNSON et. al, 2005; POPPO & ZENGER, 2002; UZZI, 1997).

According to Powell (1990), the inter-firm governance can be understood as a third organizational form, different from hierarchies and market governance. The inter-firm governance is alternative to the market and of vertical integration, since it contains horizontal and vertical structures of change, interdependence of resources and reciprocal lines of communication (POWELL, 1990). In the market, relationships are not insured, but episodic, aiming at transferring resources and products. In hierarchies, relationships are insured for a longer time than a brief episode, but the existence of a legitimate authority is recognized to solve disputes (PODOLNY & PAGE, 1998). Both forms of inter-firm governance are different from the market one because they apply a wide group of coordination mechanisms and maintain separated rights for properties (GRANDORI, 1999).

Differently from the market relationship and hierarchy, forms of inter-firm governance operate using their own and particular logic as they pursue cooperative agreements to obtain fast access to information and technological innovations. Thus, the firms get some benefits from production, research and development (R&D), and still share the risks and markets uncertainties (POWELL, 1990). However, some relationships can trigger off some negative effects to the firms either when historical events and

relationships of power became asymmetrical or when very interdependent relationships block, somehow, the innovation process. This reflects the necessity for inter-firm control. Therefore, governance takes care of the contractual aspects of control in order to conduct interactions among companies, but it also involves mechanism of collaborative relationships and peculiar ways of solving conflicts (BRITTO, 2002).

This study, therefore, is based on the need for developing not only relational mechanisms (MESQUITA et al., 2008; TIWANA, 2008; FERGUNSON et. al., 2005) but also mechanisms of control in process and performance (FERGUNSON, 2005; MARCH, SCHULZ & ZHOU, 2000) within inter-firm relationships.

## 2.1 Relational mechanisms of governance

Due to a great change in role and work division among companies, a model has come out based strongly on cooperative routines among companies, introducing new productive arrangements. The interdependence among companies contemplates long-term contracts, complex coordination mechanisms, qualitatively different information, trust and problem solving mechanisms, among others.

Numerous studies have analyzed ways of integration and relational issues among firms. Huo et al. (2013) examined the impact of institutional aspects on supplier integration and their impact on financial performance. The results showed institutional pressures affect positively both system and process integration, and these have a positive impact on financial performance. Flynn, Huo and Zhao (2011) analyzed the internal customer and supplier integration and both operational and business performance. They found that internal integration was directly related to both business and operational performance and that customer integration was directly related to operational performance. However, supplier integration was not directly related to each type of performance, but, instead, it interacts with customer integration in improving operational performance.

Howard and Squire (2007) examined the impact of modularization on supplier relationship management. The results revealed that the product modularization creates dependencies between firms and leads to greater collaboration, since

firms share assets and information. Gnyawali and Madhavan (2001) point out three characteristics of higher interdependent productive systems: (1) they facilitate the information flow and other resources; (2) they work as closed systems to trust and norms, in which standard behavior structures would increase more easily; (3) they facilitate the attribution of sanctions and responsibilities.

Inter-firm governance, characterized by interdependence channels and its typical practices, such as relational contracts and collaborative manufactures, can stimulate fast access to resources and knowhow which cannot be produced internally (NOHRIA, 1992; DYER & SINGH, 1998; SCHOENHERR & SWINK, 2011). For instance, Cousins et al. (2011) found that technical capabilities sharing between supplier and manufactures can improve new product development and firm performance. Dyer and Chu (2011) argue that the trust in supply-buyer relationships may be an important source of competitive advantage, since it (a) lower transitions costs, (b) facilitates investments in relationship-specific assets, (c) leads to superior information sharing routines. Cao and Zhank (2011) stated that firms seek to internalize resources and skills of their collaborative partners to improve their performance. Long-term relationships, such as supply chain collaboration, have to be motivated by the mutuality of intent, goal congruence and benefit sharing (CAO & ZHANG, 2011)

An issue that has been widely discussed, according to this perspective, is how trust and reputation can supplement or replace administrative procedures or even transactional contracts. Thus, the analyses of inter-firm governance contribute to a debate on some elements present in the relationship, such as: trust and opportunism, formal and informal organizations and ways of alternative hierarchy and market governance (GRANDORI, 1999). Dyer and Chu (2011) found that the institutional environmental has an influence on the development of inter-organizational trust that differs significantly from one country to another.

An issue has emerged during this research: whether the productive arrangements are based on cooperation and collaboration. According to the results of the research, most modular plants and industrial condominiums are strongly based on mechanisms related to coordination, high exchange of information, flexibility of products and processes and reciprocity. Squire et al. (2009)

found that the flexibility, responsiveness and modularity capabilities of the supplier firms positively affects buyer firms responsiveness. Also, the study revealed that the positive relationship between supplier and buyer firms' responsiveness strengthened as the level of collaboration increased. Thus, collaboration is associated with increased information sharing between the two organizations. Salvador and Villena's study (2013) revealed that suppliers are more efficiently integrated into new product development (NPD) when the buyers have superior modular design competence. These authors concluded that inter-organizational efforts refer to methods to achieve successful integration of supplier in NPD and to develop an internal capability that is completely under a buyer's control and that allows effective orchestration of suppliers' design activities. Therefore, Proposition 1 was formulated: the design and the process of modularity have stimulated the creation of relational mechanisms of inter-firm governance in the companies studied.

The relational mechanisms of governance have been analyzed according to seven categories: distribution of work among actors; problem solving mechanisms; type of circulating information; interaction frequency; commitment with resources, speed and formality/informality in the relationships. Those variables have been selected from several other studies (FERGUNSOM et al. 2005; POPPO & ZENGER, 2002; GRANOVETTER, 1985; GRANDORI & SODA, 1995; UZZI, 1997).

## 2.2 Modularity and performance control

The growth of modular assembly and modular development has significantly gathered during the last decade (DORAN et al., 2007; ISRAELSEN & JORGENSEN, 2011; CARIDI, PERO & SIANESI, 2012). This rate of modularity growth refers to increased flexibility, increased speed to market, reduced costs (DORAN et al., 2007) and increased economies of scale (KRISHNAN & GUPTA, 2001). The modularity has positive impact on capacity utilization, ROI and ROA (CHENG, 2011). Modularity affects the structure of products and the production steps (BALDWIN & CLARK, 2000). Briefly, modularity can be understood as a way of building a complex product or process through smaller subsystems, which can be independently designed and assembled and still operate together as a whole (BALDWIN & CLARK, 2000) after the final assembly.

Although there is cooperation among companies, those new organizational formats also want to have control among the actors. Modularity, then, involves a central issue in organizations, i.e., to preserve the market growth and profitability, what involves inter-firm control. (DORAN et al., 2007; ISRAELSEN & JORGENSEN, 2011; SALVADOR & VILLENA, 2013) .

Inter-firm control mechanisms involve aspects of formal and informal control (TIWANA, 2008; MARCH, SCHULZ & ZHOU, 2000; CHEN, 2011). CHEN (2011) stated that modular organization can have three aspects: extensive use of contract manufacturing, utilization of external human resources, and establishing alliances. Organizations, according to Fligstein (2007), work with two types of mechanisms of control: the internal ones, which guarantee resources and coordination for the organization, and the external ones, which guarantee stable relationships between competitors, suppliers and shareholders as well as the organization survival. External controls are those present in the relationship group with other organizations; they can be formal, ruled by contracts, and informal, such as trust. Both internal and external controls that the organizations establish involve formal and informal aspects (MARCH, SCHULZ & ZHOU, 2000). In this research, formal and informal external controls are dealt with.

With high levels of outsourcing used by automakers, it is vital to develop systems and metrics to measure the performance for the suppliers. Thus, the most significant expenses spent with vehicles are materials, parts and systems delivered by the suppliers. Therefore, control is fundamental to improve the system productivity as a whole. According to Beamon (1999), choosing measures of performance involving the whole chain is complex because it depends on many factors, such as, size, culture, needs, location, among others.

Some authors mention modularity as an element that can reduce control among companies (SANCHES, 1995). However, Tiwana (2008, p.770) points out that “modularity can reduce the control in the process, but not the performance”. Thus, Proposition 2 was formulated: design and process modularity stimulated the creation of performance control mechanisms. Mechanisms of inter-firm control involve formal and informal aspects of control (TIWANA, 2008; MARCH, SCHULZ & ZHOU, 2000).

### 3. RESEARCH METHODOLOGY

These last few years have seen internationalization in the automotive industry been intensified; a process that represents one of the core strategies for automakers. Internationalization, geographic distribution and international division of labor represent themes of studies in this sector, in view of the stabilization of vehicle production and sales in central markets: United States, Japan and Europe, according to Humphrey et al. (2000). As a result, there has been a significant change in the role of regional markets, as it has happened to Mercosul.

Currently, the sector is expanding its productive structures in most countries around the world. According to Humphrey et al. (2000), the dynamics of the automotive sector is divided, mainly, in three markets: protected autonomous markets (PAMs), integrated peripheral markets (IPMs), and emerging regional markets (ERMs). The first involves countries that protect themselves against outside competition through domestic markets, such as India, China and Malaysia. The second involves countries next to big markets, such as Mexico, the Czech Republic, Hungary and Poland. The third market involves countries that are part of emergent blocks, such as Brazil, Argentina, Russia and Turkey. Although these markets represent “new rooms” for automakers and auto parts suppliers, the internationalization in the automotive sector is not a homogeneous process.

Although the automotive industry expansion has a global aspect, the reality and peculiarities of each market question the existence of unique models of production. Volpato (2002) points out that internationalization in the automotive industry has two extremes: (1) a significant standardization of both organizational forms and decision-making processes; (2) localization and adaptation to each region. Cultural, social, political and economic differences require different ways to implement and spread out the productive systems, leading, according to Boyer et al. (1998), to a hybridization process. These authors believe that the productive system diffusion depends, for its consolidation, on a series of economic, social and historical aspects.

Emergent markets, such as the Brazilian one, are considered attractive due to the following factors: fast growth of the vehicle market, production units in lower-cost locations, accelerated growth of driving rates (LUNG, 2000), and privileged fields

for new organizational and labor experiments (HUMPHREY et al., 2000).

Transformations in the Brazilian automotive industry open up a growing field for research, which involves new production models. The large number of mergers, acquisitions, co-production, consortiums, franchising, strategic alliances, long-term contracts and joint ventures demonstrate the sector dynamic and complex characteristics. In recent years, several new organizational arrangements have been implemented within the Brazilian automotive industry, among them the modular consortium and the industrial condominium. These new arrangements contain high degree of outsourcing, long-term contracts, integrative agreements, co-production component, exchange of specific assets, information transfer and support to suppliers. These arrangements modify the relationship between automakers and car part suppliers.

The strategic change in automakers is also related to a greater rationalization in the relationships with auto parts suppliers. Economic and technological uncertainties as well as the market ones, lead to establish cooperative agreements with suppliers (KNIGHT, 1998). This fact has given first-tier suppliers high-status positions and, hence, new roles to play in the Brazilian automotive industry supply chain.

These changes have led to two consequences for the car part sector: (1) a significant increase in automakers demands concerning quality, just-in-time deliveries, global sourcing, follow sourcing, product development, co-design, and financial and technological capacitation (CARVALHO et al., 2000); and (2) concentration of the auto parts suppliers in the hands of large international groups and a deep

denationalization in the industry.

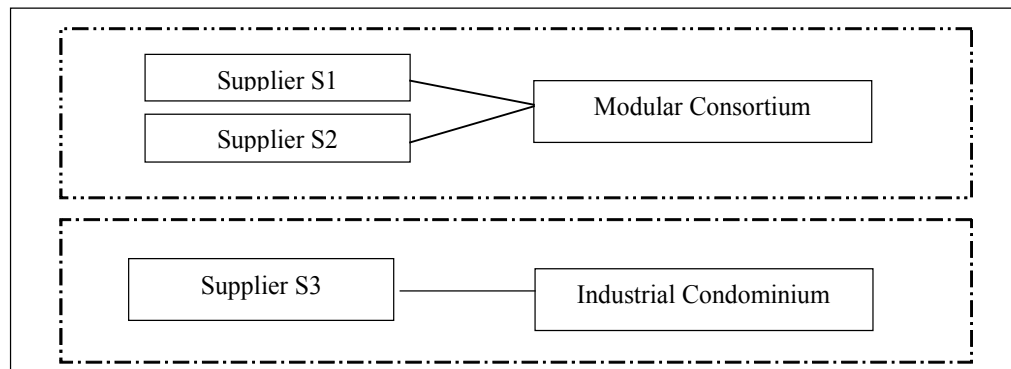
The introduction of new productive arrangements (such as modular consortium and industrial condominium) has placed the automotive industry in Brazil in the center of the discussion on industrial models (HUMPHREY et al., 2000). Brazil has become a model to several countries, including the most industrialized ones, where the company headquarters that have manufacturing units in Brazil are located.

#### 4. METHOD AND DATA COLLECTION

The methodology of the study is classified as qualitative and inductive case study (EISENHARDT, 1989; BARRAT, CHOI & LI, 2011). Qualitative case study research is defined “as an empirical research that primarily uses contextually rich data from bounded real-world settings to investigate a focused phenomenon” (BARRAT, CHOI & LI, 2011, p.329). The inductive case study is primarily used to develop new theories. For this kind of research, a priori constructs help to shape the initial design of theory building (BARRAT, CHOI & LI, 2011).

The qualitative study is adequate when the situations analyzed are contemporary, comprehensive and complex; the focus is on understanding the facts and not on its measurement; there are several methodological sources to validate the facts when it is not possible to control the events/behavior on facts/people involved in the research (YIN, 2005).

The companies (two automakers and three module suppliers) have been chosen taking into account their representativeness in the automobile industry and significance for the area of knowledge. The picture 1 illustrates the cases and relationships studied.



Picture 1: The cases and relationships studied

Non-participant observation and semi-structured interviews have been the methods used to collect data (COLLINS & HUSSEY, 2005). Interviews in loco have been accomplished in each of the automakers and auto part suppliers. All the interviews were semi-structured, taking into consideration relationships between automakers and suppliers. In the modular consortium a product quality director, a manufacture director and a purchase manager have been interviewed. As a description of interviews, in supplier 1 (S1), a sales director and an industrial manager have been interviewed. The industrial director was interviewed three times throughout the research in modular consortium. About supplier 2 (S2), an industrial director and a purchase director have been interviewed and in the industrial condominium the logistics and production directors have been interviewed. In supplier 3 (S3) the industrial director has been interviewed. All the three suppliers operate inside the assembler dependences.

In order to analyze the results, the general analytical procedure has been used, according to Collins and Hussey (2005) and the technique of intra-cases analysis (within-case analysis) (EISENHARDT, 1989).

## 5. CASES STUDIED

### 5.1.1 MODULAR CONSORTIUM

The concept of consortium is considered one of the most innovative experiments in the automobile industry in the last few years. The greatest reference is Volkswagen truck and bus factory, which has been operating since November 1996 in Resende (RJ, Brazil). In general terms, the modular consortium can be considered an important example of outsourcing, in which key suppliers (called "modulists") take over the previous assembly of the module, its subsequent assembly in the final assembly line of the automaker, the investments in equipments and tools and the administration (even partial) of the chain of module supplies directly under their responsibility. On the other hand, the automaker provides the plant and the final assembly line, executes its coordination and final test of the vehicles (COLLINS et al., 1997; PIRES, 1998). Summarizing, modularity can be understood as a way of building a product or a complex process through smaller subsystems that can be projected independently and, nevertheless, operate together, as a whole (BALDWIN & CLARK, 2000). The study case described afterwards has not discussed if what

has been studied is a system or a module.

### 5.1.2 Industrial condominiums

A few large automobile plants were established in Brazil over the last fifteen years. All these plants were built and are operating based on the logic of a special case of supplier parks which has been known as the industrial condominium, where a small group of direct suppliers, called in this study "systemists", are physically installed inside the automaker plant and participate in a share of the plant infrastructure costs. These suppliers generally provide the automaker with systems (usually more complex systems with difficult logistics or that facilitate postponing diversification of the product and increase its customization potential) on a just-in-sequence basis right next to the assembly line, but do not participate in the vehicle's final assembly line. The final assembly is done by the automaker. To make business more viable in terms of scale, in most cases the automaker does not require the systemists' resources to be used exclusively for their supplier. For the systemists, this ensures greater flexibility and less dependence on the automakers than in the modular consortium.

In this case, the plant here studied represents a milestone in the country industrialization process and in past decades it has had over 40 thousand employees. Following a corporate decision, in 2002 the plant went through a change and was transformed into an industrial condominium, after which it had eleven key suppliers (systemists) installed inside the plant facilities and began to produce a new worldwide automobile model developed at its German headquarters. This reformulation resulted in a structure with a high level of automation and state-of-the-art technology.

### 5.1.3 Suppliers

The Supplier S1 and Supplier S2 operate inside the modular consortium and the Supplier S3 operates inside the industrial condominium. As pointed out by Hatzfeld (2000), while modules are related with the assembly line, the system process has an operational function in a larger system (e.g. brakes, clutches system). So Suppliers S1 and S2 are mentioned as "modulists" and S3 as "systemist".

#### **Supplier S1 (modular consortium):**

Supplier S1 belongs to one of the largest worldwide automotive group which works with electronic

and mechatronic high technology; it has around 50 thousand employees in 34 countries worldwide and a net of centers for development and production. Nowadays, the group in Brazil is composed by approximately a thousand employees.

**Supplier S2 (modular consortium):**

Supplier S2 is the only one whose capital is entirely Brazilian present in the modular consortium. It started in 1918, when the group began its activities in Rio Grande do Sul and diversified its activities along the way, to the financial area and, subsequently, to the industrial area. From the nineties on, supplier S2 has focused its attention on the industrial area, mainly, on auto parts and rail equipment.

**Supplier S3 (industrial condominium):**

Supplier S3 is a “systemist” installed inside the automaker plant. The company belongs to a German group working in the automotive industry, supplying parts and systems to the body, chassis and power train systems. In Brazil, this supplier feeds the automaker with rear and front axles, front suspensions, auxiliary frames and radiators.

**6. RESEARCH RESULTS**

Mechanisms of governance found out in the modular consortium and in the industrial condominium will be analyzed next.

**6.1 Relational governance in the modular consortium**

Picture 2 describes mechanisms of governance found in the modular consortium. The work division among the companies in the modular plant is very high. The whole assembly of vehicles is accomplished by the suppliers although the project of the product belongs to the automaker, which controls quality, costs, and wastes, among other aspects, through strict auditing.

There are several problem solving mechanism in the modular consortium. There are meetings and daily auditing, in which the automaker points out possible problems found in the vehicles. That process involves total opening for the suppliers’ suggestions. Daily ‘face to face’ contacts also reinforce the sense of identity among the members.

**Picture 2 - Inter-firm Mechanisms of governance in the modular consortium**

	<b>Modular Consortium</b>
<b>Work division</b>	The suppliers set up the vehicle completely. The automaker controls the quality with auditing at the end of the assembly line.
<b>Problem solving mechanisms</b>	Production meetings and daily auditing. Total opening to the suppliers' suggestions.
<b>Type of information</b>	Great amount of information during the design, the production and the negotiation processes. Great amount and frequency in exchanged information.
<b>Frequency of interaction</b>	High frequency of interaction. Suppliers and automaker have an official meeting twice a day (production meeting and auditing).
<b>Commitment with resources</b>	High intensity of commitment with technological resources and administration systems.



<b>Speed of decision making</b>	Larger flexibility in the processes of provisioning of the productive line. It demands less planning.
<b>Formality and informality</b>	Presence of contracts as formal mechanisms, and presence of social nets as informal mechanism.

Within the relationship between the automaker and the module suppliers, the type of information involves high specificity and content. This happens because the relationships between automakers and modulators involve great amount of information on the component design, the production system, the analyses of performance and the negotiation processes.

The frequency of interactions between automaker and module suppliers and, among module suppliers themselves is high. As interdependence was essential to operate the system, a high frequency of interactions was verified. The module suppliers and the automaker get together, at least, twice a day, in official meetings: (1) in production meetings, which involve decisions concerning capacity, volume, models, productivity, etc.; (2) in auditing meetings held by the automaker to identify possible failures in the vehicles. If the automaker does not approve the vehicle in the auditing, because of some no conformity problems, none of the modulators of the consortium receives the payment regarding that vehicle.

Commitment with resources is strong in the modular consortium. There is a sharing between the administration systems and technological resources. The modulators invested on their own productive resources when the company was set up. The automaker paid in installments those investments over the five subsequent years. During that period, there were many challenges to make the company efficient. The automaker worked hard so that the modulators could reach high quality according to one of the interviewees. Due to it, a strong commitment could be verified with technological resources and management systems.

The modular consortium allows decision making to be faster. The fact that the system is modulate allows larger flexibility in the processes, products and in provision to the productive line.

The modular consortium maintains not only idiosyncratic formal contracts but also highly united

social nets. Therefore, high formality/informality levels are present in the inter-firm control in the modular consortium. However, the production director of the automaker mentioned that it was never necessary to use the contract to solve any internal problems. That fact demonstrates high trust among the members to work as a control mechanism and informal commitment.

Cohesion among the actors is another property that can explain several issues. The modular consortium has higher levels of cohesion. Integrated supply chains make possible to obtain accurate information, flexibility, tacit knowledge, diffusion and reciprocity.

The proximity among the actors permits to obtain accurate information between automaker and suppliers. That fact can create problem solving mechanisms with the suppliers, exchange of daily information, frequency of interaction, emotional intensity, commitment with the resources, process flexibility and presence of formal and informal mechanisms of control. The results of the research reveal that the group which has formal and informal rules is able to control and, at the same time, to create reliable norms and reciprocity among the actors.

**6.2 Mechanisms to control performance in modular consortium**

The degree of control that the automaker has over its modulator suppliers is high. All mechanisms of control established form a set of rules and norms, which make the relationships among them more predictable. Evidently, intense relationship might bring strong control in attributions and sanctions. The amount of control that the automaker has over the suppliers goes from formal to informal mechanisms.

Formally, by a continuum process, the automaker controls the suppliers making use of six mechanisms: (1) production program, (2) fulfillment of production program, (3) quality indicators, (4) process auditing, (5) control of stock and (6) control of failures. Those

mechanisms of control are registered and analyzed by the automaker daily through information technology systems. According to the production director of the automaker: “that is the easiest part because everything is in software..... in my file I have all the controls from all factories and not only from this one.... then, it is possible to control quality, processes, production, volume, productivity and human resources”. According to the interviewee, daily negotiations are activities which can involve more complexity. High degree of interdependence explains the complexity of the negotiations with the suppliers, which increases power of decision. The modular consortium has all the control of a “traditional” automaker, however, in the modular consortium, the automaker controls the indexes used by the suppliers, but it does not control the employees and the internal departments. Basically, many production costs in a traditional factory become transaction costs in the modular plant.

The automaker controls information about labor, investments, and damages, among others. That control gives the automaker opportunities for negotiation. The production director has set an example: “if one of the modules asks for a raise (cost) in their parts, we have all the information needed to check whether the raise is necessary. We can check its labor, where to invest, its production and loss..... By the end of the month, we gather all those indicators and analyze the percentage that each module achieved”.

Another mechanism of control is the strict auditing accomplished every day by the modularists when assembling vehicles. All the modules are able to know which modules could not accomplish their goals. Therefore, if the truck is not approved during the auditing, the automaker does not pay any of the module suppliers. As the production director has stated: “a module tells the other: look, your 60% has caused me damage and I didn’t get paid”. At the modular plant there is control among the suppliers,

the automaker does not even need to demand productivity, as traditionally it used to do, because the suppliers would do that – the literature calls it self-enforcement. This type of control is present among the informal aspects of the relationships between suppliers and the automaker.

The informal aspects can also interfere in the control that the automaker could impose over the suppliers. As significant as the mechanisms of control, those aspects include trust, relationship, friendship in the plant context and organizational dynamics. Those informal aspects, which are related to culture and identity, help to predict and control behavior. So, formal and informal processes are working together to control that suppliers, as pointed out by March, Schulz and Zhou (2000).

**6.3 Relational governance in the industrial condominium**

After the implementation of the modular consortium, virtually all new plants of the automotive industry in Brazil are working with the concept labeled industrial condominium, which differs from the modular consortium (PIRES & CARDOZA, 2007). In the condominium, the automaker still assembles the vehicle and the outsourcing level is lower than in the modular consortium. Thus, industrial condominiums have become an interesting alternative in terms of innovation for the automotive industry, but with an application that is slightly moderate and not as radical as is the case of the modular consortium.

Picture 3 describes relational mechanisms on inter-firm governance present in the industrial condominium. There is thorough work division in the eleven systemists. Those systemists set up sub-groups and they hand in a sequenced form to the automaker, which finishes the vehicle final assembly. Yet there is a high participation of the suppliers in the work division.

**Picture 2 - Inter-firm Mechanisms of governance in the modular consortium**

	<b>Industrial condominium</b>
<b>Division of work</b>	The suppliers set up subsystems and deliver them in a sequenced way to the automaker to set up the vehicle in the final line.

<b>Problem solving mechanisms</b>	There are daily meetings with the automaker to discuss logistics and production operational subjects
<b>Type of information</b>	High volume of information in the design, production and negotiation processes. High quality and frequency of exchange information. Daily the systemist supplier has to pass on logistics and stock information to the automaker.
<b>Frequency on interaction</b>	High frequency on interaction. Once a day suppliers and automaker take part in official meetings to deal with production and logistics matters.
<b>Commitment with resources</b>	High intensity of commitment with technological resources and managerial systems. There is a joint-venture in Germany between the supplier and the assembler.
<b>Speed in decision taken</b>	Larger flexibility of processes and of provisioning on the productive line. It demands less planning.
<b>Formality and informality</b>	Presence of contracts as formal mechanisms and presence of the social nets as informal mechanism.

Problem solving mechanisms are presented daily within the automaker-suppliers relationship. At daily meetings, operational matters involving logistics and production are discussed. Those are good moments for the suppliers to make suggestions and it can also build up some identity among people in their “face to face” contacts. Because of that, in industrial condominium the frequency of interaction is high.

The type of exchanged information involves design, production and processes of negotiation. As there is high interdependence among the automaker and systemist, high quality and frequency in exchanging information occurs. Supplier 3 has to daily inform the automaker about logistics and inventory.

There is an intense commitment with technological resources and management systems between the automaker and systemists. The fact that the automaker has a joint-venture with S3 illustrates the commitment among the companies for their mutual development on the managerial system.

The industrial condominium can speed up decision making. The fact that the plant is modular allows more flexibility to the processes, products and the

productive line supply. The industrial condominium not only involves contract, but it also maintains highly united social nets. Therefore, there are formal and informal mechanisms in the control inter-firms at the industrial condominium. In that system, because of the proximity, there is also gain in refined information, flexibility, diffusion of tacit knowledge and reciprocity, problem solving mechanisms, exchange of daily information, commitment with resources, process flexibility and presence of formal and informal mechanisms of control.

In the industrial condominium as well as in the modular consortium, the set of formal and informal rules is able to control and, at the same time, to create rules of trust and reciprocity among the actors.

#### **6.4 Mechanisms to control performance in industrial condominium**

The type of control used by the automaker involves, basically, control over the results and it differs from modular consortium, where the control in the process is much stronger and critical. The suppliers’ evaluation is accomplished multi-functionally, using different ways to measure logistics, engineering, quality, finances and commercial areas. Taking into

account the systemists' choice, those performance criteria were very relevant. But after hiring the systemist, the automaker starts to control just a few performance criteria.

The automaker starts the control taking into account its internal performance criteria. Its performance criteria directly related to the modulist are: the customer's complaints and blockage in the customer's line. If the systemists stop the line in the automaker, there is a very heavy fine (calculated by number of minutes that the line is not working). The industrial director considers that he has a more rigorous system of measurement for intern performance than that one used by the automaker itself to measure its suppliers' performance. Then, in the industrial condominium, controlling the results is more evident than controlling the process.

The systemists also have intern performance measurement systems. The S3 has various performance indicators, such as physical sales, the customers' complaints, field failures, stoppage in the customer's line, medium time of failures, waste and reject control, material blocked by suppliers, auditing of the product and maintenance control. All those indicators are available to the automaker, if necessary.

As one of the directors of the automaker has said "it is much easier to measure those performance issues with the systemists, as they bring infinitely fewer problems to us..... sometimes it is much more difficult to take care of the screw on the glove compartment from another traditional supplier, than from the systemist. If it let the line be stopped, the costs can be very high. Then, it is vital to take good care of the process. Therefore, daily meetings would allow us to do a preventive work".

Informal aspects are also present in the industrial condominium. Those aspects include trust, relationship, friendship within the plant and organizational dynamics. As mentioned in the modular consortium, those informal aspects help predictability and control of behavior and they are also related to culture and identity.

## 7. RESULTS ANALYSIS

This article has analyzed the main mechanisms on inter-firm governance present in a modular consortium and in an industrial condominium in

the automotive industry. Therefore, mechanisms of relational governance as mentioned by Fergunsom et al. (2005); Poppo & Zenger (2002); Uzzi (1997); Grandori & Soda (1995) and Granovetter, (1985) were analyzed. It has also been checked how performance control is conducted among companies, based on Tiwana (2008) and March, Schulz and Zhou's (2000) analyses.

Modular consortium as well as industrial condominium have presented considerable homogeneity in practices conciliating modularity with high relational and performance control mechanisms. The use of formal and informal mechanisms of governance in those structures is in accordance with the results presented by Poppo and Zenger (2002), Ferguson et al. (2005) and Fredriksson (2006). The actors' high interdependence generates new capacities of coordination, as mentioned by Fredriksson (2006). Modular consortiums, as well as industrial condominiums are based on relational mechanisms and performance control mechanisms (formal and informal).

There are strong evidences that both propositions mentioned in this paper could be confirmed in future researches. Proposition 1 "modularity has stimulated the creation of relational mechanisms to inter-firm governance" was confirmed according to the results of the research and studies presented by Pires and Sacomano Neto (2008); Fergunsom et al. (2005); Poppo & Zenger (2002); Uzzi (1997); Grandori & Soda (1995) and Granovetter (1985). Modular consortiums, as well as industrial condominiums, use several relational mechanisms of governance, such as high exchange of information, problem solving mechanisms, trust and reciprocity. However, in the modular consortium the intensity in relationship is stronger than in the industrial condominium, due to high levels of interdependence. However, in the modular consortium, the intensity of the relationship is greater than in the industrial condominium due to the high degree of interdependence.

Likewise, the proposition 2: "modularity has stimulated the creation of mechanisms to control inter-firm performance" can also be confirmed. However, in modular consortiums that control is stronger too, including more social and inter-firm interdependence mechanisms. In modular consortiums the modulist depend on whether the vehicle gets approved in the end of the assembly line. Then, besides formal controls, there is an indirect control among the directors of the modulist

“if a modulist makes a mistake in a performance criterion, all pay for that” said a modulist director. As formal and informal performance controls are added, a highly cohesive and controlled institutional structure is generated.

As for the type of control found in the arrangements, in the modular consortium there is intense control of the process and results, according to Tiwana (2008). In the modular consortium, the suppliers take over the module assembly and the automaker has to control the processes, amount of production, productivity, idleness, among others. Yet, in the industrial condominium, the control of results is gathered in a more intense way by the automaker. In the condominium, the process control is accomplished by the systemists and, in the modular consortium, the automaker follows up the process, controlling and adjusting it according to the needs. As a result, besides the formal elements of control, in those arrangements there is a normative and informal control among the modules in order to keep high levels of productivity. It is in agreement with Hollingsworth and Boyer (1997), who highlight there are ways of coordination, through which collective actors control each other to generate results.

Both the modular consortium and the industrial condominium involve collaborative agreements in the assembly of components, systems and modules, covering relational aspects of governance, such as: trust, long-term contracts, reciprocity, reputation, channels of interdependence and formal and informal mechanisms of control. These contemporary forms of governance have generated new forms of production organization and coordination of operations, based on cooperation, integration and control of inter-firm collaborative processes. As the results indicate, these forms of governance also contain horizontal and vertical structures to support the exchange, the resource interdependence, the mutual lines of communication, the economies of scale for research and joint production, as well as the sharing of risks and market uncertainties. In this sense, the article contributes to the discussion about the nature and main characteristics of relational and inter-firm control mechanisms in contemporary production arrangements.

## 8. FINAL CONSIDERATIONS

Taking into consideration the results of the research,

it is noticed that the higher the value added on the parts and participation in the assembly system, the bigger the need for integration in the processes through governance mechanisms and performance on the process and results will be. This result is in agreement with Hoek et al. (1998), who mention that the modular consortium simplifies the complexity of the product, but it increases inter-firm control, it combines standardization with products customization and decreases the lead team production.

Therefore, it was observed that the modular consortium applies relational mechanisms and performance control with great intensity. As outstanding for Grandori and Soda (1995), besides the existence of formal mechanisms of coordination, the consortia use an intense social coordination, where there are several informal mechanisms of coordination and control.

As Britto (2002) points out, the relevance in the ways of inter-firm governance is due to its capacity to capture the growing sophistication in relationship among companies that characterizes the contemporary economical dynamics. This research field is relevant in order to study sub-recruiting and outsourcing processes accomplished by companies specialized in certain activities. There are some relationships that are structured in vertical nets inside the productive chain (for example: relationships between automaker and auto-parts suppliers).

Ways of inter-firm governance have been rising up great interest in the last decades. Piore and Sabel (1984) were pioneers in pointing out new logic for production (flexible specialization) as an alternative system to mass production. In this system, the companies adopt new organizational ways through productive and technological inter-firm cooperation to answer to the environment demands.

In this context, ways of governance are based on formal and informal mechanisms of control as well as several relationship mechanisms. Above all, the results obtained in this study confirm that the supply chain configuration and the relationships among automaker and its suppliers are a decisive issue. Certainly, new studies about relationships among modularity, control and relational mechanisms are necessary to understand the limits and possibilities in each productive system.

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## **AUTHOR'S BIOGRAPHY**

**Mario Sacomano Neto:** Assistant Professor in Methodist University of Piracicaba. He holds a PhD degree in Production Engineering at the Universidade Federal de São Carlos (UFSCAR) and was visiting scholar at the University of Chicago (2001). He holds a Master degree in Production Engineering at the Engineering School of São Carlos (EESC), University of São Paulo (USP) and is graduated in Administration.

**Sílvio Roberto Ignácio Pires:** Graduated and has a master and doctoral degree in Production Engineering and more than twenty five years of professional experience as manager, consulting and professor of operations and supply chain management in Brazil, Switzerland, Spain, and France. Alongside he has been working for companies as Volkswagen, International Paper, SAP, Embraer and Vallourec-Mannesmann.

**Eliciane Maria da Silva:** Assistant Professor in Methodist University of Piracicaba. She holds a PhD degree in Production Engineering at the Engineering School of São Carlos (EESC), University of São Paulo (USP). Her areas of interest are operations strategy, supply chain management, best practices and performance measurement.