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EXPLORING THE REASONS FOR DIFFERENT ROLES OF MODULE SUPPLIERS IN A CAR ASSEMBLY PLANT

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Modular strategy has been implemented by car assemblers, in some of their plants, from late 90's on. In the field of operations management, this is usually referred to an innovative approach of costs reduction, what could explain the high interest showed by car assemblers in the subject. Even though the concept has been widely used in either academic or industrial debates about automotive industry, it is not always understood in the same sense. Due to this, it is relevant to say what we mean by modular strategy in this paper.

As we see it, the strategy combines two perspectives, production and business, in search of optimization and efficiency. The production 'axle'[3] [1] is driven by modularity, while the business 'axle', by outsourcing. In a few words, modularity means to join several spare components in order to form a single assembly (that is called module) and to simplify the process of final assembly of the vehicle. Outsourcing, the other initiative of the assembler, means to transfer some activities of project development and of manufacturing for some suppliers. Both terms will be deeply explored next.

A modular operation demands a particular configuration where some suppliers, especially the modules suppliers, are very close to the final assembly line. The geographical proximity is justified by the operation: the modules must be delivered just in time and, some of them, sequenced, to the final line; the assembler plant runs with zero inventory of modules and the suppliers are co-responsible for the efficiency of the whole production process and not only for the part of it in which each one acts.

Module suppliers are geographically closer to the assembler. They pre-assemble the modules and also participate more on the development of components (of the module) and on the management of the sub-suppliers (producers of components). This is how the role of the

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[3] Axle' is a used here in a free reference to 'axis'.

module suppliers is described usually and, supposing that all of them have the same behavior, we decided to confirm this assumption.

The paper refers to the diffusion of modularity and outsourcing and to the effects of modular strategy on the supply chain, namely the suppliers positioned in the first tier (module suppliers) and in the second tier (the components suppliers). In order to better understand the current strategy, this work explores the role of the module suppliers in the new configuration, as well as the reasons for that.

The research method is case study. It focuses on a modular plant in south Brazil that runs in an industrial condominium, that is, co-location of the car assembler and the module suppliers in the same site. Besides the assembler, the field research counted with two firms that supply the modules suspension and cockpit, and with some sub-suppliers of components (tier 2 suppliers). These two modules were chosen because they add more value than the other modules of the car. We have interviewed directors of production, design and purchasing of all companies, and eventually some managers of production, logistics, technical sales and purchasing.

Next, the paper presents the conceptual approach of modular strategy in order to make it clear what should be the role of the module suppliers in such schema. The third section reveals the field results and discusses the differences among the first tier suppliers.

THE MODULAR STRATEGY

In the context of automotive industry, this strategy can be described as the combination of two concepts: modularity and outsourcing. The first one, modularity, is the division of a product or process into modules (each module is an assembly of components) in order to optimize the assembly process in the final line, by reducing the number of isolated components handled during the assembly of the vehicle. However, somebody somewhere has to receive the components and to assemble the module, and this work can be done by the assembler in a parallel line, or a module supplier can do it. This leads to the second concept implemented by the assembler, which involves the supply chain: outsourcing, or the transference of some activities, responsibilities and costs for suppliers. By outsourcing production from suppliers, the assembler reduces its participation in the production of the modules of the vehicle, meanwhile it dedicates to its core business.

Baldwin & Clark [4] define modularity as the division of a complex product in several parts that are projected and produced isolated, although they function as a whole and integrated set. This division guarantees greater flexibility for who projects, produces or uses the product; that is how the authors come to distinguish three dimensions of modularity: project, production and use. In project, the modules are simultaneously developed, what allows reducing the conception time. Modularity in use aims at fulfilling the consumers, as it allows them to choose the attributes that will configure its product. The production (of vehicles) is the last dimension and also the most frequently affected by the modular logic.

Modular production, as a concept, was first described by Starr[5] in a reference to the computers industry. In the sixties, modularity was a solution for the producers of computers that could not attend all different necessities of the consumers by the conventional production system (mass production). The idea was to decompose a product in modules (assemblies of

[4] Baldwin, C. Y. & Clark, K. B. Sep/Oct 1997 Managing in the Age of Modularity. Harvard Business Review, v. 75, n. 5.

[5] Starr, M. K. 1965. Modular Production - a New Concept. Harvard Business Review v.43, n. 6.

parts and components) to optimize the final assembly and to increase the variability of the product, without increasing the costs significantly. The final assembly is faster due to the reduced number of parts (modules) and, as the modules can be combined in different versions, one can manufacture varied products and also assure the consumers satisfaction.

From the perspective of the car assemblers, modularity has benefits like to increase the productivity. Hoek & Weken[6] mention reduction of logistic costs, less complexity in the final operation and reduction of lead-time (as it speeds up the process of final assembly). Baldwin & Clark say that the division of a product into modules simplifies the assembly and makes the process faster. According to Mcalinden, Smith & Swiecki[7], modularity in design is associated to more flexibility and to faster and expanded design capability. Also, the authors say that modularity in production allows reducing labor costs and engineering costs as well as achieving scale economies with lower investment.

Other benefits are associated to outsourcing design and production from suppliers. In every situation, it is only the assembler that makes the decision about what to outsource from suppliers and about how to do this. According to Sako[8], outsourcing decisions are financially guided; whatever does not add value is transferred for a third player. Arnold[9] adds that outsourcing depends on the available resources of the assembler to do internally, and to the cost comparison between make and buy.

Other reasons for outsourcing would be mentioned at this point. Technological, productive and administrative capacities of the supplier must guarantee the deliveries in accordance and on time. The aptitude involves other equally decisive factors for the selection of module suppliers as, for example, financial capacity to set a new plant and related investments. Due to that, the suppliers search for specialization and for technological domain, they associate with competitors to enlarge productive capacity and to fortify the financial management. The fact may also explains the strong reduction in the number of firms that are capable of being module suppliers at the moment.

If it is true that outsourcing is a 'tool' for the assembler to reduce costs, it also indicates that such reduction happens only at one point of the supply chain, and that costs, together with tasks, are transferred for the module suppliers. Then, one cannot assume that it helps reducing costs production of the whole vehicle.

Having decided to outsource the assembly of some modules from suppliers, the assembler needs these suppliers as closer as possible to the final line. The place where modules are assembled is very decisive for the assembler achieving its objectives.

The proximity of the supplier guarantees the sequential delivery of modules with flexibility to support alterations in the delivery program[10]. From the perspective of the

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[6] van HOEK, R. I. & WEKEN, H. A. M. 1998 The Impact of Modular Production on the Dynamics of Supply Chains. The International Journal of Logistics Management v. 9, i. 2, 35-50.

[7] Mcalinden, S. P.; Smith, B. C. & Swiecki, B. F. 1999 The Future of Modular Automotive Systems: Where are the Economic Efficiencies in the Modular Assembly Concept? Michigan Automotive Partnership, Research Memorandum No. 1. University of Michigan Transportation Research Institute.

[8] Sako, M. 2000 Modules in Design, production and Use: Implications for the Global Automotive Industry. GERPISA International Colloquium (proceedings)

[9] Arnold, U. 2000 New Dimensions of outsourcing: a combination of transaction cost economics and the core competency concept. European Journal of Purchasing and Supply, v. 6.

[10] Salerno M. S., Dias A. V. C. & Zilbovicius, M. 1999. Global sourcing X suppliers' proximity in the new auto plants: logistics and service in industrial condominiums and modular consortiums in Brazil. Managing Operations Networks. Euroma Conference, Venice (proceedings).

assembler, it provides greater agility in services and in problem-solving as well as it can operate with lower levels of inventory.

Modular strategy is more than simply modularity plus outsourcing; it is one of the main reasons of several current changes in the supply chain as, for example, the new role of module suppliers, the increasing importance of logistics and the creation of new productive arrangements. The strategy, implemented by the assembler, re-organizes the automotive production by the redistribution of value in the supply chain. Specifically, it involves:

1. the division of the vehicle into modules in order to reduce production costs (for the assembler) and to increase the productivity, among other reasons;
2. the transference of some responsibilities on project and on process to some suppliers;
3. the establishment of new industrial arrangements. One example of that is the industrial condominium, where assembler and suppliers share the production of the vehicles.

As we see it, there is no one modular strategy, but several possible combinations. Each assembler develops its particular list of what to modularize and what to outsource, and from this point on, it starts to design a modular strategy. Figure 1 indicates diverse alternatives for specific arrangements.

THE CASE OF A MODULAR PLANT

The plant is a Greenfield that started to operate in 1999. It produces a small car (sub-compact) mainly for Brazilian market (category responds for more than 60% of internal sales). Its capacity is 120.000 cars per year in two shifts operation. The program was designed aiming at great efficiency and productivity and it proved to be the most productive plant of the assembler all over the world. This is the argument of the assembler's purchasing director, although he does not reveal the figures. The indicators, he said, are: number of cars assembled by one man, extension of the final line and lead-time in final line.

Another characteristic of this plant, from the perspective of the assembler, is that it offers less (financial) risk than the others, because it is part of an industrial condominium. In this configuration, seventeen suppliers of components (chosen by the assembler) establish their plants in the same site of the assembly plant. Besides delivering the modules just in time and, some of them in sequence, the suppliers share costs of investments with assembler. Car, plant and supply system were simultaneously developed. The main attributes of this project are: the productive configuration itself, the logistics system, the zero inventories within the assembler plant (for inventory has moved to the suppliers' plants) and the co-location of module suppliers (in terms of project, production and supply management).

For this particular program, the assembler selected suppliers that were also willing to assume responsibility for some activities during the project development and in the production of modules and components. As we see it, such description on the role of the module suppliers is too wide and, as long as we questioned this argument with the managers of both assembler and suppliers, we got to visualize that not all module suppliers are the same.

MODULE SUPPLIERS: ARE THEY ALL THE SAME?

Having many possibilities from what to outsource and what to modularize, the assembler has designed basically two particular roles for the module suppliers. Indeed, from the two modules studied, the assembler has implemented a different strategy for each supplier of module.

The first one is the full integrator, which is represented by the supplier of cockpit. It is responsible for developing most components of the module after the assembler has defined the concept of them. It makes a previous selection of tier 2 suppliers (that has to be approved afterwards by the assembler) and it is responsible for purchasing the components that it does not produce by itself. Although the assembler has the final word about the choice of suppliers, the supplier called 'full integrator' is the one that chooses and negotiates with them. It is responsible for modules performance and for quality assurance. Whenever it is demanded, the supplier solves problems and makes changes on the design of components. Besides that, it pre-assembles the module, and it delivers the modules according to the assembly call, in sequence, to the final line.

The other role of module supplier that is recognized in this research is the producer; this is the role of the supplier of suspension module. The producer receives the components and pre-assembles the module to deliver it just in time. Suspension is not sequenced (as cockpit) despite the fact that some cars offer air conditioner.

Again as in the full integrator case, the components may be produced internally or they can be purchased from a tier 2 supplier. However, this ´producer´ does not produce any component; every part of the module is made by sub-suppliers (called tier 2). The producer does not select nor it negotiates with tier suppliers tier 2; it assumes very few activities and responsibilities in comparison to the other module supplier. The assembler designs the components, it indicates who will be the tier 2 suppliers and it negotiates the price of components with tier 2 suppliers. The producer participates just on the final validation of the production and is responsible for quality of components of the module.

From the point of view of tier 2 firms that supply for the ´producer´, there are few changes on modular operation because they keep on direct contact to the assembler, following its rules. However, they also have to deal with an extra client, namely, the module supplier, because tier two firms have contracts with both assembler and module supplier.

The tier 2 companies that supply for the ´full integrator´ are more intensively influenced by the modular system because the module suppliers partially substitute the assembler. The case of the cockpit showed that as long as the assembler transfers more responsibilities of design, purchasing and production to its module suppliers, the second tier suppliers have to deal with a new direct client, that is a different organization with different management practices. It takes some time to adapt to it because, as all tier 2 suppliers said, they do not leave the position of tier 1 forever, they keep on supplying directly to the car assembler (for the other cars). In Brazil, the practice of outsourcing the design and the assembly of cockpit is very rare; in most of the cars this work is still made by the assembler itself.

Having identified these different roles of module suppliers, the next step in research was to understand the reasons for that. Indeed, we found several of them.

First one is the technological performance of the firm that will supply the module. It includes the firm's capability in research and development, but also its production capacity and, obviously, its financial capacity to invest on it. From the firms we have found as modular

suppliers in this position, all of them followed the global corporate strategy, which has efforts towards modularity. However, this is not enough.

The second reason refers to a recognized benefit brought by modularity that is the simplification of production activity [2], from the point of view of the final assembly line. The point is that on the contrary of what happened in the computer industry, the car assembler has noted that by adding new combinations of modules to the modular and outsourced operation, it got much more complexity to deal with.

More, it realized that not all module suppliers were able to supply the volumes contracted initially and guarantee prices, quality levels and schedule that were negotiated. To sum up, some promises do not come true and that is how the assembler explains the decisions on modularity and outsourcing. Instead of solving problems, the supplier becomes a problem; for instance when the components quality is not guaranteed, or schedules are not confirmed. Sometimes it is simpler to do by oneself.

Third one is the nature of the product. We found that this assembler does not outsource design of parts of the car (components or modules) that are related to the security of passengers. It happens with components of the suspension, whose designs are made by the engineers of GM in Brazil and sent to the Tier two suppliers. More, the assembler chose tier 2 suppliers, with not a word from the module supplier. The cockpit is the opposite example, as the module suppliers had participated more intensively on design, selection of suppliers.

The organizational history is not decisive of the role of the module suppliers in this case. To make it more clear, that fact that one module supplier was once linked by ownership to an assembler (like Visteon and Ford; Delphi and GM; Denso and Toyota) does not seem to influence the decisions of the assembler. In this case, the assembler is GM, the producer supplier is Delphi, and the full integrator is Siemens-VDO.

FINAL REMARKS

This study focused on the operation of a modular car plant and its supply chain. The assembler designed a modular strategy in conformance with its objectives and resources at the Gravatai plant. The role of module suppliers is one important aspect of the modular strategy.

Despite the increasing relevance of the module suppliers (tier 1), the assembler is still the governor of the productive chain. It made its decisions about outsourcing and modularity based on a business and manufacturing vision. The assembler determined what parts of the vehicle would be transformed into modules, which parts would integrate each module and which activities the module suppliers would assume. Sometimes it indicated the tier 2 suppliers and it even defined the price of components supplied by tier 2.

Having studied the cockpit and the suspension, we identified two different roles of module suppliers: full integrator and producer. What differentiates them is basically the amount of activities insourced by each one (or outsourced from assembler to each of them), namely, the activities related to design of components, to its production and to the management of the supply chain.

The full integrator supplier assumes design and manufacturing, it shares engineering expertise with the assembler and it is responsible for purchasing the components and for managing the lowered tiers. These become more linked to the module supplier than to the car assembler.

Basically, the reasons for these two roles are: nature of the module to be outsourced, technological performance of the supplier (includes productive and financial capabilities) and level of complexity of the outsourced operation. Indeed, the reasons that explain why the supplier X has more autonomy on design (or production or even supply management) than supplier Y are also those reasons that explain why a module is not outsourced.

Figure 1. - *Modular Strategy*