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11-13 Juin 2003 (Ministère de la Recherche, Paris, France)

INTERNATIONALISATION OF RESEARCH AND DEVELOPMENT, CREATION OF LOCAL COMPETENCIES IN THE PRODUCT DEVELOPMENT, AND THE RECENT PERFORMANCE OF THE MAIN ASSEMBLERS OF THE BRAZILIAN CAR INDUSTRY

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The present paper is comprised by four items. The first one – which starts with a brief discussion on the general characteristics of the technology produced by the car manufacturers segment – aims to evaluate the internationalisation of R & D process in the car industry**.**

The second item offers a summary of the recent strategies of production and R & D implemented by the five main assemblers (GM, Ford, VW, Fiat, and Toyota) installed in Brazil.

The third item presents the link between the recent performance of the main assemblers in Brazil, its perspective strategies of production (and R & D), and the creation of local competencies in production development. The paper ends with a brief debate on the results achieved.

TECHNOLOGY AND THE INTERNATIONALISATION OF R & D IN THE CAR INDUSTRY

General Characteristics of Technology of the Assembler Sector in the Car Industry

According to the methodology proposed by the OCDE (2001), the car sector should be classified – considering its technological attributes – as a medium-high technology intensity industry, likewise the electrical machinery sectors, the chemical (except the pharmaceutical one) and the machine and mechanical equipment industry (OCDE, 2001)[1]. Although it is true that the automotive industry and the cars, in general, adopt a variety of well-known technologies and several familiar system and components, it is also true that

[1] Still according to this publication, should be classified as high-tech industries the aviation and spatial equipment; the pharmaceutical products; computers and office equipment, communication equipment, radio and television, and medical, optical, and precision instruments.

both adopt widely a large number of advanced products and technologies, developed by intensive activities of R & D (McAlinden *et al*., 2000)[2].

Based on the methodology proposed by the *US Bureau of Census* (BOC) to classify high-tech industries "the automobile it self can de described as a host platform for leading-edge technologies, and the industry as a producer of these technologies" (McAlinden *et al*., 2000:20).Actually, the automotive industry employs (or develops internally) higher technologies and components of four, out of ten, advanced areas, which were classified as high-tech according to the methodology suggested by BOC (McAlinden *et al*., 2000). The four areas are as follow:

- ✓ Computers and telecommunications;
- ✓ Electronics;
- ✓ Computer-integrated manufacturing;
- ✓ Materials design.

Concerning the new technologies in the car industry (see Box 1.1) – except the alternative forms of propulsion (electrical, hybrid, fuel-cell engines) – the electronic[3], the information technology, and the new material, are undoubtedly the key variables (McAlinden *et al*., 2000; Chanaron, 2001). According to recent estimates, for example, the impact of the electronic on board in the current costs of the vehicles is around 10% and the expectation for 2010 is that it might reach the expressive mark of 20% (McAlinden *et al*., 2000)[4].

Likewise several others sectors, the car industry is expanding rapidly the utilisation of electronic systems and components. Almost all the functions of sophisticated and modern vehicles – as acceleration, break system, traction controls, and fuel injection (inclusive electronic injection), lean-burn systems, driveability, safety, adaptability of wheel and seats, navigation, anti-chock protection, telematics, system of voice control and entertainment - are already controlled and/or available by the electronic on board (Fine *et al*., 1996; U.S. Industry & Trade Outlook, 2000).

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[2] According to the *US Corporate R & D: Volume I, Top 500 Firms in R & D by Industry Category*, the engine vehicle sector and other land transport equipment, reached the third post, been preceded only by the electronic and information sectors, and by the medical substances and equipment, both in terms of intensity of R & D (correspondence between R & D and sales) and total expending in R & D accomplished in between 1996 and 1997, by the 500 biggest corporations of the North American economy (NSF and US DOC, 1999, *op. cit.*, tables 1 and 4). The data analysis according to the *US Corporate R & D: Volume I, Top 500 Firms in R & D* demonstrates as well that the expending with R & D (correspondence between R & D and sales) in 1996 and 1997 of the two largest North American assemblers, the **GM** (o,048 and o,055%) and **Ford** (o,041 and o,046%) were of the same magnitude of the correspondent expending of the two largest companies of the aviation, guided missiles and of spacial vehicles, respectively **Boeing** (o,042 and o,52) and the **United Technologies Corp** (o,048 and o,047). In fact, the GM expenses were lightly superior than the others (NSF, 1999, *op. cit.*, table 3).

[3] In a wide sense, it involved not only the so called on board electronic, but also the CAD/CAM/CAE systems, as flexible body lines, the CIM system and super-computers (EIU, 1st quarter of 1998).

[4] To give an idea of the fierce engagement of the automotive sector concerning the utilisation of electronic components, an estimate of the same research seems illustrative of it: nearly 85 % (in terms of value) of the electronic products utilised in the light vehicles made in the US, are produced inside the automotive industry itself (McAlinden *et al*., 2000).

Box I.1. Technological Change in the Car Industry*

It is possible, in a wide sense, to consider **four main scenery** regarding forthcoming technological evolution of international automotive industry. **The first scenery**, a more conservative one, considers the possibility of continuity of the present technological pattern, based on internal ignition engine, and in an increasing adoption of electronic components (the so called on board electronic), in the expansion of Internet and in the introduction of new materials. This first scenery, however, does not seem to be compatible to the prospective requirements of legislation regarding a more efficient utilisation of fuel, particularly regarding the emission of pollutants (McAliden *et al.*, 2000; PNGV: *Seventh Report*, 2001; Carvalho, 2003).

Nowadays the need to replace the present form of propulsion car engine is essential. Consequently, there is a real technological race to define, among feasible alternatives, the more efficient options to accomplish the mentioned substitution. This technological race, which is not confined only to the assemblers and parts manufacturers, might result in a deep change in the car industry and its components (*Automotive Industries*, 10/1999; McAliden *et al.*, 2000; Carvalho, 2003).

At the current stage of the research, more promising technological prospective are pointing out towards three other possible scenery. **The second scenery**, which seems to attract the attention of Toyota, involves, in a near future, the opportunity to choose among car technologies operating with batteries, fuel-cells, hybrid propulsions, and natural gas, as well as new types of petrol and diesel engines. At the present moment, therefore, it is not possible to be sure on which technology will be the dominant one. Toyota, for example, have been exploring either new technologies and developing lean-burn engine technology, which the best case is the Toyota D-4 direct-injection petrol engine (EIU, 4th, 1998; Fujimoto and Takeishi, 2001).

The third scenery is associated with hybrid vehicles – an electric engine and an internal ignition engine from mineral fuel. The technology of an electric engine, though simpler and well known, presents two difficult challenges: the limited capacity of energy storage in the batteries and the high cost (and a subsequent restriction) required by a vehicle with two propulsion engine (*Automotive Industries*, 10/1999; McAliden *et al.*, 2000).

The forth scenery considers the fuel-cell technology. The vehicles, in this case, are able to adopt, as energy source, alternatively a mineral fuel – in this situation the emission reduction would be around 20% – or a modified recycled one (as methanol, for example) – in which case the emission would be quite low, but not reaching zero – or still the hydrogen option – in which case the pollutant emission could be zero. Although the achievements are not in a quite advanced stage, the fuel-cells technology seems to be more promising in a long term. Possibly this is the reason why there is an intensification in its research. Nearly all the main car manufacturers have a developing programme of fuel-cell on (*Automotive Industries*, 10/1999; McAliden *et al.*, 2000; PNGV: *Seventh Report*, 2001; OTP, 2003).

Besides, it is evident that there is a change in attitude of the main assemblers regarding emission problems, particularly considering these new technologies. What was considered as a reluctant obedience to new regulatory norms, is now becoming a competitive battlefield. The fastness to introduce new technologies by the car manufacturers aiming to attend new regulatory standards, is increasingly seen as a potential strategic advantage in this fierce competition (*Automotive Industries*, 06/1999; Carvalho, 2003).

The potential gains and losses associated with the introduction of new technologies are expressive, particularly in the fuel-cells technology case. This scenery is mobilising large budgets, and the assemblers are drawing great attention to the problem, as they are frightened of loosing the competition in case they are not able to control the new technology (Carvalho, 2003).

* This box was extracted from Carvalho, 2002.

It seems that the current tendency points to a crescent extension of this electronic control to the less sophisticated vehicles too – depending, of course, of the complexity of the respective control systems and the prices of the models – considering the intense and

the wider utilisation of the electronic on board as a competitive instrument[5] and the relative decreasing of production costs (McAlinden *et al*., 2000).

By another side, the combination of the technology of information and the voice and data communication in real time – which have been called **telematics** – made possible the development of systems of navigation, safeness, and the emergency services in case of car accidents and/or mechanical problems – including report on stealing and monitoring vehicles, remote mechanical diagnosis, and data with medical information of the driver[6]. All this services are the result of a combination of the mobile telephony with the system of global positioning for the vehicles monitoring (McAlinden *et al*., 2000).

Apparently, the near future of **telematics** is pointing to the control voice systems for several functions of the vehicles – developed initially by the Visteon and already available, for example, in the Jaguar S-Type – of traffic information in real time, and the internet access inside the vehicle. In a more distant future, the most promising perspective for telematic seems to be the one associated to the development of the so called Intelligent Transport System (ITS) (Fujimoto and Takeishi, 2001; McAlinden *et al*., 2000).

The current conception of the ITS is considering the possibility, for example, to offer information on traffic jams by the direct communication among cars, between cars and control centres, between cars and roads controls. Some predict the possibility to adjust the distance among cars in a road by the automatic control, with the cars working as if they were virtual wagons of a train (Fujimoto and Takeishi, 2001; Fine *et al*., 1996).

If such changes are actually feasible, the traffic jams on the express road would tend to disappear. And considering the subsequent possibilities to increase the average speed of the vehicles without compromising the safety, the energy spending would diminish too. At the same time, the production of carbon dioxide would be reduced and the impact in the environment would be a substantial one (Fujimoto and Takeishi, 2001).

Traditionally considered as a steel and iron-foundry industry, the car sector is increasingly involved in the development and experiences with light material[7] – including steel of high and ultra-high resistance, aluminium, and plastic resistant to high temperatures, magnesium composite, and reinforced composite fibres (of carbon, ceramic, and other materials). All these efforts are having a considerable complementary impact on the so called advanced manufacture processes (McAlinden *et al*., 2000; PNV: *Seventh Report*, 2001).

According to the *Delphi X: Forecast and Analysis of The North American Automotive Industry (material volume)* results, the production costs are still the main obstacles to the expansion in adopting light materials, and in particular, the reinforced composite fibres, even considering its great potential as a weight reducer (McAlinden *et al*., 2000).

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[5] A recent estimate found that there are an average of 20 to 30 microprocessors in the automotive vehicles in the North American market (McAlinden *et al*., 2000). On the other hand, the Toyota Lexus LS 400, a model addressed to a top market, has 40 microprocessors according to the Assembler (Chanaron, 2001).

[6] The OnStar – offered by GM – is the most wide telematic service available up to now in the North American market (McAlinden *et al*., 2000).

[7] In search for new and lighter materials – which have been stimulated, in the US case, by new government requirements relating to a more efficient use of fuel and by new legislation regarding pollutant emissions (the *Clean Air Act*, of 1990 and the "2004 law" from California) – it has involved not only the car assemblers and the parts suppliers, but the steel producers and the complete sub-structure of research available by the *US Council for Automotive Research* (USCAR), the Universities and public laboratories of research, and the *American Iron and Steel Institute*, in this last case, through the project *Ultra-light Steel Auto Body* (USLAB) (McAlinden *et al.*, 2000).

Nowadays these materials have a restrict utilisation involving conventional vehicles of high performance, and the prototypes and research models of high mileage, which, in the American case, have been developed in the USCAR ambit, and by the programs of alternative technology of power-train (hybrid propulsion and fuel-cell ones) from Partnership for New Generation of Vehicles (PNGV) (McAlinden *et al*., 2000; PNGV: *Seventh Report*, 2001).

The Restrict Internationalisation of R & D in the Automotive Industry

Although the automotive industry is considered, in general terms, as one of the most globalised (Hatzichronoglou, 1999; OCDE, 2002) this, certainly is not the case regarding the internationalisation process of the R & D. Actually, in comparison with others sectors – as for example, the chemical (basic), pharmaceutical, computers, and electronic equipment ones – the globalisation of R & D activities of the car industry still is relatively restrict (Calabrese, 2001).

As mentioned by several authors, there are strong sectorial conditions interfering in the localization of R & D (Pavitt, 1984; Malerba, 1998; Calabrese, 2001). According to these authors, the variety of technologies and the distinct sectors are different regarding opportunity, appropriability, and cumulativeness of the innovative process. In the same way, it has been noticed that the technology and knowledge have too a tacit dimension, with a relative importance variable according to the different sectors (Lundvall and Borrás, 1999; Malerba, 1998). In the same direction, it was emphasised recently that even the different forms of organisation and the R & D dynamic have equally a sectorial characteristic (Coriat and Weinstein, 2001).

In the case of car industry, the R & D organisation seems to be conditioned too by certain characteristics of its specialisation pattern. Even considering the fact that the technological innovation is believed an essential factor, the automotive industry should be defined, regarding its technological activities, by the applied research. “Innovations are rarely radical; they often come from othe sectors and are genrally outsourced. In recent years the number of technological competencies has increased, but the prevalecent specialization is still mechanical of which the main source of renovation is traditionally based on the product and process development departments. Knowledge is tacit and hardly codifiable. These are some of the reasons why car manufacturers have high propensity to innovate internally and do not patent ” (Calabrese, 2001:8).

Box I.2. Selected Characteristics of the Automotive R & D

1. The innovation is mainly a result of the development process of the product. Such characteristic requires an organisation of R & D based mainly in project teams and in the crescent simultaneous development of part of the project activities. Apparently, the emphasis of R & D in the development of product might be, at least in part, the cause of the predominance of incremental innovations which define the automotive sector (Coriat and Weinstein, 2001; Calabrese, 2001).

2. Concerning the basic knowledge, the conditions for its respective access, the key technologies, and the ability in general Terms, the automotive industry seems to combine two essentials characteristics:

a. the innovative capacities are based mainly in specific abilities, collective, and in a large sense, tacit and of a complex codification – developed through collective and internal learning processes. For this reason, the internal organisation of product development and its connection with other functions (productive, marketing ones) of the assemblers, have been critical. That is the reason why the human resources management seems to be the base of the success of the organisational and productive conceptions of Toyota (Calabrese, 2001; Coriat and Weinstein, 2001);

b. the systemic nature of its knowledge basis and the central aspect of the design system in the development of product processes. Such facts seem to give a critical role to the conditions access of the assemblers to the different sources of knowledge, of technologies, and of information, particularly concerning the equipment suppliers (Coriat and Weinstein, 2001; Calabrese, 2001).

3. Concerning the organisational dimension of R & D, it points out the organisation according to projects and, in particular, the heavyweight team structure, which have been displaying the most efficient form both in Terms of costs and in terms of time necessary to the development and the introduction of new models. This form of internal co-ordination have been combined too with new methods relating the external links with the suppliers, particularly when they involve co-operative activities. Regarding the determinant factors of the efficiency of R & D, it has to be emphasised the central role of the conditions where the co-ordination of the human activities occurs, which, by its turn, make possible the collective internal learning process. It seems particularly important too the cohesion of the teams involved and its interaction with the other groups of the companies (Clark and Fujimoto, 1991; Coriat and Weinstein, 2001).

4. As demonstrated in recent studies, the main source of technological knowledge accumulation in the automotive industry case, is based in the ability of the companies of developing internally specific organisational capacities, much more than in the external absorption of new technologies, even when this possibility is available. The efficiency of this kind of innovation and production system, as shown particularly in the studies on the Japanese and German assemblers, seems to be strongly linked with the creation of specific routines in the interior of these companies and with the respective strategies of work management and incentives (Coriat and Weinstein, 2001; Teece *et al*., 1997; Clark and Fujimoto, 1991).

5. In terms of technological regime[8], the automotive industry can be defined by a medium level of opportunity, by a high cumulativeness, and also by a high appropriability (Malerba, 2001). Relating the conditions of the appropriability of innovations, the lead time – much more than the patents (Calabrese, 2001) – have becoming a mechanism more efficient of protection regarding the innovation of products. This last characteristic seems to be significantly related to the importance that the time reduction is increasingly acquiring in the development of the products, as a competitive tool in the automotive sector (Coriat and Weinstein, 2001).

[8] According to Malerba, a technological regime is defined by the conditions of opportunities, by the appropriability and by the levels of technological knowledge cumulativeness, and also by the characteristics of its relevant knowledge basis (Malerba, 2001).

There is no doubt that the competition in the automotive sector have been intensified in the last years, and that the assemblers have progressively changed some of theirs strategies. They have, for example, invested an increasing amount of their profits in innovation and design. Besides, they have widened too the spectrum of theirs agreements on mutual co-operation, and also with companies of other sectors. These agreements have been multiplied in specific areas as engines, box gear, platforms, and even power trains, but rarely involve the whole vehicle, R & D activities, and design (Calabrese, 2001).

The restrict integration of the development activities in the crescent number of co-operation agreements among the car assemblers, seems to be an indication of a more general limitation of the globalisation process of R & D of this industrial sector (Calabrese, 2001; OCDE, 2001). Specifically in the case of the automotive sector, the result among factors which contribute to the processes against centralisation and decentralisation of R & D, have clearly limited a faster globalisation of these activities. "The R & D centres are located in proximity to the decision making centres, rather than in areas with substantial investments in research. In other words the globalization of R & D follows the process of internationalization of companies rather than the approach of *knowledge spillovers*" (Calabrese, 2001: 7).

According to a wide research accomplished by Miller (1994), the main factors which facilitate the centralisation process of R & D in the automotive industry are as follow, in order of importance:

- ✓ Proximity required for integration of the executives in the definition and the initiation process of the product.
- ✓ Interaction between the directors and the program, required to link the development of the product and the company's strategy.
- ✓ Pressure to reduce costs of development of the product and time delays.
- ✓ Proximity between the R & D premises and the experienced first level suppliers.
- ✓ Proximity between the managers of the program and the premises of research and advanced engineering.
- ✓ Development of cars aiming global markets and market segments.
- ✓ Co-ordination of the adaptations for regional markets.
- ✓ Centralised co-ordination to reduce the numbers of under-bodies.

Still according the same study (Miller, 1994), the main factors which stimulate the dispersion of R & D activities of the car industry, are as follow, again in order of importance:

- ✓ The need to place an engineering surveillance post to monitoring the competitors advances.
- ✓ Update the tendencies of style and design with observation posts in Italy, California, etc.
- ✓ Need of expansion of R & D activities in foreign markets with expressive selling results.
- ✓ Pressure from the host governments in order to install R & D departments in their countries.

- ✓ Installation of engineering support activities next to the assembler plants abroad.
- ✓ Joint-ventures and alliances to transfer technology abroad.
- ✓ Importance of local R & D activities to be present regionally.
- ✓ The increase of external sales might influence the establishment of independent R & D premises aiming the development of new models.

The following table (Table 1) also based in Miller (1994) illustrates the average distribution of people involved in different activities of R & D in the international automotive industry, in the first half of the 90s. (Table A.1, showed in the Statistical Annexe, illustrates the distribution between internal and external R & D activities considered ideal by the assemblers, by then).

Table 1.- *Average distribution of R & D people in the International Automotive Industry*

	Average Number of Staff	**Percentage of Components in Total**	**Percentage at the Home Base**
Generic Research	1.885	4,5	83
Advanced engineering	321	7,8	89
Concept initiation and definition of attribute	336	8,1	91
Car engineering and design	2.225	53,9	68
Production readiness	615	14,9	72
Engineering support and surveillance	122	3,9	73
Styling	326	7,9	85
Total	4.130	100	74,4
Average number of staff abroad	1.060		

Source: *R. Miller. Large-scale Innovations: The automobile Industry (1994).*

Although is evident that the globalisation process of R & D in the automotive sector have been expanding in recent years – particularly when is considered the expenses of R & D and the number of researchers and employees hired by the branches of the assemblers in the main markets (OCDE, 2002) – is important to point out that, regarding new patents, there is not yet significant changes considering the pattern observed in the last years.

If we take, for example, the case of patents achieved next to USPTO by the car assemblers, it is possible to identify an intense and active participation of the headquarters (around 95%) on the total of the patents granted (see Table 2). This last point should not be minimised to evaluate the real advance and the characteristics of the decentralisation process of R & D, on course in the automotive sector.

Table 2

Total of Patents Granted next to USPTO Registered in the Country of its Origin and the Comparasion Face the Total of Patents Granted											
Assemblers	1996		1997		1998		1999		2000		OC
	Total	%	Total	%	Total	%	Total	%	Total	%	
General Motors	290	97,3	273	98,6	297	97,1	272	98,6	242	95,3	EUA
Ford	361	94,2	244	91,7	146	99,3	142	94,0	98	95,1	EUA
Chrysler	151	79,9	139	94,6	165	87,8	211	87,9	142	91,0	EUA
DaimlerChrysler	0	-	0	-	0	-	28	-	136	-	EUA
Honda Motor Co.	286	94,7	340	96,3	386	92,9	452	98,8	445	90,3	Japão
Honda Tsushin K.K. Kaisha	3	-	1	-	0	-	2	-	6	-	Japão
Nissan Motor co.	101	98,1	138	99,3	164	100	207	98,1	250	99,6	Japão
Toyota Shatai K. Kaisha	2	-	0	-	0	-	1	-	2	-	Japão
Toyota Jidosha	157	98,1	211	99,1	386	99,0	402	99,3	341	98,0	Japão
Mitsubishi J. K. Kaisha	44	-	32	-	65	-	59	-	34	-	Japão
Fiat Auto	0	-	3	-	1	-	1	-	0	-	Itália
Renault Automation	0	-	0	-	0	-	2	-	6	-	França
Daimler Benz	128	88,9	1659	92,4	239	85,7	173	79,3	36	94,7	Alemanha
Daimler Chrysler	0	-	0	-	0	-	86	-	308	-	Alemanha
Volkswagem	19	-	8	-	18	-	39	-	43	-	Alemanha

Source: *USPTO*

PRODUCTS AND R & D STRATEGIES OF THE MAIN ASSEMBLERS INSTALLED IN BRAZIL*

Products and R & D Strategies of Ford in Brazil

By 1983, Ford has remodelled its main plant in Brazil, in S. Bernardo, S. Paulo, and launched its medium size model, the Escort, which became the most important product of the North American assembler during the Autolatina experience (1987 to 1996). By 1992, the S. Bernardo plant was again re-shaped to install the Ford Escort/VW Logus project, which permitted the utilisation of Escort platform by both partners of the Autolatina (Kolodziejski, 1998).

By the time the Autolatina was disassembled, in 1995, the S. Bernardo plant was again totally remodelled to start the Fiesta[9], the new compact of the US assembler. The Fiesta model was launched in 1996 and represented – altogether with the ending of

* This item was based on Carvalho 2002.

[9] It was spent about US $ 1,6 billions to restructure the Fiesta production line at Anchieta plant (Kolodziejski, 1998).

Autolatina in the same year – a new phase of the Assembler's interests and investments in the Brazilian market (EIU, 1997). The launching of the Fiesta in its Brazilian model – the first product by Ford in the most important segment of the Country's market – confirmed a turning point in the Assembler's strategy. By that time, Ford begin a fierce and extensive dispute for the "popular cars" segment (EIU, 1997).

By 1996, the Assembler introduced a remodelled Escort in the Brazilian market, with a new engine (Zetec 1.4 and 16v) and a similar style to the European one. The production of Escort family model, by the same time, moved to Ford's plant in Argentina, in Pacheco. The Assembler tried to reinforce its presence in the small cars segment, so Ford introduced, in 1998, the Ford Ka – the first sub-compact product (or mini) made in Brazil. With an avant-garde design it was seen with a certain scepticism by the competitors. Ka model was a pioneer introducing a new segment in Brazil called the city cars[10].

Around November of 2000, Ford launched the Focus hatchback model in Brazil, with an engine Zetec 1.8c.c. and 16v. It was produced in the Argentinean plant and destined to the Brazilian market. The arrival of the new medium model of Ford, only two years after its introduction in Europe, was followed by a great expectation by the Brazilian branch. They believed that with a good marketing campaign around Focus – which in Europe and in the States, in less than two years the sales have surpassed one million units – it could benefit the whole line of Ford models in a short term. "The idea is that the modern image of the model will have positive effects in the other segments, particularly in the popular one"(*GM*, 11/12/2000).

The new Fiesta was launched in 2002 – which was called Amazon Project (*Valor*, 14/12/01). As it was already pointed out in another place (Carvalho, 2002 and 2003), the Amazon Project is the Brazilian version of Ford's attempt to introduce a "world car". In accordance with the current strategy of Ford products, the development of the Amazon project "has the participation of a Brazilian team aiming to offer all the particularities on the conditions of the Brazilian market during the definition of the project. Consequently, as it occurs with the Ford Ka, it will be not necessary a large amount of *tropicalization* to adapt itself to the local conditions" (Consoni and Quadros, 2001 : 5).

With the new model – which the hatchback version, with five doors, is produced in Ford's plant in Bahia – the company hopes to consolidate its participation in the local market and also expand its exports. Recent data reports that, with the new Fiesta, Ford's participation in the Brazilian market for light vehicles went from 6,6 % in August of 2001 to 11,3 % in August of 2002 (*Valor*, 28/10/02)[11].

The new car line introduced by Ford in the Brazilian market is presented by the Mondeo and Taurus models, brought respectively from Belgium and from the States. The Assembler was already considering to produce the Mondeo model in its S. Bernardo plant, with an amount of 40 thousands units per year. Regarding the segment of light commercial vehicles, Ford developed locally the pickup version of Fiesta, the Courier, and the full-size pickup F 250 and F 1000, this last one from the US model F 150. The models to this segment is completed by the Ranger pickup, and by the Explorer, imported respectively from Argentina and from US (Santos *et al*., 1999, Kolodziejski, 1998).

[10] "Competitors such as Fiat and VW "believe that such small cars do not have a significant potential in Brazil" (EIU, 1997: 70).

[11] Regarding the exports, the news are promising: there are estimates that the North American assembler sales might reach US $ 500 millions in 2002, comparing to the US $ 445 millions achieved in 2001 (*Valor,* 28/10/02). (See table 5.4, for data related to the assemblers exports in units).

During the 70s and 80s, "Ford built in Brazil one of the majors units of a product architecture of Latin America, which was responsible by the development of derivatives as Corcel" (Quadros *et al*., 2000: 186). With the increase of globalisation and the end of Autolatina, Ford gave up completely the strategy to produce regional models. Since then, the contingent of product engineers hired by Ford decreased clearly. By the year of 1999, the total of engineers responsible for product and process development was about 120. At the moment, a large amount of tests and design of prototypes is made in England. In Brazil the activities involving product development are restrict to "local input of global platform (Amazon project)"[12] and to the design of the Fiesta pickup derivative – the Courier model (Quadros *et al*., 2000: 188)[13].

Ford is the second in the ranking of total patents achieved next to INPI (Instituto Nacional de Patentes Industriais). With 385 patents of the Brazilian car industry samples, it is surpassed only by Fiat, with 414 (Carvalho *et al.*, 2001). In addition, Ford is the assembler that presents the largest amount of patents (48), which previous country was Brazil itself. Regarding the number of patents acquired next to INPI, Ford is the second largest assembler in Brazil, surpassed only by VW, and the Assembler considers Brazil as its priority (Carvalho et. al., 2001). The surprising conquests of Ford, concerning patent qualifications, is partially accounted for, is believed, by the previous performance of the products engineering of the Brazilian branch (Quadros *et al.*, 2000).

Product and R & D Strategies of Fiat in Brazil

In 1990, Fiat launched the Uno Mille 1000cc model, and in the next year it introduced the Tempra saloon. Besides it starts in a new segment with this model, Fiat introduced innovative technologies in the local car industry as, for example, the first 16v engines, and also the first vehicle with turbo-compressor. Fiat Tipo was imported from Europe, from 1993, and it came out as a successful launching. The Fiat Tipo model started to be fabricated locally in the production line of Tempra (Kolodziejski, 1998).

Fiat first 178 project made in Brazil – a line of models addressed mainly to the emergent markets, was presented in April of 1996. Initially it launched the models Palio hatchback, of three and five doors. The station wagon (also produced in Betim) came in March, 1997. Following these models, the station wagon version (Palio Weekend), van and pickup, was also presented to the market. The Argentinean Fiat was responsible for the production of the saloon version (Siena) (Bursa *et al.*, 1998; EIU, 1997).

By October of 2000, in Rio de Janeiro, Fiat introduced to the international market its second generation of Palio family, re-styled in its shape, particularly in the engine an technology embodied (*Autodata*, October, 2000). The motorization is built with a new engine called Fire (Fully Integrated Robotized Engine) 1.0, 1.3 and 1.6 (with 8 or 16v), produced in the brand new line plant of engines in Betim, in Minas Gerais.

[12] "About 60 Brazilian engineers are currently working in the development of a world platform at Ford main unit in Dearborn. They will be in the US until June of 2001 and by their return they will reinforce the development area of the local Ford" (*GM,* 16/02/2000).

[13] It was announced that Ford was beginning the restructuring of its engineering development, in the Taubate unit, where 60 engineers, the majority of them recently employed, were engaged in the development of local engines (*GM*, 15/08/2000). This information, though promising, does not seem sufficient to change the character of the previous observations, regarding the present stage of activities of product development of the Brazilian branch of Ford.

From the previous line of products, Fiat presented the models Uno Mille Smart (the cheapest car in the national market) and the version of Palio Young (first generation), though with a more conventional design, and slightly more expensive than the Celta (GM), it presented the versions with two and four doors (*Autodata*, October 2000).

Almost simultaneously with Italy, Fiat launched, in 2002, the Fiat Stilo (a medium size model, hatchback version). This was the first vehicle from the Turin Assembler to adopt a GM engine, resulted by a recent joint-venture with the biggest North American automotive assembler (*Autodata*, November, 2002).

Fiat's current line of products – still from the second generation of Palio – comprises the family (platform) Brava/Marea (segments C and D respectively), launched in 1998[14], and the imported ones Alfa Romeo (164, 145, 155 and Spider). Some of the special models of the Assembler are imported as Tempra SW and Coupé (*Autodata*, October, 2000; EIU, 1997).

During the 90s, Fiat was the assembler that grew quicker than any other in Brazil, in such way that, at moment, it is disputing with VW the position of the largest automotive producer in the Country (*GM* online, 21/03/02). The Brazilian market increase favoured largely the Italian Assembler during the 90s, and Fiat understood immediately the opportunity given by the consistent expansion of the small-size car segment, which resulted in the adoption of the Automotive Deals (in 1992 and 93), and particularly, the incentive given by the Government to produce popular vehicles, in 1993 (Bedê, 1997)[15]. The Brazilian total car sales reached an astonishing amount of 272,7% between 1990 and 1997, but Fiat sales were even bigger, it expanded around 489,2% (Kolodziejski, 1998) in the same period.

Considering the technological strategy of the Fiat in Brazil, it is important to point out initially, the building of a technical centre in Betim, by 1993, focusing on engineering activities and product development. In connection, via satellite, to the laboratories in Turin, the Brazilian technological centre had at that time, according to Quadros *et al*., (2000), a staff of around 150 engineers – or 1/8 of the main technological centre of the Assembler (Fiat Research Centre), in Turin[16].

The project 178, which development was based in Italy, counted with a significant co-operation from the Brazilian engineers, who participated in the project from its conception phase, according to information available (Quadros *et al*., 2000: 188; Kolodziejski, 1998)[17]. The recent development of the contribution of the technical centre of Betim in the activities of the Italian assembler, in a latest account, is not accurate, due the data on the participation of the Brazilian engineers in the development of the second generation project of the Palio family are not yet available.

Fiat is the leader assembler in the Brazilian ranking, regarding the achievements of patents – in Brazil given by INPI - reaching 414 patents (Carvalho *et al*., 2001). However, it is important to mention here that only 7,5% of the total of patents had Brazil as a priority Country (Carvalho *et al.*, 2001).

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[14] In substitution to Tipo and Tempra models.

[15] With the advantage of been the single assembler to produce a 1000cc car – Uno Mille – since 1990 (Hollanda Filho, 1996) Fiat started from favourable conditions and conquered a large share in the crescent and important segment of popular cars.

[16] According to the annual report of Fiat group in 1998, it had then a technical staff of 850 workers.

[17] Again according to Quadros and Carvalho *et al*., 2000, the technical centre in Betim is developing a design derivative from Palio (sedan, wagon, and pick-up versions) and engine 1000cc. Despiting counting with a modest number of laboratories, the centre is able to develop prototypes locally.

Product and R & D Strategies of VW in Brazil

The German assembler in Brazil, up to recent years was maintaining the tradition of developing specific models for the Brazilian market. VW has developed locally a sport car (SP2) in 1972, the hatchback Brasilia, in 1973, and three generations of Gol – launched in 1981, and remodelled successively in 1993 and 1999 (EIU, 1997; *GM*, 26/02/99).

Regardless the huge success of the Gol family in Brazil – which sold around 448,7 thousand units in 1997, responsible for about 80% of the sales of the German assembler in the Country (*GM*, 26/02/99) – probably it will be the last model addressed specifically to the national demand, and also, it is possible that it will not share the platform with any other model of the Assembler. The new strategy adopted internationally by VW – reducing the number of platforms – is not, in fact, compatible with the strategy of developing local models (Bursa *et al*., 1998).

The new model, the PQ-24, a small car developed in the same platform as the 4th generation of the Polo family, addressed to the European and the Brazilian market[18], and a natural substitute of the Gol, came out more expensive than the expected, which product could be positioned, in terms of price, between the Gol and Golf segments.

Recently, VW has announced the launching of a new model of Polo family in 2004, which will be produced at its unity in S. Jose dos Pinhais, at Parana State. The new car, known as Tupy Project, according to the Assembler "is born with 99 % of nationalisation rate", and it aims to be a substitute for Gol (*Valor,* 30/10/02).

But, in fact, it seems that the Polo model and the Tupy project will replace gradually, and probably only in part, the products of the Gol family, which will represent a similar role as the Uno Mille at Fiat. Apparently, the replacement of Gol model will not occur as it was initially thought, considering its importance in the local market, and the difficulties found by the Assembler to introduce a new model with compatible prices (*GM*, 13/02/2001); *Valor*, 30/10/02)[19].

A significant aspect of the product strategy of VW to be considered in the Brazilian market is the delay regarding the "global cars", besides, there was a low competitiveness in the small car segment (A and B segments). Even considering that, during the 90s, the German assembler was the one that has introduced more new cars platforms in the Country (Quadros *et al.*, 2000), none of them were destined to the small cars segments, neither it was involved in the "global cars"[20] production. In fact, only in 2002 the Company launched the new PQ-24 model, nearly 10 years later than its competitors[21].

It seems that one of the main reasons why the VW lost its privileged leading position in the Brazilian market, was the delay in modernise its products aiming a crucial segment of the market. From 1997, VW started a dispute for the leadership with Fiat (Kolodziejski, 1998; Carvalho *et al*., 2001).

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[18] The Brazilian Polo produced in S. Bernardo do Campo, and already launched in 2002 in its hatchback and sedan versions, should not come with an 1000cc engine (Auto Business, 27/11/02).

[19] In fact, the German assembler does not dismiss the possibility to introduce the so called Gol Generation 4 (Valor, 31/07/01).

[20] By 1997, all the VW competitors, for example, introduced versions of the so called "global cars" in the Brazilian market, while the German Assembler was restricted to the renovation of Gol. Fiat launched Palio, GM the Corsa, and Ford, which had already the Escort Hobby 1000, introduced Fiesta and Ka (Kolodziejski, 1998).

[21] We are not considering the introduction of Golf, which begin to be produced in the S. Jose dos Pinhais (PR) unit from 1999, due this model – although is defined as a "global car" – be usually classified as a medium size vehicle, and therefore belonging to the segment C.

The line of light vehicles produced in Brazil at VW presently is comprised by the Gol family (Gol, Parati, Saveiro), by the Santana/Quantum platform[22], by the obsolete Kombi (pickup and van), and by the new models Golf and Audi A3 produced in the new unit in Paraná since 1999[23]. The line is completed with the Polo Classic, imported from Argentina, and Bora from Mexico[24], Passat/Variant from Germany[25] and with Seat Ibiza and Seat Cordoba, from Spain (EIU, 1997b; Kolodziejski, 1998; *GM*, several numbers).

In the technological area, the main advantage of the German assembler was that it was the first one to introduce, in the Brazilian vehicles, the electronic fuel injection, ABS breaks, and the catalysers. Besides, VW was the first assembler to get the ISO 9001 and 9002 register, both to its plant in Taubaté and to its retail sales net. The Assembler's unit in Taubaté, where the family Gol is produced, is considered one of the most advanced car manufacturer of Latin America. By 1997, this plant had a productive capacity of 1.100 car daily, a team of 167 robots (69 of them working in the paint-work sector) and a productivity of 43 units per worker, which was far superior to the 33 units produced, by then, in its pioneer and complex plant in S. Bernardo (Kolodziejski, 1998, EIU, 1997)[26].

Considered once the biggest of its type in Latin America, the design and engineering centre (Ala17) of VW, at S. Bernardo unit, had once 450 engineers, with the capacity to develop whole cars and trucks. Stations CAD-CAM were available and connected by satellites to the R & D centre of VW in Germany. The plant, by 1997, offers "a complete prototype shop, with press and injection moulding machines, a laboratory that has 28 dynamometers and a facility that can crash-test cars to US Specifications" (EIU, 1997: 89).

The centre produced the design of the line Logus/Pointer, which were based on the Escort platform, during the Autolatina experience. Also the centre was responsible for all generation of Gol platform and engines 1000cc (including the 16v and the turbo version ones). Although it had an important role as it was mentioned above, the participation of the Brazilian development unit, regarding the new PQ-24 project has been more restrict, focusing on local inputs of the "global" platform, not including the concept definition (Quadros *et al*., 2000). Besides, Brazilian centre has been involved in the development of trucks and coaches lines of VW, which activity started in partnership with Ford, since the Autolatina period. By 1996, when the joint-venture ended, VW concentrated in its production of heavy vehicles in a new plant in Rezende, in Rio de Janeiro, the only unit of the group to invest in the heavy vehicles, since its beginning in 1995 (EIU, 1997b). It is possible that this situation might suffer some changes, considering the recent acquisition of Scania, the Swedish truck assembler, by the VW group.

[22] The Santana/Quantum family, launched in 1984, went through little changes, and it is still on, due mainly to its attractive price. It is the only one in its segment produced locally. Planned to replace the Passat family, it gained more strength with the currency devaluation in 1999 (EIU, 1997b; GM, 04/07/2000).

[23] Golf was first imported from Europe, and more recently from Mexico, before been produced in Brazil (EIU, 1997b).

[24] Launched in the Brazilian market in December of 2000, Bora is a medium sedan based on the Golf platform (*O Estado de S. Paulo*, 2001).

[25] It was mentioned by the press the possibility of Passat be produced in the S. Jose dos Pinhais (PR) unit.

[26] In this unit it was produced then three distinct groups of cars, engine, gear box, and even some parts foundry work (Kolodziejski, 1998).

Surprisingly, VW is the 7th assembler in the ranking of the Brazilian car industry, regarding the patents, reaching an amount of only 34 patents (Carvalho *et al*., 2001) . Although the majority of the patents achieved by the German assembler is not expressive – 28 of a total of 34 (82,4%) – it had Brazil as a priority (Carvalho *et al*., 2001).The low number of patents achieved by VW in the Country, might be explained by this fact. It seems that VW does not intend to validate in Brazil the patents achieved in Germany. Even if there was a focus to produce on the patents locally, the performance of the Brazilian centre of design and engineering of VW would reach the third place in the Brazilian Autoindustry (Carvalho *et al*., 2001) which is a modest result considering that its technical capacity is relatively high (Quadros *et al*., 2000; EIU, 1997).

Product and R & D Strategies of GM in Brazil

A more aggressive strategy of products was adopted by GM, from 1992, resulting in a new model at each year. The first one was Omega, which replaced the obsolete Opala, in 1992. Respectively in 1993 and 1994, it was launched the station wagon version of the Omega (Suprema), Vectra and Corsa hatchback. In 1995 and 1996, GM presented a compact pickup S10 and the new Vectra. GM brought the Astra model from Europe, the pickup and saloon[27] versions of Corsa and the sports-utility model Blazer (EIU, 1997b; Bursa *et al*., 1998).

The Celta model was presented by GM in 2000. It was a new subcompact, based in the Corsa platform, produced in the Assembler new plant in Gravataí (RS). Differently from the previous cases, the Celta model is a car "designed, detailed, and produced in Brazil". It was projected specifically to work with low-potency engines and characterised by a clear design, and regarding equipment and accessory is very basic. Despite it, "Celta has a characteristic extremely important in terms of strategy of the product to GM in Brazil: it is a vehicle built specifically to the emergent markets, and it was launched internationally in Brazil. Besides, the Brazilian branch had an expressive role in this strategy, following closely and participating in the whole process of the development of the product" (Consoni and Quadros, 2001: 5).

Still in 2000, new versions were re-launched, as the Astra and Vectra. By 2001, the US assembler introduced in the Brazilian market the Zafira, a mini-van built in the Astra platform and assembled in the São José dos Campos unit, in S. Paulo (OESP, several issues). Finely, in 2002, new versions of Corsa hatchback and sedan were launched altogether with the mono-volume Meriva (*Automotivebusiness*, 27/11/02).

The full-size pickup D20 has completed the line of light vehicles of GM in Brazil, which at the present moment is imported from Argentina, and by Calibra – a two doors *coupé* coming from Europe (EIU, 1997b; Bursa *et al*., 1998; *O Estado de S. Paulo*, several issues).

[27] By the time, it was planned as well the introduction of the Corsa, in its station wagon version, which, together with the pick-up and saloon models, were developed locally, from the Corsa basic platform, by the GM Technical Development Centre based in S. Caetano plant (Bursa *et al*., 1998).

The advanced GM plant in Rio Grande do Sul – which up to its launching cost US$ 554 millions, with 40% backed by the Rio Grande do Sul State government – was built in an industrial area. In this new conception of organising the production, the suppliers of systems and sub-systems – installed next to the plant – deliver them complete, or partially ready – the just-in-time concept – which will be added to the vehicles right in the assembly line[28]. The unit plans, initially, a production of up to 120 thousand units yearly, and it will operate, in its first phase, with a total of 120 robots, with the majority of them functioning in the tin section (*O Estado de S. Paulo*, 21/07/2000)[29].

The GM unit, located in the S. Caetano do Sul plant, was the first one to complete the final assembly of four cars – Kadett, Monza, Vectra and Omega – in the same line. This unit is the base of the GM Technical Development Centre, responsible for the development of the local derivatives of the Corsa platform (saloon, pickup and station wagon). The Centre is in charge too of the Astra sedan, the engine 1000cc, and had a participation in the Blue Macaw project from its concept. (Bursa *et. al.*, 1998; Quadros Carvalho *et al*., 2000).

GM has expanded considerably[30] its "substructure and R & D staff in the second half of the 90s", which was in consonance with its multi-regional product strategy. By 1999, the Technological Centre, in S. Caetano, employed more than 1000 people, and 400 of them were product engineers. Again according to the Quadros *et al.* (2000) study, GM was the only subsidiary installed in Brazil to get "return selling its technological services to other countries (around US$ 100 millions, in 1998)" (Quadros *et al*., 2000: 189).

The Brazilian branch of GM is the third in the ranking of car assemblers regarding the patents achieved next to INPI, in Brazil, with an amount of 264 patents (Carvalho *et al*., 2001). Also GM arrived in the third position with 23 patents and 8,7% of accepted patents by the INPI, which has the Country itself as a priority (Carvalho *et al*., 2001).

Toyota in Brazil

In 1998, the second Brazilian plant of Toyota was installed nearly 40 years after the launching of its first plant in S. Bernardo, S. Paulo. The new unit, of US$ 150 millions, was placed in Indaiatuba, SP, and it was initially planned to produce 15 thousands units, yearly, of its Corolla model, a medium size sedan vehicle. The first previsions pointed to a possibility of expansion up to 200 thousands units per year. Also there was a project to produce a second model, which should be a small car to compete in the segment of 1000cc (EIU, 1997b; Kolodziejski, 1998).

[28] GM informs that it was possible to assemble, in the same place, 16 of a total of 17 systems suppliers in charge of the production of components and responding by 85% of the price of Celta (*GM*, 18/07/00).

[29] By the time of its opening, in the 21st of July of 2000, the Gravataíi unit employed 2100 workers. Prospective account points to 4000 workers from the moment the plant works at its full capacity (*O Estado de S. Paulo*, 21/07/00).

[30] The same occurred to Fiat as well (Quadros *et al.*, 2000).

The performance of the biggest Japanese assembler in the Brazilian market can be defined as moderate, even when is considered that its achievements were better in the last year, in comparison, for example, to Renault. The sales of Toyota, an amount of 28,3 thousands units had surpassed Honda, with 19,7 thousand units only in 2000, which granted it the fifth position in the ranking of the assemblers based in Brazil (*GM*, 19/01/2001). The two Japanese assemblers sold around 17 thousand units each one, by 1999. Toyota modest achievements in Brazil is due mainly to the relatively conservative marketing policy of the assembler, and to its absence in the segments of major demand in the Brazilian market[31], which are the small cars segments.

In fact, the line of regional models of Toyota is restrict to the medium size sedan Corolla, which was re-launched in a new version in 2002, and the pick-up Hi-lux, produced in the Zarate plant, in Argentina. The model line of Toyota in the Country is completed with the cars Corona and Camry, and the sports-utility models Blaser (SW4) and Rav 4, imported from Japan (*GM*, several issues; *Automotivebusiness*, 27/11/02).

The Corolla new generation launched in 2002 is quite different from its previous model. The new design, borrowed from the version produced in the US, seems much more attractive than the previous one and should increase its sales. Based in a new platform, the new Corolla is bigger and more spacious than the other one, and it should be presented in two versions:1.8 and 1.6 litres, both with 16V, and a variable valves command (*Autodata*, 07/2002).

CREATION OF LOCAL COMPETENCIES IN THE PRODUCT DEVELOPMENT, AND THE RECENT PERFORMANCE OF THE MAIN ASSEMBLERS OF THE BRAZILIAN CAR INDUSTRY

According to Carvalho (2002 and 2003), in his review of product and R & D strategies of the five main assemblers installed in Brazil – GM, Ford, VW, Fiat, and Toyota – discussed in the item II of the present article, with the respective global analysis of product and R & D of the mentioned assemblers – seems to indicate evidences of a fierce link, in general terms, between global strategies of products and the local performance of their respective branches, either concerning the intensity and the nature of their participation in the development of product (Quadros *et al*., 2000; Consoni and Quadros, 2001 and 2002). This way, the assemblers which have been adopting strategies with models of ***glocalisation*** – involving both the changes in global platforms to local adaptation[32], and the development of platform in the emergent countries[33] – as, for example, GM and Fiat, which presented too an expansion of theirs local substructures of R & D[34] (Quadros *et al*., 2000).

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[31] Such actitude is typical of Toyota regarding emergent markets, with the exception of the Asiatic countries (Bursa *et al*., 1998).

[32] Including even the development of derivatives of the referred platforms to attend the preferences and needs of the emergent market. Such were, for example, the cases of the sedan, wagon, and pick up models, based on the Corsa platform (and more recently from the mini-van Meriva) and the four doors version of Astra developed by the Brazilian branch of GM (Consoni and Quadros, 2001).

[33] Such are the cases of the Project 178 of Fiat, which produced the platform of Palio family (and its derivatives Weekend, Siena, and Strada) and of Celta of GM (Blue Macaw Project). In a large extent, and up to recently, this was the case too of the Brazilian VW with the local development of three generations of the Gol family and its derivatives (Gol 1000cc and Parati) (Consoni and Quadros, 2001 and 2002).

[34] "This two assemblers have independent regional divisions in Brazil and they have expanded their engineering teams due the increment of activities related to the development of product which attend the local demands" (Consoni and Quadros, 2002: 10). Besides, and probably the most important fact, they have

All these important facts, seem to achieve more relevance when is considered the performance of the varies models as it is analysed the recent evolution of the assemblers of the Brazilian car industry. The exam of the tables 3 and 4, seems to support entirely the premise that the recent success in the Brazilian car market, is associated to the introduction of models presenting a visible adaptation to the local characteristics and preferences[35], either by the development of platform for emergent countries and/or local ones – which is the case of the Gol family (VW) and Palio[36] from Fiat, and the Celta model (GM) – or by the specific derivative and/or strongly adapted – which is the case of the Uno Mille of 1000cc of Fiat[37], and the sedan, station wagon, pick up, and Meriva versions of Corsa, and also the four doors version of Astra of GM.

Table3.- *Internal car sales up to 1000 cylinders*

	2000		2001		% Sales
	Sales in units	Share in the market %	Sales in units	Share in the market %	2001 and 2000
VW Gol	231.532	29,6	258.371	28,2	10,7
Fiat Palio	136.758	17,5	154.734	16,5	13,1
Fiat Uno	103.142	13,3	111.416	12,4	8,0
GM Celta	23.251	3	90.159	9,8	287,8
GM Corsa Sedan	78.822	10,1	70.065	8,5	-11,1
GM Corsa Hatch	73.150	9,4	48.820	5,1	-33,3
Ford Fiesta	39.949	5,1	41.885	4,6	4,8
Fiat Siena	10.288	1,3	25.740	2,8	150,2
Renault Clio	20.330	2,6	23.763	2,6	16,9
Peugot 206	-	-	17.707	1,9	0,0
Fiat Palio Weekend	6.922	1,1	16.069	1,7	132,1
Ford Ka	24.641	3,2	14.480	1,5	-41,2
VW Parati	9.161	1,2	13.280	1,4	45,0
Renault Clio Sedan	-	-	11.755	1,3	0,0
GM Corsa Wagon	7.659	1,0	4.385	0,5	-42,7

Source: *www. automotivebusiness.com.br*

presented activities of development of products of an essentially distinct nature from those carried by the branches of Ford and VW. Regarding the VW case, there was an important change recently.

[35] Regarding the specific wheelwork conditions (which imply, for example, additional demands to the suspension system of vehicles), the availability of specific materials, the utilisation of alternative fuel, the particular needs for certain derivatives, and also the demands for 1000cc engines with 8 up to 16 valves (Humphrey and Salerno, 2000; Consoni and Quadros, 2002; Dias, 2001).

[36] Here included the derivatives Palio Weekend, Siena, and Strada.

[37] Developed from the Uno platform, the Uno Mille was the first vehicle of 1000cc introduced in Brazil, and it was too the first expression of the strategy of products of Fiat during the 90s, "totally directed to the expansion of the local engineering towards the development of small cars, particularly of the popular cars segment (...)", which had with the Palio launching, its apogee (Consoni and Quadros, 2001: 6).

Table 4.- *The 15 cars top sellers in 2001*

Ranking 2001	Model	Sales in units in 2001	% Share in the market
1	VW Gol	265.898	20,5
2	Fiat Palio	163.706	12,6
3	Fiat Uno	114.416	8,8
4	GM Celta	90.159	7,0
5	GM Corsa Sedan	83.526	6,4
6	GM Corsa Hatch	52.123	4,0
7	Ford Fiesta	42.559	3,3
8	Fiat Palio Weekend	37.303	2,9
9	Fiat Siena	33.942	2,6
10	VW Golf	32.627	2,5
11	Renault Clio Hatch	27.021	2,1
12	Peugeot 206	26.911	2,1
13	VW Parati	24.697	1,9
14	GM Astra Hatch	21.677	1,7
15	Honda Civic	21.399	1,7

Source: *www.automotivebusiness.com.br*

In fact, the analysis of the referred tables reveal that the five top sellers models – both among the 1000cc vehicles and the others (VW Gol, Fiat Palio, Fiat Uno, GM Celta and Corsa sedan) – are examples of strategy of product which offer a large amount of adaptation to the regional demands and/or local ones, which have been generally defined as ***glocalisation*** (see Carvalho, 2003).

By another side, these tables reveal also that the typical models of the globalisation strategy adopted by Ford (and more recently by VW[38]) as the Ka model, and mainly the Fiesta, were not very well succeeded in the Brazilian market. Actually, the Ford Fiesta was only the seventh vehicle of 1000cc in the top sellers ranking in 2000 and 2001, both placed behind the Corsa hatchback of GM[39]. The Ford Ka, by its turn, was the eighth and the 12th in the top sellers ranking respectively in 2000 and 2001.

In summary, the companies that have been implementing strategies of an intense adaptation of products to the local market – as Fiat, GM, and VW up to recently do – are the ones which achieved the best results in the so called "popular cars" segment, with important consequences to their performance in the totality of the domestic market, considering the large part represented by this segment (Carvalho *et al*., 2001)[40]

[38] As is the case of Polo launched in 2002 in the Brazilian market.

[39] The Corsa hatchback model, as the "global platform" Corsa, do not fit properly to the strategy of products implemented by Ford, and recently adopted by VW (see Carvalho, 2003).

[40] More than 70 % of the total car sales accomplished in between 1998 and 2002 (around 80 and 90 % of the total sales of compact vehicles).

It should be pointed out too that the improvement and the introduction of models with a marked adaptation to the characteristics and preferences of the local market, involves the previous existence of the local competence regarding the development of product as well as the additional promotion of it.

All these characteristics can be observed, for example, by the fact that the assemblers that have been adopting such strategies of products, were distinguished as well by presenting significant differences regarding the performances of their branches, either relating the nature as the intensity of their participation in the development of product destined to the local market. In a similar way, these assemblers are the same that have been deciding for a more aggressive and objective attitude regarding the respective local substructure of R & D.

As an example of a more radical choice, Fiat invested in a strategy "focused in vehicles of small size and low potency engine" (Quadros *et al*., 1997), with the 1000cc cars responding for 62,8 % of the assembler total production in 1998 (Carvalho *et al*., 2001). The emphasis in vehicles of small size is certainly coherent with the pursued strategy by the Italian assembler since it first time in Brazil, and it is also consistent with the recently adopted strategy of regional platform (Quadros *et al*., 2000; Bursa *et al*., 1998)[41]

Even GM – defined by a larger diversification of the mix production, and by, traditionally, giving less attention to the small vehicles segment – did not disregard the "popular cars" segment, as can be seen by the well succeeded launching of the several versions of Corsa during the 90s, and, more recently, of Celta. In fact, in 1998, the participation of 1000cc vehicles in the total production of GM was 45,5 % (Carvalho *et al*., 2001).

In a certain extent it is surprising and modest the VW attitude relating the "popular cars" segment – particularly when is considered its tradition of producing small cars in Brazil. The fact is, despite that the process of "remodelling Gol seems taking into account the need of a lighter body, which could comprises a less potent engine" (Quadros *et al.*, 1997), the sales of popular cars of VW – which by 1994 were around 40 % - surpassed the mark of 50 % (55,6 %, to be more precise) of its total production only in 1998 (Carvalho *et al*., 2001).[42]

The VW case is quite peculiar and slightly paradoxical. By one side, the new strategy of reduction platform adopted worldly by the German assembler, does not seem compatible with keeping the strategy of developing local models, which is a famous and essential characteristic of the well succeeded history of the Assembler in the Brazilian market. By another side, VW was forced to postpone the announced replacement of the model that have been a top seller for more than one decade. Equally ambiguous and uncertain have been the position of VW regarding the future of its present team of development of production and processes – the tendency is to decrease – and the competence acquired on a long period with the development of models for the local market (Quadros *et al*., 2000; Consoni and Quadros, 2001 and 2002).

[41] Considering all that, it is undoubtedly clear that a possible acquisition of Fiat by GM – as it has been insistently reported by the press – it would cause an impressive impact on the present and in the forthcoming vehicles sector of the Brazilian industry. This impact, clearly, would be much more striking than the fact – very important by itself – that the mentioned take over would grant to the new assembler (GM-Fiat) at least a 55 % share in the domestic market (*Valor*, several issues).

[42] For this reason VW and GM are favourable to the project of unification of the Brazilian IPI (industrial tax), eliminating tax privileges which, at the present moment, benefit the vehicles up to 1000cc (*Automotivebusiness*, 11/02).

With the project of Ford 2000, the Assembler has abandoned radically and completely its old strategy of regional models. Its local team, responsible by the development of products and processes – which in the past used to be one of the largest engineering units of products of Latin America – has been, since then, continuously reduced (Quadros *et al*., 1997 and 2000).

Meanwhile, in the "popular cars" segment, Ford has been, since the middle of the 90s, fairly more aggressive. After a relative disregard towards its activities in Brazil – which was illustrated by its subordinated association to VW in the Autolatina, the North American assembler re-considered its plans. By 1996 and 1997, Ford launched successively the Brazilian version s of Fiesta and Ka (both in 1000cc), promoting an important change in its product strategy, which, since then, began to give priority to the "popular cars" segment. Consequently, the participation of vehicles of 1000cc in the total production of Ford, reached the impressive number of 79,4 % by 1998 (Carvalho *et al*., 2001).

On the other hand, not even a concentrated effort towards the segment of vehicles of 1000cc – no other assembler, not even Fiat (with 62,8 %), is so strongly dependent on this segment – has been sufficient to Ford to regain its lost territory. This last fact, which probably is not a mere coincidence, and in a certain extent, it is an opposite example of VW, seems to reinforce the previous idea that the success in the Brazilian car market – including, of course, the "popular cars" segment – requires more than simply new models. The Brazilian car market requires mainly models defined by a high level of adaptation to the local particularities and preferences. These are attributes that the models designed under the so called strategy of globalisation of products have not been capable to absorb properly, considering the recent evolution of the Brazilian car market.

Based mainly in the sales expansion derived by the launching of the new Fiesta in 2002 – the new generation of its popular car originally presented in Brazil in 1996 – in a fierce market and sales investment, and counting as well with the help of Focus, with the relatively obsolete Ka and with the old Escort and Fiesta (which are still on), Ford have been trying to regain its lost share lately. The sales success of the new Fiesta seems to stimulate the expectations regarding the future of the Assembler in Brazil, and the fear towards its possible depart of the Brazilian market were minimised (Carvalho *et al*., 2001; Valor, 28/10/02 and 07/11/02).

DISCUSSION

Regarding the evaluation of recent strategies of products and R & D of the five assemblers analysed here (and in previous articles), it should be pointed out that there are evidence of a strong link between the global strategies of product and the local performance of the assemblers, both regarding the nature and the intensity of the branches participation in the development of products. Consequently, the assemblers which have been adopting strategies of regional models or platforms, as Fiat and GM, have too a more aggressive and objective operations regarding its respective local substructure of R & D (Quadros *et al*., 2000; Carvalho 2002 and 2003).

In a similar way, an probably not by a mere co-incidence, the assemblers that have implementing strategies of a marked adaptation of its models to the local market – as Fiat, GM, and VW up to recently – are the ones that reached as well more promising results in the "popular cars" segment, and, consequently, they are having a better performance in the domestic car market in general (Carvalho 2003).

In the case of distinct conducts adopted by the Brazilian branches of the international assemblers, seems to present four essential determinants:

- ✓ The relative importance to the assemblers of the local branch (and of its respective national and/or regional market);
- ✓ the distinct competence achieved internally by local branch in terms, for example, of the development of local products, etc.;
- ✓ the implementation stage of the respective internal process of globalisation/integration and,
- ✓ the respective competitive strategies – of production, investments, products, R & D, etc. – of each assembler (Carvalho 2003).

STATISTICAL ANNEXE

Table A.I- Ideal in-House Versus External Distribution for R&D Components

	Percentage Ideally Performed In-House
Research: Expenditures to anticipate or explore new technologies in software, electronics, material, combustion, alternate power sources, communication, etc.	61
Advanced engineering: development of innovative but proven solutions such as ABS, 4WD, suspensions etc. that can be incorporated in new car models	91
New model initiation and production definition*:* initial car concepts, strategic market position and definition of product attibutes: this activity ends with cay models and corporate approval.	96
Car engineering*:* full scale execution of engineering of components, sub-systems, integrated systems and interfaces	88
Car Design: full scale execution of design components, sub-systems and interfaces	66
Production readiness*:* preparation for production up to Job 1 on experimental product line	86
Engineering support: support of assembly facilities and development of supply network	81
Styling: home-based or foreign-based styling activities	78

Source: R. Miller/ Large-Scale Innovations: The automobile Industry (1994).

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