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Company Actors on the Look Out for New Compromises
Developing GERPISA's New Analytical Schema

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STRATEGIES OF PRODUCT DESIGN, PRODUCTION AND SUPPLIERS SELECTION IN THE AUTO INDUSTRY: FINAL FINDINGS OF A BROAD RESEARCH IN THE MAJOR BRAZILIAN ASSEMBLERS' SUBSIDIARIES, HEADQUARTERS AND SUPPLIERS

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THE AUTOMOBILE INDUSTRY IN CHANGE

The automobile industry is undergoing important changes in the relationship among companies that operate in the chain, in the location of production activities, in the areas of engineering and development and in the organization of productive processes. The changes are taking place globally, affecting the way the sector structures itself in the various countries where there is automobile production and especially in Brazil. The phenomena can be characterized as follows:

New supply relationships and location of production activities. At the beginning of the 1990s there was an intensification of the flow of commerce and capitals on a global scale as a result of the liberalization of both capital markets and consumer goods. In this period, the large automobile corporations sought to expand their productive capacity to regions with a greater potential for growth in demand, given the low rates of growth in the central regions and countries (North America, Western Europe and Japan). The promise of growing demand in the "emerging" countries (among them Brazil, Argentina and Mexico, but also China, Russia and India the most significant market icons, which had not been so accessible or potentially decisive until then) led the large companies in the sector into an intense and concentrated process of internationalization. Brazil was one of the countries that most received industrial assembly units, whether from new entrants such as Renault, Mercedes-Benz (automobiles), Chrysler (at the time), PSA-Peugeot/Citroën, four small units of Honda, Toyota and Mitsubishi, or new factories such as that of VW, VW Trucks (presently VW Veículos Comerciais), Ford, and GM in addition to intense remodelling of existing units at all the companies already located here. The entry of new companies in the auto parts sector was associated to this wave of new investment[1] whether to install new plants to meet the demand for the production of new vehicle models, or by association with or acquisition of national capital companies[2]. Thus, the sector was internationalized and included in the global chain of production. There was an increase in the imports of various components, which generated a

sharp reversal of the sector's commercial balance[3]. A new division of labour for designing and producing parts and vehicles was established during this process, setting up a marked hierarchy in the chain of production. Brazil was the subject of experiments in organizational arrangements which attributed a new role to a certain kind of auto parts company – the direct suppliers – that of captaining so-called "modularity". All the new automobile assembly units - and even many of the older, remodelled units – came to utilize this concept in some way. At the same time, several of the new units were installed outside the traditional geographic industrial axis of Brazil (the state of São Paulo and to a lesser degree, in Minas Gerais), pointing up the issue of decentralization in the processes of value added which, as we will see, has not occurred as one might imagine at first glance.

The restructuring of production. In the 1980/1990s, the industry sought to meet the operating efficiency standards established by the Japanese companies of the sector, and beginning in the 1990s, a system of "lean production" was configured and included all related elements, such as just in time, team work, total quality (TQC/TQM), certifications of compliance with international quality norms, as well as microelectronic automation. Even with unequal advances, there is evidence that the large– and even the mid and small size – companies restructured their internal production apparatus in a quick and intense way: the absolute and relative reduction in jobs in the sector is an indicator of this[4].

Engineering activities and product design. Since product definition is decisive to the success of the automobile business, involving considerable sums (on the order of billions of dollars) and relatively long timeframes (on the order of 2 to 4 years or more), design activity has received special attention, becoming a priority over the other activities in the offices. CAD/CAM/CAE[5] automates and integrates the design activities of a company and its suppliers. Sharing costs of product development by producing in several countries, with the growing integration of suppliers at the first tier and at the first stages of project detailing, came to be the objective pursued by the "world car", which gave way to the worldwide platform strategy, aiming to make possible refittings and adaptation for markets with different characteristics. On the one hand, the world car and worldwide platform strategies raise the question of the possibility of a re-centralization of product design activities being developed in the peripheral countries, reframing the question of the international division of labour in these activities. On the other hand, it is verifiable that some of the vehicle designs have been headquartered in countries not central to industry, such as is the case of Brazil, and have been able to generate positive effects for the local establishment of this and other industries, attracting new investments and conferring major strategic importance to operations located in Brazil.

OVERVIEW OF THE STUDY: METHODOLOGY AND PROCEDURES

In order to deeply understand the changes which took place in Brazil's automotive chain, we undertook a two-phased procedure: first, a quantitative study and later, an in-depth qualitative study. The research did not consider companies that supply raw materials such as steel, paint and polymers since such activities follow a different logic than those of the auto parts chain properly speaking, and aside from price issues (linked to the dollar), there were no indications of deeper changes in the supply relationship. The quantitative phase, undertaken and completed in 2001, involved sending questionnaires to auto parts companies located through the use of several databases[6]. 224 questionnaires were processed, the largest sample that we know of in studies of this genre.

One of the main problems in defining the representativeness of a sample of Brazilian industry is the lack of reference parameters about the universe. This is no different in the auto parts industry, which notwithstanding its business concentration and institutional organization (Sindipeças), has undergone sharp restructuring in recent years. The exact number of active companies in the sector is not known, and neither are their sales income and employment levels. However, based on indicators provided by Sindipeças[7], the following profile of the representativeness of the sample can be sketched:

- ✓ 224 companies equal 48% of the total of 468 Sindipeças member companies, according to information on the internet. Nevertheless, not all 224 companies are listed on the entity's register.
- ✓ According to data from the questionnaires, the sample represents 131,298 jobs; Sindipeças estimates total jobs in the sector to be 170,000. Thus the sample covers 77% of the jobs estimated by Sindipeças.
- ✓ Answers about the origin of foreign capital of the companies in the sample are coherent with those of Sindipeças: 50% foreign and 50% national.

An analysis of the reliability of the sample can also be done using data from the RAIS 1998. Code 34-4 (Factory for Parts and Accessories for Automotive Vehicles) reveals that establishments with 20 or more workers[8] (795 occurrences) totalled 148,575 workers; our sample is equal to 88% of those reported to the RAIS. Even if we take the 7,194 establishments from the entire base of the RAIS for the activity code considered, which would raise the number of workers to 246,103, our sample is equal to 53% of the total number of jobs in the largest database available in Brazil[9].

The sample obviously shows a bias toward larger companies, which is to be expected in surveys of this type.

Once the results of the analyses of the quantitative survey were in hand, discussion activities were organized with the companies at Sindipeças. The focus group technique used, served not only to validate the data obtained, but also to begin the qualitative survey. Three groups were organized: direct suppliers, 1st tier indirect suppliers, and those at 2nd and 3rd tiers. These groups discussed basically the issues of bottlenecks and problems in the chain and general aspects of the transformations that had occurred.

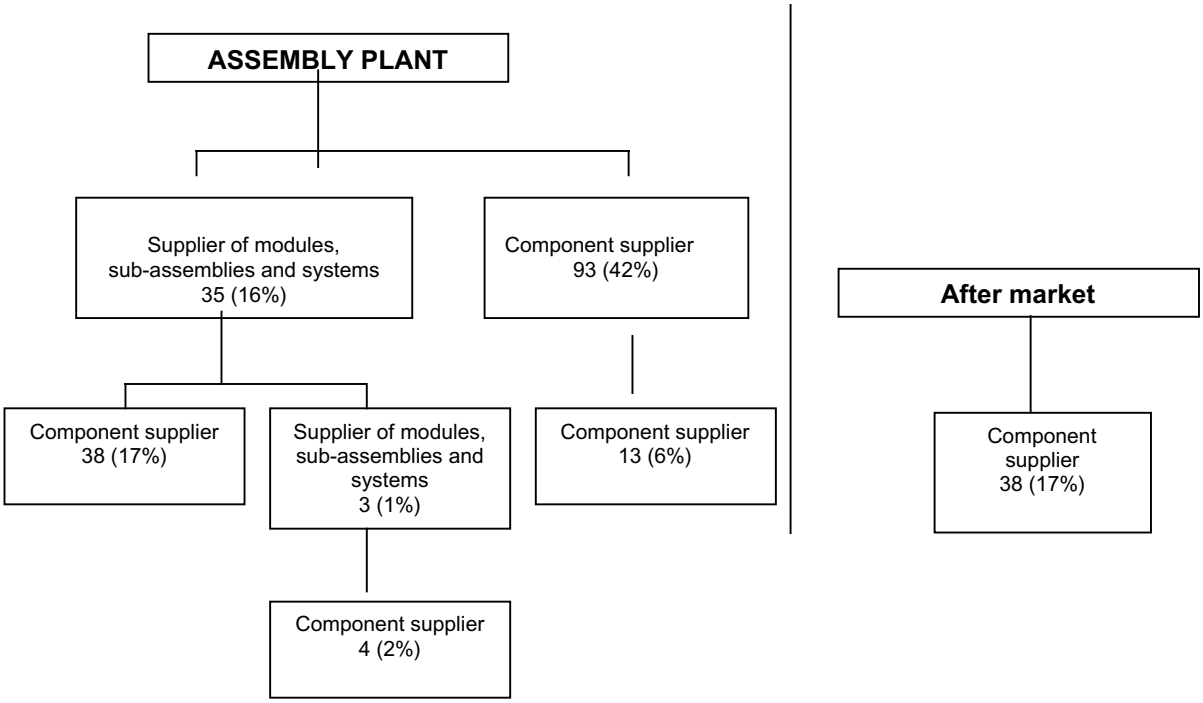
Later, 33 auto parts companies and 7 assembly plants (including the five oldest) were studied in depth through a survey of secondary data, an analysis of the quantitative questionnaire and interviews with directors in the areas of purchasing/supply and design/product development[10]. In parallel and again in a new way for studies in the sector, interviews were done abroad, involving 4 company headquarters, a visit to two development centers and one recently installed factory. This made a deeper understanding of the issues possible, especially the position of the Brazilian subsidiaries in the context of the group, and the policies in relation to suppliers and product development[11].

In this way, by integrating quantitative and in depth qualitative research and surveys at the company headquarters, we can create a sufficiently broad understanding of the automotive chain in Brazil.

SUPPLY RELATIONSHIP

The automotive chain underwent major transformations beginning in the 1990s. If up until then the assembly plants had promoted efforts to reduce the number of suppliers, they had not invested in changes to the chain's structure: reducing the number of suppliers had earlier meant reducing the number of suppliers per piece or part rather than the transformation of pieces/parts into sub-assemblies. This transformation was deepened with the advent of so called "modularity", in the second half of the 1990s, transforming the relationship between assembler and supplier. The new factories in Brazil were pioneers, making Brazil the priority testing ground for the global automobile industry (Lung et al., 1999). Thus it was that the assembly plants reduced the number of direct suppliers from around 500 to about 150 using the modular scheme, and a new level of hierarchy was created in the chain - the direct supplier, also known as the module supplier. This supplier provides modules, sub-assemblies and/or systems to the assembler, as can be seen in Figure 3.1 below.

Figure 3.1. - *Structure of the chain of distribution of the companies that responded to the questionnaire*



The process of choosing suppliers, the role of engineering and the importance of locally commanded design

The different assemblers are using a very similar process for choosing suppliers. Qualifying factors for suppliers are: **the certification of quality**; **financing capability** - to reduce the risk of supply discontinuity since there are few parts and sub-assembly suppliers, and to try to guarantee technology updates; **qualification of the production process of potential suppliers**, analyzed by the assembler's engineering and quality departments; **engineering capability** - fitting of graphics software, prototyping and the capacity for product

development, which is a decisive factor for vehicles whose design is headquartered in Brazil, and a history of supply.

Price is a factor in winning orders, i.e., if there is a certain number of suppliers who have quality certification, financing capability, engineering capacity and a good history and these are ratified as potential suppliers, the one that quotes better prices for a given bid wins the order.

The contracts have a clause about "maintaining competitiveness", i.e. the company that wins the supply contract must keep itself competitive for the duration of the contract. Thus, the assemblers get price quotes from competitors during the life of the contract and "renegotiate" conditions with the supplier when they find more advantageous conditions. In these cases, changing suppliers effectively happens independently of the terms of the contract, since it is considered that there was bad faith in the contract clause.

The assemblers choose their suppliers from the list of certified suppliers. Exceptions to this rule are rare and tend to be ever more remote, due to purchasing process being on the internet. The assembler sends information for quotes, i.e. chooses who participates in the quotations (only certified suppliers). Purchasing professionals interviewed at the company headquarters and at Brazilian subsidiaries state that the internet purchasing process tends to concentrate suppliers[12].

Teams from the purchasing, quality, product engineering and logistics departments typically participate in the selection process. When the financial function is separate from purchasing, that area also participates. The quality and engineering divisions also play a decisive role in qualifying the candidates, since they evaluate their capacity for production and product development, i.e. their capacity to produce according to the specifications of the assembler and in the required quantities.

Thus, engineering in practice has veto power over supplier candidates. At all the main assembly plants studied, we found cases where the purchasing director had proposed a less expensive supply option, but the engineering division argued that the company didn't have the technical conditions for supply, alleging an inability to produce the required tools, as in the case of one candidate to supply the plastic panels for the most sophisticated vehicle; or it alleged a lack of production capacity, as was the case of a candidate to supply cable, or the engineering department simply did not know the company and opined that it wasn't worth it to analyze it, (as in a case raised during the quantitative analysis involving the headquarters and a subsidiary of the same company).

In these circumstances, the engineering division of the assembly plant plays a decisive role in choosing suppliers. The "auction" of prices only happens after engineering has approved the candidates. As a result, the location of the engineering division becomes decisive, or better stated, the location of the unit where engineering analyzes candidates for supplier becomes decisive. This engineering belongs to the unit that *centralizes the vehicle design,* i.e. the unit that commands and make decisions about the project design, its development and modifications[13].

Contact is made with the key suppliers during the phase of defining the vehicle concept. The unit that develops the project design from the conceptual phase (the initial phase of a vehicle project, which defines its general characteristics) is the unit that will contact suppliers, and those located close to the assembly plant have an advantage. Importation is less viable when the vehicle design is headquartered in Brazil, since in this situation there are pieces and parts that are not designed and/or produced abroad, making the experimental development of parts themselves or of pre-assembled sets of parts for cars easier to do in the

country. Further, the engineering department that certifies supplier's credentials is the local engineering department, which has a different list of suppliers than company headquarters, consisting of local companies that are known to them, whether from the days of a more closed market, or from monitoring the local industry.

To sum up, the subsidiary that owns the command of the project also attracts *co-design*, suppliers design activities and local suppliers; therefore, it improves the chances that local companies win orders.

General features of the supply chain in Brazil

Based mostly in the data obtained from the quantitative study, we now proceed to a general characterization of the supply chain for the assembly plants (OEM). In this way we exclude after market companies. We will take into account a sample of 191 companies (83% of all who responded to the questionnaire), with nearly identical distribution between multinationals (49%) and Brazilians (51%). These data allow us to have a notion – though still superficial and not evolved in historical terms – of the importance that national capital still plays in the automotive chain in Brazil.

Who invests in modernization? (proxy: depreciation)

Investments in modernization and/or to expand capacity increased for half of all the companies studied[14]. This behaviour is more accentuated for larger enterprises and multinationals and for companies at the higher tiers of the chain (direct suppliers, 1st tier indirect suppliers owned by foreign companies).

Table 3.1. - *Position on the chain x increased depreciation*

Suppliers' position (as in Figure 3.1.)	% of firms that declared increased depreciation	% accumulated
Supplier of modules, sub-assemblies or systems	25.0	25.0
Supplier of components for the assembler	47.8	72.8
Supplier of components for the supplier of modules	13.0	85.9
Supplier of sub-assemblies for the supplier of modules	1.1	87.0
Supplier of components for the supplier of components	10.9	97.8
Supplier of components for the supplier of sub-assemblies	2.2	100
Total	100	

Broad diffusion of quality certification

One of the findings that appears clearly in the processed data is a broad diffusion of certificates of quality by the assemblers supply chain. 80% of the OEM companies reported certification by ISO-9000 norms and another 4% were in the process of doing so. Only three companies declared a lack of interest in this certification. Of the companies certified, 57% are national.

Similar behaviour has occurred with certification by the QS family: 73% (55% national) of the companies in the sub sample are already certified and another 8.4% are ready to become so. 3.7% are analyzing the possibility. Further, 43.5% of the companies already have or are in process of acquiring other types of certification.

Long term contracts: only for TNCs 1st tier firms

Of the companies studied in the sub sample, 69% of the companies allege some long term contract (one year or more) with their clients, and of these 57% are multinationals (TNCs). This number indicates a change of major proportions in the panorama of supply relationships in the automotive chain in Brazil, although the fact that almost 70% of the companies have long term relationships does not necessarily mean that this applies to the majority of their products and clients. Very probably it is the contrary that prevails.

But only 34% have long term contracts with their suppliers. Of these contracts, multinational companies represent 80%. 23% of the companies have contracts that guarantee their suppliers exclusivity in supply and again the multinationals appear outstanding in this number (73% of them).

It is worth stressing that the further we get from the assemblers, the less frequent is the practice of long term contracts and exclusivity in commercialization. In interviews with the companies and in the focus groups, we perceived that there are small and mid size companies that don't even have formal contracts with their clients, receiving orders via fax.[14]

Table 3.2.- *Position on the chain x long term contracts with clients*

	Frequency	%	Accumulated %
Supplier of modules, sub-assemblies or systems	26	21.5	21.5
Supplier of components for the assembly plant	62	51.2	72.7
Supplier of components for supplier of modules (2nd tier)	21	17,4	90.1
Supplier of modules for supplier of modules (2nd tier)	2	1.7	91.7
Supplier of components for supplier of components (2nd tier)	8	6.6	98.3
Supplier of components for supplier of modules (3rd tier)	2	1.7	100
Total	121	100	

Table 3.3.- *Position on the chain x long term contracts with suppliers*

	Frequency	%	Accumulated %
Supplier of modules, sub-assemblies or systems	20	33.9	33.9
Supplier of components for the assembly plant	28	47.5	81.4
Supplier of components for supplier of modules (2nd tier)	5	8.5	89.8
Supplier of modules for supplier of modules (2nd tier)	1	1.7	91.5
Supplier of components for supplier of components (2nd tier)	59	100	

Frequency of deliveries and inventory transfers

The JIT schemes and other similar procedures introduced by the assembly plants to reduce their stock of components and sub-assemblies have provoked sharp debate: do suppliers absorb the cost of stock or will the chain transform everything into "lean"? Will the process of stock reduction be a generalized phenomenon throughout the automotive chain or can part of these stocks be warehoused at some point along the supply chain? We used a quantitative treatment to clear up this point, asking the companies about the frequency of deliveries and receivings.

The answers received allowed us to conclude that 68% of the companies declare deliveries to their main clients on a daily basis and even several deliveries per day (19% of them), which shows a clear change in relation to the traditional frequency of deliveries observed in the past.

What appears more surprising is that only 26% of the OEM companies declare receiving from their main suppliers on a daily basis or with several deliveries on the same day, while 49% of the companies receive weekly and 6% monthly.

Considering the frequency of deliveries as a *proxy* variable for the level of stock, the data suggest that along the chain the companies tend to keep higher levels of inputs received (whether raw materials or parts/sub-assemblies received from the suppliers) than semi-finished components or finished parts that these companies manufacture.

Table 3.4.- *Position on the chain x deliveries per day*

	Frequency	%	Accumulated %
Supplier of modules, sub-assemblies or systems	32	23.7	23.7
Supplier of components for the assembly plant	60	44.4	68.1
Supplier to the spare parts market	8	5.9	74.1
Supplier of components for supplier of modules (2nd tier)	20	14.8	88.9
Supplier of modules for the supplier of modules (2nd tier)	2	1.5	90.4
Supplier of components for supplier of components (2nd tier)	9	6.7	97.0
Supplier of components for the supplier of modules (3rd tier)	4	3.0	100
Total	135	100	

The greatest frequencies of delivery are from companies that supply sub-systems and they tend to fall off in line with the distance from the assembly plant. Such data deserve to be

analyzed with some care, since the total percentage of companies at the second and third tiers of the sample is slightly underestimated in relation to the companies at the first tier. However, a more detailed analysis also shows us that the "gap" between deliveries and receivings at all tiers of the chain tends to remain more or less stable. Examples: for the suppliers of sub-systems, 86% of the companies make deliveries every day and 46% receive every day (for a gap of 42%); for the companies that provide components to the direct supplier of components the "gap" is 38%, with 69% of deliveries daily and 31% receiving at the same frequency.

This "gap" is 35.7% for the various tiers and positions on the chain, which suggests that even with less frequent deliveries, the more distant companies take less frequent deliveries, and this constitutes similar behaviour in terms of the differential frequency of delivery and receivings all along the chain.

The structure of the chain into tiers and the schemes for industrial condominium modular consortiums and the like caused a restructuring of the stock issue even for the direct and module suppliers. The modular supply scheme leads the large direct suppliers to produce parts centrally, and to do just the final assembly and forwarding to clients' assembly line in the condominium or similar places alongside the assembly units.

Financing Patterns

The capacity of auto parts companies to invest and their working capital levels are more and more relevant, whether to be able to take advantage of opportunities to obtain supply contracts, to allow them to absorb the shocks resulting from oscillations in demand, to avoid discontinuity of supply, or to be able to absorb costs related to product development.

Data obtained during this study reveal that the main source of financing in the auto parts sector is the companies' own capital. It is the main source pointed to for all the types of applications investigated, i.e., retooling, working capital, new products, plant modernization and new plants. In other words, the companies in the sector have the capacity for self-financing. This could indicate on the one hand, that for some companies –the transnationals – access to financial resources depends basically on the generation of results and the eventual transfers from the head company, which has access to the global capital markets. For the other smaller companies with national capital, the fact that their main source of capital is their own – and their low capacity for generating it – indicates their limits to realizing the investments needed to achieve scale and consequently competitive cost levels.

There is also a high incidence of utilization of the resources of private Brazilian banks, despite the magnitude of the interest rates practiced during the period of the study: 42% of the companies state that they use banks to finance their working capital. Of these, 72% are national – which points to the companies' problems with self capitalization. Of the direct suppliers, only 17% state that they go to private banks to finance their working capital, against 46% of other providers at the 1st tier, 53% of companies not OEM (spare parts), 45% of component suppliers for the direct suppliers: i.e. it is confirmed that the higher the position on the chain, the fewer resources from private national banks, suggesting a greater current capacity for self financing.

BNDES, dealt with on the questionnaire together with FINAME (a public fund oriented to finance machine/new technologies acquisitions), appears as the second most cited source for purposes of plant modernization (24% of companies cited it), but their own capital is cited by 47% of the references. New plant financing is a similar case. The incidence values are lower, revealing that more companies are modernizing already existing installation than

opening new ones. BNDES is cited as the financing source for new plants by 8% of companies, against 23% who cite their own capital.

The companies financed by the BNDES have the following profile:

58% export up to 10% of their sales income; 84% export up to 30%, revealing that the investment priority is the internal market. They are large companies; 45% are allocated to the largest band of sales income and employ an average of 865 workers. 74% of the OEMs financed by BNDES are 1st tier, revealing the low penetration of the Bank at the lower tiers. 40% of the "direct suppliers" receive financing from the BNDES, as well as 38% of the suppliers to the first tier indirect suppliers. In contrast, only 29% of the second and third tier companies stated that they used resources from BNDES.

The OEM companies with national capital are the main users of the BNDES/FINAME system to modernize plants (63%), and the transnationals are the main users (73%) for new plants.

25% of the OEM in the sample stated they use BNDES/FINAME to modernize their plants, and only 8% allege they used this source to finance new plants.

Thus we have a panorama in which the companies are primarily self financed and BNDES, which is the main source of capital for productive investment in Brazil, has a low penetration at the lower tiers of the chain where the preponderance of national companies are located.

The national companies, roughly speaking, are the major users of FINAME resources to modernize plants.

Modularity and modular supply: suppliers add as little value as possible inside the condominium

Looking at the modular plants (greenfields) in Brazil, we found a great similarity concerning the type of sub-assemblies supplied by firms located inside the condominium (see Table 3.5).

As a rule, the module suppliers in the condominium deliver products which present logistic problems (high transportation costs, fragility) or which provide diversification of the models of the assembled vehicles by allowing the assembler to postpone delivering orders. Thus, there are seat suppliers inside the condominium who receive the assembler's order for a vehicle that is to be assembled just 50 minutes before its final deadline in the assembly line.

This delay gives the assembler enough flexibility to make changes in the production schedule. For instance, should there be any problems with supplying, say, 1.0 engines or ABS brakes, the assembler will want to rearrange the production sequence, and reschedule it so as to exclude the models with the missing parts and include fully supplied ones.

Therefore, if the above 1.0 or the ABS models use seats upholstered with special material or stereo panels - and because the assembler only releases the supply order a few minutes before the final delivery deadline - the assembler can simply change its own schedule and inform the direct supplier, who in turn, will meet the new deadlines.

Table 3.5.- *Direct suppliers' typical activities at the condominium*

Components	Ford BA	GM Rio Grande do Sul	Renault Paraná	VW Paraná	DC Minas Gerais	VW Taubaté	VW SBC	Fiat Betim
Panels	X	X	X	X	X		X	X
Seats	X	X	X	X	X	X		X
Exhaust systems	X	X	X	X	X			X
Tires and Wheels	X	X	X	X	X		X	
Axles		X	X	X		X	X	X
Suspension	X	X	X				X	X
Fuel System	X	X		X		X	X	
Electrical harnesses				X	X	X	X	
Doors	X	X		X			X	
Medium-sized and Small die cast parts	X	X				X		X
Windows	X	X		X				
Bumpers	X	X				X		X
Cooling/Refrigeration		X		X				X
Roof	X	X						
Carpets, insulation	X	X						
Brake Lines	X	X						
Lighting		X		X				

Obviously, it is impossible to make a seat from scratch in 50 or 150 minutes. As a rule, direct suppliers must keep stock within their condominium units. Some units, such as the window units, are ultimately stock storages since they do not make windows. At most, they reshape flat glass into car parts. As a result, whenever analyzing the quantitative research data on stocks, one must take into account that stocks are absorbed, even when direct suppliers make daily deliveries.

The strategy used by the companies participating in the modular supply system inside the condominium is clear: minimize the risk of a capital used with a sole client, and minimize redundant capacity in order to optimize the previously installed capacities at their central units (local headquarters), as will be discussed in the next item. Therefore, it is totally unreasonable to assume that the new vehicle assembly units will be similar to those of the 1960s and 1970s, which were highly vertically integrated, and whose nearby suppliers (in the case of the ABC) were also highly vertically integrated.

THE NEW GEOGRAPHY OF THE CHAIN: DECENTRALIZATION OF ASSEMBLY UNITS DO NOT RELOCATE THE PRODUCTION BASE WHERE MOST VALUE IS ADDED

The new vehicle assembly plants (greenfields) have been designed and configured like an industrial condominium, where some direct suppliers units are installed within the condominium site and very near to the assembler. Table 4.1. shows some examples of that. Only one of the plants mentioned below operates as a modular consortia, in which the direct suppliers are within the assembly plant.

Table 4.1.- *Distance of suppliers from the vehicle assembly units*

plant location	number of firms				% of firms			
	inside	<50km	>50km	Total	inside	<50km	>50km	Total
DC Campo Largo	1	3	34	38	3	8	89	100
DC São Bernardo	2	39	54	95	2	41	57	100
DC Juiz de Fora	2	1	50	53	4	2	94	100
Fiat Betim	4	12	82	98	4	12	84	100
Ford Camaçari	9		42	51	18		82	100
Ford São Bernardo	6	50	57	113	5	44	50	100
GM Gravataí	11	3	54	68	16	4	79	100
GM São Caetano do Sul	3	55	58	116	3	47	50	100
GM São José dos Campos	5	6	109	120	4	5	91	100
Honda Sumaré		8	42	50		16	84	100
Mitsubishi Catalão			1	1			100	100
Peugeot Porto Real	3	1	41	45	7	2	91	100
Renault S. José dos Pinhais	2	9	55	66	3	14	83	100
Toyota Indaiatuba	1	4	40	45	2	9	88	100
Volvo		1		1		100		100
VW Resende	8		86	94	8		91	100
VW São Bernardo-Pólo	4	45	57	106	4	42	54	100
VW São Carlos			1	1			100	100
VW Taubaté	4	6	98	108	4	6	91	100
VW/Audi São José dos Pinhais	7	4	65	76	9	5	85	100
Total	72	247	1026	1345				100
% Total	5	18	76	100				100

Note: The figures account for the companies that have reported either direct or indirect supplies to the assemblers.

Only 5% of the companies are inside a condominium or similar place. On the other hand, 76% of the auto parts plants are farther than 50 km from the assembler's complex. Table 4.1 above shows that the shortest distance between supplier units and final vehicle assembly units is registered for the ABC area, as opposed to what happens at other locations, including the new plants in Paraná and Rio Grande do Sul. Since the formulated question refers to direct or indirect supply, one can make a rough estimate for the chain as a whole, and not only of the position of the last unit before the shipping to the assembler.

New investments do not relocate the command of the chain

The industry is largely concentrated on the state of São Paulo; 212 (60%) of the plants that belong to the enterprises that answered the questionnaire are in São Paulo (SP)[15]. Way behind, Minas Gerais ranks second with 38 plants (11%), followed by Paraná (27 plants, 8%), Rio Grande do Sul (25 plants, 7%), Argentina (17 plants, 5%), Santa Catarina and Rio de Janeiro (10 plants each, 3%), Pernambuco, Bahia and Amazonas (3 plants each, 1%), Ceará (2 plants, 1%) and Espírito Santo (1 plant). The northeast has only 2% of the plants, even when taking into consideration the responses from Ford suppliers in Camaçari (BA). São Paulo, followed by Minas Gerais, has the most diversified production – in other words, it has a more complete network of the auto parts industry; São Paulo has factories for all the functional segments of the vehicle, while Minas Gerais only has factories for 60% of them.

The plants that were inaugurated in the 1990s were primarily set up in the state of São Paulo. 52% of the plants inaugurated between 1990 and 1995 were in SP, compared to 165 in Minas Gerais, 8% in Paraná , 8% in Rio Grande do Sul, and 4% in Rio de Janeiro. Between 1960 and 1965, the percentage of the new plants set up in SP was 85%.

Over the years, SP has lost its condition of host of new plants: 72% between 1970 and 1979; 60,5% between 1980 and 1989. But, after 1995 there is an abrupt reduction: SP received only 35,4% of the new factories (plants) in Brazil. Even though this is a significant percentage in itself, it shows a sudden drop, probably due to the new factories that have been set up in the industrial condominium of the assemblers' new units. The effects of the so-called "fiscal war" may also have influenced this drop.

But employment is an even more concentrated factor. SP accounts for 64,8%, Minas Gerais for 14,2%, Paraná for 6,6%, Santa Catarina for 5,7%, Rio de Janeiro for 2,8% and Rio Grande do Sul for 2,5% of the jobs in the sector. By comparing employment data with data concerning plants set up in states which have hosted automotive factories recently, one can see that there is not a univocal relationship between the increase of number of plants and number of jobs. This may lead to the assumption that, at least for the time being, the system of modular factories in those states has attracted factory units that perform few operations internally and most of the material they receive is previously processed at other locations.

Santa Catarina ranks first as the state hosting plants of companies run with national capital: 90% of the total capital of the state[16].

São Paulo ranks second, with 49%. In accordance with the pattern of inducements to investment and the macroeconomic policies of the 1990s, foreign owned plants predominate in the new poles.

In light of the fact that these new poles have boosted the scheme of industrial condominium and modular supply, it turns out that Paraná and Rio Grande do Sul concentrate the highest percentage of direct suppliers in their auto parts parks: 33% and 27%, respectively, as opposed to only 20% in Minas Gerais and 14% in São Paulo.

These data may be interpreted differently, though: there can't be any direct suppliers without a supply base for parts and components. In the case of São Paulo and Minas Gerais, having fewer direct suppliers shows, first of all, the greater complexity of the industrial complex in these states.

In-depth studies and visits to the greenfields (industrial condominium) show that only the final manufacturing and sub-assembly activities are carried out there. For instance,

exhausts suppliers centralize the manufacturing of the components - except for the final touches - which they do in the condominium. The same for seat suppliers, and suppliers of instrument panels, tires and wheels, suspensions and axles, which are the most common sub-assemblies in the condominium, as shown in Table 3.5. This is because there is an underlying economic aspect to be considered in relation to scale, besides the fact that suppliers are strategic and seek not to replicate investments or dedicate them to a sole client.

As to the issue of added value in the condominium, one must always keep in mind that engines and transmission are produced in the state of São Paulo. This is the case of GM-Gravataí (engines come from GM plant in São José dos Campos/São Paulo), Ford-Camaçari (engines come from Taubaté/São Paulo) and VW-Paraná (engines come from São Carlos/São Paulo). Moreover, the Gravataí situation, for example, shows that a significant share of the parts assembled or stored by the module suppliers inside the condominium are manufactured at their plants located in the ABC area (near the city of São Paulo) and, on a much smaller scale, in the south of Minas Gerais. The remaining parts are either imported or, in the case of the less costly ones, supplied by companies from Rio Grande do Sul. This is the pattern for the remaining condominium. Table 4.2 shows details of the ramifications of the supply system in one of the condominium that were surveyed.

Table 4.2 – ***Origin of components and logistics at the Gravataí condominium***

Arteb	Lenses and headlights: Arteb/São Paulo- monthly receipt. The suppliers' small parts are consolidated in São Paulo and delivered weekly by an outsourced company.
Arvin	Exhaust components: Arvin Cambuí-Minas Gerais – weekly receipt. A supplier in Sta. Catarina and another in Novo Hamburgo/Rio Grande do Sul deliver weekly.
Delphi	Components are delivered by Delphi Chassis- Jambeiro/São Paulo, along with 20 suppliers, to a consolidator in São Paulo that ships them to Gravataí three times per week. There are 6 suppliers in São Paulo. Axles are supplied by a company in Panambi/Rio Grande do Sul ; delivered daily.
Inylbra	Some items are manufactured by Inylbra-Diadema/São Paulo and by another five suppliers in São Paulo. The rest are manufactured in Gravataí.
IPA	Tank components: IPA/São Paulo; daily or every other day delivery,
Lear	Components and inputs leave Lear/Minas Gerais every two days. Fabric is supplied by a company in Caxias do Sul/Rio Grande do Sul ; delivered daily. Foam rubber manufactured in the condominium by Pelzer and delivered by the JIT system.
Pelzer	Inputs for plastic are received once a week.
Polyprom	Steel and aluminium coils : São Paulo- one or two loads per week.
Sogefi	Filters: Sogefi/Minas Gerais Resonator: supplier in Joinville/SC. Hoses, brackets and cushions: São Paulo. Sensors = imported by Delphi/São Paulo from the USA.
Valeo	Gets components from Valeo Itatiba/São Paulo and from a supplier in Caxias/Rio Grande do Sul every two days.
VDO	VDO/São Paulo components and remaining parts are consolidated in São Paulo and delivered every two days. The plastic panel is injected in Curitiba and delivered in the same round.

Survey of direct suppliers; data refer to March 2001

Product design activities are even more spatially concentrated. São Paulo concentrates 72% of the companies (Brazilian headquarters) that carry out product design activities; Minas Gerais ranks second with as little as 8%. In other words, in addition to the number of factories

and level of employment, the state of São Paulo concentrates even further value added activities and the more complex engineering activities.

More than an issue of how many units, the hegemony of the chain is in São Paulo because the local command and the units of highest value added are located there.

PRODUCT DESIGN AND DEVELOPMENT

Product design activities are of utmost importance to economic development and in the automotive chain in particular. They involve high value added, through jobs considered to be "quality jobs" (that is, demanding highly educated and highly paid personnel).

To be carried out, product design has to be directly related to the production chain's establishment within a given industrial complex. In the highly internationalized automotive chain, which is undergoing structural transformation in terms of location and of the division of labour among companies and among countries, to host significant product design activities, in terms of quantity and especially quality, is a concrete and prospective sign of a country's relevance in the context of the international division of labour.

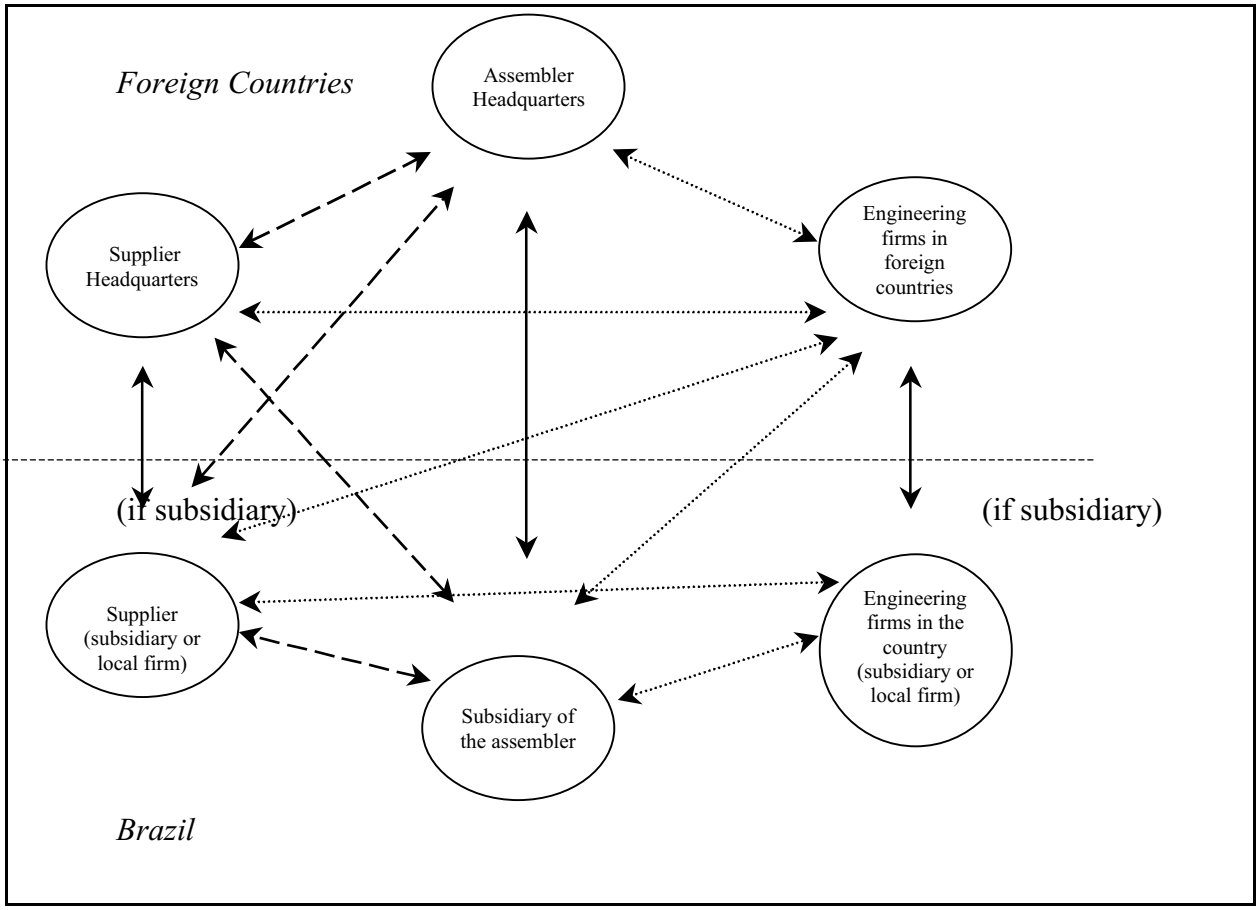
The location of activities like design and development of a vehicle, as well as the types of division of labour between headquarters and subsidiaries, is a burning issue for major countries (considering market, installed base, engineering) in the automotive industry, such as Brazil. While the strict concept of a world car is of second priority, the winning concept is that of worldwide platforms that are adaptable to fit the particularities of each market (Humphrey, Lecler and Salerno, 2001). Such adaptations, variations or derivatives require significant effort of design activities that can conducted in these major countries or in the pertinent subsidiaries. We introduce, then, a central idea to understanding the dynamics and the possibilities of the chain in Brazil: the relocation of the design headquarters (or design main center).

There is a "virtuous" cycle between local vehicle design command / derivatives and local supply

There is a clear relationship between the local development of a vehicle or a derivative (such as the family known as VW-249 Tupi, GM Celta, Fiat Palio, and even the new Ford Fiesta family[17]) and local supply. Local vehicle design and development give local enterprises greater opportunities to participate in the design (which is the case of Arteb, MWM), which would be unlikely if the design were headquartered in another country. This increases the chances that local suppliers, not the "global ones", with non-transnational (it means national) capital have of joining the supply chain.

Given the characteristics of the assembly industry in Brazil, one must take into account an intermediate stage somewhere between the complete autonomous design/development of a vehicle and the simple adaptation, with no major changes, of an already finished design. In other words, an activity, which demands ongoing teams working on the vehicle's design engineering and on the experimental development of the projected vehicle (such as tests to refine and regulate the engines, emissions, the suspension system, noise, dust-proof sealing, etc) and could imply modifications to the original basic foreign product, or even the development of a new product niche that does not exist abroad (such as in the case of the VW Tupi and Gol, the GM Celta and Meriva and the Fiat Palio).

Chart 5.1 *The network of enterprises for product design and development*



Legend:

Design shared among headquarters and subsidiaries

Co-design

Outsourced designs

Within this spectrum, 'to be the design headquarters' means that the unit (subsidiary) manages most of the design activities, from the points of view of management control, engineering control and definition and modifications of the part numbers. It means that local engineering qualifies or cuts suppliers, it analyzes orders for adaptations and modifications coming from other units, etc. Depending on the circumstances, it means that the unit creates, designs and develops a new platform.

The differential in terms of the local implementation of activities lies between the assemblers' designs that are centralized in Brazil and those that are not. Not surprisingly, the assemblers whose designs are locally commanded (in Brazil), those producing large volumes of vehicles, are those who have been located here for a longer time than the others, and who have also developed product niches that are not developed in the central countries. Overall, the vehicles are inexpensive "entry level" products for markets with characteristics similar to

those of the Brazilian market, such as South America and parts of Africa and Asia (such as China). There is no record of a 'design headquarters' with a different profile.

Local design and design development activities favour local suppliers. As shown in item 3.1, when the design is centralized in Brazil, the control of specifications and certification (as well as veto) of suppliers is maintained by the local engineering division. Since the latter has a background of good relations with the local suppliers, and knows the local supply base, the companies located here have better chances of winning contracts. In the interviews conducted with the assemblers and suppliers who carry out design, the relationship between locally commanded design ('headquarters') and local supply was cited across the board, though not in same terms as it appears in this text, which are proposals of our elaboration (see Figure 5.2).

Therefore, having capability (structure, personnel and knowledge) of design and of product development in Brazil are factors that differentiate an auto parts company; the assemblers that centralize in Brazil the design command for a vehicle explicitly state this requirement. Therefore, one may conclude that strengthening and internalizing the chain in the country means strengthening design and product development activities.

Profile of companies that design products in Brazil

Except for the commercial vehicle (truck and bus) manufacturers, the assemblers having design centers in Brazil that manage the product development do so on behalf of niche products that will eventually obtain reasonable volumes. They have a strategic definition for operating with specific vehicles for the market characteristics of a supposedly homogenous group from the "emerging" countries (typically: Latin America, Africa, the Middle East and China). They also aim at concentrating the design and product specification control activities for those markets in Brazil. Assemblers seated in Brazil as of the 1990s do not go in for significant product design activities, and there is little evidence that they will do so.

The success achieved by local development led a few assemblers to set up centers of excellence' in Brazil, or 'vehicle development centers for the emerging countries'[18]. These centers are integrated with the headquarters' central vehicle design and development activities and provide a few services, such as suspension adjustment.

As for the suppliers, product design activities are not distributed uniformly along the supply chain, but are concentrated in the direct suppliers and the first ranking companies in the chain. In other words, the transnational companies that have a hegemonic role at the upper layers of the chain do the bulk of the auto parts design activities.

Nevertheless, the way activities are distributed among the several transnational auto parts companies leaves the most significant phases of the design (design of the part/assembly, basic specifications, engineering design) to be carried out abroad, as we have pointed out both in the quantitative survey and the in-depth survey (table 5.1 below). Local participation (of the Brazilian branch) improves as we shift from design and product design activities towards adapting product or process activities to local conditions. This suggests that, in general terms, the sector has a concentration of Brazilian engineering in process design activities and not in product design.

Table 5.1.- *OEMs and TNCs : division of labour between headquarter and branches*

Activities	Headquarters	Brazil	Both
Did not answer any item: 16 companies: (17%) [19]			
Product outline, design definition, components selection	54%	23%	14%
Engineering designs	47%	32%	14%
Prototype/tests	32%	46%	21%
Product adaptation to local environment or market	12%	69%	08%
Production process development	22%	64%	14%
Production process adaptation to the local environment	09%	83%	3%

Note: the figures stand for % of companies (in relation to respondents) that reported having developed this activity at the referred location.

The reading of the "Brazil" column in table 5.1 shows that at most a third of the transnational companies in the sample carry out product design activities ("designs"). When it comes to product concept, activities are even more centralized (less than one-fourth claim to carry this out here). Also, among the national capital OEMs, fewer than half (45 in 92, that is, 48,9%) reported carrying out product design activities.

Table 5.2.- *Project Activities at the national capital OEMs*

How major product development occurred	In relation to enterprises that report having product design activities	In relation to the total domestic OEMs
Client provided basic information and maintains the design property; enterprise developed product based on client's basic specifications	64,4%	31,5%
Client provided basic specifications; enterprise carried out product development based on client's basic specifications and holds property of design.	22%	10,9%
Client purchased a pre-defined portfolio product; enterprise did 100% of product development	13,3%	6,5%

Note: 45 out of the total 92 OEMs of national capital fit here.

A word of caution when interpreting the last category of Table 5.2, which may show a great capacity for autonomous design, however, this may be related to "commodity" type products, such as universal fixation elements (brackets, setscrews, etc.) and regular plastics. To dispel doubts, only a more detailed analysis of every one of the companies can clear up this point. Indeed, one notes that this group produces either just commodities or spare parts or they might even actually develop product designs, but they do not have state of the art technology. To sum up, there are practically no national enterprises that hold autonomous automotive technology [20].

22,2% of the companies that reported product design activities (10,9% of the total OEMs of national capital) report holding the property of the main product design. The bulk of the companies that reported product design activities (64,4%) do not hold the design property.

That is to say, even considering all the discrepancies that tend to overestimate the relevance of product design activities, and by reframing the companies included in the last category in table 5.2 (as discussed above), we understand only 13% of the OEMs with national capital own the main product design property. Here we have excluded all cases of foreign shareholder participation, which often come in with the product technology.

In sum, much needs to be done for front line design activities to be internalized in the Brazilian chain in a broader way.

What favours the design and the development of automotive products in Brazil?

There is a certain installed capacity for design in Brazil. Recent moves made by a few assemblers also show that this activity is not totally consolidated, and it must be tackled by a public agent.

To put it in a nutshell, the factors that induce, motivate and favour product design activities in Brazil are:

Volume

The assemblers that invest in design activities and product development in Brazil are those that have greater production volume. More specifically, the vehicles for which there is or there have been design activities headquartered here are those geared to greater production volumes by the assemblers in focus.

Product Regulation and Market Conditions

The peculiarities of Brazilian regulations help with the location of the design activities. Alcohol and 1.0 engines are examples of the influence of regulations. Sedans and pick-ups for small cars are a feature of the Brazilian market, attracting the allocation of these design derivatives. Purchasing power, road conditions, dust and insulation needs, among other characteristics, facilitate the setting up of specialized centers – all the assemblers with more significant design activities in Brazil work on suspensions, for instance, and auto parts dealers in the rubber business wind up profiting from that – on the international market also – for having developed parts which stop dust penetration (seals, retainers, etc.).

A possible regulation regarding bi-combustible engines (alcohol and gasoline) could promote the local development of these systems.

Niche

Design-seated vehicles in Brazil are niche vehicles, and they are specific for automotive periphery countries ("emerging markets"). Even at assembly plants with local design activities, products, which were originally launched in central countries and subsequently in Brazil, have little Brazilian engineering[21].

Vehicle design in Brazil, which results in design activities from suppliers, is focused on inexpensive cars, which are simpler than the market entry models in the central countries.

Design overload at the headquarters due to differentiation policies

The assemblers' design centers focus primarily on the products geared to major markets, that is, for the central countries. In principle, nothing prevents these centers from also dealing with products and adaptations for the peripheral countries, but the work overload at

many of these centers favours the decentralization of second priority activities, such as niche cars.

Current Ongoing Training

The fact that there is ongoing training in Brazil helps attract projects, whether for niche vehicles or even participation in more sophisticated product designs to be launched in central countries. On-going training in suspension development is probably the most well known and utilized. This means having local technical competence and management, as well as low costs and quick response capacity to demands from the design centers at headquarters.

Product variation policy and integration with headquarters design centers (due to design demand)

The greater the diversification of the local market and of countries considered homogeneous, the greater the need for new launchings, and the greater the likelihood of a more perennial allocation of product design activities in Brazil.

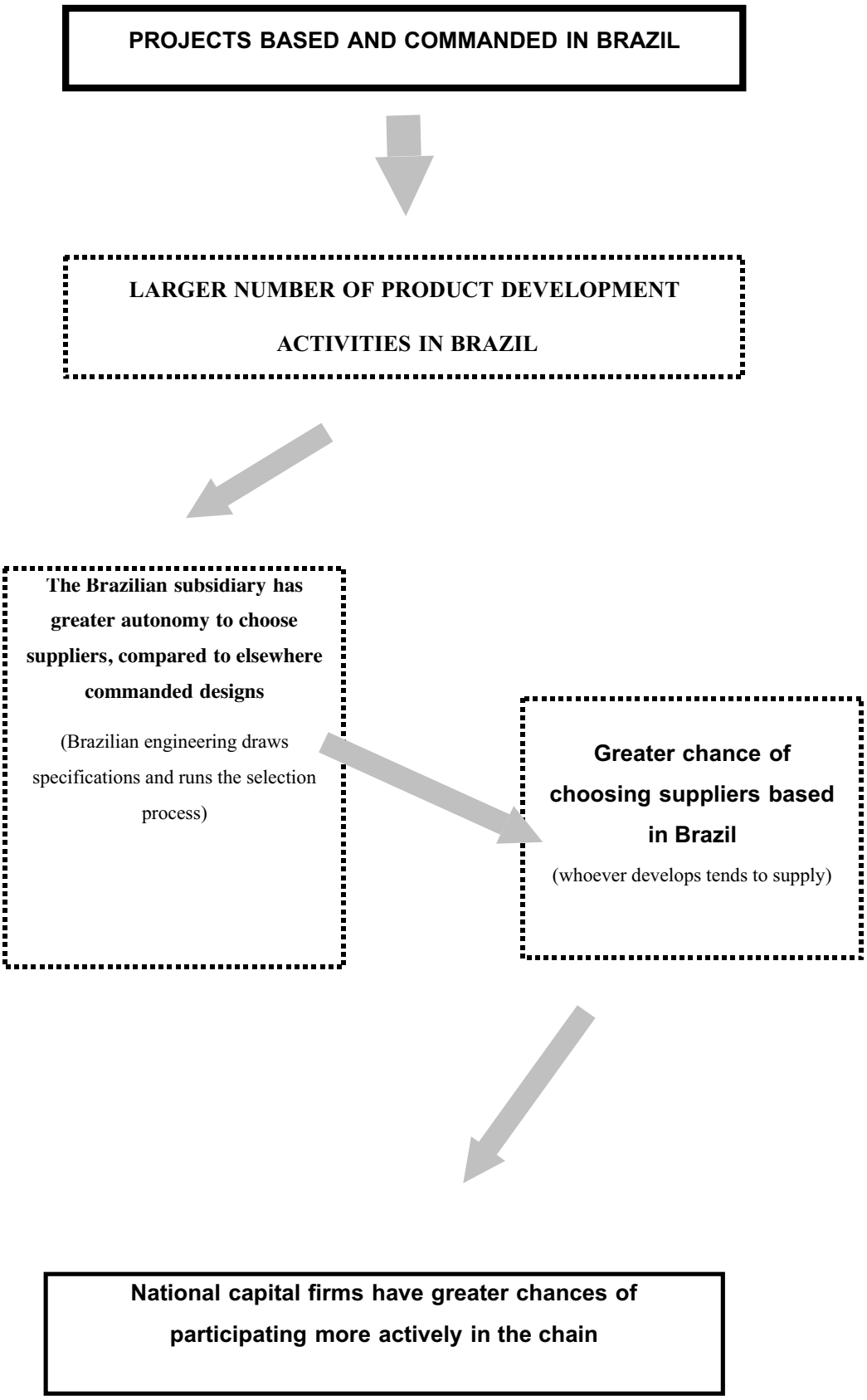
The importance of local unity in the group's business

Creating a design center in a peripheral country is a major step for an assembler, not to mention how important to business strategy product design activities have become. Thus, only if the local unit of an assembler is relevant within its operations or its global strategy is there a chance that a local product design center be set up. An assembler's local unit may be considered important from the point of view of sales volume, profitability or efficiency and potential for innovation in the operations.

Policies

Assemblers and suppliers allocate product design activities under legal constraints and in accord with public sector policies to encourage such activities.

Figure 5.2.- *The relationship between design headquarters and local supply*



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Notes

1 Between 1990 and 2000, the assembly plants alone invested US$ 16.6 billion, and 72% of this amount was invested after 1995 (Anfavea, 2002).

2 In terms of sales income in auto parts, for instance, the foreign companies registered with Sindipeças went from 47.6% of the total in 1994 to 73.3% in 2001 (Sindipeças, 2002).

3 The commercial surplus of US$1.2 billion of 1991 turned into a deficit of $US407 million in 2000.

4 Despite vehicle production having grown from less than 1 million in 1990 to 2 million in 1997 and 1.8 million in 2001, there was a continuous reduction in employee: the 117,396 employed in automobile production, reached a level of 85,257 in 2001. (Anfavea, 2002).

5 CAD – computer aided design; CAM – computer aided manufacturing; CAE – computer aided engineering.

6 Members of Sindipeças, firms with 20 or more workers, registered in the RAIS-1998, i.e. 795 firms (RAIS was used with the formal authorization of the Minister of Labour and Employment, obtained with intermediation by the SEADE Foundation). Further, we requested lists of certified suppliers, and we obtained them from Daimler-Chrysler, Fiat, Ford, General Motors, Iveco, Valtra, Volvo e VW; questionnaires were sent to all the suppliers listed. Other databases were used in "partnership" and collaboration with entities such as the AEA – Associação Brasileira de Engenharia Automotiva The Brazilian Association for Automotive Engineering, Paraná Automotivo, IFICS-UFRJ, G-CARS Rio Grande do Sul/PPGA-UFRGS, Photon Editora (which provided a register of companies through which we could reach more after market firms), Sindicato dos Metalúrgicos do ABC, DIEESE e Subseção DIEESE – Metalúrgicos do ABC, Prefeitura do Município de Santo André, SAE–Brasil (Society of Automotive Engineers).We also used records from specialized journals in the sector and mailing lists obtained by the "Snowball" technique: we asked for a list of suppliers in the

questionnaire itself. For more detail on why we used such diverse address lists and on procedures, see www.poli.usp.br/pro/cadeia-automotiva.

7 Information, data and estimates done by Sindipeças were obtained from the site http://www.sindipecas.org.br (performance of the sector) on August 2, 2001.

8 The cut of 20 or more workers was determined together with the BNDES team.

9 Obviously the data involved are different (December 1998 for the RAIS, first semester 2001 for the study – in some cases, employment data is from 2000). But, even admitting a linear increase in employment in line with the increase in vehicle production (an unlikely hypothesis), there would be an 14% differential between 1998 and 2001 (comparing annual volume of production), which would change the percentage use in the text very little.

10 Obviously the number of interviews in each company and the position interviewed varied according to the size and internal organization of each company.

11 The detailing of procedures, the link to partner websites, the questionnaires, the names of firms of the sample, the scripts of the qualitative survey and other documents can be obtained at www.poli.usp.br/pro/cadeia-automotiva.

12 At some assembly plants we learned that of 89 electric parts, only 3 were supplied by local companies – items such as batteries and speakers.

13 The concept of "project local command" is deeply discussed in the full text of the project report, Chapter 7, at www.poli.usp.br/pro/cadeia-automotiva.

14 This does not necessarily mean that the global capacity of the chain increased.

15 All the company units can be tracked down through the questionnaire.

16 The information concerning Santa Catarina may be interpreted in more than one way. On the one hand, it shows a high concentration in relation to the enterprises run with national capital; on the other hand, it may imply that those companies are of no interest to the transnational companies of the sector. This means they do have the profile the TNCs look for, which, in turn, implies they might not be among the outstanding companies of the sector.

17 The assemblers listed here have different levels of local implementation of product engineering activities, and they are not all similar from this viewpoint. However, they are the four oldest sports vehicle assemblers in the country with the biggest number of these activities. There are assemblers that do not carry out any product design activities in Brazil.

18 Involving the following phases: car style, body and interior. Basic engine designs, for example, do not fit this definition.

19 Based on previous knowledge about the companies that did not answer this question (previous team research, or specific literature), we understand that half of them certainly have product design activities in the branch, although we are unable to say much about the other half. Therefore, we chose to deal with only the respondents since, as a rule, the non respondents distribute themselves relatively evenly between the two major categories (whether or not design activity takes place in the country).

20 Such as, for instance, multinational holders of ABS brake technology, diesel fuel-injection pumps, air bags, etc, who hold the technology independently of the assemblers.

21 The success of the product design and development experiment has led some assemblers to take advantage of the local capacity for products to be launched abroad as well. However, this tendency is not likely to be perennial nor to spread out by itself.