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The Automotive Supply Chain: Global Trends and Asian Perspectives

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The Automotive Supply Chain: Global Trends and Asian Perspectives

Francisco Veloso
Rajiv Kumar

January 2002

Asian Development Bank

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THE AUTOMOTIVE SUPPLY CHAIN: GLOBAL TRENDS AND ASIAN PERSPECTIVES

Francisco Veloso
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January 2002

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Foreword

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I. Introduction

The objective of this paper is to provide an overview of the major trends taking place in the automotive industry across the world, with an emphasis on the Asian market. It is not a comprehensive report, but rather an informed view of the issues and a panorama of the behavior of the major players, both automakers and suppliers. In the final section, the paper presents some suggestions on how to measure firm competitiveness in this fast moving industry, focusing on automotive suppliers, particularly the smaller ones that make up most of the local autoparts industry in Asia.

Besides this initial introduction, the paper has five additional sections. The second section describes the major drivers of the auto industry. It explains how today's fast changing business environment, where the client is in charge, the technology evolves at breathtaking speed, and regulatory issues are pressing, is altering the industry characteristics, strategies, and products.

The third and fourth sections address the behavior of the major players in the industry. The third section focuses on the responses of the automakers. These firms are the lead actors in the industry and have been on the first stage of industry evolution. The section summarizes the major strategies they have followed in the recent past, as well as those forecast for the near future. The following section looks at the auto components sector. One of the characteristics of the industry transformation is an increasing responsibility and importance of the suppliers, some of which have become as large as an automaker. This section highlights the new roles that are being taken over by these firms, particularly those that are first-tier supplier to the automakers and describes the challenges that the smaller, lower-tier firms are facing to remain in the sector.

The fifth section focuses on Asia. First it presents the general prospects for the region as a whole, pointing to common trends and similar issues. Then it describes in more detail the key characteristics of each of the major markets outside Japan. The last section discusses implications of the major issues reported in the previous sections of the paper and suggests some perspectives on how to measure firm competitiveness in this fast moving industry, focusing on smaller automotive suppliers, the firms that make up most of the local autoparts industry in Asia.

II. Major Drivers of the Automotive Industry

Many influential factors affect decisions made in the automotive world. Consumer preferences determine the current styles, reliability, and performance standards of vehicles. Government trade, safety, and environmental regulations establish incentives and requirements

for modernization and change in design or production. Competitive rivalries and corporate strategies provide equally important impetus for research, design innovations, and changes in the manufacturing process. All automakers are constantly under pressure to identify consumer preferences, national biases, and new market segments where they can sell vehicles and gain market share. Their ability to be flexible enough to quickly respond to all these pressures is determining their future in the industry. The implications of these factors are vast and propagate along the supply chain of the automakers. In the following paragraphs, we review some of these critical issues and how they might affect the industry.

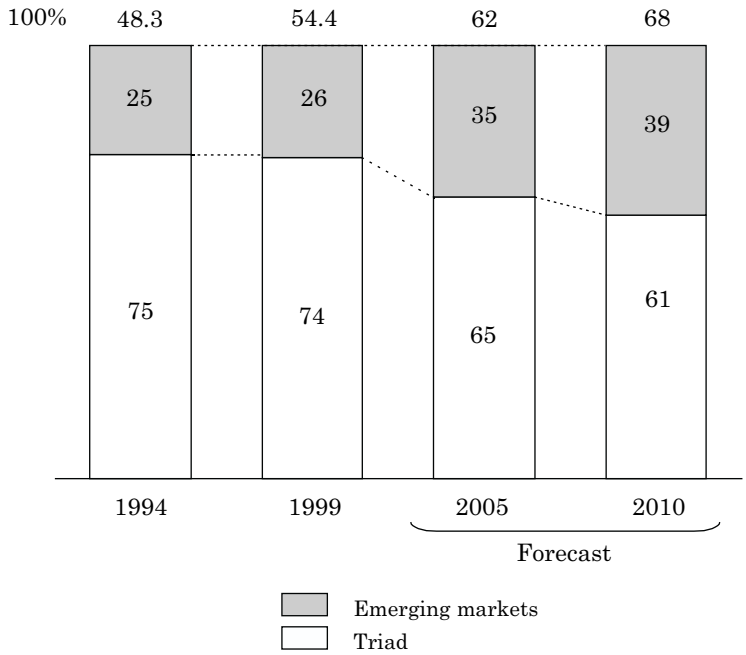
One of the major competitive factors is the pattern of demand for new cars. In any of the Triad regions (Western Europe, Japan, and United States [US]) original equipment manufacturers (OEMs) have been facing a mature market for the past 10 years, with stagnant demand, product proliferation, and stiff price competition. The demand for new cars has been growing on average less than 1 percent percent a year during the past 10 years and this trend is forecast to continue. This situation is particularly sensitive in the US market, where growth in the number of new cars sold has been virtually zero, and it has not been more acute because of the growing market share of the high-margin sport utility vehicles (SUVs).

A flat demand is aggravated by increased competition in the product market. During the past two decades, most OEMs have invested heavily in plants outside their home base to better reach local consumers. As a result, market shares of incumbent players have become thinner. In the US, domestic automakers have lost more than 20 percent market share to Japanese and Korean automakers in the past two decades. Europe has experienced a similar trend, although ameliorated by the stricter regulations on the participation of Japanese OEMs that were in place until recently.

Sales growth is now coming from developing regions, with South America, India, People's Republic of China (PRC), and Eastern Europe leading this trend (see Figure 1). Sales of automotive vehicles outside the Triad surpassed 14 million vehicles in 1999, representing around 26 percent of total new sales. Although this number is only slightly up from 25 percent of sales just half a decade ago, mostly due to the recent economic crisis in the developing world, it could go up to 40 percent in less than 10 years. The leading growth region has been South America. Until 1998, when a severe financial crisis hit Brazil and Argentina, sales in that area of the world were growing an average of 10 percent a year, lead by an astounding 15 percent growth in Brazil (*Automotive News*). As economic growth in the regions picks up, the strong pattern of sales growth is expected to continue.

In India and the PRC the evolution will be slower because their levels of economic development are far behind those of Brazil. Nevertheless, the size of their population is still making them important markets. The rest of Asia is also kicking back faster than expected. Important sales growth that had been forecast before the 1997 financial meltdown in the ASEAN region and Republic of Korea (henceforth Korea) turned out to be a severe market contraction. Nevertheless, some of these nations recovered rapidly and are now back to levels of economic growth slightly below the ones before the crisis. As a result, analysts are reviewing demand

Figure 1: **New Vehicle Sales in Triad versus the Rest of the World**
(millions of vehicles)



Source: McKinsey, *Automotive News*.

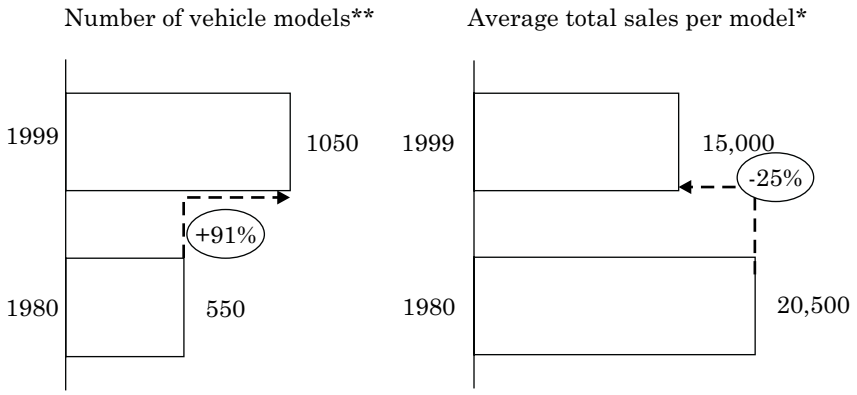
estimates monthly, with all the corrections upward. Another booming area is Eastern Europe. Deprived of car imports during the era of the Soviet bloc, these nations are using their recent improvements in living standards to buy more cars. Sales in Eastern Europe (The Czech Republic, Hungary, Poland, Slovakia, and Slovenia) reached one million vehicles in 1999, double the figure of 1994 (*Automotive News*).

Both maturity in the Triad and sales growth in developing countries have led to increasing diversity in market needs. In regions where households have multiple cars, vehicles perform specific roles. Moreover, consumers have developed particular expectations in what concerns vehicle features, performance, or safety. In emerging markets, social characteristics, government tax structures, and income levels also generate needs for diverse cars. Vehicles of choice in the PRC and Thailand are inexpensive, small pick-up trucks and vans; in Malaysia the mini vans are the top sell; in Brazil, the 1000cc is the leading car segment.

The need to respond to an increasing diverse set of customers generated a large proliferation of segments and models. As seen in Figure 2, the number of vehicle models offered for sale in the US market alone doubled from 1980 to 1999, reaching 1,050 different models in 2000. In addition to the different models, there is also a myriad of features that can be added to each of the models, from power steering, to power seats, and cruise control, just to name a few. An increase

in the number of models in the Triad, where demand is stagnant, and the smaller size of emerging markets resulted in an important reduction in scale. The average annual sales per vehicle in the US went down from 20,000 in 1980 to less than 15,000 in 1999, a 25 percent decrease.

Figure 2: **Increasing Models and Decreasing Scale, US Market**



*Total number of models of cars and light truck/total (per year)
Source: McKinsey, *Automotive News*.

While consumers' expectations around the world are certainly steering the overall direction of the industry, government regulation has also been playing an important role. Starting in the late 1960s and early 1970s, safety began to be an important issue. Standards for safety of the vehicles were established and regulation for mandatory devices such as seat belts, and later on airbags and autobrake systems (ABS) was enacted. The other area where government has been extremely active is environmental damage. Laws to regulate tailpipe emissions and fuel economy have been in place in Europe, Japan, and US since the late 1960s and have become increasingly strict. More recently, recycling became another target for regulation. In Europe, the take-back policy is soon to be a reality. Despite some mishaps both in Europe and particularly in the US on readiness of the technology to perform the tasks desired by the government within the time frame established, this regulation has certainly been affecting the evolution of the industry. McKinsey estimates that the cost of car contents that are the result of regulatory measures may be in excess of US$4,000.

The other factor determining the course of the auto industry is technology. Historically, the major driving forces behind technological implementation in the auto industry have been based on consumer demands for better vehicle performance and reliability. In recent years, technological improvements have also been aimed at areas such as safety, reduced environmental impact, and additional consumer features unrelated to the operation of the vehicle, such as stereo systems and navigational aides. Some OEMs use early introduction of technological innovation as a strategy for increased market penetration of particular models. Nevertheless, recent history

has demonstrated that, sooner or later, all automakers incorporate new technological features in their vehicles to remain competitive. The relationship between market and technology also works the converse way, with the emergence of new technologies affecting the evolution of the car. Recent plans for the introduction of access to the Internet in the car is an example of this reverse effect.

New technologies are present at all levels of car manufacture. Demands for improved vehicle performance, improved vehicle safety and crash worthiness, and reduced environmental impact have led to numerous developments in structural areas. The full frame designs originally used in vehicle body architecture were almost completely replaced with unibody construction by the 1980s. More recently, spaceframe-based designs and modular composite designs have also emerged.

At the same time, cars have become more reliant on electronics and less reliant on mechanics. A myriad of electrical systems, electronic sensors, and actuators have "taken over" control and monitoring of car performance. Electronics used to trouble-shoot and perform diagnostics, operate navigational systems, and provide entertainment units. A vehicle today has approximately double the electronic functions of one manufactured just 10 years ago. Additionally, they contribute to overall vehicle cost by as much as 35 percent (Veloso et al. 2000, chapter 2). Electronics have also been instrumental in shaping the evolution of the engine and powertrain, playing a crucial role in controlling today's performance of these systems. Nevertheless, the revolution in this area of the vehicle is yet to happen with the announced emergence of hybrid vehicles and, toward the end of the decade, fuel cells.

New technologies are also determining the way the auto industry does business. In 1999, despite the fact that only 5 percent of the car sales were done through the Internet, as much as 40 percent of the buyers of a new vehicle in the US used it at least once to obtain information about the car they are buying (J.D. Power and Associates 2000). Sales through the web are expected have an explosive growth in the years to come. Changes are also happening at the level of the supply chain. With the recent announcement of Ford, General Motors, Daimler Chrysler, Renault, and Nissan to join their e-commerce initiatives, the auto industry is entering a new era of supply chain management. The new marketplace is going to group some estimated $250 billion per year worth of purchases. Volkswagen has also announced the creation of a similar e-marketplace for its suppliers and all other major carmakers will soon join the established exchanges or create their own. This trend is not happening only at the OEM level. In April 2001, six of the largest auto suppliers announced plans to conduct a joint study of internet strategies, which may lead to their own e-marketplace.

Despite increases in diversity of models and advances in technology, the industry focus on lowering costs has never been as acute. In any country, costs associated with buying and operating personal vehicles represent a substantial portion of the average household expenditures. In countries like England it is the top item of expenditure. Therefore, increasing auto sales requires meeting all the challenges of segmentation and introduction of technology, while keeping costs down. The consumer cost pressure is exacerbated by stiff competition among OEMs across the globe.

The trends described in the previous paragraphs are determining most of the evolution of the automotive industry. They generate a set of drivers to which all automakers have to be able to respond to remain competitive. Moreover, they are also conditioning the supply chain that is an integral part of the industry, reshaping it in fundamental ways. The following sections explore how the industry players are responding to these challenges.

III. Assembler Strategies

To respond to new market trends and demands, automakers are pursuing a set of strategies that are common among major firms. The first strategy is an adoption of a global perspective in their operations. Until the end of the 1980s, despite some overseas presence, competition among OEMs would still be mostly within regional brands. American automakers dominated the US market, Japanese the Asian market, and European automakers their regional market. During the 1990s, this picture changed completely. A growth of transplants in the beginning of the decade led to a presence of all competitors in virtually every corner of the globe (see Sturgeon and Florida 1999). This has become particularly important in emerging markets, where all OEMs are fiercely disputing market shares as the market grows. As a result, automakers are now planning operations on a global scale, with models being launched at the same time in different locations with similar standards. With new investments, firms are also trying to replicate supply chain structures, demanding suppliers to be present in the new regions where they are located, often near their plants.

Figure 3: **Examples of Platform Strategy (1999)**

Automaker	Platform	Vehicles	Annual Production Volume (Top Selling; Millions of Units)
Volkswagen	A	Audi A3, Audi TT, Skoda Octavia, Seat Toledo, VW Golf	1.4
General Motors	Mid Range	Buick Century, Buick Regal, Chevrolet Lumina, Chevrolet Monte Carlo, Oldsmobile Cutclass, Oldsmobile Intrigue, Pontiac Grand Prix	0.9
Fiat	178	Palio, Palio Weekend, Siena, Strada, Minivan	1.0
Ford	F	F Series, Super Duty, Expedition, Lincon Navigator	1.2

Source: The Economist Intelligence Unit, *Automotive News*.

The second important strategy automakers have been pursuing is a reorganization of their vehicle portfolio around product platforms and car modules and systems (see Figure 3 for examples of global platforms). Declining sales per vehicle and short product life cycles were preventing automakers and suppliers from reaching economies of scale in design and manufacturing, with an important adverse impact on cost. Moreover, new models had to be available all over the world while responding to increasing regulatory and consumer requirements. By focusing on common platforms and interchangeable modules, OEMs are able to make faster and lower cost deployment of new solutions across the whole product range, while tailoring vehicles to a multitude of tastes and preferences of consumers in the world. Moreover, they can assure enough differentiation between products to cope with proliferation while maintaining scale efficiency and a proper management of brand equity (see Lung et al. 1999).

The Fiat 178 project is probably one of the more ambitious standardization strategies (Camuffo and Volpato 1999). While most OEMs are designing vehicles with a common underbody platform, adapting body, trim, and ride to particular market conditions, Fiat's "world car" concept is more ambitious. It involves the deployment of five models stemming from the 178 platform, with absolute cross-country identity in the car, as well as the same manufacturing performance requirements in all the plants. Moreover, the supply chain is designed to be global, with cross sourcing of parts from across all the 10 regions involved in manufacturing and assembly.

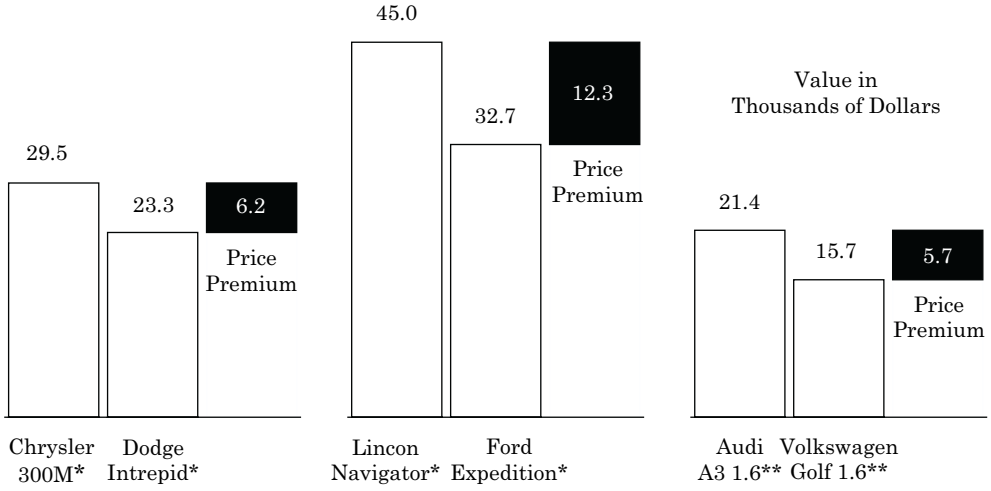
In the past two years, this need to focus assembly around global platforms that share individual components, modules, or systems has become dramatic. Some of the players with less models and production volume in certain segments have found out that they could not compete. As a result, losses mounted and a wave of consolidation followed suit. The perspective of future platform sharing was clearly acknowledged in deals such as Nissan-Renault and GM-Mitsubishi. The Daimler acquisition of Chrysler was not an explicit need for platform sharing, but has been regarded as an opportunity to spread Mercedes investments in high technology across a broader range of vehicles. This wave of consolidation is expected to continue. It is estimated that within the next five years, less than 10 independent automakers may survive (EIU 1999).

The OEM strategy to share platforms and modules across products has also been driving a smaller level of real physical differentiation between cars in virtually all market segments. But other aspects are equally relevant to this homogenization of car characteristics. The fast pace of technical change and the vigorous competition in the industry leads automakers to rapidly adopt new technical solutions that can improve car performance, comfort, or safety throughout their fleets. For example, safety devices such as ABS and airbags were exclusive characteristics of the top models or brands in the mid-1980s, when they were first adopted. Today, they are standard in almost all vehicles sold, from small economy cars to luxury sedans, and they are manufactured from the same firms. Likewise, features such as power windows or power locks, or even cruise control that existed in a tenth of the vehicles produced in the early 1970s are now a standard feature in about 80 percent of the vehicles sold.

Decreased differentiation in physical characteristics and manufacturing techniques brought more intangible aspects such as brand equity and overall customer experience to the forefront

of the business. As shown in Figure 4, customers continue to be willing to pay a premium for brands that are associated with prestige cars, even if the real difference to other vehicles is small. Nevertheless, as the entrance of brands such as Lexus and Acura in the US market show, success requires a careful management of the brand, and a close interaction with clients to understand and respond to their needs and expectations. Good assistance on sale, post-sale service, and maintenance are a fundamental part of this brand experience.

Figure 4: **Brand Premium for Equivalent Cars based on Same Platform**



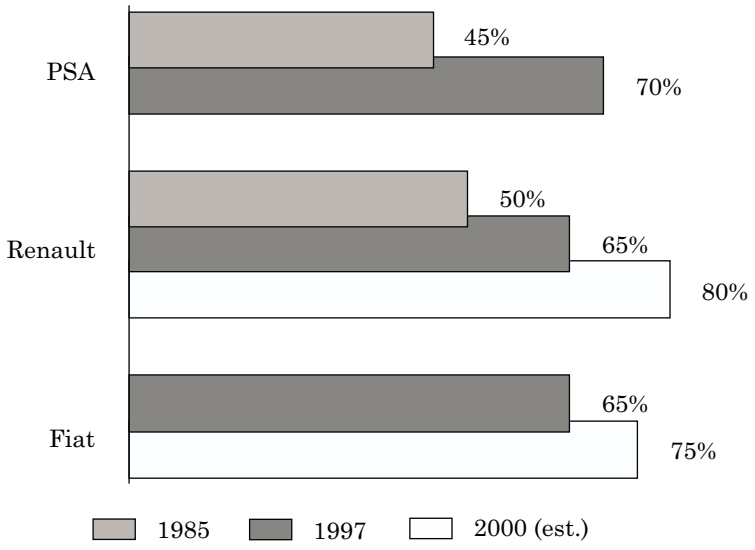
Models of Comparable quality
*Prices for 1999 models in the US
**Prices for 2000 models in France

Sources: *Automotive News, Journal de L'Automobile.*

As a result of this increasing importance of design, brand management and customer relationship, assemblers have clearly set a strategic direction toward capturing more of the section of the value chain that links them to the final customer, including dealerships and services. They are also finding new ways to reach the customer, among which the Internet has been getting most of the recent attention. While the overall revenues of distribution and after-sales service are already larger than the assembly business, they are bound to become even more important in the future (Group 1998). The car is evolving from being a product to being more of a service and OEMs want to be in this thriving business.

To be able to focus more on car-related services and to cope with the huge costs associated with an ever growing number of new modules and systems, OEMs are becoming less involved in manufacturing and assembly, passing the responsibility of developing, manufacturing, and assembling important sections of the car on to their suppliers. They also wish to reduce asset intensity of their operations to boost shareholder return on assets, while improving responsiveness and quality. As seen in Figure 5, the increase in supplier responsibilities is reaching impressive levels.

Figure 5: **Increasing Vehicle Outsourcing**
(percent of car value)



Source: The Economist Intelligence Unit.

Assemblers acknowledge that the critical issue in subcontracting is research and development cost. Manufacturing cost of modules and systems is often as high or higher in suppliers than in assemblers. Therefore, cost-wise, outsourcing becomes worth doing only if the supplier does all the engineering work. This is particularly relevant for complex systems or modules such as an ABS, where it is assumed that the supplier is able to spread its development cost across several clients (assemblers).

Given the importance of the systems being subcontracted by assemblers, there is a clear strategic goal of these firms toward working with a smaller number of large suppliers. For example, the objective of Renault is to have only 350-400 suppliers by the year 2000. Figure 6 shows that this is a general tendency that can be found in all automakers. Despite being an overall strategy, assemblers are following it to different extents. Companies like Renault and Volkswagen have a more conservative policy strategy toward supplier reduction, while Ford is being more aggressive.

The strategy of Volkswagen and Renault could be described as the 2+1 suppliers:

(i) For each major module, the OEM forms a partnership with key suppliers;

(ii) In each region, two suppliers are considered privileged partners, with involvement in the early stages of the development process. A third follows closely, being given less responsibility, but enough for it to be ready to replace any of the existing suppliers.

(iii) Because the same cars are being sold in several regions of the globe, this strategy is generating a tendency to have the same suppliers around the world for a given module in a particular car. Since assemblers demand car parts to have the same

characteristics in any given plant around the globe, suppliers are often faced with the options of either investing near new plants to supply the module, or transferring their knowledge to a local supplier. They often prefer the first option.

(iv) These OEMs consider the mono-supplier strategy of Ford a bad idea.

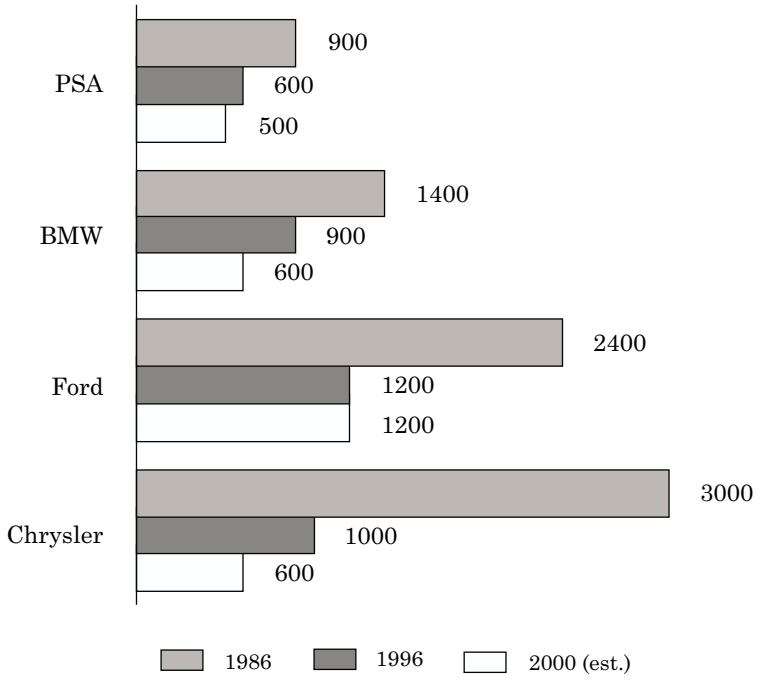
The Ford supplier strategy is considered more aggressive:

(i) There is a clear drive toward increased use of large modules rather than individual components or even subsystems.

(ii) The ultimate (theoretical) goal is to have a single firm supplying modules like the complete interior for a given car across the world.

(iii) The company is also pushing for the supplier to own the tools, another way of pushing the risk associated with volume fluctuations onto the supplier rather than Ford. Suppliers will have to be concerned with their amortization schedule when quoting prices because payback for the investment in tools must now be included in price.

Figure 6: **Trend for Reduction in Automaker Direct Suppliers**



Sources: The Economist Intelligence Unit, Wards.

This policy is inevitably going to lead to a drastic reduction in Ford's direct supplier count, with most current first tier suppliers likely to become second or third tier. Ford admits that their supply strategy is NOT the industry standard. Their strategy is not without pitfalls. By outsourcing more and more parts, and worse still, moving toward a single, very large system integrator (like Lear or Magna), Ford will be giving up a lot of power over their supply chain, and knowledge

of the supplier industries. At the moment Ford has an extensive databank of "benchmark" cost of supply for many parts. Therefore, it is able to understand what the cost of assembled modules containing these parts should be. In the future, they may only know about the cost of the entire system, and not its individual components, and thus will have little knowledge to use during negotiations with the major systems integrators.

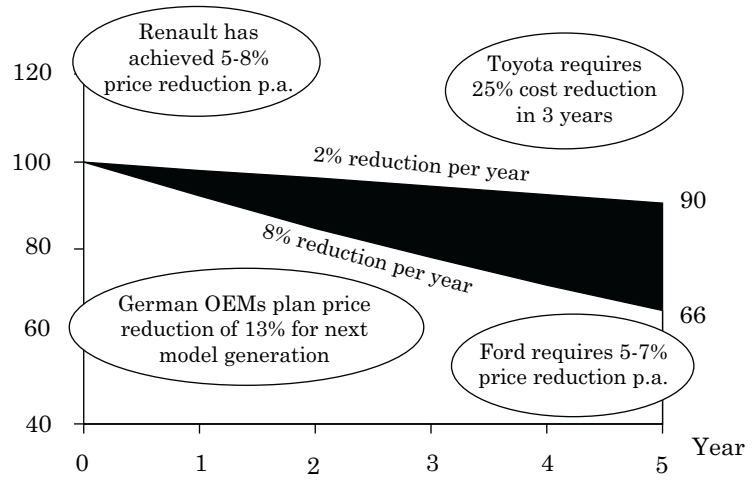
Given what was described above, choosing partners that are able to work with the assemblers in the development and manufacturing of the systems becomes crucial. Major criteria for choice of supplier to be a strategic partner include:

(i) Cost and quality competitiveness
(ii) R&D capacity
(iii) Closeness to development center (Paris for Renault, Wolfsburg for Volkswagen)
(iv) For parts with substantial logistics costs, location is also an issue
(v) Absolutely no nationality criteria

Increasing responsibility is not happening only in development and manufacturing. OEMs are also trying innovative approaches in terms of assembly, with Brazil as the test bed of some of the most daring approaches. In both Volkswagen *consorcio modular* and General Motors *blue macaw* projects in Brazil, suppliers assemble a number of modules in final assembly plant and attach them directly to the vehicle themselves (Lung et al. 1999). The benefits that assemblers claim are reduced asset intensity, reduced supply chain management costs, as well as improved quality and productivity.

More responsibility has often come with strings attached. In the first place, assemblers require suppliers of modules to have quality performance above their own, and with continuous improvement. This has meant that suppliers may need to improve rejects, scrap, and rework by as much as 5-7 percent a year. Second, all assemblers are including price reduction objectives in the contract (see Figure 7). The key features of this concern are:

Figure 7: **Price Reductions Demanded from Assemblers**



Sources: The Economist Intelligence Unit, Wards.

(i) Contract length and overall value are related to price reduction targets that the supplier is able to commit to.
(ii) For some of the assemblers, suppliers can also propose alternative designs that have the same economy results.
(iii) Magnitude of reduction per year varies from 2 to 8 percent.

IV. The New Supplier Roles

The growing importance of suppliers in the automotive industry is affecting their structure (see Table 1). Traditionally, the industry supply chain was organized in tiers. OEMs would design and assemble the car. First tiers would manufacture and supply components directly to the automaker (e.g., the fuel pump). Second tiers would produce some of the simpler individual parts that would be included in a component manufactured by a first tier (e.g., the housing of the fuel pump), and third and fourth tiers would mostly supply raw materials. This simple configuration no longer fits the actual structure of the industry. The new direct suppliers are becoming large global firms, which are either specialized in complex systems, or integrators of several simpler subsystems. They are expected to have a substantial responsibility in the design and engineering of these systems and to coordinate the supply chain necessary for their manufacturing and assembly.

Studies within the International Motor Vehicle Program (IMVP) and other outside analysts suggest a new configuration that will probably involve a division along the following lines (see Veloso et al. 2000 for additional details):

(i) *Systems Integrator*: Supplier capable of designing and integrating components, subassemblies, and systems into modules that are shipped or placed directly by the supplier in the automakers' assembly plants. This company has also been treated as the tier 0.5 suppliers.
(ii) *Global Standardizer–Systems Manufacturer*: Company that sets the standard on a global basis for a component or system. These firms are capable of design, development and manufacturing of complex systems ("black-box" design). Systems manufacturers may supply motor vehicle manufacturers directly or indirectly through Systems Integrators.
(iii) *Component Specialist*: A company that designs and manufactures a specific component or subsystem for a given car or platform. These can include "process" specialists, such as a metal stamper, die caster, injection molder, or forging shop that builds parts to print. They might also have additional capabilities such as machining and assembly, supplying components such as a steering column or the pedal system. These firms will increasingly work as suppliers to system integrators and standardizers.

(iv) *Raw Material Supplier*: A company that supplies raw materials to the OEMs or their suppliers. This includes products ranging from steel coils or blanks, to aluminum ingots or polymer pellets. The presence and competitive structure of the specific marker varies, with steel and polymers mostly a regional business, and aluminum or magnesium a global market. Some of the raw material suppliers are also moving into component specialists to add value to their products.

Table 1: **OEM Supplier Characterisitics**

	Raw Material Supplier	Standardizer	Component Specialist	Integrator
Focus	A company that supplies raw materials to the OEM or their suppliers	A company that sets the standard on a global basis for a specific component or system	A company that designs and manufactures a component tailored to a platform or vehicle	A company that designs and assembles a whole module or system for a car
Market Presence	•Local •Regional •Global	•Global	•Global for 1st tier •Regional or local for 2nd, 3rd tiers	•Global
Critical Capabilities	•Material Science •Process engineering	•Research, design, and engineering •Assembly and supply chain management capabilities	•Research, design, and process engineering •Manufacturing capabilities in varied technologies •Brand image	•Product design and engineering •Assembly and supply chain management capabilities
Types of Components or systems	•Steel banks •Aluminum ingots •Polymer pellets	•Tires •ABS •Electrical Control Unit	•Stampings •Injection molding •Engine components	•Interiors •Doors •Chasis

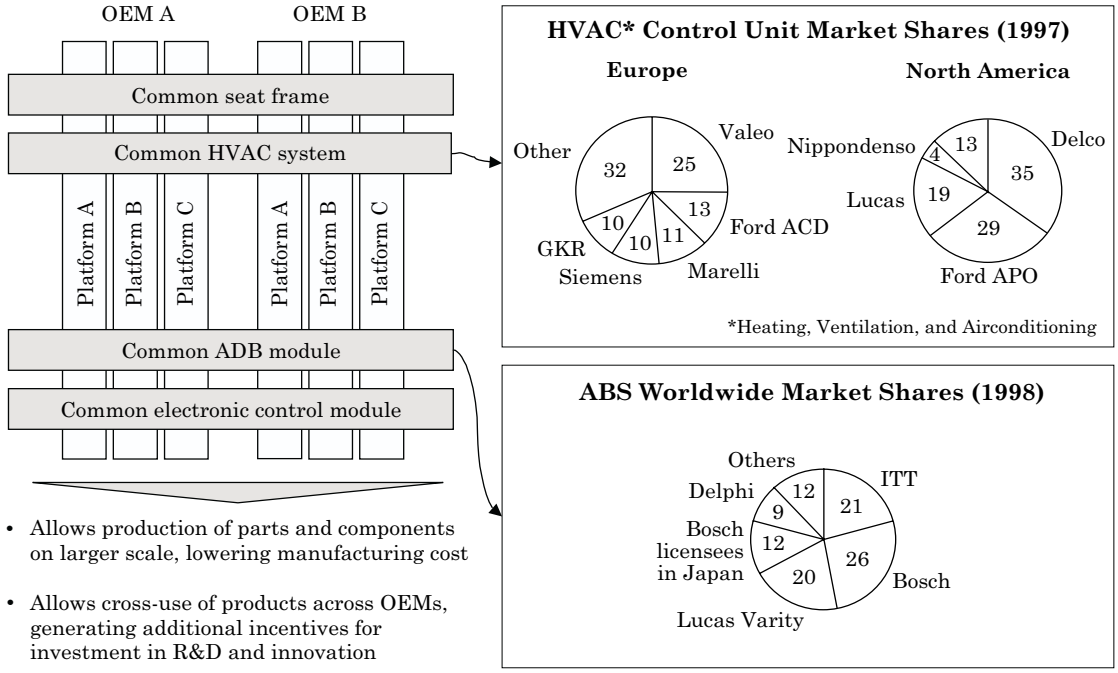
This new configuration of the industry also means an important restructuring, with firms actively engaged at some of the levels identified above, and others leaving the industry. The important aspect is focus. Companies must identify a clear positioning strategy and derive a consistent set of actions along the critical development and manufacturing dimensions. For example, the low cost producer is probably not the most flexible one; and the manufacturer of low value added components should not be the one with more resources devoted to product innovation.

A. First Tier Suppliers

System integrators or standardizers will need to provide a wide assortment of products and services for automakers (see Figure 8). They also need to have a global presence, supplying assemblers wherever they have plants. These aspects, combined with the automakers' desire to reduce their number of firms with which they have a direct relationship with will make the supplier industry more streamlined. It has generated the recent wave of consolidation in the industry, and some firms are expected to leave the industry altogether. It has been estimated that by 2005, the US market will have 30 to 50 system integrators; 150 to 250 standardizers; and 2,000 to 3,000 component suppliers (Pilorusso 1997).

Its current capabilities and position in the industry, available resources, and profitability that will largely determine the development paths of each supplier. Available options are to sell all or some of the business or move up the supply chain hierarchy by buying other businesses, joint ventures, or partnerships, as well as endogenous growth. If the firm is not able to meet the strict requirements that OEMs place to system integrators and standardizers, selling or merging with another supplier is probably the best option, as it may allow the joint firm to position itself in the supply chain at a first level. If moving up the hierarchy is an available option, then crucial considerations to think about are: success in long-standing relationships, manufacturing and assembly capabilities, ability to react quickly to OEM customers' needs, design and development capabilities, program management capabilities, and global presence.

Figure 8: **Examples of Products Targeted for Standardization**



Source: McKinsey.

Evolving to be a major supplier has important implications:

(i) *Standardizer–System Manufacturer*. Developing a whole system and manufacturing it for an automaker requires important engineering maturity, proprietary technology, an extended network of suppliers, presence in key production regions, and plenty of financial muscle. System manufacturers supply core products and technologies. Because of this, development costs easily reach 10 percent of sales, with three to five years between starting to work in a program and starting to produce revenues. Therefore, any firm wishing to move in this direction has to be able to cope with this challenge.

(ii) *Systems Integrator*. These firms need to strengthen systems engineering and integrated supply chain management capabilities. They should also place plants where automakers expand. Possibilities for systems include seats to complete interiors, axle/suspension/brake/wheel modules, and complete front-end modules (see Figure 9).

Figure 9: **Example of Evolutions toward System Integration**

Dana's Brazilian "Rolling Chassis"	**Lear complete seat and interior integration**
• Dana core products include axles, brakes, drive-shafts, structural products, and engine components • Now moving to provide complete modular systems across the world • Leading example is complete chassis to new Chrysler Dakota pickup truck in Brazil –Invested $15 million in plant near the Chrysler operations to build chassis, –Chassis incorporates 200 parts from 70 suppliers, which Dana manages –Module represents approximately one third of the truck's value and includes frame, rear axle, driveshaft, suspension, steering system, brakes, fuel tank, electrical circuits, wheels, and tires –Chassis are assembled and placed in Chrysler's assembly line within 2 hours of order	• By 1985 Lear major automotive parts revenue came from the sale of metal seat frames • Entered complete seats business through acquisition of OEM seat operations and other firms –Ford in 1993 and Fiat in 1994 –Automotive Industries in 1995 –Keiper, Dunlop cox, and ITT seating in 1997 –Delphi and Hyundai Seating businesses in 1998 • These purchases included global networks in virtually the whole world • Now growing to be a full interior supplier –Acquisition of Masland for acoustics technology –Acquisition of Borealis for instrument panels –Acquisition of Pianfei and Strapazzini for trims –JV with Donnelly Co. to develop overhead systems

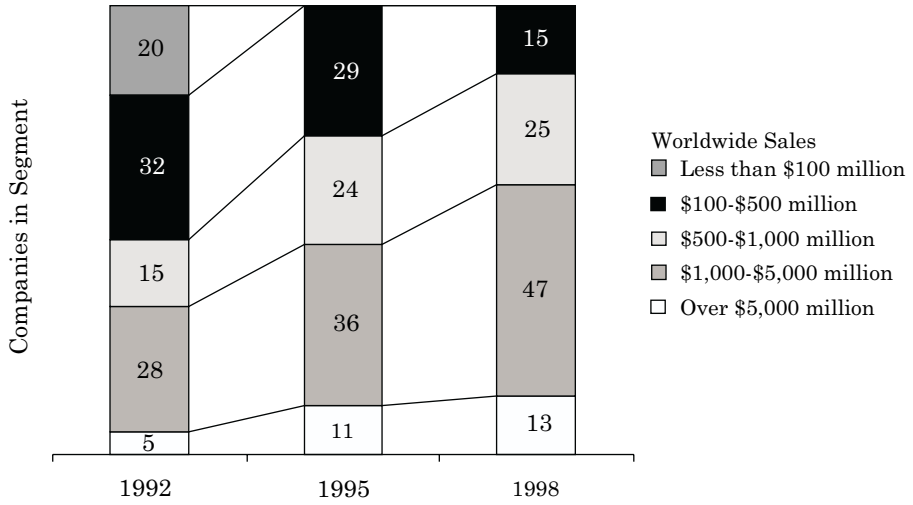
Sources: Automotive Industries, Wards Automotive Reports, Hoover's online, Companies' web pages.

Because of size, expertise, and presence, system integrators and standardizers are generating a new focal point in terms of industry aggregation and rebalancing the relative weights in the auto supply chain. Companies like Denso, Allied Signal, or Magna have as much market value as a Renault, a Mitsubishi, and certainly more than OEMs with the dimension of Hyundai. In the near future, some of them may also become contract manufacturers of the whole vehicle, which may be sold with a particular brand. This situation is already happening for niche cars

such as *Cabrios*. Autonova, for example, manufactures Volvo C70 *Cabrio,* and for Karmann the Mercedes CLK and SLK models.

Most existing suppliers were not equipped to respond to the challenges associated with these new supply responsibilities. They were mostly regional, focusing on particular components and had limited resources to withstand financial outlays on product development for several years before actually seeing returns on investment. As a result, a wave of foreign investments and consolidation has swamped the supplier industry during the past few years. As seen in Figure 10, in 1992 there were only 28 US suppliers with sales between US$1 and 5 billion and five companies with sales higher than US$5 billion. In 1998 these numbers were 47 and 13, respectively. Much of this growth has been achieved through mergers and acquisitions between companies. The value of deals peaked at an astounding US$30 billion in 1999, representing close to 7 percent of the total sales of the autoparts industry. Companies like Federal Mogul grew over 300 percent in sales over a period of three years both through acquisitions and endogenous growth (Hoover's on-line).

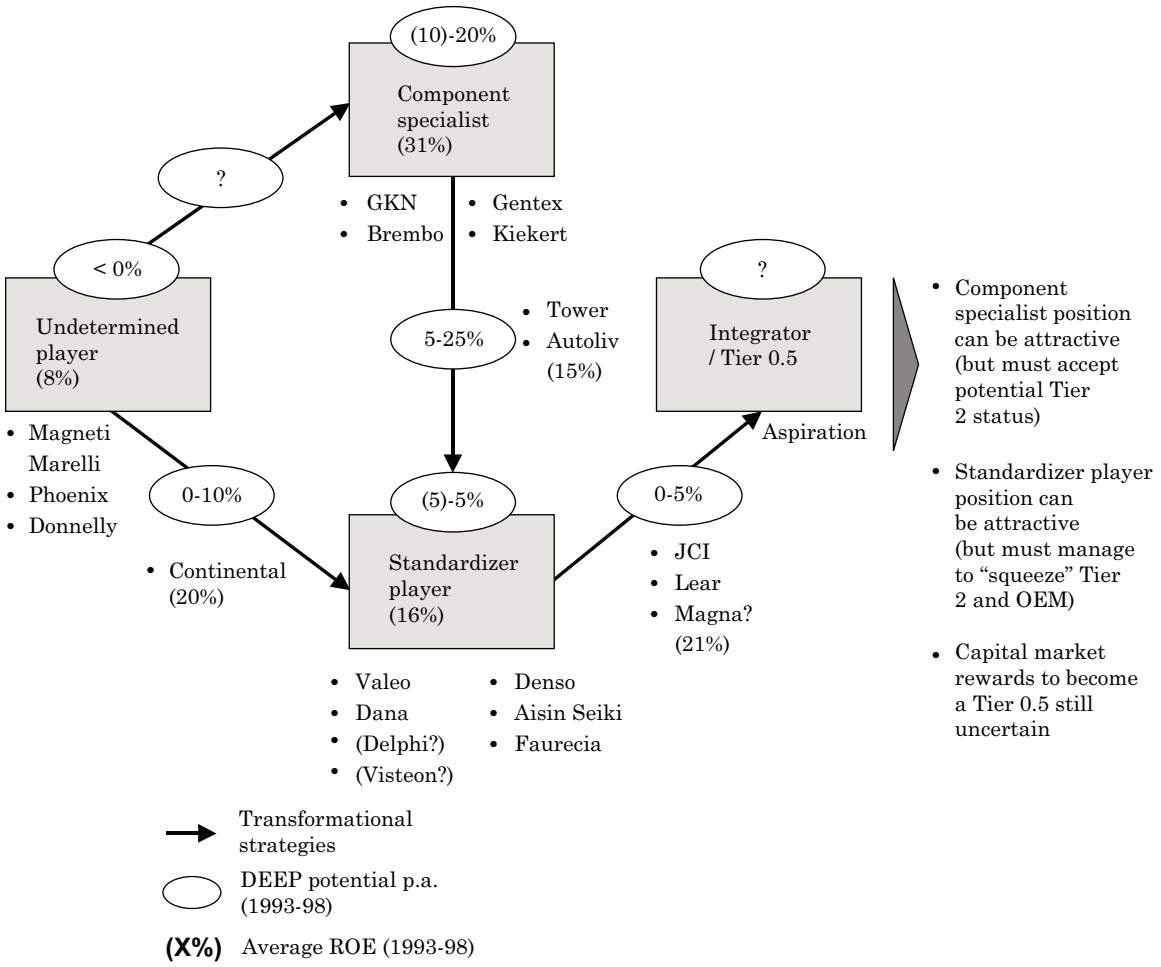
Figure 10: **Top 100 US Suppliers by Sales Volume Category**



Source: *Automotive News.*

Despite the dynamics of the market and the growing importance of these players, their financial results are still uncertain. As shown in Figure 11, both the return on equity and the discounted earnings expectation projection has been larger for component specialists than for standardizers. The same holds for firms like Magna or Lear, which are now aiming to be full-fledged integrators. These figures demonstrate that companies should carefully assess whether moving from being a component specialist into a standardizer or integrator is in their best interest. If their strongest capabilities and competences are associated with particular components, they may be able to do as well or better than systems manufacturers, even if that means working

Figure 11: **Position, Evolution, and Prospective Returns of Automotive Suppliers**



DEEP = Discounted Earnings Expectation Projection (expectation of market for future earnings, discounted to the current day).
ROE = Return on Equity
Source: McKinsey.

as a second tier firm. Despite some uncertainty in the level of financial results, having a clear strategy has a clear financial return. As seen in the figure, both standardizer and component specialists show better results than indeterminate players with no explicit strategy.

Teaching and learning in the supply chain is being redefined by the emergence of mega suppliers. In the past, OEMs were concerned with transferring best practices in manufacturing and design to their suppliers. Nowadays, they are actually hoping to learn from them. These new large 1st tiers are taking on this role of teaching the smaller lower tier firms. Lear Corporation, for example, has set up the COMPASS program. This program provides assistance in a broad range of areas, ranging from industrial engineering to quality and systems expertise.

Raw material suppliers are also using automotive supply chain restructuring to reposition themselves (see Figure 12). Although the volume of steel or aluminum devoted to the auto is small, it is one of their products with greater margins. They have felt severe price pressures in the last decade, and they have been concerned that they may suffer a "commoditization". To counter this tendency they are using supply chain disaggregation and innovative material use to become suppliers of formed parts and components. A good example of this trend is Usiminas in Brazil, which took over stamping operations of Fiat.

In addition to traditional first tiers that deliver some physical product to the OEM, new roles are also emerging. The growing system complexity, either at an OEM or first tier supplier, is inducing the development of a new type of supplier. These do not supply physical products, but rather services, in particular design and engineering. Response to strict deadlines and product proliferation in both OEMs and suppliers requires the ability to rapidly develop and test new concepts and solutions. Given the cyclical nature of these processes, it often does not pay to have all the design and engineering capability in-house. Therefore, as noted in Table 2, several companies are emerging as providers of these services for the overall industry, whether OEMs, first tiers, or even smaller firms with particular needs.

Figure 12: **Repositioning Strategies of Raw Material Suppliers**

Goal: Explore new global opportunities generated in the auto supply chain through the development of innovative material-based solutions that can generate increased value added for the OEMs and the supplier

From	To
• Supplier of steel coils or blanks • Global supplier of aluminum ingots	• Supplier of fully formed body parts to the assembly line • Global supplier of aluminum castings

Another service role that is emerging is aggregator and intermediator. Information technology, in particular the Internet, is enabling the possibility for firms to do an electronic mediation of supply relationships, either on a one to one basis, or by aggregate demand for particular goods or services. This new role is still on its early stages and important change may happen in the next couple of years before an established business model emerges.

Table 2: **The Emergence of Design and Engineering Suppliers**

Role	Focus	Example of Firms
Global design company	A company that would design vehicle systems or bodies for OEMs and/or Tier 1 supplies	Porsche Engineering Bertone Italdesign Pininfarina
Global engineering company	A company that will provide engineering resources for OEMs/Tier 1 suppliers for detailed design	Lotus Modern engineering MSX Porsche Engineering

Source: McKinsey.

B. Component Suppliers

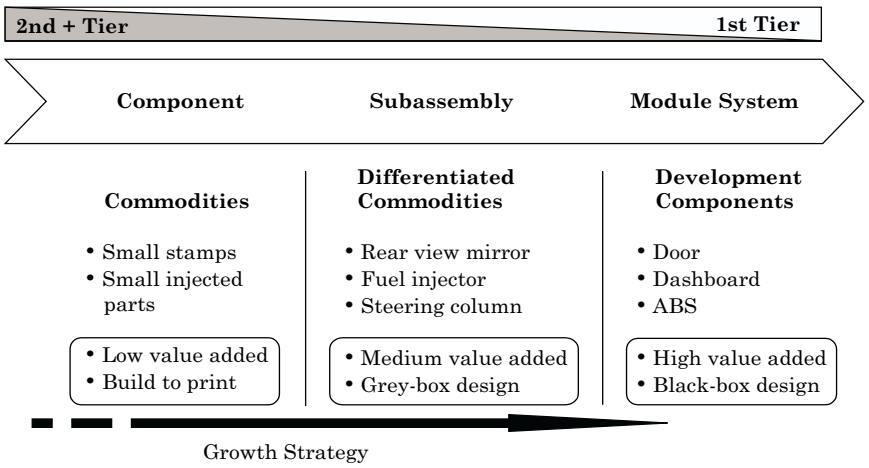
The majority of the suppliers that participate in the automotive supply chain are not system integrators, neither component standardizers, nor even raw material suppliers. Most of the firms, often smaller and working at a second or third tier level, are component specialists. Component specialists can be further divided into:

(i) *Component Manufacturer*: "Process" specialist, such as a metal stamper, die caster, injection molder, or forging shop. A component manufacturer often has the responsibility for design and testing of the component(s) it manufactures, but not the design of the entire subassembly where the components fit ("gray-box" design). In almost all cases, a component manufacturer is an indirect supplier to the motor vehicle manufacturers. Their direct customers are other suppliers that are higher in the hierarchy.

(ii) *Subassembly Manufacturer*: A process specialist with additional assembly, integration, and design capabilities. Supplies may include a steering column, a pedal system, as well as product-type subassemblies such as a radiator or a battery. Firms often elect a subsystem as a target and nurture the necessary technological competences to excel in its design and manufacturing. A subassembly manufacturer is an indirect supplier in most cases, with fewer and fewer opportunities to supply directly to OEMs.

The actual position and objectives of a supplier company, illustrated in Figure 13, determine the strategy it ought to pursue. The situation of a large number of national firms in virtually any country is that of a small process-focused company. Moreover, their objective is often to remain as such. If this is the case, then they should focus on a broad array of lower value products, small facilities in few locations, very efficient manufacturing, with a lean business structure and limited engineering.

Figure 13: **Company Positioning in the Supply Chain**



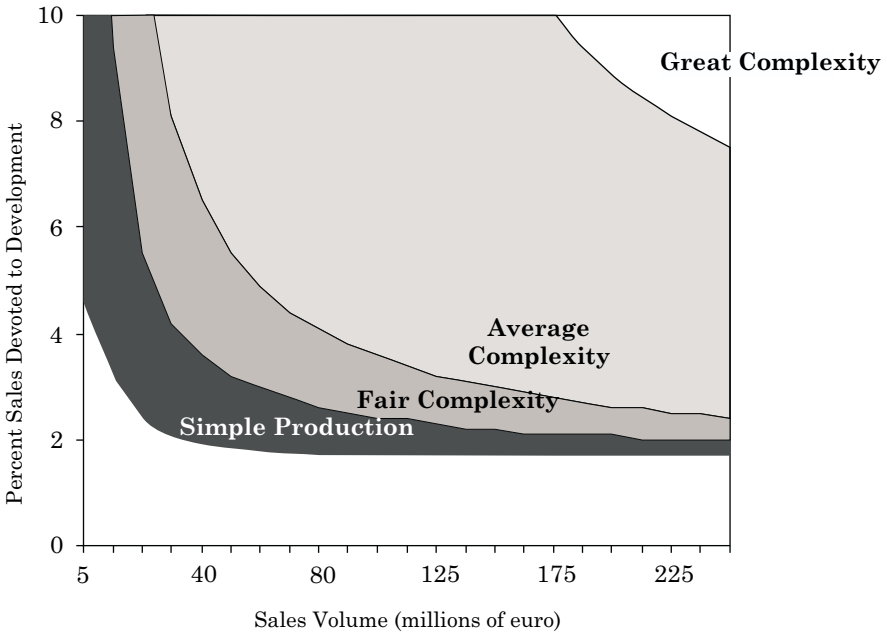
Source: Veloso et al. (2000).

As suppliers begin to move from Component to Subassembly Manufacturer, it is important to have capabilities in several manufacturing processes needed to produce the component, the ability to manage its own supply chain, and an improved presence in regions where automakers are assembling the vehicle and where subassembly will be incorporated. Nevertheless, it is the enhancement of engineering capabilities that often becomes the crucial (costliest) issue. Design, test, validation, and prototyping have to be part of these firms' capabilities. Therefore, to work at a subassembly level, suppliers need, not only to be able to supply at low prices, but also to demonstrate significant engineering capabilities and enough financial resources to withstand financial outlays on product development for several years before having any revenues. Overall, it is estimated that the best subassembly manufacturers consistently spend about 3 percent of sales on engineering, mostly on product development.

Given the requirements associated with being a subassembly supplier, how do new firms get accepted to work at this level? OEMs claim that the process is rather open, with virtually any supplier with the necessary cost, quality, and development capabilities being admitted in the chain. The critical step is what Volkswagen calls the ESA (Engineering Source Approval). For most components, the OEM has to approve both component specifications and overall company engineering capabilities. The problem is that assemblers often hold newcomers to a higher standard than they do with suppliers whom they have had joint engineering history, demanding important commitments in development capabilities without any real certainty of a contract.

Therefore, the current conditions are such that only companies with a certain minimum critical size can play an active role in the supply chain. Size is important because of foreign presence, but particularly because of development capability. Figure 14 presents an estimate of the relationship between sales volume and commitment to development activities. It shows

Figure 14: **Company Size and Required Commitment to Development**



Source: Veloso et al. (2000).

that the development of one simple product, with 1,500 hours of engineering work, requires a German company with 30 million euros of turnover to commit 3 percent of its sales to development. If one considers that a company may want to work in three products simultaneously, it must sell 90 million euros to use only the same 3 percent of sales in development. If the ambition is to work in one product with a fair level of complexity, with 8,000 hours of engineering, sales requirements rapidly reach 100 million euros; for one product and 3 percent of sales, climbing to over 200 million euros if we consider 15,000 hours of development. These sales volumes are beyond the reality of most small and medium firms working on a single country.

Gaining size to be able to free enough resources for development may actually benefit regions with labor cost advantages. Traditionally, low wages have been seen as an advantage for tasks and processes where labor costs matter, in particular manufacturing. However, labor cost advantage has often been overlooked at the level of human capital. Firms located in regions such as Portugal or Thailand, with low cost of highly qualified labor relative to Germany or Japan, may eventually have a potential advantage in comparison with a rival from one of these countries when developing similar products.

But these firms need to gain size if they wish to enter the development of products with more complexity and higher value added. The same holds true for their presence abroad. Successful companies working at the component and subsystem level have been channeling financial resources to endogenous growth, partnerships, mergers or simply acquisition of other firms abroad. As

illustrated in the examples shown in Table 3, this is true for large conglomerates producing a diverse array of products, such as Federal Mogul, as it is to smaller players working in narrow product ranges such as Simoldes in Portugal or Zanini in Spain.

Table 3: **Component Specialist Global Strategies—Example**

Company	Major Products	Globalization Strategy
Federal Mogul–US	Components for Engine Systems	Sales increased 276% from 1997 to 1998 Growth strategy focusing on its core competencies of manufacturing and engineering of components for engine systems, with complementary acquisitions of companies to enhance its product base and expand its global reach
Zanini–Spain	Hub Caps	Sales increased 30% from 1997 to 1999. Company focuses almost completely in the engineering and manufacturing of hubcaps, accounting for a third of the European market Has fostered growth both through acquisitions and green field investment in Europe, India, and Latin America
Simoldes–Portugal	Injection molded components for interiors	Sales increased 52% from 1997 to 1999 Niche player with development mostly through endogenous growth; investment in new plants in France and Brazil

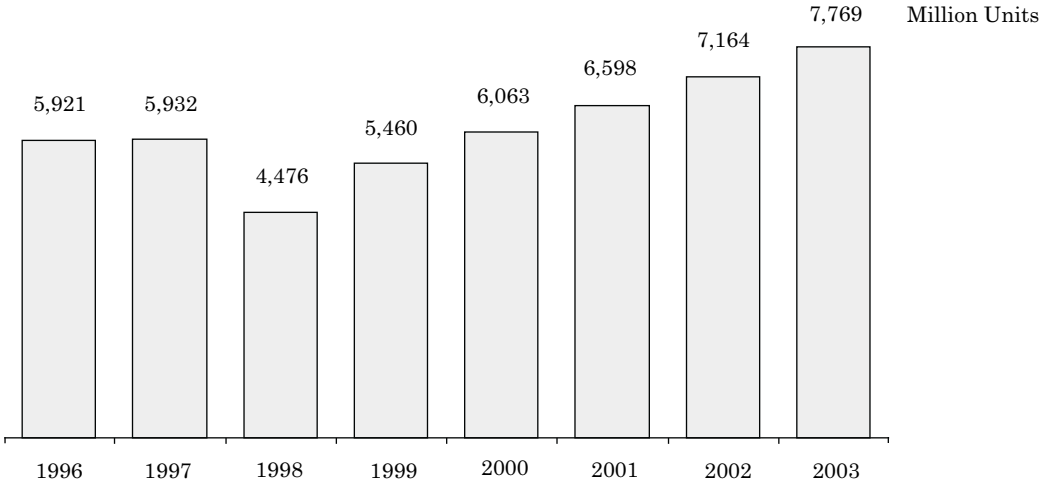
Sources: Company web pages, Federal Mogul 10k report.

V. Focus on Asia

A. Prospects for the Asian Market

In 1998, the prospects for the Asian automotive market were gloomy. The currency crisis and the economic turmoil that followed sent the demand for cars plummeting. As seen in Figure 15, overall sales fell by 30 percent from 1996 levels and only expected to reach equal levels in 2000. A similar downturn happened with vehicle assembly volumes. Within Asia, the ASEAN countries were the most affected by the turmoil. After a decade with industry annual growth rates above 15 percent, production fell from the 1996 height of 1.4 million units by more that 60 percent in 1997 and 1998, going back to the volume of the mid-1980s. But now Asia is recovering from the meltdown faster than anticipated, and rapidly becoming again a very attractive investment area. Over the next decade, analysts predict that the Asian and Pacific region will be a key driver of worldwide industry growth. Standard & Poor's DRI expects sales of light vehicles in Asia (excluding Japan) to rise by 150 percent, from 5.5 million last year to 13.5 million by 2010.

Figure 15: **Historical and Projected Vehicle Sales in Asia (except Japan)**



Source: Standard & Poor's DRI-Global Automotive Group (2000+ vales are forecasts).

In 1999 the overall Asian market grew by 20 percent, and most local markets have already shown strong signs of recovery. Car sales in Thailand, one of the largest markets in the region, rose 52 percent to 218,000 units. Sales in Malaysia were expected to increase from 280,000 units in 1999 to 300,000 in 2000. Despite its troubled economic and political conditions, Indonesia has also shown some sales growth. According to PriceWaterhouseCoopers (2000), the demand in this area of the globe will represent almost 50 percent of the projected global automotive growth from 1998 to 2006, making it an interesting investment destination for assemblers and suppliers alike.

Despite this overall growth trend, the area comprises a number of distinct markets, with very different characteristics. Asia's three core markets are PRC, Japan, and Korea. Japan, with a sales volume close to 6 million cars, dwarfs its Asian neighbors in unit sales. But contrary to the rest of the region, it is a mature market, with slow growth and expected lower returns. PRC and Korea, despite sales of only 3 million vehicles this year, are growing fast. Over the next decade, DRI-McGraw Hill predicts that Korean and Chinese light-vehicle sales will more than double, reaching the same volume of Japan. The rest of the Asian market, excluding these three countries, generated modest total sales of 2.5 million vehicles last year, roughly equivalent to Italy. Nevertheless, as seen in Table 4, it is in the ASEAN countries and India that sales are expected to grow faster. The compound average growth rate in ASEAN countries is expected to be in the order of 10 to 20 percent until 2010; 10 percent in India; and only 4 percent to 8 percent in PRC; Korea; or Taipei,China.

Table 4: **Current and Prospective Vehicle Sales of Asian Countries**

	Year		
Economy	1999	2005	2010
Japan	5,861	6,816	7,000
Korea	1,275	1.948	2.650
PRC	1,925	3,238	4,673
India	830	1,432	2,209
Thailand	218	687	1,253
Taipei,China	423	560	638
Malaysia	289	504	747
Indonesia	94	439	696
Philippines	74	244	533
Pakistan	67	99	114
Australia	787	898	1,051
Others	102	148	186
Grand Total	11,944	17,014	21,750

Source: Standard & Poor's DRI.

The growth in these markets, combined with a need to strengthen the financial structure of many of the domestic players weakened by the financial crisis has led to an important resurgence of foreign investment in Asia. The Asian market will take time to grow, but the sales potential places it high in the agenda of OEMs and large suppliers. Entering Asia is of particular importance for American and European brands, which have been marginal players in the region. Besides trying to seize local sales potential, automakers are also looking for synergistic opportunities in local players. For example, producing small cars at a profit continues to challenge both European and American manufacturers. By teaming with Asian firms, Western OEMs expect to broaden their brand and product portfolio, while leveraging local small car expertise into global markets.

If Japan is excluded, Hyundai and Kia are the leading manufacturers in Asia, with almost 20 percent market share. Suzuki, the minicar maker, is slightly behind with 12 percent, followed by the Toyota group, which holds a 10 percent market share in the region. Western manufacturers fall slightly behind, with General Motors and Volkswagen leading the group at about 7 percent and 6 percent share of the region respectively. But this situation is expected to change in the next years. Foreign carmakers have made significant inroads into the region and their investments will soon be transformed in market share.

DaimlerChrysler has been the last to join the procession of ties between Asian and Western automakers. The German-US automotive group secured a 33.4 percent stake in Mitsubishi Motors

of Japan and, more recently, agreed to acquire 10 percent of Hyundai Motor, Korea's largest carmaker. Through these agreements, it joined a bandwagon that includes General Motors, Ford Motor Company, and Renault of France—all of which have forged alliances with Asian manufacturers. According to the *Financial Times*, DaimlerChrysler aims to use these agreements to lift Asian sales from a modest 3.5 percent to 25 percent of its turnover in the medium term.

General Motors has secured stakes in Suzuki, Isuzu, and Fuji Heavy Industries, which makes Subaru cars. Ford had already 33 percent of Mazda and recently won the bid over General Motors and DaimlerChrysler to buy Daewoo and Ssangyong. Renault acquired a 36.8 percent stake in Nissan Motors in 1999. Volkswagen, unlike other manufacturers, is aiming to increase its presence to double-digit market share through locally produced own models. Volkswagen defends its strategy by pointing to its Chinese track record, where it has close to 50 percent market share. Toyota and Honda, the region's two leading carmakers, have shown no interest in establishing relationships with Western automakers that go beyond technical cooperation.

Despite this frenzy of investment in the region, the payoffs may still be far off in the future. Besides the fact that volumes are still small in most of the countries and the market is highly fragmented, there is a major cost driver: overcapacity. Excess capacity is a severe market destabilizer that burdens vehicle manufacturing cost and hurts the profitability of automaker operations. The Asian and Pacific market is a major contributor to global excess capacity. According to PriceWaterhouseCoopers (2000b), overall utilization in the broader Asian and Pacific market is in the 65 to 75 percent range, well below utilization rates in Western Europe and North America. Moreover, it will take some time for the market to grow into its present capacity. For example, Jamey Power, head of international operations for J. D. Power and Associates, claims that it will be five to 10 years before DaimlerChrysler and Mitsubishi earn a profit in PRC and India (*USA Today* 2000).

The interest in the Asian market is not only at the OEM level. Suppliers are also entering the region in great strength. On one hand, as foreign automakers establish new operations in Asia, they invite their suppliers in other regions of the globe to join in, particularly system integrators, with sensitive responsibilities in the design and manufacturing of the car. On the other hand, mergers and acquisitions between Western and Japanese or Korean automakers are breaking the traditional parochialism of the Asian supply chain. As OEMs integrate operations, bidding of new components is becoming open to suppliers outside the Japanese *keiretsu* or the Korean *chaebol*.

The influx of foreign players into the Asian market is facilitated by the depleted financial condition of local suppliers. The demand crunch followed by huge interest rates severely hurt local firms, most of them without operations outside Asia to compensate for the negative impact of the regional crisis. Some analysts claim that this situation is spurring a much-needed wave of consolidation between firms, most of them with subeconomical production scales. Nevertheless, while this will certainly have positive effects in the industry, resource constraints prevent the companies to withstand the outlays on product development and new technology that automakers are demanding.

Participation of Western OEMs and suppliers in the Asian market is expected to continue, and will have far-reaching effects in the structure of the industry. This overall trend is well illustrated the recent figures in the volume of mergers and acquisitions involving the region. The transaction value of disclosed equity deals in the auto sector involving Asia jumped from less than 1.5 percent of the world activity in 1998 to 13 percent in 1999 (PriceWaterhouseCoopers 1999, 2000). This volume of deal activity is expected to continue or even increase in the next years.

B. Major Trends in Regions and Countries

1. India

With a population of one billion, India is one of the most attractive future markets for the auto industry. Nevertheless, due to the very low incomes of the population, the number of passenger cars sold in the country is only 600,000 units a year. Moreover, new vehicle sales in India are unlikely to exceed 2 million units a year by 2010, meaning that the market will be smaller than in France or the UK nowadays. The Indian market is also very protected from foreign participation. Like most Asian countries, the government has considered the automotive industry a key sector for the development of the country. Therefore, it enacted industrial policies that include high tariffs, severe restrictions to vehicle and components imports, as well as limits to foreign investment. Small size and strong protection have kept foreign OEMs at large, which have overlooked investment in the region.

In the absence of strong foreign competitors, the local car manufacturer Maruti Udyog has dominated the Indian market in all segments. Sales in 1999 achieved the record level of 385,000, corresponding almost to a 60 percent market share (*The Indu* 2000). At the very bottom end of the market, there is little alternative to Maruti, and the low cost Maruti 800 is ubiquitous on India's roads. However, in higher segments of the market, Maruti is now facing some competition from foreign carmakers. Some interest in the local market, more possibilities for the participation of foreigners in the economy, but the same restrictions to car imports, is summoning the world players into India.

Ford entered the mid-range market with the Ikon model and quickly boosted sales from a paltry 180 for the month of April 1998 to 1,600 in April of this year. Like Ford, Honda has also made inroads in the mid-range market with its City, selling about 9,500 units in 2000. Mitsubishi, Hyundai, and Daewoo have also started to produce vehicles locally. Both firms have successfully positioned their models between the mid-range Ford Ikon and the bottom-end Maruti 800. As a result of these new investments, Maruti's market share has fallen to 56 percent in April 2000, down from 76 percent in the same month last year. In the same period, Hyundai raised its share to 14 percent from 8.3 percent, Telco to nearly 10 percent from 4 percent and Daewoo to 9.5 percent from 2.3 percent (*Financial Times* 14 June 2000, *The Indu* 2000).

Nevertheless, the surge in investment has also led to a mounting problem of overcapacity. Estimates suggest that installed capacity may be about 3 times larger than that required (IndiaInfonline.com 2000), mostly due to too many assemblers, currently 24. This will lead to an inevitable shakeout in the industry, with mergers and acquisitions between automakers and the closure of some of the production units. But some automakers are countering the overcapacity problem by looking at India as a basis of regional sourcing, rather than a destination market. Daweoo is among the leaders in this strategy. Its car factory in Surajpur includes facilities to make 300,000 engines and transmissions each, as well as press and aluminum die-casting. More than half of the production is to be exported.

Unfortunately, the example of Daweoo is still quite singular. The overall automotive components sector is highly fragmented and has important quality problems. Over 300 small and medium companies service directly the 24 companies assembling vehicles in the country, with as much as 5,000 other micro firms working for the first tier suppliers and for the replacement market. Mostly due to regulation, component import dependence is also small, with 87 percent of the domestic demand satisfied by local firms. Despite these levels of localization, the industry is quite small by international standards. Sales in 1999 were below US$3 billion, with 10 percent of this value corresponding to exports (IndiaInfoline.com 2000). This volume of sales is roughly equivalent to the Portuguese autoparts industry, a country that assembles less than half the number of vehicles of India, but where the 150 local firms export 60 percent of the production (Veloso et al. 2000).

Small capacity and a large model variety are particularly harmful for suppliers. Estimates suggest that Indian facilities producing at optimal scales may enjoy a cost advantage of 10 to 30 percent over competitors in other regions of Asia, largely due to cheap labor and lower overheads. Nevertheless, these cost advantages are mitigated by lack of volume and low productivity. A poor quality record, with client rejects in the order of 2900 parts per million (ppm), ten times the world class level of 240, is likewise a source of concern. Given this context, it is not surprising to find most foreign automakers to be unsatisfied with Indian component manufacturers, stating that they would rather prefer free imports (IndiaInfoline.com 2000).

Like the overall market, the supplier situation is rapidly evolving. Despite a slowdown in 1998 and 1999, the domestic production of components registered a compound growth rate (CAGR) of almost 20 percent between 1994 and 1999, and sales are expected to grow at least at the same speed in the next years and exports even faster. Like Daewoo, Visteon has announced that it will source components from India to its global operations. Other foreign companies are following. The leading local firms have established over 200 technical cooperation agreements with foreign firms to be able to reach international standards in cost and manufacturing. As a result of this effort, the industry aims to reach US$1 billion in exports by 2002, a very ambitious objective (IndiaInfoline.com 2000). But the industry has little alternative. As the WTO guidelines enter into force in 2001 and imports are liberalized, local firms either begin to compete in equal footing with foreigners or face leaving the business.

2. People's Republic of China

In 1999, the PRC produced 1.7 million cars and trucks, 3 million agricultural vehicles, and 8.3 million motorcycles. By 2010, domestic production may reach 5 million units (not including motorcycles) making the PRC one of the world's largest automobile markets. The industry is made up of 120 complete vehicle manufacturers, 780 refitted and special-purpose vehicle manufacturers, and over 1,800 auto parts and components enterprises, 149 of which are joint ventures. Altogether, these firms employ 1.85 million workers. The total industrial output value in 1999 was US$40 billion, a 16 percent increase over 1998 figures and total profit and tax was US$1.1 billion, a 50 percent increase compared with 1998. While there are a large number of players in the industry, production is dominated by three large firms (CNAC 2000).

The FAW (Group) Corp. is the first large-scale motor vehicle production base in the PRC, having an agreement with Volkswagen to produce the Jetta and Audi sedans. In 1999, the total motor vehicle output of the Group was 342,000, ranking first in the automotive industry in the PRC. The second large group is Dong Feng Motor Corporation (DMC). DMC has three major production bases that form the Hubei automotive industry corridor. In 1999, the number of total vehicles produced was 257,000, with production mainly focusing on heavy-duty, medium-sized, and light-duty trucks. It also has a joint investment with French Citroen to produce Fukang sedans. The third group, Shanghai, began its production of cars in the 1960s but in a small scale. In the 1980s, it made a joint investment with Volkswagen to produce Santana sedans, which gave it a strong push forward. By 1999, its capacity had reached 257,000 vehicles, with its profit exceeding the sum of other automakers' profits. Part of the 1999 output also includes Buick Century sedans, which come off its recent joint venture with GM, targeting to produce 100,000 cars a year (CNAC 2000).

The PRC government gives high priority to developing a competitive indigenous auto industry. Present central government policies vigorously protect Chinese manufacturers from foreign competition. The PRC's current tariff and quota policies mean that legally imported cars are not a threat to the domestic auto industry, accounting for less than 3.5 percent of the domestic market in 1998. But these barriers have contributed to illegal imports. It is estimated that 100,000 cars are smuggled into the PRC annually and that 90 percent of these are sedans. Vehicle joint ventures are limited to a maximum of 50 percent foreign ownership and are generally limited to a single product line. Local content regulations require at least 40 percent local content for sedans and 50 percent for commercial vehicles. Moreover, sedan manufacturers must use 60 percent local content in the second year and 80 percent in the third year. In addition, joint ventures are also pressed to accept parts produced by subsidiaries of their partners, often at higher cost and/or lower quality.

Recently, central leadership is aiming to consolidate, rationalize, and develop the much fragmented auto sector and nurture a few globally competitive vehicle manufacturers. China currently has more than 120 vehicle automakers, most of them producing less than 15,000 units. Its production capacity is 2.5 million units, compared to the present market demand of 1.7 million

units. To avoid further excess capacity and strengthen the existing players, the government has not approved any new major vehicle programs since the Shanghai-GM partnership. Moreover, it has announced that during the Tenth Five-Year Plan (2001-2005), the state will not establish new sedan-manufacturing facilities. Instead, the PRC's auto industry officials aim at gradually concentrating on developing its three major auto groups, Shanghai, FAW, and DMC (December 28 China Information, reported in ChinaOnline.com).

Compared to its advanced international competitors, the PRC's auto industry is underdeveloped technically and managerially. Therefore, making it internationally competitive will be a major challenge. The labor productivity of the PRC's automakers is also only one eighteenth that of Japanese automakers. Moreover, because most automakers are small and do not perform R&D, their technological capabilities are limited. Even the large automotive groups must have the cooperation of foreign partners to develop new cars. The PRC is now adopting policies and measures to further promote product development capabilities through existing joint ventures. Nevertheless, any results are still far in the future.

Like the assembler industry, the auto components industry is also very fragmented. In 1998 there were 1,628 enterprises, employing 760,000 workers. The gross industrial output of the industry was US$6.9 billion, with a profit of US$335 million. The export value of auto parts and components reached US$490 million, accounting for 40 percent of total export value of automotive products (CNAC 2000). The industry has come a long way since the government started a component localization policy in the early 1980s. But the overall situation is still market marked by dispersion, disorder, and high costs.

The problems faced by the Shanghai-GM joint venture are a good example of the present conditions. This year, following government requirements, 60 percent of the parts for the Buicks produced at the plant must come from domestic suppliers. But there are several problems in trying to achieve these goals. Domestic components are estimated to be 20 percent more expensive than imports and the technology is not up to international standards. In order to produce many of the car's high tech components locally, Chinese parts manufacturers must import technology and equipment, at great expense. But because the scale of production is small, cheaper labor does not give Chinese parts makers a competitive advantage on the international market. In addition, many components use foreign technologies for which Shanghai-GM must pay royalties, further increasing the cost of Buicks (*China Automotive News* 29 April 1999).

Since the ninth Five Year Development Plan (1996-2000), four categories have been considered a priority for the development of the automotive components industry. The four categories are engine parts, chassis and related parts, auto electrical appliances, and other components. In addition, there are 25 products in which the government encourages overseas investment and joint ventures. This is one of the steps toward preparing the industry to the accession of the PRC to the WTO, which is expected to have an important impact on the country's automotive sector. The trade barriers will be reduced, tariff lowered, import permit and quota eliminated, service trade set up, and foreign firms will be allowed to open business in sale, service, financing, leasing, and transport of motor vehicles. All these will enable the domestic automotive

market to gradually gear into the track of the international automotive market on one hand, but will also make Chinese automotive enterprises face direct competition in a global scope on the other hand.

3. Republic of Korea

In 1997, Korean automobile production accounted for about 10 percent of total manufacturing production and 3.7 percent of GDP, employing 358,000 persons. During the previous 17 years from 1980 to 1997, the automobile industry grew five times as fast as GDP. But in 1997 and 1998, the economy was strongly affected the Asian financial crisis. Slumping demand at home and poor exports brought automakers' capacity utilization rate down to nearly 40 percent, while some parts makers went bankrupt. The economic downturn spurred a radical transformation of the sector.

Before the crisis, Korea was home to five car makers: Hyundai, Daewoo, Kia, Ssangyong, and Samsung, which together annually sold 1.7 million passenger cars in the domestic market and another 1.3 million vehicles overseas. Today, no independent manufacturer remains. The drop in demand that drove domestic car sales down to less than 780,000 in 1998 left the local OEMs facing crushing debt loads, a massive overcapacity, and an ever more competitive global market. As a result, a dramatic process of mergers has been taking place.

First Hyundai took over Kia, while Daewoo absorbed Ssangyong Motor. Then in 2000, the French automaker Renault purchased Samsung Motors, the first buyout of a local automobile producer by a foreign company. This year, Daewoo/Ssangyong was put on sale due to major financial problems. Although the agreement is still not final, Ford is seen to have won the bid over General Motors and DaimlerChrysler. Finally, DaimlerChrysler and Hyundai Motor Company have agreed to form an alliance under which DaimlerChrysler will acquire a 10 percent stake in Hyundai.

Hyundai currently has about 45 percent of the domestic market while Kia has some 25 percent, making the combination the dominant force in the Korean car industry. Within the Hyundai-Kia agreement, the latter continued making and selling its own marques. But the two Korean firms consolidated their research and development organizations and were slashing the number of manufacturing platforms from 23 to 7 (Asiaweek.com 18 June 1999). Under the new agreement, DaimlerChrysler, Hyundai Motor Company, and Mitsubishi Motor Company will develop and produce a range of world-class, high-quality small cars to compete in key global markets. Hyundai will also spin off its commercial vehicle division to be operated as a 50-50 joint venture with DaimlerChrysler. Renault, Nissan, and Samsung are pursuing a similar strategy, aiming to increase the volume of Samsung's brand from a paltry 5,000 in 1999 to 400,000 by 2005.

The Asian crisis has seen a quick turnaround, and exports are on the rise. Given the important presence of Korean brands in Asia, the prospects for assembly growth over the next decade are extremely positive, particularly because the alignment with global players will enable

more resources and upgraded technology. In the first six months of 2000, Korean production swelled another 24.5 percent growth, after a 41 percent increase in 1999, where it reached 2.85 million vehicles, of which 1.5 million were exported (KAICA 2000). The growth trend is expected to continue in the next years, although not with the same vigor.

According to trade data from the KAICA, 1,339 Korean companies supplied automotive parts and accessories to seven Korean motor vehicle manufacturers and two major service companies affiliated with Hyundai Motor and Kia Motors. Domestic production of automotive parts and accessories was approximately US$18.9 billion in 1998, with US$1.2 billion in exports. Because local players dominate the domestic OEM market, sourcing has mostly been done locally. Korean production accounts for roughly 94 percent of the automotive parts and accessories market. However, the Korean automobile industry still depends largely on foreign suppliers for important components and parts, such as transmissions, engine parts, body parts, and brake parts.

Since the 1980s, OEMs and local component suppliers have been working together to improve quality and productivity in the Korean autoparts industry. Great progress has been made and Korea has pulled well ahead of other developing nations (together with Taipei,China) in these areas (McKinsey 1999, chapter 9). Korean auto parts and components have earned some reputation for quality and competitiveness in the world market. Nevertheless, they are still behind world standards. Moreover, because the automotive parts industry is playing a more important role in the development of cars, there needs to be further effort in research and development. The participation of foreign players in the assembler industry is expected to have a very positive contribution to this effort.

4. Association of Southeast Asian Nations (ASEAN)

Like the rest of Asia, the ASEAN automotive sector is now bouncing back from the devastating economic crisis of 1997/1998, that crippled the region's automotive industry. In the four largest ASEAN markets—Indonesia, Malaysia, Philippines, Thailand—total vehicle sales dropped from nearly 1.5 million units in 1996 to about 450,000 units in 1998, a 63 percent drop. Sales in the ASEAN region recovered strongly in 1999, totaling about 550,000 units. Average annual growth to 2005 is forecast at 16 percent, led by commercial vehicles with average growth of more than 19 percent each year. Nevertheless, recovery to 1996 levels is generally not expected until 2004 (Supplier Group 1999).

In Thailand, the recovery in vehicle demand started in the second half of 1999. In the first half of 2000 vehicle demand increased by 43 percent over the same period in 1999. For the whole of 2000, total vehicle demand is projected to be over 270,000 units, an increase of 24 percent over the 1999 level. Likewise, the Malaysian vehicle market has equally been recovering. Total vehicle demand is expected to grow by 19 percent to just over 340,000 units. Vietnam is also experiencing strong growth in vehicle sales, particularly domestic sales.

Indonesia was the hardest hit in 1998 with political and social upheaval adding to its economic difficulties. Nevertheless, despite ongoing political instability, total vehicle sales rose

by 455 percent in the first half of 2000 to just below 127,000 units from under 23,000 units in the same period in 1999. In the medium term, the industry's evolution will depend much on the political situation. Political instability and some stock market events have probably been responsible for the Philippines's lag in entering the recovery phase that has been observed in most of the ASEAN countries (figures based on DRI 2000).

Malaysian models hold the top three positions in the ASEAN car market, almost entirely due to their strong dominance of the car market in Malaysia. The Isuzu pickup and the Toyota Hilux pickup, both built in Thailand, lead the ASEAN commercial vehicle market, followed by the Toyota Kijang, the largest-volume vehicle in Indonesia, and the Daihatsu Terios. Apart from the Malaysian manufacturers, only three non-Japanese cars—BMW 3-series, Kia Sephia and Hyundai Accent/Excel—have been represented in the top 20 selling models in the ASEAN region. In terms of market share, Malaysia's Proton has a commanding 26 percent, followed by Toyota (22 percent) and Perodua (13 percent) in the top three positions. Next come Isuzu (9 percent), Mitsubishi (8 percent), Honda (6 percent), and Nissan (5 percent). These figures reflect the slowness of the European and US manufacturers to take up the challenge of the region, a situation that is now changing with increasing output in the Thai plants of Ford/Mazda and GM (DRI 2000).

The automotive sector is a scale-intensive industry and none of the ASEAN economies is large enough for an automotive company. Even though vehicle sales in the region increased from 300,000 units in 1986 to about 1.5 million in 1996, individual markers ranged from 160,000 units in the Philippines to 590,000 units in Thailand, figures hardly sufficient for two to three efficient plants. The problem is that, due to the restrictive policies that all the members of the region have, very little was exported among ASEAN markets. The same held true for components, whose circulation among countries was limited by local content rules. Therefore, most of the assembly units have not been competitive on an international level.

Automotive giants, when they size up the region, would like to look at it as one market and not on a per country basis. When one of them invests in any country in the region, the viability of the venture is hinged on access to neighboring markets. This integration is now being considered through AFTA, the ASEAN free trade agreement scheduled to take effect in January 2003. If AFTA goes ahead, member economies commit to limit tariffs in parts and vehicles to a ceiling of 5 percent among signatories. This integration will make the region much more attractive for global investors. It will lower manufacturing costs and maximize available facilities and resources by increasing the scale of production and promoting competition. Existing investments are counting on AFTA to take place. GM plans to export 90 percent of the production of its new Thai plant. Likewise, the Ford plant, currently making several models at suboptimal efficiency, has been designed to rapidly convert to making one model highly efficiently for export across the region. BMW has a considered similar perspective.

But the ability of ASEAN members to honor AFTA commitments is doubtful as they commence to adopt nationalistic policies to facilitate recovery from the Asian economic meltdown.

Malaysia announced that it could not meet the previously agreed deadline to slash tariffs on motor vehicle parts. It obtained an extension of 2 years to liberalize the industry, i.e., January 2005. Malaysia is at the extreme in terms of creating a protective environment to the local industry. Its strategy has been to foster the development of its national car brands, Proton and Perodua, in which the government has poured millions of dollars. At present, due to restrictive import policies, the car plants of the national manufacturers enjoy the best scale economies in the region and export a significant share of their production throughout the region. The country is aiming to become a significant production center for passenger cars in the region. But to achieve this goal, the local OEMs and their suppliers have to overcome the big challenge of producing their own models, instead of reengineered Mitsubishi cars, a very difficult endeavor in today's industry context.

Within ASEAN, Thailand is on the opposite extreme to Malaysia, being the first country in the region to open its doors to the world's biggest automakers. Since January, carmakers in Thailand have been freed of a requirement to buy at least 54 percent of their parts locally. Now they can import from the lowest-cost, highest-quality, most-innovative producers anywhere in the world. The aim of the government is to make the country a regional export platform for all major OEMs, spurring the industry growth. But with local-content requirements lifted, multinationals plan to obtain parts globally, meaning they will buy far less from domestic suppliers. The switch is likely to become apparent when they place orders in 2002 for new models to be unveiled in 2002. General Motors plans to import nearly 85 percent of its parts, while DaimlerChrysler and BMW, newcomers to Thailand, will also import most of the parts for their luxury models, industry analysts claim. This is the potential downside of the laissez-faire strategy.

Emerging or less competitive local firms will face a crunch, as they can no longer operate under protective governmental policies. With the expertise, experience, brand acceptance, and economies of scale that the larger and more established players enjoy, the smaller or less competitive players may face depletion in market share and eventually bankruptcy. A July report by the German Technical Cooperation Agency shows that of about 500 car parts makers in Thailand, nearly 300 are Thai-owned, and nearly all 300 risk going under. Last year, a study by the Federation of Automobile and Parts Industries of Thailand produced similar findings, claiming that up to 30,000 Thai jobs were at stake. A 1998 study of the industry by Thailand's Productivity Institute found "inconsistent quality, high costs of production, deviation from delivery schedules and unresponsiveness to sophisticated production technology. According to industry analysts, the message to Thai car-parts makers is clear: Either find a technologically fit partner, or perish. But, so far, few are facing up to that hard fact" (Crispin 2000).

The rest of the ASEAN economies are facing challenges that often larger than those faced by Thailand. Because of smaller scales and unused capacity in Viet Nam or the Philippines, the ability to develop local firms to compete in the regional market will be even more difficult. Finding the balance among all the countries will be hard, but it is the only solution for the development of the regional automotive industry.

5. Taipei,China

Taipei,China is currently home to 13 automobile manufacturers, the majority of which have contractual joint ventures with foreign makers, mostly from Japan. These companies both produce and import automobiles. The production value of the automotive industry reached close to US$10 billion in 1998, the equivalent of 5 percent of Taipei,China's aggregate manufacturing production value of that year. Approximately 402,000 automobiles were produced in Taipei,China in 1998. During that year, despite the threats by imports from Japan and the US, the domestic automobile industry still managed to capture around 84 percent of the market, proving that local consumers had accepted the quality of the local automobile producers.

Over 70 percent of the 292,000 domestically made sedans were supplied by three companies: Ford Lio Ho Motor Co., Ltd. (20.3 percent), Yulon Motor Co., Ltd. (28.6 percent), and Kuozui Motors Ltd. (22.4 percent). In the commercial vehicle market, China Motor Corporation maintained its traditional top position, producing over 50 percent of the 115,700 commercial vehicles sold. Although Taipei,China imposes a quota on autos imported directly from Japan, Japanese vehicles have, like many other commercial products, successfully penetrated the Taipei,China market and built a solid customer base. In 1998, nearly a quarter of the imported vans were Japanese brands that had been made in American factories. Of the top ten best sellers in the Taipei,China market, all were either products of Sino-Japanese joint ventures, or directly carried Japanese brand names.

The Taipei,China autoparts industry has expanded tremendously over the last two decades. At present, there are about 400 suppliers of OEM products to auto makers, and an additional 2,000 second and third tier suppliers and aftermarket service providers, with a total workforce of 70,000 employees. Capitalization in 1998 was roughly US$5 billion, with sales on the order of US$4.2 billion and exports exceeding US$2.1 billion. The Taipei,China components sector, like the Korean, is the more advanced one in Asia (outside Japan). It has established a solid export market, the largest in the region and twice that of Korea. The components have a reputation for quality, being extensively used in the replacement market across the world, particularly in Japan and the US.

Like many other domestic industries, Taipei,China's automobile industry is short on R&D when compared to its Western counterparts. It needs to develop its own technology in engines, computerized gearing systems, and several other components, and enhance its design capability. For example, Taipei,China's reliance on foreign engines has for years hampered its plans to export vehicles. In preparation for the impact that Taipei,China's admission to the WTO will have on the island's automobile industry, the Ministry of Economic Affairs has allocated important budget resources to encourage R&D. Under the joint efforts of the MOEA, the Chungshan Institute of Science and Technology, and the private sector, the government aims at upgrading local automobile manufacturers' capabilities to produce key parts, such as engines and airbags, which would otherwise have to be imported from Japan.

VI. Understanding Automotive Supplier Performance

A. Focus of the Study

A study of the automotive industry in Asia should primarily focus on evaluating the capabilities of the local components firms and identifying future development paths for these firms. With OEMs increasingly dominated by multinationals, and relying more heavily on their suppliers for engineering and manufacturing, the development of the auto sector in any of the countries of the region will primarily depend on the strength of the local supply chain. Therefore, it is crucial to promote a good understanding of the Asian auto components sector and to derive appropriate policies for its development.

The major characteristics of the industry described in previous sections show how the automotive industry at the OEM level is dominated by a small number of global firms. Technological requirements, platform strategies, and the need to establish a global presence have led to a wave of consolidation in the industry, a trend that is likely to continue in the next decade. This path is having a major impact in the Asian market. Japanese firms have traditionally dominated the regional market, either directly or through partners that local governments imposed. But now this situation is changing, with some of the Japanese firms signing agreements or selling part of their equity to the major players in America and Europe and a wave of direct investment of these foreign players in the region.

For several decades, most Asian nations outside Japan have tried to launch car programs that would enable them to have a national flag vehicle. The most successful so far has been Korea, which was able to position its cars in the world market. Despite this success, the new requirements of the industry and the financial crisis that hit the regional market left the local firms in a fragile financial situation, ultimately leading to a full sale or, in the case of Hyundai, a partnership with partial equity sale. While PRC, India, and Malaysia continue to press on the development of national carmakers, their success is extremely uncertain and the likelihood that these firms end in one of the international OEM alignments is very high.

Whether successful or not, the outcome of these national efforts depends chiefly on complex negotiations between the key players, both at firm and political levels. The role of technical capabilities is likely to be a secondary one. As a result, any in-depth analysis of the capabilities of Asian OEM will provide limited information as to their future viability as internationally competitive firms. Nevertheless, OEMs are important players in the industry and their strategy conditions the whole auto supply chain. The components sector, in particular, is highly influenced by the strategies of the assemblers. Therefore, a study of the Asian auto industry should definitely provide a good understanding the development strategies these firms are pursuing, but not a thorough evaluation of their capabilities. The focus should be on where OEMs are going and how they perceive the future requirements of the components firms in the region. Direct consultation with top managers in some companies is probably the best way to gather firsthand opinions.

The evolution of the auto industry in the Asian region will mostly depend on the development of the autoparts sector. The OEM trend to increase outsourcing means that location decisions will be conditioned by the availability of local suppliers of low-cost quality parts, which are also able to take responsibility for development. Therefore, upgrading the local autoparts industry should be at the core of the policy of any of the Asian governments. This is precisely the reason why the proposed study should focus on evaluating the capabilities of the local firms and identifying future development paths in the region. The analysis may have two levels: first tier suppliers / integrators and component suppliers.

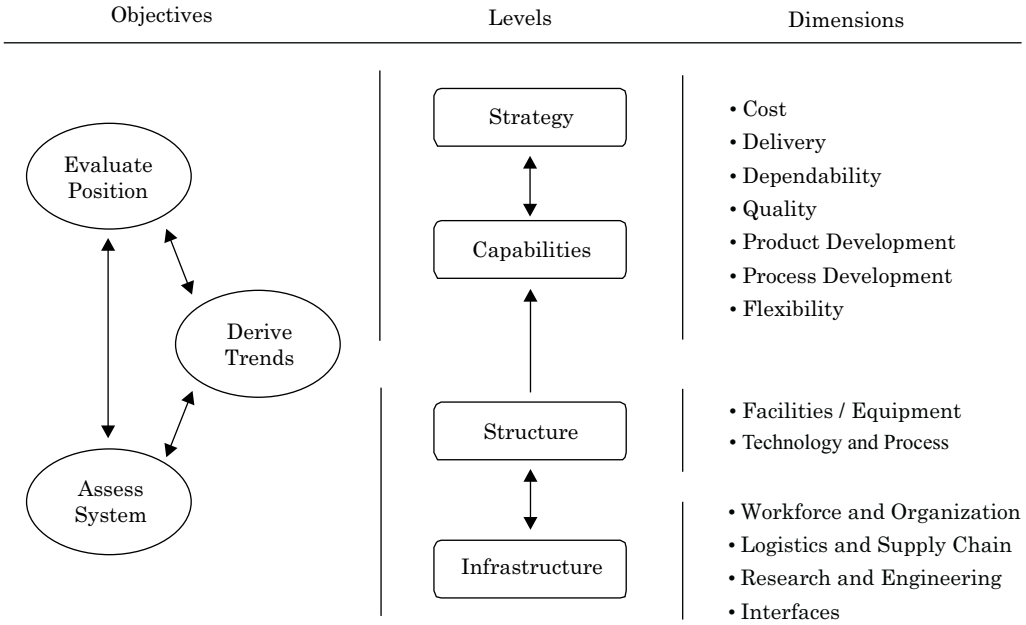
As described in previous sections, large suppliers are responsible for the design and manufacturing of whole modules or systems of the car. Like the OEMs, these are becoming global firms that work worldwide with the automakers. Short on cash and lagging on technology, few Asian firms outside Japan will be able to compete at this level. Nevertheless, it is possible that some firms in each of the countries may are able to remain at a first tier, even as the markets open up. Identifying these firms and the mechanisms that could prompt them to become competitive suppliers around the globe should be part of the project objectives.

At another level it will be important to diagnose the capabilities of the smaller component suppliers. An influx of foreign system integrators that come to work with the OEMs may have a very positive impact in the region. As they focus more on integration, they subcontract important manufacturing and design activities. But a substantial share of the suppliers in the Asian countries is still far behind world requirements, particularly when compared to European, Japanese, or North American firms. Those that are prepared may enjoy substantial growth and those that are not should be the object of coherent development policies. A thorough focus of the project at this level can be very interesting for the regional industry. It would enable a clear understanding of the existing capabilities of the supplier industry and an evaluation of paths to foster the upgrading of the industry, helping it to become a stronghold of development in Asia.

B. Evaluating Manufacturing Excellence

Manufacturing companies compete on a set of dimensions that are well understood and characterized in business and industrial engineering literature. Some of the critical ones are cost (price), logistics, quality, flexibility, and development. Depending on the positioning strategy toward their clients, firms will place more or less emphasis on each of these capabilities, and organize their internal structure and infrastructure to better respond to the chosen strategy. It is certainly different to be a supplier of generic injection molded parts for multiple clients or the manufacturer of complete steering columns. Therefore, research should cover a clear identification of the position of the companies in the automotive market, the strategy they wish to pursue, as well as their perception on relative strengths and weaknesses in the face of the chosen path. Figure 16 highlights the set of aspects that can be considered when analyzing the capabilities of manufacturing firms.

Figure 16: **A Model for Assessing Manufacturing Capabilities**



The set of strategic positioning factors of a company is supported by capabilities that can be assessed. The analysis of manufacturing capabilities may involve indicators related to quality, responsiveness, and development. Automakers have a common set of business and technology practices and have been converging in their requirements toward their suppliers. Therefore, competing in the auto supply industry creates similar types of requirements for the companies. This enables a comparison of a set of performance indicators across companies, even if they are producing technologies as diverse as plastics and metal stampings.

Quality and Logistics are two of the dimensions that automakers consider to be crucial when assessing suppliers. The evaluation of quality begins with systems certification. Ever since the development of QS9000, the auto industry version of ISO9000, automakers are considering it as a necessary condition for a supplier to bid for a part. But the capability of the firm in terms of quality is often evaluated through two indicators, client rejects and rework. Although the levels of these indicators vary from process to process, world class levels are considered to be in the order of 200 ppm and 1.2 percent, respectively. Other indicators such as internal rejects or scrap have also been considered.

In the just-in-time world of today's auto industry, that is expected to become even more so with the advent of the Internet, logistics capabilities are a major concern. There are a number of issues that OEMs value in terms of logistics and it is not uncommon for suppliers to face dozens of questions regarding their logistics systems. Two indicators, nevertheless, have become ubiquitous in the auto industry: order lead time (the time between final order and delivery at the client)

and on-time delivery. While some first tier suppliers located in the same industrial park as the OEM are now receiving orders for the final assembly within a few hours of delivery, the pressure for fast response is widespread throughout the supply chain. World-class response is associated to a lead time on the order of a day. Expectation for on-time delivery is between 98.5 and 100 percent, depending on the responsibility of the supplier.

The indicators mentioned above are clearly some of the most valued by the client. Nevertheless, they are often looked at as requirements that a potential supplier has to fulfill, rather than true measures of their ability. As mentioned earlier, the true benchmark that OEMs used to decide among suppliers is cost. Potential suppliers are invited to bid and the cost competition is severe. Another aspect that is increasingly relevant to assess supplier capabilities is development capability, which will be dealt with separately in the next section.

The indicators mentioned in the previous paragraphs are all dimensions of manufacturing capabilities. These dimensions are supported by a set of enabling factors that form the structure and the infrastructure of the company. As presented in the figure above, these include human resources, operations, and supply chain management, among others. Evaluating company systems is a very complex task, which usually requires an in-depth analysis. Moreover, outstanding firm capabilities are usually the result of a combination of unique characteristics, which are difficult to systematize. This task becomes particularly difficult if one is evaluating a whole sector instead of an individual company. Nevertheless, there are certain aspects that, while not revealing the true nature of firm or sector competitiveness, can help identify issues that hamper or foster their development. The literature developed throughout the 1990s, particularly on lean production, has established several aspects of the plant to be crucial for firm performance.

Worker characteristics and practices is certainly a key aspect. For example, a recent study of the competitiveness of the autoparts industry in Portugal has revealed that firms with better quality and logistics records employ more workers who completed high school and give them more empowerment, including involvement in problem solving activities and self-management teams. Another aspect is the adoption of productivity and management tools. The use of tools such as Statistical Process Control, MRP, Kanban, or Quality Function Deployment is known to have an impact on operations and it are certainly aspects that can be tracked down. A new area that is becoming under stricter scrutiny is the ability of the company information systems to cope with the need to access, manipulate, and provide information over the Internet.

Enabling indicators such as inventory levels, lot size, and number of suppliers may also provide valuable information regarding company performance. One other dimension that is also used to assess the characteristics of a company is its interface with environment. Cooperation agreements among companies, or with universities and research institutes are a good indication of the ability of the firm to interact and learn from its business environment.

C. Analyzing Innovation Capabilities

During recent years, development capability emerged as the critical issue differentiating supplier roles. Product proliferation and the incorporation of more technology in the car generated the need to disperse development effort throughout the supply chain. As a result, OEMs and first tier suppliers make a detailed assessment of the development responsibilities that smaller suppliers are capable of accepting. This means that they inquire the supplier on aspects such as the number and qualification of the workers involved in development, the number of CAD stations and their software, the characteristics of the testing and prototyping facilities, as well as the knowledge of design methods and tools (e.g., FMEA, DFA, QFD). Collaboration with outside organizations in technology sourcing is also valued by OEMs.

But the aspects highlighted above are only inputs or enablers of the development process. They do not guarantee that the firm will be able to materialize them in designs and engineering work. Therefore, automakers place particular value in the record of supplier involvement in product development. This includes the characteristics of the products in which the company has had a development role, as well as any registered designs and patents. Albeit important, this task of measuring the suppliers' development record is difficult, particular in smaller firms. Traditionally the magnitude of the companies' expense in research and development has been used to assess their commitment to the generation of new knowledge. But while this indicator may be adequate for large organizations with formalized departments devoted to research and development, it is not so adequate to measure the same effort in small companies with activities that are often not research, but do involve relevant levels of development.

To address this problem, a recent study of the Portuguese autoparts industry used the number of engineering hours associated with the development of each of the products as a proxy for firm development capability. This is an indicator that is better understood by managers in the company and easier to quantify than expenses in R&D. Moreover, it provides a good notion of the level of complexity of the product in which the company is involved.

Table 5 describes several types of products in terms of the engineering effort associated with each of them, both in terms of time and resources. As we can see, developing a high-end screwdriver is a rather simple task, which occupies two persons for part of their time during a year, involving less than 2,000 hours of engineering. A product like a pair of rollerblades or a custom microfilm case requires engineering ranging from 8,000 to 15,000 hours. The same happens if we move up the scale of complexity toward something like a jet printer or even a car. While these values are merely indicative, they provide a reasonable notion of the several levels of engineering complexity that the company can tackle.

Table 5: **Product Complexity and Development Effort**

	Jobmaster Screwdriver	Rollerblades	Microfilm Case	DeskJet Printer	Mid-Size Car
Number of Unique Parts	3	35	35	200	10,000
Development Time	1 year	2 year	1 year	1.5 years	3.5 years
Size of Team for Development	2 people	3 people	10 people	65 people	500 people
Engineering Hours	1800 h	8500 h	14000 h	14000 h	2.5 million h
Development Cost	$150,000	$750,000	$1.5 million	$50 million	$1 billion

Source: Ulrich and Eppinger (1995).

To understand how firms rank in development capabilities, levels of complexity in terms of product and process development can be used (disregarding products like a whole car). For example, one can consider:

(i) Simple products: Total of 1,500 hours of engineering
(ii) Fair complexity product: Total of 8,000 hours of engineering
(iii) Average complexity product: Total of 20,000 hours of engineering
(iv) Very complex product: Total of 150,000 hours of engineering

This indicator, together with information on the systems and development practices, including cooperative efforts may provide very important insights in what concerns the development and innovation capabilities of the Asian suppliers and provide valuable information to trace meaningful development paths.

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