THE CREATION OF LOCAL SUPPLIERS WITHIN GLOBAL PRODUCTION NETWORKS: THE CASE OF FORD MOTOR COMPANY IN HERMOSILLO, MEXICO

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INTRODUCTION

The automotive industry is a highly concentrated sector, with a small number of very large assembly firms and a privileged group of highly globalized transnational suppliers. While increased globalization was a major driving force for the whole industry transformation, in the case of the vehicle assembly the trend was one of increased regional integration within major international markets. In order to improve coordination and delivery times, the production of the bulkier, as well as some specialized parts, required suppliers to relocate their operations closer to the assembly plants.

Some analysts regards this process of increased regionalization as an invaluable opportunity for local suppliers to join into the global value chains, whereas many others are inclined to believe the evidence to the contrary. It is widely thought that this process has reinforced the control over the automotive supplier chain by a limited number of transnational corporations (TNCs), creating higher barriers to entry and limiting the opportunities for local firms to integrate into the higher value links of these chains. Nonetheless, it also evident that the relocation of a greater number of global parts manufacturers creates a greater density of interactions with local economies, which should have some spillover effects that could increase the opportunities for local suppliers.

Mexico is indeed and interesting testing ground for this controversy. As part of this process of global reorganization, Mexico assumed an increasingly relevant role in the manufacturing of automobiles for the North American region. Aside for its geographic proximity with the United States, Mexico became a highly attractive location for global automobile assemblers, because low production costs came associated with high productivity levels, thereby making this country a critical location in the bitter struggle for market share in North America.

This article is based on a case study designed to identify the presence of technological and knowledge spillovers, and the type of linkages that foreign major assemblers had with local knowledge-intensive firms within the automotive complex led by Ford Motor Company plant in Hermosillo, a city of the northern border state of Sonora, in Mexico.

GLOBAL PRODUCTION NETWORKS, LEARNING AND LOCAL ENTREPRENEURSHIP

The debate on technological learning as a vehicle for regional and local development has major relevance today as TNCs are occupying an ever more dominant place in developing countries, especially in those which are experiencing growing difficulties in successfully inserting themselves into the global economy. For Mexico, this is a critical issue since the country has lacked a coherent industrial policy to promote the growth of knowledge-intensive, high value-added sectors. Several studies have shown that as TNCs using advanced manufacturing processes get established in the country, the transfer of complex manufacturing and managerial tasks increases. However this has been a spontaneous process that has not been taken advantage of to articulate policy measures that could promote endogenous development (Carrillo and Hualde 1998; Contreras 2000; Dutrénit, et. al. 2006).

Under the influence of the international literature on learning and innovation, the Mexican debate has recently embraced the discussion about the role of TNCs as agents of knowledge and technology transfer, and about the creation of internal capabilities through spillovers.

The recent debate on technological learning, innovation and upgrading has fed mainly on two analytical approaches. On the one hand, the perspective of the Innovation Systems, that emphasizes the role of technological trajectories and institutional assets in collective learning. Geographic proximity and relationships between the actors enables the interchange of knowledge and create an institutional environment which encourages learning and innovation. This approach has argued that learning and the accumulation of technological capabilities are decisive factors for national and regional competitiveness, and that market incentives alone do not explain the complexity of that process. Innovation is an interactive process involving actors, institutions, and social norms (Nelson 1986; Lundvall 1992).

The research programme deriving from the Innovation Systems approach has produced several empirical pieces of regional and sectoral research, analyzing the conditions of the environment and the institutional framework which encourage or inhibit technological learning and innovation.

The second perspective is that of the Global Value Chains (GVCs), closely linked to that of the Global Production Networks (GPNs).[6] Both approaches have their origin in the Global Commodity Chain (GCC) approach, formulated initially in the works of Gary Gereffi. Global Commodity Chains are defined as: Sets of interorganizational networks clustered around one commodity or product, linking households, enterprises, and states to one another within the world-economy. These networks are situationally specific, socially constructed, and locally integrated, underscoring the social embeddedness of economic organization (Gereffi, et. al. 1994: 2).

The focus on global chains emphasizes the international linkages between companies operating in worldwide production and distribution systems, rather than emphasizing local institutions and networks (Gereffi and Kaplinsky 2001; Ernst and Kim 2002). It also emphasizes learning and innovation, but the knowledge flows mainly through the global value chains. Particular attention has been paid to the role of leading corporations that carry out functional integration and coordinate internationally dispersed activities (Gereffi 1999). One of the central contributions of this perspective consists of highlighting the limitations placed on development by the structures of corporative power inherent in the intra and inter-business networks, in showing how capacities to generate value are distributed asymmetrically, given the structure of the GVCs (Henderson, et. al. 2002). By controlling the chain, these global leaders also structure the opportunities for improving local producers (Humphrey and Schmitz 2002).

However, even within that restrictive framework, the very operational logic of the global networks creates the spaces for the participation of local actors. Without losing sight of the power relations that subordinate local agents, the GPN

[6] For a review of the similarities and differences between the perspectives of GVCs and GPNs, see Henderson, et. al. 2002; Coe, et. al. 2004; Sturgeon, et. al. 2008)

approach do not underestimate their capacity to influence the configuration of these networks (Ernst 2000; Gereffi 1999; Schmitz 2004). Although the networks are hierarchical and generally TNCs control them, they cannot internally create all of the various capabilities needed for global competition. Thus, a critical aspect of competitiveness is the ability of a firm to locate providers of specialized services outside the company. This can range from simple subcontracting at the assembly phase to sophisticated engineering or design processes (Ernst and Kim 2002).

There is increasing evidence in the empirical studies about the experiences of product and process upgrading on the part of local businesses supplying TNCs. "Local producers learn a great deal from global buyers about how to improve their production processes, attain consistency and high quality, and increase their speed of response to customer orders. This upgrading effect is particularly significant for local producers new to the global market" (Humphrey and Schmitz, 2004: 356). TNCs need to transfer technical and managerial capacities to their affiliates and their local suppliers, so that these firms will be able to both fulfil the quality standards and lower their production costs. Once the firms have managed to raise their capability levels, the new standards achieved become an incentive to delegate more sophisticated processes to these local suppliers.

From the point of view of the local economies, three elements define the rationality of the global production networks. First, they allow leading corporations to maintain their competitiveness by giving them access to specialized suppliers in locations that can offer low costs and flexible responses to the companies' requirements.

Second, the leading corporations act as the vehicle for knowledge transfer. These firms need to transfer knowledge to their local suppliers to improve the technical and administrative abilities of these smaller firms, enabling them to meet the technical specifications of the leading corporations. Once a supplier in the network improves its capacities satisfactorily, that creates an incentive for leaders to transfer more sophisticated knowledge, including areas such as product and process engineering.

Finally, only when they have developed their own capabilities can local suppliers effectively absorb the knowledge that the leaders in the global network have disseminated. The effectiveness and the speed of the transfer will depend not only on the quantity and quality of the knowledge transferred by the leaders but also on the local suppliers' capacities to absorb that knowledge. The initial endowment of knowledge at the local level determines the level of sophistication of the knowledge transferred, while the intensity of the effort accelerates the speed of the transfer (Ernst and Kim 2002: 1422-25).

This last aspect is closely related to the perspective of the Innovation Systems, insofar as the capacity to absorb of the local businesses not only involves features of the businesses themselves but also the characteristics of the local setting and of its institutional framework. In the perspective of the GPNs, one of the crucial aspects for knowledge transfer and local capacity to absorb is valued in terms of how well the GPNs and the regional assets fit together, an interface which arises as a result of the institutional capacities through diverse geographical and organizational scales. The argument is that regional development will depend in the final instance on the efficiency of this fit to stimulate the process of creation, increase and capture of value in the producer localities (Henderson, et. al. 2002).

In the case of the automotive industry, one of the decisive factors in the structuring of opportunities for new producing regions arises from the process of concentration of production in an ever smaller group of assembly and supply companies. Aiming at lower production costs and concentration on core competencies, the assemblers have increased their pressure on the supplier industry. Global sourcing and the transfer of some design responsibilities have shaped new patterns of relationship between producer and supplier. The need to achieve global presence and to reinforce technological capabilities have accelerated the restructuring of the automobile parts industry, and a series of mergers and acquisitions have given rise to a handful of giant companies with privileged relationships with the assemblers.

This reorganization is further encouraged by the transition from integral to modular manufacture in the automotive industry. Assemblers and suppliers have developed a concept of the automobile as a complex system which can be broken down into discrete parts, or modules, which can then be

linked with each other through standardized interfaces and within a standardized architecture: modules thus defined contain not only the components of the subsystem, but also a kind of and a quantity of specialized knowledge (Camuffo 2003). One of the consequences of this is the transformation of the functions of and relations between manufacturing plants and suppliers, creating incentives to transfer the design and manufacture of components to the suppliers (Takeishi and Fujimoto 2002). This has meant greater use of the practices of outsourcing, determining greater coordination with the suppliers and greater importance for the suppliers in the global network.

Although these are two aspects which are conceptually and technically different, modularization and outsourcing are practices which are closely related, since suppliers are increasingly likely to design, produce and deliver complete modules, while manufacturers reduce to a minimum their investment and concentrate on the engineering of the vehicle, the quality of the product, and customer services.

The implications for the local economies are ambiguous, since such strategies lead to a re-centralization of technologically intensive activities in the developed countries and in the TNCs, reducing opportunities for knowledge acquisition and moving up the scale for the small local providers (Quadros and Queiroz 2001; Sturgeon, et. al. 2008). Even when the local companies manage to join the global chains at some point and thereby raise their capacities in products and processes, moving up the scale in this way may turn out to be a two-edged sword, since the links with the TNCs usually become an encumbrance towards functional moving up the scale for the local companies and leaves them at the mercy of pressure from the powerful TNCs (Schmitz 2004).

By the other hand, several studies have shown how participation in RGPs encourages knowledge and technology transfer. Both in Eastern Europe (Lorentzen 2003), and in China (Ivarson and Alvstam 2005) or in Mexico (Dutrénit et. al. 2006; Lara and Arellano 2007), suppliers integrated into the global networks increase their accumulation of technological and managerial knowledge. In the case of the local companies, the links with the TNCs are based on the hierarchy, but at the same time these are relationships which evolve and which are interdependent. Local companies' collaboration with TNCs often provides them with vital technological and organizational training that the local firms use strategically to develop their market networks and their innovative capacity in the home market (Ivarson and Alvstam 2005). The two perspectives commented, that of Innovation Systems and that of the RGPs, have had considerable influence on recent research on the Mexican case. In a study on the electronics industry in northern Mexico, Dutrénit and her coauthors (2006) found that the accumulation of local technological capabilities involves more than just a TNC's strategy for decentralizing their own capacities. She found that it is also influenced by local managers, through their efforts to exert pressure on TNCs to recognize the accumulated local capabilities and to let them carry on technical activities with greater innovative content (Dutrénit et al. 2006).

Casas and Luna identify the emergence of *regional knowledge spaces* in several regions of Mexico. These have been constructed through a re-combination of knowledge by universities and research centres and through their relationships with companies. In virtue of these processes, the regions have been transformed "from passive hosts possessing factors and geographic advantages into active structures, capable of implementing their own projects that stimulate the formation of regional systems and that are capable of generating innovative processes" (Casas and Luna 2001, 37).

Other studies have focused on the accumulation of institutional capabilities. Over recent decades, various local institutions have appeared. These organizations, called *bridging institutions*, act as a link and as support agents for industry. Their function is related to the creation of an environment of trust and certainty, through the formation of collaborative networks between various actors, which facilitates interaction and learning (Casalet 2004). Moloman (2006) found that these institutions arose under the initiative of the local actors themselves and have taken on a major role in their local environments by offering information, training, financing, and coordination.

Research on the Mexican automotive industry addressed the topic of technological learning only very recently. A study based on data from national surveys found that after the North American Free Trade Agreement (NAFTA), learning has intensified, there being two main sources:

increased formal training for workers, and increased acquisition of machinery and automated equipment. The study also found that the relationships between automotive companies and local universities are precarious and do not represent a significant source of knowledge transfer (Vallejo 2005). In a case study of car seat suppliers, Lara and coauthors (2004) found that during the transition from integrated to modular manufacturing, the suppliers have relied on a strategy of *technological upgrading*, through a slow change from labour-intensive to capital-intensive processes. This means an increase in the degree of automation, the use of complex machinery, and a wider use of electronic components and synthetic materials. Lara and Arellano (2007) found a process of technological co-evolution between the Multinational Corporations' (MNC) global suppliers of seats and the machine-shops in the central region of Mexico.

Local entrepreneurship linked to the operation of TNCs has been only marginally addressed. Contreras (2000) some cases in Tijuana and Ciudad Juárez of managers and engineers who had set up their own businesses by taking advantage of the knowledge and social networks acquired during their experience as employees of the TNCs. Dutrénit and Vera-Cruz (2004) found knowledge spill-overs from TNCs in the machine shop industry in Ciudad Juarez, and documented some cases of TNC employees who later established their own local companies. In a study on industrial clustering by General Motors, Chrysler, and Nissan in Toluca, in central Mexico, Bueno (2004) found that some local companies have been marginally incorporated into the supply chain as manufacturers of moulds, tools, and components. Echeverri-Carroll (2008) found that during the transition to free trade, many large firms in Monterrey, in Northern Mexico, adopted several strategies such as concentrating their activities in "core competencies", creating an opportunity for some skilled workers to create their own small startup companies. The large firms not only served as business incubators, providing experience and knowledge for the new entrepreneurs, but in many instances they were the new firms' only customers. An important finding in this last study is that in Monterrey the creation and consolidation of small technological companies has been accelerated as a result of government policies at federal and state level, and also as a result of the action of technological business incubators in the local universities (Echeverri-Carroll 2008).

Studies on technological learning and upgrading of local companies within the framework of the networks governed by TNCs show the double character of the GPNs. On the one hand they limit, subordinate and frequently exclude the participation of local companies; but on the other hand they constitute an access route to global markets and a vehicle for the acquisition of technical and managerial knowledge. The local society in which the GPNs work is relevant in two senses. In one sense it defines a horizon of possibilities for the local implementation of the TNCs, whether that be by interacting with the existing companies and institutions or by stimulating the creation of new networks of social and economic relations in the place of implementation (Henderson et. al. 2002). But, furthermore, in the interaction with the TNCs, the local agents expand their capacities as agents and can modify their conditions of participation. Insofar as they satisfy the operative needs of the GPNs, they can at the same time promote their own insertion and upgrading, by mobilizing the knowledge deposited in the social networks (Sturgeon et. al. 2008).

FORD MOTOR CO. AND THE AUTOMOTIVE INDUSTRY IN MEXICO

Ford Motor Co. was the first firm to set up an assembly plant in Mexico, in 1925. Currently the firm has three plants in the country, employing close to 5,000 workers, the majority of them in the Hermosillo stamping and assembly plant[7]. The Hermosillo plant began operations in 1986, with capacity for 130,000 vehicles per year, in what was one of the first movements of the "southward migration" on the part of the automobile industry in the United States. In 2005 the plant expanded and was reorganized to introduce new models and increase capacity to 300,000 vehicles per year. This expansion forms part of the new Ford strategy to cope with intense competition from the Asian firms in the market for sub-compact cars in North America. The strategy includes reducing costs, raising the quality of their vehicles and recovering participation in a segment where the "big three" of the United States (including Chrysler and General

[7] The city of Hermosillo is the capital of the state of Sonora, one of the five Mexican states located on the border with the United States. Henceforth, references to the "the region" allude to the state of Sonora, while "North American region" used to refer to US-Canada-Mexico "trade region" as is usual in international political economy studies.

Motors) are systematically losing ground to the Asian brands.

The installation of Ford Hermosillo is one of the cases that best illustrates the importance for some regional economies of North American Free Trade Agreement (NAFTA). The treaty eliminated a large quantity of legal and tariff barriers for shared-production schemes and intra-firm commerce. TNCs were thus able to implement organizational strategies that encompass the entire NAFTA region as one productive platform, taking maximum advantage of Mexico's geographic proximity, low salaries, and high quality workforce (Shaiken, 2001).

One important measure introduced by NAFTA was indeed the reduction of local-content requirements, which dropped to 32% in 1994 and were then gradually reduced until they disappeared completely in 2004; the elimination of import quotas on new automobiles; the gradual elimination of tariffs on automobile parts produced in Mexico, the United States, and Canada; and the removal of import tariffs in Mexico on vehicles produced in Canada and the United States, which were gradually eliminated between 1994 and 2004. For its part, the United States completely eliminated the tariffs on automobiles from Mexico (Tuman 2003).

The effects of the new regulatory framework were immediate and profound, reshaping the geography and dynamics of the industry in the country. Between 1999 and 2005, the automotive sector attracted US$11.5 billion in foreign direct investment (FDI) and the vehicle production increased 43%, reaching more than 2.0 million in 2006 (AMIA, 2006). Seven new factories were built and several others increased their capacity.

New investments were directed to strengthen the export capacity of Mexican factories. Vehicle exports grew from 16% of total production in 1987 to 75% in 2005. The reorientation towards the foreign market (mainly the United States) has been accompanied by the modernization of existing plants, the opening of new plants, product specialization, automation of production processes, and the adaptation to new forms of work organization.

New factories specialized in compact and subcompact vehicles (particularly models such as the Ford Escort, the GM Cavalier, and the Chrysler Sebring), light trucks, and certain automobile parts, such as four cylinder engines, wire harnesses, interior upholstery, silencers, and exhaust pipes. The new investments went in the first place to northern Mexico (Coahuila, Chihuahua, Tamaulipas, and Sonora) and later to north-central Mexico (the states of Aguascalientes, Puebla, San Luis Potosi, Guanajuato, Zacatecas, and Mexico). A recent trend has been to establish suppliers nearby to facilitate modular production.

This new trends reinforced the control of the automotive sector by TNCs. Beginning in the 1980s, in an attempt to confront the Japanese manufacturers, the Big Three U.S. automobile manufacturers (GM, Ford, and Chrysler) started using Mexico as their low-cost export platform for small cars (Mortimore, 1995). Those firms chose Mexico because of its low wage costs and geographic proximity, as well as the favorable political context created by the Mexican government's supportive policies. Later, some European (the 'German Big Three') and Asian firms (Nissan, Honda and Toyota) followed the same tendency.

The new assembly and engine plants were very successful in introducing high technology and the Toyota Production System (TPS) (Womack, Jones, and Ross 1990). The US Big Three were the companies that expanded their production in Mexico the most, and they were the ones that began the reorientation toward the export market. By 1993, the three companies were already exporting almost 60% of their output, whereas the non-American companies (VW and Nissan) maintained their focus on the domestic market. This situation has changed, and by 2006 all the auto manufacturers were exporting a high percentage of their production, with the American firms still concentrating most of the production in the country (53%).

The Big Three have been continuously losing their market share in the U.S. market against the Asian firms. Currently, Toyota vehicles are ranked first in the market, and both Honda and Hyundai are continuously improving their position. The US Big Three had 70% of automobile sales in 1999, but by 2005 dropped to 55%, and it is anticipated that their market share will decline to 50% by

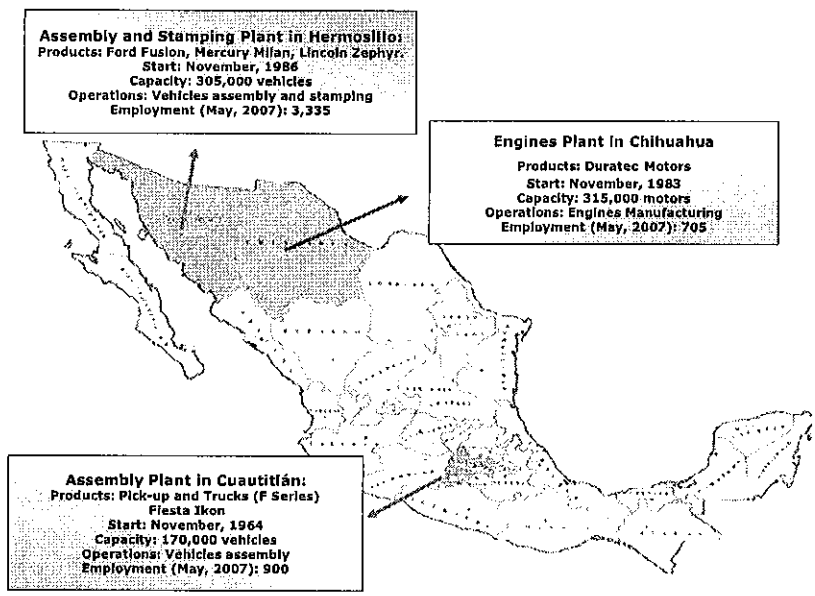
2011. Asian firms have increased from 25% to 38% from 1999 to 2005 (Vildozo, 2006).

In that context, Mexico has become a strategic location for all the global players in the automotive industry, especially for the U.S. firms. In 1980, Mexico was producing 5% of the vehicles assembled in North America (Canada, United States and Mexico); by 2006, the vehicles produced in Mexico accounted for 13%. Ford Motor Co. in Mexico is the most conspicuous and studied example in the process of reshaping the automotive industry in Mexico (Shaiken and Herzenberg 1987; Carrillo 1993; Sandoval Godoy 2003). Their first plant in Mexico opened in 1925, with 250 employees. A second plant was set up in 1932, also in Mexico City, and in 1964 the company built an industrial complex in Cuautitlán, in the outskirts of Mexico City (Carrillo 1993).

During the period of Import Substitution (1950-1982), Ford came to control almost 26% of the national automobile market. From a high peak of 38% in 1988, its participation in the Mexican market has been declining continuously, to 19% in 1990, to 15% in 2000, and 7% in 2004. This was a consequence of the success of the Asian firms operating in Mexico, and also of the growing imports, which now account for almost 76% of all vehicles sold in the Mexican market. Ford Motor Co. has four locations in Mexico: their central administrative offices in Mexico City, the Cuautitlán industrial complex in the State of Mexico, an engine manufacturing plant in the northern state of Chihuahua, and the stamping and assembly plant in Hermosillo city (Map 1)

Map 1

Ford Motor Co. Plants in Mexico



The Cuautitlán plant is an old industrial complex, built in 1964 under the Import Substitution policy and in response to government requirements for national integration, with the objective of selling to the domestic market (Carrillo, 1993). After 1983, and over a period of 15 years, the complex was subject to various adjustments centred on the automation of production and the introduction of lean manufacturing. But the most notable change was the labour-market adjustment and trade union reorganization. The company made efforts to introduce major organizational changes; in particular, the Total Quality Control system clashed with the detailed and complex job descriptions for qualified and specialized workers (more than 300 categories), whose functions were protected by union officials. However, the factory continued to be inefficient and local unions continued to hold onto a strong collective bargaining contract despite restructuring. The complex had a very strong union

with more than 7,800 members in 1982. Only five years later, labour restructuring had cut the number of jobs by a half, and by 2007 there were only 900 employees remaining. The Hermosillo plant contrasts dramatically with that of Cuautitlán. This plant began operating 1986, with an investment of US$500 million. The goal was to build a specialized factory, with an annual production capacity of 130,000 vehicles, to service the foreign market. It was part of Ford's "world car" project, whose objective was to reduce the gap with the Japanese automobile manufacturer performance. The stamping and assembly plant in Hermosillo was designed from its inception to operate with the TPS, and in order to avoid conflicts and worker dissatisfaction, from the beginning an attempt was made to structure labour relations differently to how they had been in Ford's older plants. During the next 20 years, the plant underwent various expansions and reorganizations, while always maintaining high levels of quality and production. The most important of these expansions occurred in 2005, when three new models (the Ford Fusion, Mercury Milan, and Lincoln Zephyr) were introduced, increasing the production capacity to 300,000 vehicles annually. A flexible manufacturing system was established that places this plant at the forefront of global automotive technology and that reorganizes the first-line supplier network in order to manufacture new models according to the modular manufacturing paradigm. The number of workers increased from 2,000 to 3,800. With an investment of US$400 million, a new industrial park was also created for 20 first- and second-tier transnational suppliers. These firms employ close to 4,000 additional workers.

METHODOLOGY

The study was carried out from May 2005 to July 2006 and consisted of the conducting of semi-structured interviews and a sample survey of small and medium-sized enterprises (SMEs) in Hermosillo.

A first series of interviews was conducted with 4 directorial level members and managers at Ford Motor Co. (2 in the central offices in Mexico City and 2 at the Hermosillo plant), and with 10 TNCs managers in Hermosillo. The subjects of these interviews were: products and production processes; origin of materials supplies and purchasing policy; links with local businesses; cases of success in incorporating local businesses into the supply chain; coordination mechanisms with the Ford plant; links with local institutions, and training policies. In the interviews with the TNCs managers numerous local companies supplying TNCs were mentioned; as a result of that information 12 more interviews were carried out with owners of small local businesses supplying specialized services for the Hermosillo Ford plant, or to its large suppliers. The subjects of these interviews were: origin of the business; main products and production processes; main customers; competitiveness strategies; links with transnational businesses in the automotive sector; staff preparation and training; technological capacities, and links with local institutions. The average length of these two series of interviews was one hour, and for their analysis all the interviews were transcribed onto a text processor and fed into a contents matrix.

Finally, 30 interviews were conducted with engineers and managers who at some point in their careers had been employed at the Ford Hermosillo plant and who left this post to take up other activities. In this case a biographical interview format was designed centring on occupational trajectories.

The final phase of the study consisted of conducting sample interviews with 166 SMEs, selected according to the following criteria: a) they are located in Hermosillo; b) they are Micro, Small or Medium-sized Businesses, according to the INEGI (the official Mexican statistics agency) definition (Micro, from 1 to 30 employees, Small, from 31 to 100 employees, and Medium-sized, from 101 to 250 employees); c) dedicated to one of the 17 activities (sub-branches, in the INEGI classification), which were mentioned by the transnationals as the main sources of materials and services provided by local businesses, excluding cleaning, security, transport and industrial canteen services.

In total 293 businesses were identified as meeting these criteria. On fixing a precision of 5% and a 95% confidence level, a sample size for the survey of 166 businesses was obtained. The questionnaire applied contained 48 questions divided into 8 sections: 1) origin of the business; 2) main products and production processes; 3) main customers; 4) competitiveness strategies; 5) links with transnational businesses in the automotive sector; 6) staff preparation and training; 7)

technological capacities, and 8) links with local institutions.

Some results of this study are presented in this article, specifically those related to the creation of new local, knowledge-intensive companies.

TECHNOLOGICAL LEARNING AND THE EMERGENCE OF LOCAL SUPPLIERS

Around the time when the Hermosillo Ford stamping and assembly plant was installed, the economy of the state of Sonora was in the middle of a profound process of structural change. Until the middle of the decade of the 1970s, development in the region revolved around the axis of the robust agricultural sector and dynamic agro-industrial activities, with strong participation from local businesses. Most of this economic activity was destined to the Mexican market. From that time on, as it was the case from other regions along the border of Mexico with the United States, the state of Sonora underwent an accelerated process of industrialization which was set off by foreign investment and based mainly on the establishment of foreign assembly plants for export, also known in the academic literature and policy debates as *maquiladoras*[8]. The signing of the North American Free Trade Agreement, in 1994, accelerated the implementation of this model by eliminating barriers to foreign investment and to the flow of merchandise between Mexico and the United States

The region ceased articulating its economy around the agricultural valleys and assumed a new role as a manufacturing link in global chains of production under the command of the transnationals, principally in the fields of electronics and the automotive industry, and with their main centres in the cities on the border and in the state capital (Contreras and Rodríguez 2003).

An effect of that transition was that local agents were displaced from the central role they had previously held in the conducting of the regional economy. Both in the case of the *maquiladoras* and of the automotive industry, the local businesses had a marginal role to play in the new industrial conglomerates, whose supplies came in the vast majority of cases from the United States, and partially from Japan in the case of the Ford plant. Three main factors made it difficult for regional businesses to enter the supply chains for the new electronic and automotive industries: the incapacity of local businesses to meet standards for quality, volume and deadlines demanded by the transnationals; the purchasing policies of the transnationals, which gave privileges to their global partners and suppliers over local businesses, and the absence of an industrial policy which might promote the creation of technological and entrepreneurial capacities in local businesses (Dutrénit, et al., 2002; Carrillo and Contreras, 2004).

From the local point of view, the Hermosillo plant meant a huge economic spill-over, since in order to expand the manufacturing plant and build up a new fleet of suppliers, more than 1,700 million dollars was invested and more than 8,000 new jobs were created. But above and beyond the evident and immediate economic impact, the academic and policy debate around the installation of this plant followed the arguments regarding the role of automobile TNCs in the local sphere and on the real possibilities of the local businesses for participation in their supply chains.

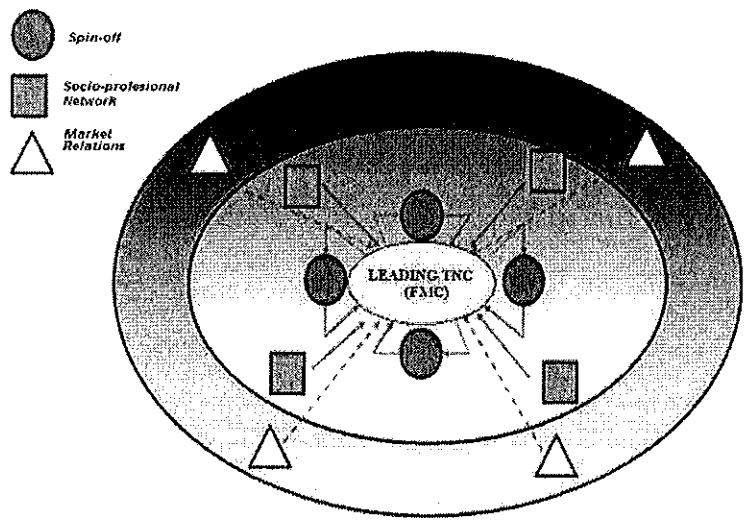
There is ample evidence regarding the limitations of global production networks to allow for the creation of high level local suppliers, especially in the abundant literature about *maquiladora* assembly plants (Wilson 1992; Kopinak 1996; Sargent and Matthews 2003). The evidence obtained by our survey does not refute this thesis, having identified a large majority of local suppliers in low level supplying positions within the larger supplier chain. Nonetheless, what the survey and further in-depth analysis revealed was the extent and scale of recently emerged phenomena around Ford Hermosillo: the presence of a handful of knowledge-intensive small local businesses incorporated into the network of suppliers of TNCs in the automotive sector. One of the reasons that explain why this process went mostly unnoticed before, even to those familiar with Ford Hermosillo, was the fact that these local

[8] "Maquiladoras," in formal terms, are firms operating under a special fiscal regime applied for manufacturing and processing services, by which they are allowed to temporarily import their raw materials, components and machinery, in order to process or assemble them in Mexico, with the condition that they entirely re-export it, primarily to the United States, paying taxes only on the added value generated by the operation. This is one of the main sources of direct foreign investment in Mexico and a significant component of its industrial growth since the late 1970s.

firms were founded in the 1990s and become increasingly visible only at the end of the decade. It is important to asses the magnitude of this phenomena, in order not to overstate its presence. In the interviews with the large Ford suppliers established in Hermosillo we were able to record a total of 215 local businesses participating as suppliers, although the majority of them were providing general services such as cleaning, security, transport, and so forth. On the basis of that general result a decision was made to carry out an inventory of small and medium-sized businesses supplying products and services linked to production, and to apply a sample survey in order to estimate more exactly the scope of this phenomenon of incorporation of local businesses.

Figure 1

Three Mechanisms for the creation of local suppliers



A total of 99 businesses supplying products or services linked to production were found[9], of which 16 are businesses specializing in the automotive sector and the rest are diversified businesses which serve other industries as well as the automotive industry. More than 90% are micro or small businesses, in other words with 50 employees or fewer, and 63% had started their operations after 1994. The most numerous group was made up of metal-mechanical businesses (37), followed by engineering services (27) and industrial maintenance businesses (23).

With the aid of in-depth interviews we set to identify some patterns regarding the emergence of these firms, which could also help us understand the empirical forces that contributed to their firm evolution. While many interesting factors were at play in their individual stories, three particular trends were more prominent, and contributed more emphatically in explaining the particular nature of these firms. We conceptualized these as *enabling factors* for the creation and evolution of knowledge intensive local suppliers. These factors were:

1. The in-house learning and knowledge acquired by managers and engineers within Ford Hermosillo,
2. The effectiveness of socio-professional networks and market relations to diffuse

[9] The activities which are considered as linked to the productive process are: wood and plastic products; manufacture of metallic products; machining of metallic parts; manufacture of machinery and industrial equipment; engineering services; repair, installation and maintenance of industrial equipment; IT consultancy services; software development, and handling of waste products and environmental remediation services. Excluded are cleaning, security, staff transport, canteen services, and other general services.

knowledge and helping firms to identify opportunities to participate in these supplying networks, and
3. The ability to learn and create increasing trust in the supplier network, through repeated exchanges.

Enabling factor 1. In-house learning as a foundation for creating local suppliers

One of the most frequent mechanisms for the incorporation of local companies into the supplier pool involves companies created by engineers previously working in the Ford plant. Since the start of their operations in 1986, the company sought to recruit young engineers, preferably recent university graduates. The ex-employees interviewed for this study were between the ages of 23 and 28 when they were taken on by Ford. At the moment of the interview, their average age was 38.4, with an average of 2.7 posts during their careers and an average of 15.8 years since starting their first job. For half of them the Ford plant was their first job, and for more than 30% the automotive company was their second job. The average duration as employees of Ford was 6.3 years.

The adoption and adaptation of the TPS to local context (Abo 1994; 2007) allows human resources to follow a process of technological learning. In a short period, and based on the acquisition of abilities, a fast upgrading in the category-wage system as well in the labour competence's system occurred. Internal and external training programs, on-the-job-training, and company visits -- including Japan-- were carried out. This allowed the development of the specialized technicians' different abilities (technical and organizational), particularly of the engineers of the plant. The time they spent with the automobile manufacturer turned out to be a very formative experience for these engineers, since it gave them the opportunity for professional development in a global company practising advanced manufacturing and organizational techniques. That experience had proved very useful for these engineers, not only because of the technical and administrative knowledge they acquired but also because of the relationships that they built with other employees, managers, and suppliers. Those connections would turn out to be crucial for enabling these new entrepreneurs to grasp the intricacies of the market in which they would be moving.

Of the 30 engineers interviewed, 16 had left Ford to start their own business and 14 to take up management positions in other companies in the region. All expressed the main motive for leaving the post at Ford as being the existence of prospects for improving their professional position, be it through the offer of an attractive post on the part of another company (generally another transnational) or as a result of their own business project. In some cases the post as employees does not exclude the own business activity, since 6 of these new businessmen created their own company while they carried on working as employees at a transnational.

The majority of the engineers who took up contracts as employees after leaving the Ford plant did so at other transnationals, generally occupying directorial posts (mid-level or high level) in *maquiladora* and automotive businesses on the border, including various people who moved to Tijuana as a result of the opening of the Toyota plant in 2004.

The knowledge that engineers acquired through their work experiences in the automotive assembly plant falls into two main areas: technical and organizational-administrative knowledge.

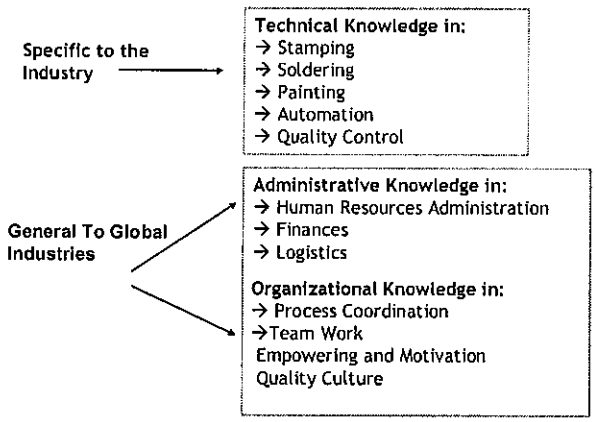
Technical learning is the type that is most directly connected to the automotive industry itself, but it is also applicable to other areas of manufacturing. In contrast, administrative and organizational learning can be applied to a wide variety of activities, above all, in companies that operate to international standards (Figure 2)

Independently of the emphasis on the technical or organizational aspects of the knowledge acquired at Ford, all those interviewed always referred to the "culture of quality" as their principal source of learning. It is worth remembering that at its time this plant was designed as a state-of-the-art plant at world level. Not only was the production process highly automated (95% of welding operations carried out by robots, and 90% of stamping automated), but also the entire process was organized according the principles of Total Quality Control and Just in Time (JIT), which means a complex structure of coordination and administrative standards appropriate for JIT and the handling of massive information flows. In this way, the experience of working in the plant meant a source of intense technical knowledge acquisition in such specific

areas as welding and stamping, or such generic areas as software and quality control handling. Another type of knowledge acquisition frequently mentioned by the engineers refers to the coordination of processes, an area involving a wide range of technical knowledge, but above all organizational type abilities.

Figure 2

Knowledge acquired by Ford engineers and disseminated towards the local economy



The relationship with outside suppliers and with other Ford plants involved in the design, development and manufacture of the models assembled in Hermosillo, means a complex structure of information flows and interactions between multiple actors. During the first five years of operation, the plant established a Just in Time system despite receiving 65% of its materials supplies and parts from Japan, which also turned it into one of the greatest sources of pride for the employees.[10] As well as the organization required to keep the plant routines in place, the communications technology itself turned out to be a novelty in the regional context, as one of the first companies to introduce a corporative IT network for communications in real time and, years later, the first to use an intranet-type corporative network to handle information flows.

Trained in conventional academic programmes, the Ford engineers were not only put through empirical contact with advanced technologies and organizational methods by the company, but also constant updating through formal capacitation in areas such as statistic process control, reduction of inventories, manufacturing cells, rapid model changes, Just In Time, predictive maintenance, elimination of waste, teamwork and ongoing improvement, amongst others. This training is an asset which the engineers take out into the regional environment when they leave the company.

Among the 16 cases identified of ex-employees who left Ford to set up their own company, two types of business can be distinguished:[11] industrial establishments and specialized service companies. The majority of these firms are small businesses in high value-added activities, whose origin is directly linked to work experience in the

[10] The suppliers sent the material to the "consolidation centre" in Hiroshima, which sent them to the Hermosillo plant, with a maritime travelling time of 18 days. The containers were unloaded in the nearby port of Guaymas in the same sequence in which they were loaded in Japan, and between 10 or 12 containers were loaded with the material required by the plant for one day's production, meeting the "Just In Time" principle despite the great distance between Japan and Mexico. Since 1990 the consolidation centre has moved to Detroit, Michigan, maintaining a high dependency on outside suppliers, but preserving the principles of Just In Time and Total Quality (Sandoval and Wong, 2005).

[11] Excluded from the analysis are retail businesses since they are activities which are not linked to the industry nor, apparently, to the process of spillover and absorption of know-how in the region.

automotive company and which maintain the assembly plant as one of their main customers.

An example of this type of new business is that of *Integración Robótica y Mantenimiento Industrial* (IRMI), founded by five industrial and electronics engineers who had worked at Ford since its opening in 1986. Between 1999 and 2000 these engineers gradually left the company, with each one setting up their own business, dedicated to maintenance activities for stamping and welding equipment, process automation, installation and equipment maintenance for paintwork and electro-mechanical installations. In 2003 these five micro-businessmen joined together to form the IRMI Group, which began with 17 employees, with Ford as its only customer. At the end of 2007 it already had 340 employees and had also become a supplier for other large Ford suppliers such as Collins and Aikman, Magna, Martinrea and Antolín, as well as the new Toyota plant in Tijuana. In 2007 IRMI invoiced more than 9 million dollars.

Enabling factor 2. Effective Socio-Professional Networks and Market Relations

The second mechanism identified in explaining the emergence and evolution of knowledge intensive local suppliers, regards the interactions within socio-professional networks. In their daily operations, the presence of major transnational corporations involves the frequent interaction with (and even the formation of) social and professional networks in the local community. Over time, the employees of the corporations along with various local people, institutions, and companies weave a network of relationships through which information flows and experiences are transmitted.

When relating their experiences with the local suppliers, a reference common to all the transnational managers is the necessity to turn to local businesses to deal with problems with equipment or installations, especially in emergency situations in the face of failures or breakdowns, but also in order to optimize times and costs in maintenance tasks. Especially in unexpected situations, to have to use the original suppliers of the equipment or turn to the corporation itself in search of solutions is normally expensive and very time consuming, given that the technicians have to travel to Sonora from the United States or Japan, and the cost of repairs is normally determined by hourly labour cost and not by task. A further advantage when transnationals manage to find local suppliers is that the proximity of the company allows them to monitor the work done and to carry out specific adjustments to the work carried out.

In such circumstances managers usually turn to their social networks, be they relatives, friends or professional links, in search of ways to solve the problems as quickly and as cheaply as possible. Furthermore, the growing *endogenization* of the bodies of management has made this process more likely. In line with the Ford Hermosillo Human Resources area, in the first years of their operation, over half of the plant managers were Japanese and from the USA, and they were gradually replaced by Mexican managers. Currently all the plant managers are Mexican, most having been educated at local universities.[12]

These relationships often begin in the university environment, among students (or between students and teachers), who, after having been together at the university, later find themselves working as managers at a TNC plant or as owners or managers of local firms. These socio-professional networks are forged over time, and it is one of the most common paths that regional companies utilize to connect themselves to Ford's supplier networks.

Finally, the third mechanism is based on market relations. Market relations between transnational companies and local firms arise out of the operational needs of TNCs as they seek local suppliers capable of offering low cost, flexibility, and quality. Usually TNCs require general services such as cleaning, security, cafeteria, and so forth. Because of their nature, these sorts of services tend to be acquired in the local marketplace, frequently through competitive processes. However, the lead companies also require more specialized services, such as maintenance, equipment repair, machining, programming, logistics, automation processes, among other services.

Belonging to a socio-professional network or having been employed by Ford can facilitate participation, but in some cases the link is established outside of social networks, starting instead through conventional market relations. When the local socio-professional networks do not offer those options, the company must turn to the marketplace to search for local suppliers.

[12] Interview with G. Rayas, Human Resources Manager at Ford Hermosillo, 24th November, 2005.

One case which illustrates access via socio-professional relations is that of Kinematics, a company set up in the year 2000 by a professor from the University of Sonora. Given his solid academic reputation in the area of design, when some of his ex-students achieved managerial positions in the Ford plant, they began to consult him about adjustment and adaptation problems in some pieces of equipment. On the basis of those jobs as a consultant, he was commissioned to carry out larger adjustments in a manipulator used by Lear Corporation (one of Ford's large suppliers) to install the seats in the Fiesta model. This commission culminated in the complete re-design and manufacture of the manipulator, and the company Kinematics was created to this end. Since then, this company has specialized in the design and manufacture of industrial manipulators, growing from the 6 initial employees of 2000 to 135 in 2007, with invoicing of 10 million dollars. As well as diversifying its clients in Hermosillo and in other Mexican states, in 2007 it won an international tender to design and manufacture the manipulator with which the hybrid Ford Fusion batteries will be installed.

An example of incorporation through the market is that of the company *Asesoría Integral de Ingeniería* (AIISA), founded in 1991 and dedicated to the design of networks, software development and automation processes. The relation with Ford began in 1992 through maintenance jobs on the IT network. Subsequently it was involved in the replacement and programming of PLCs and achieved a stable relationship as a consultancy firm on matters of automation as a result of a problem in the assembly lines, when a conflict of movements in the welding robots arose. On the basis of those jobs, its portfolio of customers grew within the automotive cluster and towards industries in different parts of the country, and its staff grew from the initial 2 employees to 24 in 2007.

Enabling factor 3. Effective learning trajectories of local firms.

While the companies created through spin-off type processes start off from an organic relationship with the leader company, those which join the supply chain through socio-professional networks, and above all through the market relations, follow a more contingent path, in a sequence which requires repeated experiences of efficient response to provide the basis of a relationship of trust.

Based on empirical evidence collected in the interviews with local suppliers, we identified a pattern in the process of strengthening the technological capabilities through their interaction with leading firms. This stylized sequence takes the cases of software development, automation processes, and precision machinery firms as its main reference. However, the same logic applies to all companies that increased their capabilities through their links to the Ford plant and its major suppliers. The sequence has four stages:

- *Problem solving:* At this stage, a local supplier starts a connection with Ford or one of its suppliers by solving operational and unexpected problems in the production process, or minor maintenance tasks and adaptations to the facilities. This usually involves problems associated with systems compatibility, equipment failures, or changes in the assembly line. When a local provider is capable of solving those types of contingencies, it means the beginning of a relationship of trust that will eventually give the local company ongoing access to other tasks within the firm.
- *Trustworthy, temporary supplier:* After the local supplier has proven its willingness and capacity to solve some of the factory's operational problems, a more solid relationship is established and a reputation is built with the decision-makers within the leading company. Based on that reputation, the local provider becomes incorporated into the stable supplier pool.
- *Permanent, diversified supplier:* The local company becomes an ongoing supplier of products or services. Often, these firms manage to diversify the products or services they offer to the assembly plant and their portfolio of other clients within the automotive industry.
- *Outsourcing of engineering, quality control and maintenance:* Some local companies evolve towards a higher level, becoming an outsourcing partner in areas such as engineering, programming, quality control, device design and manufacturing, among other things. As a result, the local provider becomes fully included in the assembly plant's supply chain.

CONCLUSIONS

The emergence of knowledge intensive local firms within the automotive complex led by Ford Motor Company in Hermosillo is linked to changes occurring within the global networks themselves. The introduction of practices associated with Toyota Production System enables the employee's knowledge upgrading within advanced manufacturing plants. As they depart from Ford Hermosillo, the first hand knowledge of these engineers and managers regarding how the supplier relations works, as well as the capabilities developed to provide the level of efficiency, quality and lead times required by Ford, become invaluable assets. At the same time, the tendency toward regionalization of supplier networks and the need for increased geographical proximity of critical operations explains the increased openness of Ford and other major assemblers to find and help establishing local suppliers of engineering and other knowledge based services, especially if these firms can meet the rigorous standards that major assemblers impose to their partners.

None of these findings refute the main arguments raised by critics of global production networks, regarding the obstacles that local firms experience when a regional economy based their growth in the increased presence of TNCs. To those enabling factors introduced in this article, we must incorporate into the picture those inhibiting factors, like the ones widely documented in the literature of the *maquiladora* industry, in the case of recent industrialization of northern Mexico. Both, modularization of major parts and sub-assemblies, as well as the entrenchment of major globalized suppliers firms within global production networks are formidable obstacles in the creation of higher level local supplier firms.

What this study shows is that upgrading trajectories are extremely recent, and might be associated to the maturing of changes introduced by manufacturing operations like Ford Hermosillo. Whether the forces enabling this recent emergence will prevail or will subsume to the forces inhibiting them, is a matter that will require further analysis in the evolution of this particular regional economy. We should also emphasize that while these findings are only the result of an initial approach to this phenomena, we are certain that they reveal enough evidence to identify the emergence of these firms as a qualitative change that parallels at some level, similar process of upgrading that have occurred in other regions and localities of the world. In the last analysis, the emergence of knowledge intensive firms on the Hermosillo automobile complex does point to the importance of a government policy that could further encourage their development.

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