Supplier Involvement in Product Development Process (PDP) for Automotive Industry.

Dirlene da Costa Leite (dibedi_costa@hotmail.com).

Milton Borsato (borsato@utfpr.edu.br)

Universidade Tecnologica Federal do Paraná (UTFPR)

Abstract: *In order to comply with the market demands and a complex product development cycle such as the automobile, the assembly companies are integrating the suppliers in the product development process (PDP). There are strong indications that this customer-supplier collaboration provides benefits such as cost reduction, development time reduction, reducing the chances for project delays, and facilitates the incorporation of new technologies. The objective of this article is a revision of the literature about the integration of the supplier in the product development process.*

Key words: *supplier involvement in PDP, automotive industry, product development.*

1. INTRODUCTION

The global transformations that occurred during the last decades, reduction of product life cycle, increasing customer demands and the need for launching the products faster in the market, has led to the automotive industry to rethink its product development process. In order to support this step increase, the assembling companies rationalized the internal activities for developing new vehicles, valuating project actors and development of competing engineering "Middler et al.(2008)". With a complex product development cycle such as the automobile, the automotive industry has adopted integrating the supplier in the PDP "Tang (2007a)". According to "Amaral and Toledo (2008)", there is a strong indication that the collaboration of client and supplier may bring positive factors to the PDP, such as increasing productivity, reducing development time, reducing the chance of project delays, facilitating the incorporation of new technologies, among others. The objective of this article is to revise the literature for the new research on the involvement of the supplier in the development process of the automotive industry.

2. REVISION OF THE LITERATURE

2.1 Product Development Management

The product development process (PDP) may be used as strategic and factor and competition of the company. PDP may be generically characterized by the following stages: product design management, product planning, product design, process design and pilot production. This is a didactic stage division and does not emphasize the interdependency among the same, however, in practice, these stages are overlapped and are interactive in surveying solutions "Martins et al. (2003)".

According to "Toledo et al. (2001)", in order to obtain competitive advantages resulting from differentiated products, the organizations, besides a good production capacity, should also have performance over the PDP, obtained in large part due to appropriate strategy and efficient management. "Martins et al. (2003)" adds that factors considered as critical for good management and performance of PDP are obtained from team work, leadership, project management, involvement of suppliers and customers, simultaneous and integrated development, prototype manufacture capacity, tests, tools and pilot production.

Automotive industry, with the goal of launching products faster in the market in order to comply with the demand, has been integrating the participation of the supplier in the product development process, this requires a revision and improvement of the management of the product development process.

The contribution of the PDP to the competition capacity is more and more emphasized and at the same time is important is acknowledged for defining the final quality of the product "Martins et al. (2003)".

2.2 Supplier Involvement in the PDP of the automotive industry.

According to "Corswant and Tunanlv (2002)", in the long term, the competition capacity of any manufacture industry is associated to the capacity of developing success products, this activity is considered as a difficult task since it is an interactive process, no linear, which should be tuned with the market objectives. Due to this, some of these industries have identified the need to mobilize efforts, inside and outside the organization, and direct such effort to the PDP.

To support increasing the steps, the OEM´s (original equipment manufacturer's) rationalized their internal activities for developing new vehicles, valuating the project authors and development of concurrent engineering. 50 years ago the

added value of the automotive chain was almost integrally in the hands of the large vehicle manufacturers. Currently, 70 to 75% of a vehicle acquisition cost is directly depending on the operation of the suppliers, which went from an intermediate corporate structure to larger global groups such as Arcelor, Bosch, Faurecia and Valeo "Middler et al. (2008)".

According to the authors "(Amaral et al. 2008; Corswant and Tunalv 2003; Da Silva et al. 2007; Hartley et al. 1997; Martins et at. 2003; Moreira, 2005; Ragatz et al. 1997; Rozenfeld et al. 2006 and Silva et al. 2003)", the involvement of the suppliers in the PDP may significantly contribute to improve the performance of the process in terms of time, quality and cost. May allow faster technological innovations and allow the company specializing in its *core business*, i.e., design and assembly of the vehicle, and not its specific parts. The OEM may complement its competence with the gains obtained with the involvement of the suppliers in the PDP "Xenphon et al. (2007)". According to "Langer and Seidel (2009)", besides reducing cost, time and increasing quality, the involvement of the supplier may help the supplier to solve manufacture problems when participating in early design, the supplier may use its experience to provide suggestions and improve process and product performance.

The decision of involving the suppliers in product development is more than a *make or buy* decision, this is even more determinant in the case of the automotive industry, since the decision to buy a component does not necessarily imply in designing the same. "(Martins et al. 2003 and Silva et al., 2003)".

"Toledo et al. (2005)" emphasizes that it is practically impossible for an assembly company to be an expert in all the components and systems, since a car has about 30,000 components with varied technologies. The company shall be more and more expert in designing and assembling automobiles, in the same way, involving all the suppliers in the development process presents difficulties. The assembly companies have a trend of adopting a hierarchy among various suppliers, creating levels or tiers among them. In the most part, only the 1st level suppliers end up involved in product development with the assembly company "Silva et al. (2003)" and "Toledo et al.(2005b)".

2.3 Forms for Supplier Integration in the PDP

According to the authors "(Amaral and Toledo 2008, Martins et al. 2003, Silva et al. 2003, Toledo et al. 2005b)", specifically for the automotive industry, may be identified three types of projects according to the information flow, grade of integration of the assembly company and the suppliers of car parts involved in the project, and the responsibilities that are shared. The projects may be; parts integrally designed by the supplier, parts with high involvement of the supplier with the assembly company for executing the design (*Black-box*), and part with design executed by the assembly company (*Gray-box*).

According to "Xenophon et al. (2007)" in *Gray-box* type design the supplier may work side to side with the OEM, exchanging experiences, information, know how, technology, and providing suggestions, but generally do not take over the responsibility for developing the design of car parts or final product modules, on the other side, in the *Black-box* type design, the OEM and the supplier may develop the design in their own company, in this case each one concentrates on its tasks and components. The *Black-box* may be granted to the supplier for developing parts, components or subsystems. According to "Hartley et al. (1997)" in *Black-box* practice, the supplier may develop the product, component or system with high quality, faster than the OEM and also with lower cost. According to "Xenophon et al. (2007)" both types of design may provide return such as innovation and product quality.

"Toledo et al. (2005b)" present the co-design as a relationship between the assembly company and the supplier, this is a practice that considers the joint development of a product. "Toledo et al.(2005b)" present the main characteristics that may be observed in co-design practice:

- The requests are presented earlier to the supplier, including specifications about target price and functional description of the product.
- The selection of the supplier is also done by the project department and not only by the purchase / provisioning department.
- Transfer of know-how to the supplier.
- Few suppliers per products (one or two).
- Presence of supplier representatives in the design team of the assembly company with direct responsibility for the development of the automobile.
- A project manager is assigned at the supplier. The supplier has autonomy for selecting the methods and techniques to be used for developing the system or subsystem, but has the obligation to make a clear selection.
- Intensive communication among both parties.
- Flexibility for requests of the assembly company with changes occurring during the design with due agreement of the parties;
- Earlier integration of the financial aspects with the technical aspects of the project.
- Validation of results obtained in a continuous or iterative process.

According to "Ragatz (1997)", for many companies, the extension of the participation of the supplier in product development depends on characteristics such as; technical complexity, strategic importance, dollar or projection volume. According to "Tang (2007)", considering the collaboration depth, the integration/involvement of the supplier in

the PDP may be defined as two forms of collaboration: *quasi supplier integration and full supplier integration* as shown in (fig. 1). In *quasi supplier integration, the Know How* and information remain individually with each one, there may be an exchange of recommendations and feedback. In *full supplier integration* during all the development cycle, occurs a free exchange of know how and information.

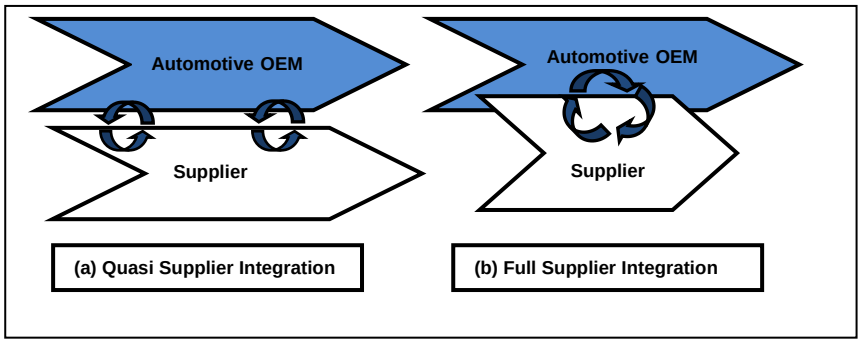

Figure 1: Forms of integration- *quasi supplier integration and full supplier integration.* Adapted from Lindquist et al.(2008)

"Lindquist et al.(2008)" demonstrates other three partnership formats (fig. 2) in product development, considering the benefits and limitations of each one. The first option would be having a representative of the supplier as an engineer physically resident at the OEM, this would allow him to have the same information as the OEM team, however, this may tie the company to the supplier, which may generate future difficulties for promoting competition with other suppliers, presenting difficulties for changing the supplier when another could provide better products.

The second option is the collaboration in *satellites offices* where the suppliers are in their own companies, but work with safe networks of PLM (*Product Lifecycle Management*) solution of the OEM´S, this is used only for consulting services, and under the condition that this should not present risk for the competition among the suppliers of the same product, the problem of this option is obtaining the permission of the OEM for the transfer of information in its PLM network to the supplier network.

The third option would be each one working in its own company and exchanging information by e-mail, this is an apparently safe and easy way to exchange information, however, it is difficult to maintain updated information.

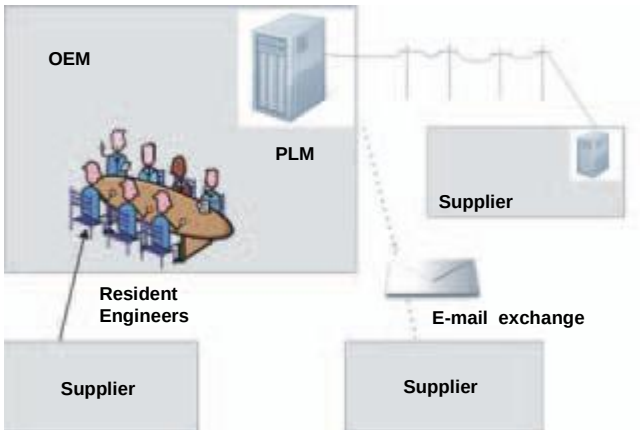

Figure 2: Forms of integration – Adapted from Lindquist et al.(2008)

"Middler et al.(2008)" presents a model of cooperation used in Europe, which, against the current practice, had a leading role in the affirmation of a new relation model, *Co-development*. This model associates competition and cooperation. Competition occurs when the suppliers work for the group of vehicle manufacturers, which on their part places them in competition among them. The cooperation shows up when, instead of the classic purchasing system, the manufacturers signal their intentions to the suppliers still during the initial stage of the project, using as reference an agreement on the key objectives of the program. Then, the selected supplier is intimately integrated into the process. This dissemination of *co-development* presented an important contribution for improving the vehicle development process, the improvements may be identified in relation to the capacity for developing new products, time for development, as well as the cost for this development.

"Middler et al.(2008)" demonstrates some aspects referring to co-development:

- Reduction of the group of certified suppliers
- Early involvement of partners and larger margin for maneuver
- Intervention perimeters
- Responsibility for reaching an objective with priority for the global result "quality, costs-terms"
- Frequent and clear communication
- Strong integration of technical logic and economic logic.

According to "Rozenfeld et al.(2006)", the definition of partnership in *co-development* may occur during all the stage of Conceptual Product Design. According to "Young et al. (2008)", the integration of the supplier during the initial design stages was fundamental for reducing the lead time, avoided future problems of production and unnecessary costs, these characteristics were observed in the Japanese management model.

2.4 Methods and Tools used in PDP with Supplier integration

In the survey conducted by "Martins et al.(2003)", the tools used in PDP were; using the manuals of QS9000 (APQP), QFD, FMEA, 8D, the CAD tool was also a strong contribution source used for simulating the integration of the components, besides these, were also used other tools proposed by the manuals of the development center of the headquarters.

"Toledo et al.(2005b)" identified the presence of multifunctional design teams, using FMEA, QDF and the manuals of QS9000, and for those suppliers with a defined practice for PDP, the assembly company disseminated its management practice.

"Silva et al.(2003)" discovered in these studies that the main identified practices were; using the principles of Simultaneous Engineering, FMEA, QDF, DFM, exclusive team for each project, and using the Information Technology in the PDP method.

According to "Toledo et al(2005ª)", tools such as: expansion of simultaneous Engineering to other suppliers and clients of the company, adapting VDA standards (German Quality System Standard), adoption Six Sigma Programs and using software for supporting the PDP are the most common tool used for PDP management. With a survey of the possible practices and methods used for PDP, "Toledo et al(2005ª)", surveyed the influences of the same in the PDP, such as one of the examples identifying which tools or methods (fig. 3) influenced the quality of the design, when used.

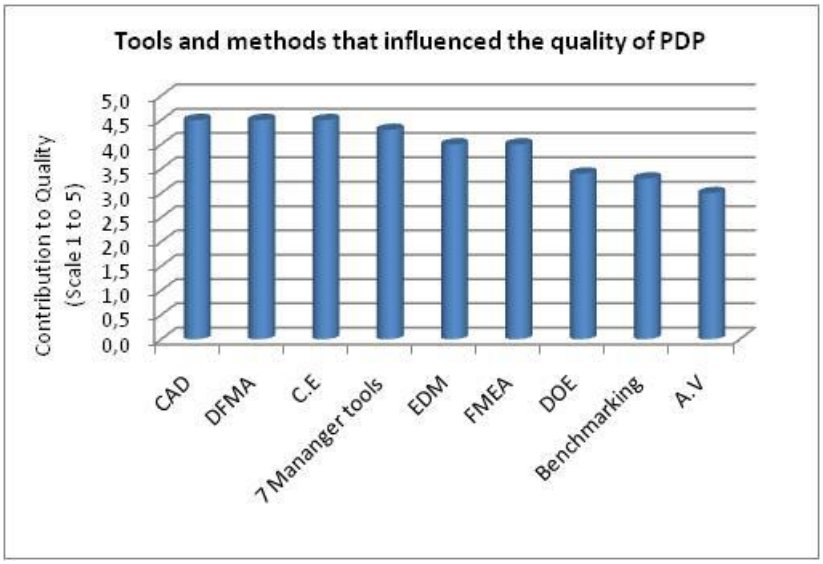

Figure 3: Tools and methods that influenced the quality of PDP.

According to "Toledo et al.(2005a)", the methods and tools that most influenced the time characteristic of PDP are represented in (fig. 4).

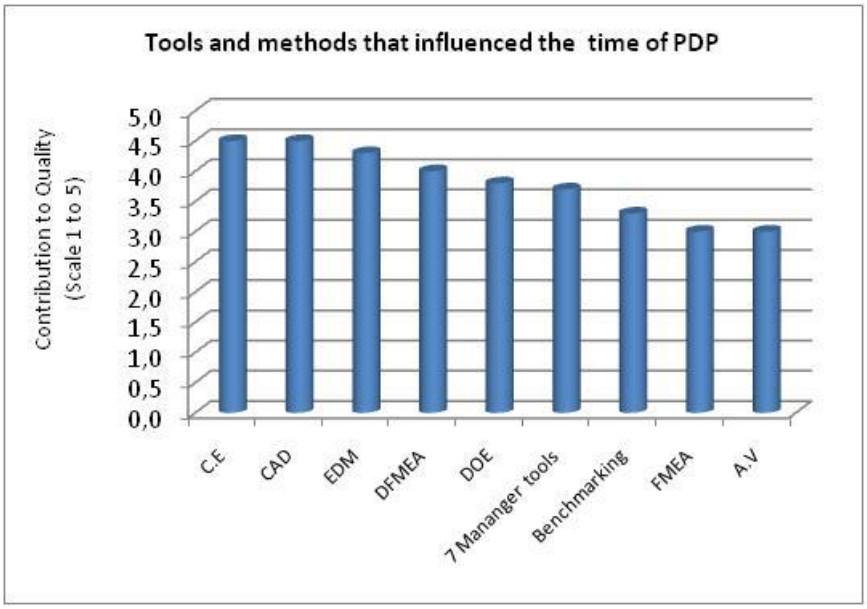

Figure 4 Tools and methods with influence in the time of PDP

Similarly, "Toledo et al.(2005a)" represent in (fig. 5) the methods and tools with more influence in the productivity of the PDP.

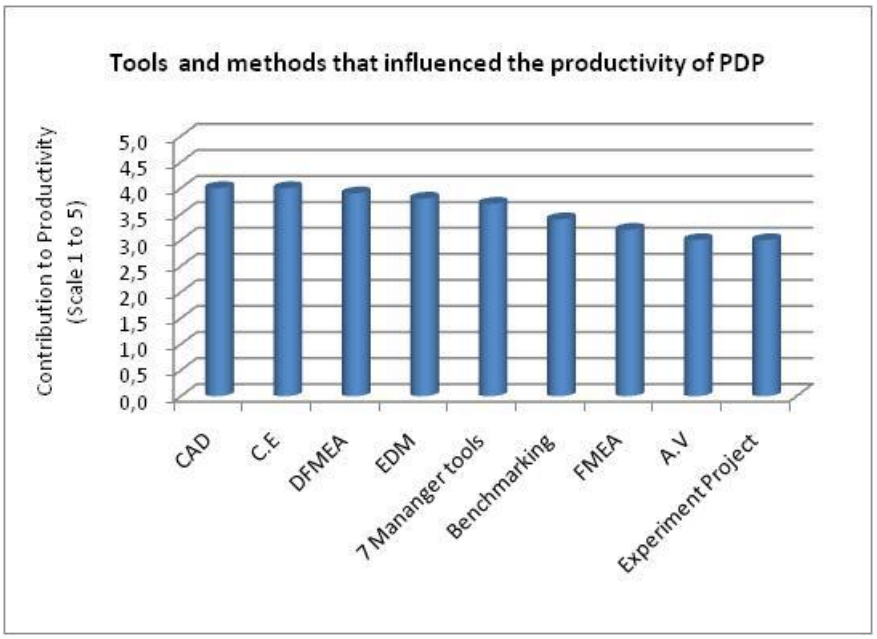

Figure 5: Tools and methods with influence in the productivity of the PDP

3. POSITIVE AND NEGATIVE FACTORS OF CO-DEVELOPMENT

This section presents the positive and negative points of the involvement of the supplier with the PDP of the automotive industry obtained from case studies in the surveyed articles.

3.1 Positive and Negative Factors informed by the assembly companies

With case studies, the authors "(Martins et al. 2003, Silva et al. 2003 and Toledo et al. 2005b)" surveyed the impact caused by the integration of the supplier in the PDP, this survey identified positive and negative factors. Among the positive factors informed by the assembly companies are the following:

- Quality above the expected.
- Analysis of interaction of components.
- Awareness for adopting management model for PDP.
- Application and consolidation of simultaneous engineering concept.
- Transfer of *Know How*.

- Application of FMEA technique simultaneously for product and process bringing may benefits and finding solutions for the problems.
- Design performance according to the expectations in terms of time, above the expectation in terms of productivity and quality.

And as negative factors, the following were mentioned by the assembly companies;

- Expertise and autonomy needed to solve problems.
- Supplier too dependent on the headquarters.

3.2 Positive and Negative Factors from the point of view of the suppliers:

In the same way as several studies informed the positive and negative points of view of the integration observed by the assembly companies, the suppliers also informed the balance obtained during the co-development process. According to "(Martins et al. 2003, Silva et al. 2003 and Toledo et al. 2005b)" the positive points presented by the suppliers are as follows:

- High integration resulting in final product quality
- Team work
- Good communication
- Participation in the early stages for more efficient design
- Performance in time and quality above the expectations
- Flexibility for proposing changes
- Strong interaction with the other suppliers
- Close relation for solving and anticipating problems.

And for the suppliers, the factors that may be considered as negative for the obtained experience were:

- Delay in defining the supplier
- Lack of technical information at some time
- Lack of final *Feedback* of the design under test
- Exchange of data with the assembly company
- Insecurity of the assembly company due to being the 1st experience with the supplier
- Tests of integrative proof only at the end of the design
- Low productivity due to a lot or reworking as a result of lack of definitions and design changes by the assembly company
- Lack of volume assurance
- Delay by the assembly company for approving suggestions for change
- Very tight costs due to the lack of integration of the internal areas of the assembly company (engineering and purchases).

4. DISCUSSION

Currently, it is evident that for having an more efficient PDP, particularly in the development of new vehicles and the urgent needs for increasing the step and reducing costs, reducing time and increasing quality, the integration of the supplies is required in this process. The large challenge is resumed as how to do it and how to manage it in order to maximize its contribution. Customer-supplier collaboration in the product development process may bring goods results for both involved parties, but in order to this being effective, it is necessary to overcome some difficulties during the integration process. More than having tools to facilitate the integration process, it is necessary to have a manageable process. The divisions of tasks and responsibilities, maintaining the trust and partnership are factors that should be cultivated to maintain the win-win relation for new developments. Tools such as FMEA, QFD, 8D, Simultaneous Engineering, have demonstrated being very useful and recurring cases of successful PNP helping in optimizing them and managing risks of cost, design quality, may also help in anticipating possible problems and solutions.

On the other side, many suppliers do not have the necessary expertise for participating in this development presenting a high grade of dependence with the development centers and the headquarters abroad. Also, they face some difficulties to obtain information with the assembly companies that delay passing design information.

5. REFERENCES

[1] AMARAL, DANIEL. C, TOLEDO, JOSE C., 2008, "Colaboração cliente fornecedor e qualidade no processo de desenvolvimento de produto". 15 october 2008 <http://www.iautomotivo.com/desenvolveproduto.htm.>

[2] CORSWANT, FREDRIK. TUNALV, CLAES, 2002,"Coordinating customers and proactive suppliers: A case study of supplier collaboration in product development". Journal of ENGINEERING AND TECHNOLOGY MANAGEMENT JET-M, Vol.19, pp. 249-261.

[3] DA SILVA, KAREN. M, ZAWISLAK, PAULO A., May/aug. 2007, "O Processo de desenvolvimento de produtos, em um estudo de casos de três empresas fornecedoras da cadeia automotiva no Rio Grande do Sul", Rac-Eletronica, Vol.1, n2, art 4, pp.51-65.

[4] HARTLEY, J.L, et al., 1997, "Suppliers' contributions to product development: An Exploratory study", IEEE Transactions of Engineering Management, Vol.44, n.3, pp.258-267.

[5] LANGNER, B. SEIDEL, V.P., 2009, "Collaborative concept development using supplier competitions: Insights from the automotive industry", Journal Engineering and Technology Management, Vol.26, pp.1-14.

[6] LINDQUIST, ANDREA et al., 2008, "Supplier integration and communication strategies in collaborative platform development", Concurrent Engineering ,Vol.16, pp. 23-35.

[7] MARTINS, MANOEL F. Et al., 6 a 8 de oct. 2003, "Um estudo de caso de Co-design em um ambiente de condomínio indústria", IV Congr. Bras. Gestão e Desenv. de Produtos - Gramado, RS, Brazil.

[8] MIDLER ,CHRISTOPHE, et.al., april/may 2008, "Gerenciamento de projetos na indústria automotiva, do co-desenvolvimento à co-inovaçao", Revista Mundo Project Mangement, year 4,nº 20.

[9] MIGUEL, PAULO A.C., June 2006, "The Potential of new product development in the automotive industry in Brazil, an exploratory study", Product Management e Development, Vol.4, pp.35-43.

[10] MOREIRA, ANTONIO C., jan-abr.2005, "O problema da co-especialização no desenvolvimento de produtos colaborativos de novos produtos", Revista Produção, Vol.15, pp.023-033.

[11] RAGATZ, GARY.L. et al., 1997, "Success factors for integrating suppliers into new product development", Elsevier, Vol.14, pp.190-202.

[12] ROZENFELD, H. et al., 2006, "Gestão de desenvolvimento de produtos: Uma referência para a melhoria do processo", Ed.Saraiva, S.Paulo, 249 p.

[13] SILVA,SERGIO L. et al., 6 a 8 de oct. 2003, "Participação de fornecedores no Desenvolvimento de produtos, O projeto da nova versão do Fiat Palio", IV Congr. Bras. Gestão e Desenv. de Produtos - Gramado, RS, Brazil.

[14] TANG, DUBING., 2007, "Collaborative Supplier integrations for automotive product design and development", Proceedings the 2007 11 the International Conference on Computer Supported Cooperative Work Design.

[15] TOLEDO, JOSE C. et al., Set.2001, "A gestão do processo de desenvolvimento de produtos na indústria brasileira de autopeças, praticas correntes e principais problemas", 3º Congr. Bras. Gestão e Desenv. de Produtos - Florianópolis, SC, 25-27.

[16] TOLEDO, JOSE C. et al., 2005, "A gestão do desenvolvimento de produtos na indústria brasileira de autopeças", Revista Instituto Fabrica do Milênio,Vol.3, pp.20-34.

[17] TOLEDO, JOSE C. et al., 2005, "Um estudo de caso sobre o Co-design na indústria automotiva brasileira", Revista Instituto Fabrica do Milênio,Vol.3, pp.55-69.

[18] XENOPHON, A. KOUFTEROS et al., 2007, “Black-box and Gray-box Supplier integration in product development: Antecedents, Consequences and the Moderating Role of Firm Size”, Science Direct Journal of Operations Management, Vol.25, pp. 847-870.

[19] YOUNG, K. Ro et al., May 2008, “Involving Models of Supplier Involvement in Design: The Deterioration of the Japanese Model in U.S. Auto”, IEEE Transactions of Engineering Management, Vol.55, n.02, pp.359-377.