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Technological Change in the Indian Passenger Car Industry

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The Energy Technology Innovation Project

The overarching objective of the **Energy Technology Innovation Project** (ETIP) is to determine and then seek to promote adoption of effective strategies for developing and deploying cleaner and more efficient energy technologies in three of the biggest energy-consuming countries in the world: **China**, **India**, and the **United States**. These three countries have enormous influence on local, regional, and global environmental conditions through their energy production and consumption.

ETIP researchers seek to identify and promote strategies that these countries can pursue, separately and collaboratively, for accelerating the development and deployment of advanced energy options that can reduce conventional air pollution, minimize future greenhouse-gas emissions, reduce dependence on oil, facilitate poverty alleviation, and promote economic development. ETIP's focus on three crucial countries rather than only one not only multiplies directly our leverage on the world scale and facilitates the pursuit of cooperative efforts, but also allows for the development of new insights from comparisons and contrasts among conditions and strategies in the three cases.

Acknowledgements

This paper draws upon discussions and interviews with a large number of experts—too numerous to name individually here—from various Indian automobile firms, government agencies, and other organizations who freely shared information as well as their views and insights on the Indian automobile industry. We are grateful to all of them. Of course, the final responsibility for the paper, and the interpretations offered therein, lies with us. The David and Lucile Packard Foundation and the Winslow Foundation provided generous support for this study.

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Abstract

The last decade has seen a major transformation of the Indian car industry, from a protected business with only one world-class manufacturer to a landscape that includes most of the world's major players as well as some emerging domestic firms vying for a significant piece of an expanding market. In the process, the industry has also leaped forward technologically, driven by a confluence of factors such as intense competition, demanding consumer preferences, government policies (especially tightening emission standards), and the global strategies of the various players. Now, cars manufactured in India are based on designs, and incorporate technologies, that are often comparable with those available globally; in fact, in some cases, the Indian launch of a vehicle (such as the Hyundai Santro Xing) has been its first launch worldwide. At the same time, Indian car exports are also growing. Interactions with automobile manufacturers also continue to fuel substantial changes within ancillary auto-component firms. The substantial deepening of technological capabilities in the Indian automobile industry augurs well for the future. Many of the players increasingly see India as their global manufacturing hub for small cars, and the government's new Auto Policy intends to build on, and promote, such developments. The government also anticipates undertaking policies that will reduce the environmental impact of automobiles, an issue that will be of escalating importance as the vehicle population in the cities and rest of the country continues to grow. At the same time, the industry also will likely face new challenges as India further integrates with the global economy, and as other developing-country players such as China become more prominent in the global automotive landscape. Meeting these goals, and navigating these challenges, will require a range of innovative public policies, including those that help further strengthen the technological capabilities of the sector.

1 Introduction

India's automobile industry has undergone a remarkable transformation in the last decade or so, following the liberalization of the Indian economy. This period has seen a remarkable expansion of this industry, and the entry of a host of new ventures as well as a reorientation on the part of some existing firms. The result – an abundance of choice and significant upgradation in technologies – has been a nothing short of remarkable from the point of view of the consumer. At the same time, vehicles have progressed from having outdated technology (with some notable exceptions) to being mostly contemporary with products in global markets. Along with this rapid evolution in technological characteristics of the vehicles being sold in the country, there have been concomitant changes in the underlying manufacturing and assembly processes, and within suppliers of components and fuels. The result has been a substantial deepening of technological capabilities within the industry. This is a welcome development since such capabilities are essential for managing technological change, which lies at the heart of any approach to meet market or environmental challenges that will face the car industry in the future. Drawing on a detailed study of four firms (Ford India, General Motors India, Maruti Udyog, and Tata Motors),[1] this paper seeks to highlight the various factors that have driven this transformation, the kinds of changes that have resulted, and the kinds of issues that may assume significance as the industry moves forward.

2 The Indian automobile industry: an early history[2]

Automobile manufacturing in India has a history that goes back to the earlier part of the last century. In 1928, General Motors set up a plant in Bombay to assemble cars and trucks. Soon after, Ford set up a plant in Madras in 1930 (and additional ones in Bombay and Calcutta in 1931). While the British had actively opposed the establishment of an indigenous automobile industry in India (since they were of the view that it was more profitable to sell imported cars than to manufacture them), World War II gave the opportunity for Indian industrialists to enter the automobile sector. Thus the Birla group, a major Indian industrial house, incorporated Hindustan Motors (HM) in Calcutta in 1942, and the Walchand group set up Premier Automobiles Ltd. (PAL) in Bombay in 1944. These firms set before themselves the progressive goals of the manufacture of vital automobile components and eventually the manufacture of vehicles. The first partially manufactured cars in India rolled off the HM assembly line in 1949 (although PAL had already been assembling Dodge DeSoto and Plymouth cars beginning 1946). But the

[1] Appendix II contains a brief discussion of these four firms.

[2] This section is drawn mainly from Hindustan Motors (1967), Venkatramani (1990), and Mohanty, Sahu, and Pati (1994).

intense competition in the country – in 1950, for example, numerous importers and assemblers were offering 61 models of automobiles for the total market of 20,000 vehicles – forced these manufacturers to operate at a loss in the early years.

In 1952, the Government of India set up a Tariff Commission to explore approaches to develop an indigenous automobile industry in the country. In its 1953 report to the government, this Commission recommended that for the suitable development of the automobile industry, only those firms that had a manufacturing program should be allowed to operate in the country and that mere assemblers of completely-knocked-down (CKD) motor vehicles should be asked to terminate their activities within three years. As a result, by the end of 1955, there were only six approved manufacturers of automobiles in the country: Hindustan Motors (HM), Premier Automobiles (PAL), Standard Motor Products, Ashok-Leyland, Mahindra & Mahindra, and the Tata Engineering and Locomotive Company (Telco).[3] Only the first three were manufacturers of passenger cars at that time.[4]

A number of factors, however, conspired to keep the Indian automobile industry mostly in a period of technological stagnation for the next three decades. The Indian government viewed the passenger car as a "luxury" item and hence did not accord it much significance in its developmental priorities. Government control over the industry's output and import of capital equipment and raw materials considerably hobbled the manufacturers in their technological decisions. At the same time, the high taxes on automobile components and the vehicles put the car beyond the reach of most Indian consumers, thus ensuring low levels of production and therefore lack of any significant economies of scale. And last, but not the least, given the tight controls on car imports and over the licenses for new manufacturing firms, existing manufacturers had a captive market and therefore were able to operate on a "cost-plus" basis. Therefore, these firms had almost no motivation to improve significantly the product offered to the customer, and even if they had wanted to, the foreign exchange and other restrictions by the government would have limited access to technology from foreign manufacturers.

As a result, until the 1980s, the vehicles being offered by Indian car manufacturers were essentially 1950s vintage technology with only minor modifications. Customers had a choice between only three models: the PAL Fiat 1100D (that became, with some changes, the Premier Padmini), the HM Ambassador, and the Standard Herald

[3] Telco was established in 1945 to manufacture locomotives and other engineering products, and started manufacturing commercial vehicles in 1954 (under collaboration with Daimler Benz).

[4] In 1954, the installed capacity of HM for cars and commercial vehicles stood at 9,000 units. Initially HM manufactured Studebaker trucks and two Morris models, but by 1958, it made only Hindustan Bedford trucks and the Ambassador (basically a Morris Oxford). The installed capacity of PAL in the same year was 5,000 on a single-shift basis. It produced Dodge and Fargo chassis for trucks and Fiat 1100 cars. Standard Motors produced the Standard Herald, which was a version of the Triumph Herald (Hindustan Motors 1967).

(and then Gazel).[5] Furthermore, given the controls over production volumes, there was a long waiting list for the purchaser – it could be more than a year between placing of the order and delivery of the vehicle. Even in the 1970s, the combined annual production of the two main manufacturers (PAL and HM) was about half of the demand for cars,[6] which in the mid-1970s was estimated to be about 80,000 units (Hamaguchi 1985). As late as 1981, the estimated car and multi-utility vehicle (MUV)[7] population in Indian was only one million.[8] Manufacturers made changes to their model only after significant intervals; these changes were generally minor, and often only cosmetic.

3 Recent evolution of the industry

After this long period of stagnation, the 1980s saw the beginning of an evolution of the Indian automobile industry, catalyzed in large part by a number of major policy changes in the country. By the mid-1970s, the government had started relaxing somewhat its controls over the Indian automobile industry. For example, it allowed an automatic growth of capacity of up to 25% in a 5-year plan period. Beginning in 1983, the government also allowed "broad banding" that gave automobile manufacturers greater flexibility.[9] It also gave the manufacturers exemption from the Monopolies and Restrictive Trade Practices Act (MRTP) which removed yet one more hurdle to the expansion or setting up of new plants. The government also greatly eased the restrictions on technical and financial participation by foreign firms that allowed technology and product upgradation by existing manufacturers. For example, in the light commercial vehicle (LCV) market, which probably saw the greatest change within the sector in those early years, the government allowed four Indian industrial houses to begin LCV production. These firms were DCM, Eicher, Swaraj and Allwyn, which had entered into collaborations with Japanese companies, namely, Toyota, Mitsubishi, Mazda, and Nissan, respectively.

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[5] These were based on the Fiat Millicento, the Morris Oxford and the Triumph Herald, respectively.

[6] Estimates of the annual production of cars during the 1970s range from 33,000 (Okada 1998) to 47,000 (ICRA 2003).

[7] The MUV segment consists of utility vehicles (UVs) as well multi-purpose vehicles (MPVs).

[8] While there are data on cumulative registered vehicles in the country, exact data about vehicles in use are not available since vehicles are rarely de-registered if they are taken out of service. If one assumes that 50% of vehicles registered in 1961 were off the road by 1981, i.e., taken out of service after twenty years, then the number of cars and MUVs on Indian roads was about one million in 1981 (using the Motor Transport Statistics of the Ministry of Road Transport and Highways; http://morth.nic.in/mts.htm).

[9] The "broad banding" policy basically meant that production of a closely-related version of an existing product would be covered under the initial license rather than requiring a new license. The rationale for this was that production of these related products could benefit from existing design and manufacturing capabilities. This policy allowed manufacturers of vehicles with four or more wheels to produce any product mix within its licensed capacity.

There were significant changes also in the two-wheeler and the passenger car markets during this period. But perhaps the most important change was the 1983 joint venture between the Government of India's Maruti Udyog Limited (MUL), which was established in 1981, and the Suzuki Motor Company of Japan to produce a small "people's" car. This joint venture (JV) (initially owned 74% by the government, and 26% by Suzuki) resulted in a significant addition to the country's car production volume, which helped satisfy the unmet consumer demand. The JV served another important function: by bringing in cars at a low cost that were based on modern (and fuel-efficient) automobile technology, it galvanized the existing Indian firms to start upgrading their own technology, thereby initiating a modernization of the Indian passenger car industry.

The other major Indian manufacturers also all moved to upgrade their own offerings, catalyzed partly by Maruti's entry into the Indian car market: HM entered into collaboration with Isuzu of Japan for the manufacture of gasoline and diesel engines and power-train assemblies, and with Vauxhall of the U.K. for design and tooling technology, which in turn led to the Contessa (a derivative of the Vauxhall Victor). PAL entered into a technical agreement with Nissan of Japan for their A-12 engine and matching transmission which was placed in a Fiat 124 body. PAL also entered with a consultancy agreement with AVL of Austria to improve its existing gasoline engine, and through an acquisition, an arrangement with FNM of Italy for diesel engines (leading to a diesel car being offered in 1989) (Mohanty, Sahu, and Pati 1994). Standard Motors began offering a luxury car, the Rover 2000, in collaboration with Austin Rover of the U.K. (Venkatramani 1990).

In 1991, a balance-of-payments crisis led to the adoption of a structural adjustment program by the Indian government that involved a range of economic liberalization policies.[10] The government also revisited its Industrial Policy and began a move towards deregulation and delicensing of the industrial sector, thereby allowing for capacity expansion as well as entry of foreign capital and firms.[11] The automobile sector also changed course. The new automobile policy announced in 1993 included removal of licensing restrictions on production, automatic approval of foreign investment up to 51% in Indian firms opening the doors for foreign firms to enter the Indian market (subject to government approval, up to 100% foreign equity participation was also allowed), and reduction of excise duty as well as import duties on CKD as well as completely-built-up (CBU) units.

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[10] These included currency devaluation, partial convertibility of the Rupee, liberalization of capital markets sharp reduction of tariffs, and relaxation of controls over imports.

[11] Specifically, the industrial licensing was abolished for most industrial sectors; automatic approval for FDI up to 51% equity in Indian companies in a number of industries (and subject to approval by the Foreign Investment Promotion Board for the rest); removal of most controls over foreign technology agreements; and restrictions designed to curb monopolistic practices were relaxed, allowing large industrial houses to expand.

This ushered in a new era in the Indian automobiles sector, with the entry (mostly through joint ventures with Indian manufacturers) of a number of major multinationals who were eager to meet the projected demand for vehicles in the country. Figure 1 depicts the various stages in the evolution of the country's passenger car industry.

By 1996, a total of eighteen automobile companies from the US, Europe, and East Asia had either begun operations in India or planned to do so (Mukherjee and Sastry 1996). Subsequently, there was a bit of shake-out in the industry, but more than ten car manufacturers or assemblers still continue to operate in the country.

4 Current size and structure of the industry

The Indian automobile industry has grown significantly in the last decade, with a compounded annual growth rate (CAGR) of almost 10% (although with a major hiccup in the mid-to-late 1990s when the growth stalled for a couple of years, due to a slowdown in the economy). Figure 2 shows the sales, in recent years, of vehicles in various segments. The domination of the middle class is reflected in the fact that about 80% of the vehicles sold in the country are two-wheelers; cars and MUVs account for only about 13% of the sales.[12]

Figure 2: Sales of passenger vehicles in India

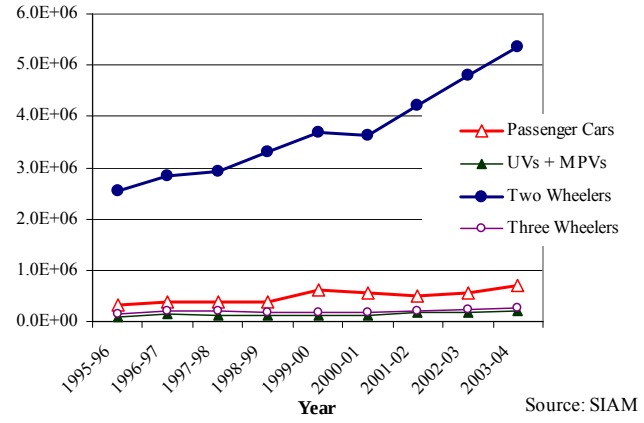
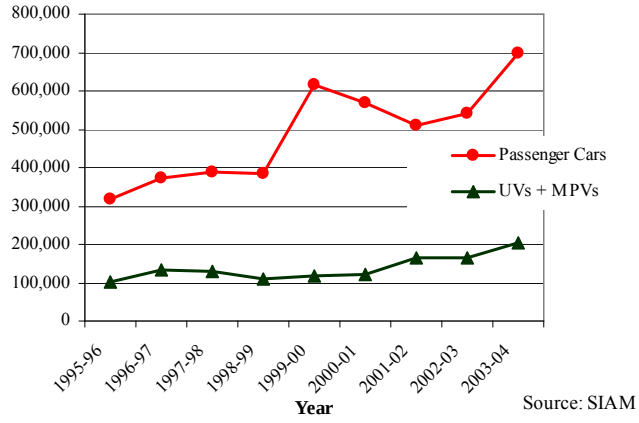


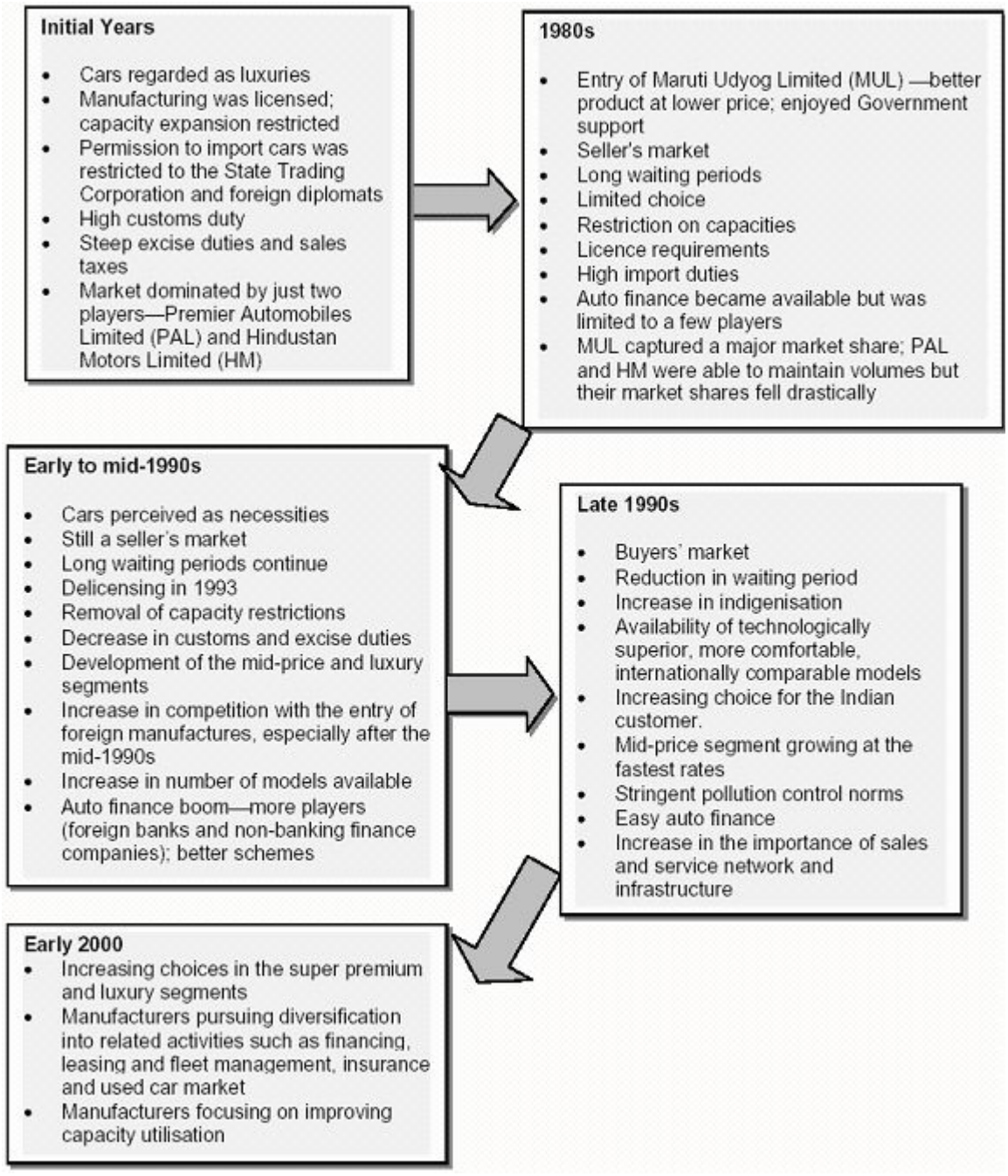
Figure 3: Sales of 4-wheel passenger vehicles



Still, passenger-car sales in the country have continued to increase at a CAGR of over 10 percent. Figure 3 shows the recent sales trends in the passenger car and multi-utility vehicle (MUV) segments. The rapid growth in the sector has been driven mainly by the substantial increase in the purchasing power of the Indian upper middle class, availability of

[12] There has also been a major shift within this segment from scooters to motorcycles. In fact, total scooter sales have declined slightly over the past decade, while motorcycle sales have gone up, on average, over 20% per year.

Figure 1: Evolution of the Indian passenger car industry



Source: ICRA 2003

financing options, competitive pricing, as well as a reduction in government tariffs that have helped lower the price of vehicles. The total number of passenger cars and MUVs produced in the country exceeded one million for the first time in 2003-04 (SIAM 2004).

Despite such growth, in global terms the Indian automobile industry remains minuscule: in 2002-03, it accounted for 1.91 percent of the world vehicle production and sales, respectively (OICA 2003).[13] From the perspective of the Indian economy, though, the auto industry is a key contributor: it is the largest manufacturing industry in India, which along with related industries, accounts for about 4% of the country's GDP (Frost and Sullivan 2002). It also employs 0.45 million people directly, and about 10 million people indirectly. Furthermore, given the low penetration of passenger cars in India of about 7 per 1000 persons, this industry is expected to see substantial growth in the coming years.[14]

There are a number of automobile manufacturers in the country offering a wide range of vehicles spanning all the way from the "mini" segment (less than 340 cm length, generally less than 800 cc engine displacement) to the "luxury" segment.[15] Table 1 highlights the profiles of the major players in the passenger-car segment, and Table 2 lists the main vehicles offered by them. Note that foreign firms now hold all or much of the equity in most of these firms, even though most of them initially formed 50:50 (or close to that) JVs with Indian partners (Mukherjee and Sastry 1996). The inability of Indian JV partners to contribute their share towards capacity expansion allowed the foreign partners to buy out their Indian partners and convert the JV into a fully-owned subsidiary, or significantly increase their stake in it (ICRA 2003).

Many of the segments in the industry are dominated by two to three players. In the case of the passenger-car segment, MUL, Tata Motors, and Hyundai Motors control around 85 percent of the total annual sales,[16] even though most of the major global auto manufacturers are operating in the Indian arena. Figure 4 details the sales of the various manufacturers in 2003-04, and the percentage of the car market held by them.

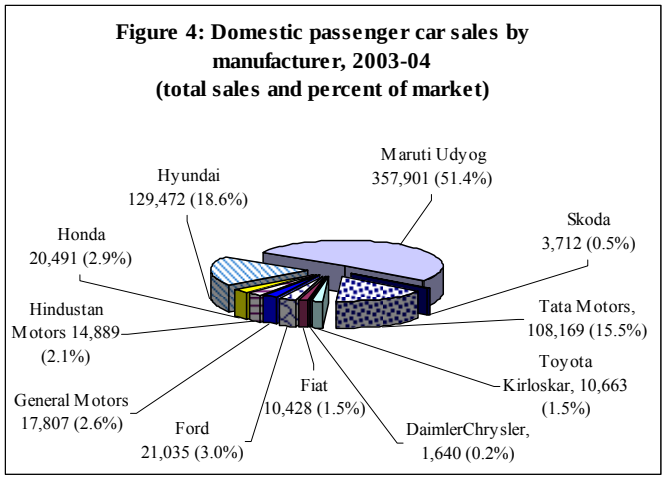
[13] In comparison, the Chinese automobile industry accounted for 7.33% of the world's motor vehicle production in 2002-03 (OICA 2003).

[14] As in Footnote 8, if one assumes that 50 percent of the vehicles registered in 1981 were off the road by 2002, then the number of cars and MUVs on Indian roads in 2002 was about seven million.

[15] The Society of Indian Automotive Manufacturers (SIAM) classifies these vehicle categories according to length.

[16] Similarly, in the two-wheelers segment, Hero Honda, Bajaj Auto, and TVS Motors account for approximately 80 percent of the total sales and in the commercial-vehicles segment, Tata Motors controls around 56 percent of the total annual sales by itself. The auto components industry, on the other hand, is highly fragmented, though there are dominant players in some of the critical segments.

Another notable feature of the Indian car market is that it is very heavily skewed towards mini and compact vehicles – these segments account for almost 80 percent of the car sales in the country (see Table 3).[17]



MUL dominated small-car sales until recently (in 1996, it had 80 percent of the country's car market) since many of the earlier entrants into the Indian car market did not target these segments. Furthermore, MUL was able to offer its vehicles at a very competitive price since it had relatively high indigenization levels, an established vendor base, and a depreciated plant (ICRA 2003). But it has lost significant ground with the entry of Hyundai Motor India Limited (HMIL) with its line-up of small cars, and the launch of Tata Motors' Indica – Maruti's share of domestic sales is now down to just over 51 percent, while Hyundai and Tata account for almost 19 and 16 percent (and rising), respectively. HMIL – a wholly owned subsidiary of Hyundai Motor Company, South Korea – is now the second-largest and the fastest-growing car manufacturer in India.[18]

Table 3: Passenger vehicle sales and exports, 2003-04

Passenger Vehicles	Domestic Sales	Exports
Passenger Cars	696,207	125,327
Mini	167,565	10,479
Compact	369,537	84,077
Mid-size	139,304	30,739
Executive	14,337	0
Premium	5,368	32
Luxury	96	0
Utility Vehicles	144,981	3,067
Multi Purpose Vehicles	59,564	922
TOTAL	900,752	129,316

Source: Society of Indian Automobile Manufacturers (SIAM)

[17] Many of the mid-1990s analyses of the future of the Indian passenger car industry mis-forecast a segment shift in the market by assuming that people would move towards larger cars (Friedman 2004). This resulted in many of the entrants focusing on the mid-size segment.

[18] HMIL began commercial production in September, 1998, and now presently markets over 18 variants of passenger cars across five models. In 2003-04, it produced almost 172,000 cars, and exported over 42,000 units.

Table 1: Major passenger car firms in India and their foreign relationships

Manufacturer	Indian partner	Current foreign partner/collaborator	Foreign equity	Year of incorporation
DaimlerChrysler India Pvt. Ltd.	--	DaimlerChrysler AG (USA/Germany)	100%	1995
Fiat India Automobiles Pvt. Ltd.	--	Fiat Auto SpA (Italy)	100%	1997
Ford India Ltd.	Mahindra & Mahindra	Ford Motor Company (USA)	84.1%	1995
General Motors India Ltd.	--	General Motors Corp (USA)	100%	1995
Hindustan Motors*	C K Birla Group	Mitsubishi Motors, Japan	--	1942
Honda Siel Cars India Ltd.	Siel Ltd.	Honda Motor Company (Japan)	99%	1995
Hyundai Motor India Limited	--	Hyundai Motor Company (Korea)	100%	1996
Maruti Udyog Ltd.	Govt. of India	Suzuki Motor Company (Japan)	54.2%	1982
Tata Motors Ltd.	Tata Group	--	--	1945
Toyota Kirloskar Motors Ltd.	Kirloskar Group	Toyota Motor Corporation, Japan	88.9%	1997

* HM has a marketing tie-up with Mitsubishi for manufacture and sale of its Lancer and Pajero vehicles in India, but it also continues to sell updated versions of its Ambassador car.

Source: ICRA 2003, Industry documents

Table 2: Vehicles offered by major passenger car firms in India*

	Mini < 3400mm	**Compact 3401-4000mm**	**Mid-size 4001-4500 mm**	**Executive 4501-4700 mm**	**Premium 4701-5000 mm**	**Luxury > 5000 mm**	**MUV**
DaimlerChrysler				Mercedes C Class; M Class	Mercedes E Class	Mercedes S Class	
Fiat India		Palio	Petra Adventure				
Ford India			Ikon		Mondeo		Endeavour
General Motors India		Opel Sail	Opel Corsa Opel Swing Chevrolet Optra	Opel Vectra			Chevrolet Forester Chevrolet Tavera
Hindustan Motors*			Ambassador Mitsubishi Lancer	Contessa			Mitsubishi Pajero
Honda Siel			City		Accord		CR-V
Hyundai Motor India		Santro	Accent	Elantra	Sonata		Terracan
Maruti Udyog	800 Omni	Alto Zen Wagon R Versa	Esteem Baleno				Gypsy King Grand Vitara
Tata Motors		Indica	Indigo				Sumo Safari
Toyota Kirloskar				Corolla	Camry		Qualis

Source: Industry documents

* Note that this is not a comprehensive list.

Furthermore, there also has been a slow shift towards larger cars. While the 'mini' size (especially the Maruti 800) dominated the market until the mid-1990s, there has been a shift towards compact and mid-size vehicles. In fact, the mid-size segment that has seen the highest growth in the last few years, although its overall sales are still small. It is felt that while the mini segment will continue to sell well and maintain its absolute numbers in sales terms, it will lose share in the overall market as the compact and mid-size segments grow (ICRA 2003a).

The Indian passenger-car industry is also characterized by substantial over-capacity, resulting partly from over-optimistic projections that seemed to prevail in the mid-1990s (Friedman 2004). While the sales-to-capacity ratio has improved from 66% in FY 1999 to 73% in FY 2002 (ICRA 2003), many of the manufacturers remain under pressure to utilize their installed capacity. Furthermore, the low volumes of many manufacturers do not allow them to take advantages of economies of scale.

5 Current drivers of technological change

The Indian automobile industry has seen rapid technological change over the last decade in terms of both product characteristics as well as manufacturing processes. At the same time, technological changes and the deepening of technological capabilities have been confined not only to the car manufacturers – there have also been spill-over effects to the auto components industry. The capability to manage technological change will be important to meet the challenges of an increasingly globalized automobile market, as well as local and global environmental challenges. This section and the next one will outline the main drivers of these changes in the Indian automobile industry, as well as the resulting changes.

Detailed discussions with a number of senior managers from the automobile industry as well as our other research suggest to us that the major drivers of these changes have been (a) the business environment in the Indian car industry, (b) consumer preferences, (c) regulations and government policies, (d) global strategies of the Indian manufacturers.

5.1 Business environment

The business environment in the Indian car industry can be characterized mainly by four factors: growth in demand; the presence and influence of multinationals; intense competition; and overcapacity.

Changing income levels and aspirations of the Indian middle class, and the deteriorating public-transport network which is unable to meet the mobility needs of these consumers, have led a large growth in demand for personal vehicles (leading, over the last decade, to an average annual increase of about ten percent in car sales). Given

that there is an expectation that the Indian car market will continue to expand, most of the major global car manufacturers have established a presence in India, either through their subsidiaries or through JVs.[19] These multinational corporations (MNCs) have access to the latest technology – both in product as well as manufacturing process terms – as well as a range of products and have been bringing these resources to bear in their efforts to make inroads into the Indian market (or maintain the market share, as in the case of MUL).

The entry of these MNCs resulted in a shift in the price-value equation in the Indian auto market. At the time of the opening up on this market in 1993, the market was dominated by the low-price/low-value segment (i.e., the Maruti 800). Given MUL's advantages as the incumbent and volume producer in this position, the initial entrants chose to focus on the high-price/high-value segment by bringing in premium and luxury cars – a strategy that wasn't particularly successful. Eventually new players such as Hyundai and Daewoo[20] changed the dynamics of the market by offering superior value at a price that was still higher than that of the Maruti 800 and Omni, but significantly lower than of the cars in the high-price/high-value segment. This eventually led to a transformation of the Indian market towards "compact" and "mid-size" cars that were technologically more advanced than the cars in the "mini" segment and also offered a greater number of features (ICRA 2003a).[21] This has helped transform the technological landscape of the Indian car market.[22]

As Table 2 showed, a number of models are competing for sales in most of the segments of the Indian car market – for example, the mid-size segment that has seen the highest growth in the last few years (although the overall numbers are still small), has 15 models. Overall, there are about 50 models, and several hundred variants, in the market.

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[19] Nissan/Renault has not, as of yet, entered the Indian market. Volkswagen does not have a direct presence, although its subsidiary, Skoda Auto India, has been selling cars in the country since 2001. Peugeot was selling cars in India through its JV with PAL, but withdrew from the market in 1995, because of differences with its Indian partner.

[20] Daewoo was one of the early entrants into the Indian car market – it started selling cars in 1995. Although it started with the Cielo, a mid-size car, it launched the Matiz in India in late 1998 (soon after the car's global launch). The Matiz, an internationally acclaimed car, did very well in the Indian market, in part because of its fuel-efficiency. But Daewoo's financial troubles eventually forced it into bankruptcy in late 2000 and it was eventually taken over by GM in late 2002 .

[21] This outcome was advantageous to the new players as the minimum economic size of plants in these categories is much lower than in the 'mini' category. It took Maruti a while to respond to this strategy and introduce cars in these segments in which time it had lost first-mover advantage to the other entrants (ICRA 2003a).

[22] Small cars need not necessarily be simpler technologically than their larger counterparts. For example, Japanese regulations confer a substantial tax advantage on cars of a maximum size (length (3.4 m), breadth (1.48 m), engine size (660cc) and output (64 bhp)). Manufacturers often pack these small cars, termed "K-class" cars, with numerous technological features as a way of coaxing performance out of these vehicles.

At the same time, many of the players are utilizing only a small amount of their capacity (see Table 4).[23]

Table 4: Sales-to-capacity ratios of selected car manufacturers in India

	1999	**2002**
DaimlerChrysler	11%	14%
Fiat India	17%	35%
Ford India	6%	46%
General Motors India	14%	34%
Hindustan Motors	67%	65%
Honda Siel	32%	36%
Hyundai Motor India	20%	78%
Maruti Udyog	131%	99%
Tata Motors	8%	55%
AGGREGATE	66%	73%

Source: ICRA 2003a

5.2 Consumer preferences

Consistent with recent trends, it is estimated that while the mini segment will continue to sell well and maintain the absolute numbers in sales terms, it will lose share in the overall market as the compact and mid-size segments grow (ICRA 2003a). Thus consumer preferences are shifting away from the stripped-down, low-cost models towards higher priced models (that still offer good value) that also have greater array of features (technological or otherwise). At the same time, there is also greater awareness among consumers about various characteristics of cars and their demand for technologies is on par with most mature countries (Friedman 2004). Indian customers now also have access to various channels of information about automotive technology (technical features as well as driving practices) – these include TV channels, internet, personal travel overseas, and automotive magazines (Deb 2004).[24] The last may be particularly important because they not only review cars' performance, features, and related issues such as the price-value equation that keep the manufacturers on their toes, but also educate consumers about technology and other options. At the same time, Indian consumers remain extremely cost-conscious. Philip Spender, a previous Managing Director (MD) of Ford India, noted that "the Indian consumers are very demanding. They aspire to have the best, but they won't spend excessive amounts of money" (Hilsenrath 2000).

[23] This overcapacity results, in large part, due to excessively optimistic projection of growth in the Indian market at a time when these manufacturers were making decisions about plant sizes.

[24] India has seen the introduction of number of magazines (such as Autocar and Overdrive) that have a dedicated focus on the automobile market.

The high sensitivity of Indian consumers to cost combined with the high cost of fuels has also been causing a shift towards diesel-engine-powered vehicles – although these have a higher initial cost, their considerably higher efficiency (as compared to gasoline cars) and the significant price differential between the two fuels makes them attractive in the long term.[25] A number of manufacturers have begun to offer, or are considering offering diesel model of their vehicles[26] – the Tata Indica's diesel variant, for example, has been selling very well.[27]

5.3 Government Policies

5.3.1 Emission norms

The rapid growth of vehicles in the country has led to severe air pollution, especially in urban areas.[28] This has catalyzed the promulgation of a range of policies aimed at tackling vehicular pollution.[29] The first vehicular emission regulations in India– idling emission norms–were introduced in 1989. These placed a limit on the concentration of carbon monoxide (CO) in exhaust during idling from gasoline vehicles; diesel vehicles were regulated also in terms of hydrocarbon (HC) emissions. The Air Pollution Act of 1991 introduced mass emissions limits (CO and HC) for the first time in India – gasoline vehicles were covered beginning 1991 and diesel vehicles from 1992. These standards were further tightened in 1996 and 1998.

At the same time, the Supreme Court directed the government to require that new passenger cars sold in the four metros of Delhi, Calcutta, Mumbai and Chennai be fitted with catalytic converters starting April 1995. It also required a move towards supply of unleaded gasoline in these cities. Availability of unleaded gasoline was further extended to 42 major cities and by February 2000, it was available throughout the country.

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[25] Gasoline and diesel prices are set by the government through the Administered Price Mechanism. As of early July, 2004, the cost of gasoline was Rs. 35.71/liter, while the cost of diesel was Rs. 22.74/liter (Delhi prices). This is equivalent to approximately $3/gallon for gasoline, and $1.9/gallon for diesel. One also needs to bear in mind that in purchasing-power-parity terms, the per-capita income in India is less than one-thirteenth that in the United States. Fuel costs account for about 65 to 75% of the running costs of cars in India (Sumantran 2004).

[26] Maruti, for example, is setting up a greenfield diesel plant with an annual capacity of 100,000 units per year. It plans to produce a 1.3-litre common rail direct injection (CRDi) engine, with technology for this being sourced from Fiat and Opel Adam (Economic Times 2004).

[27] This trends towards dieselization is a source of concern to many environmentalists in India. See, for example, http://www.cseindia.org/dte-supplement/air20040331/hells_angels.htm

[28] We estimate (using the same assumptions as in Footnote 6) that the total number of vehicles on Indian roads rose from about 11 million in 1987 to about 48 million in 2002.

[29] An additional set of policies aimed specifically at reducing air pollution in Delhi included phasing out older commercial vehicles and moving the remaining over to compressed natural gas (CNG). Although a somewhat controversial policy at the time, it has, by universal agreement, been very successful in cleaning up the city's air.

The next major step in emission norms for India came in mid-1999 when the Supreme Court required passenger cars and commercial vehicles in the National Capital Region to meet India-2000 (Euro-I equivalent) norms. These norms were extended to the rest of the country in January of 2000. Bharat Stage-II (BS-II, which is Euro-II equivalent) norms were also put in place for the National Capital Region (NCR) from 2000 for passenger cars and multi-utility vehicles.[30] These were extended to the other three major metros – Mumbai, Kolkata, and Chennai – from 2001. In the same year, BS II norms were also put in place for commercial vehicles. BS-II emission norms for four-wheelers are in force from 2001 in the four metros of Delhi, Mumbai, Chennai and Kolkata and have been extended to other key cities from April, 2003.

The recent Auto Fuel Policy (AFP) of the government requires BS-II norms to be adopted through the entire country by 2005. It also requires the adoption of BS-III (Euro-III equivalent) norms in eleven highly polluted cities by 2005.[31] In the longer term, the AFP expects BS-IV (Euro-IV equivalent) norms to be adopted in the major metros by 2010, and for BS-III norms to be extended to the rest of the country at the same time (AFP 2002).[32] Table 5a and 5b detail the trajectory of the recent and projected emission standards for the country.[33]

Table 5a: Passenger car (gasoline) emission norms in India (g/km)†

Standards	CO	HC	NOx	HC + NOx
1991	14.3-27.1	2.0-2.9		
1996	8.68-12.4			3.0-4.36
1998*	4.34-6.2			1.5-2.18
2000	2.72			0.97
BS II	2.2			0.5
BS III	2.3	0.2	0.15	
BS IV	1.0	0.1	0.08	

* For vehicles with catalytic converter

[30] BS standards have some minor changes in test condition from Euro standards: the maximum speed in the driving cycle was changed from 120 kmph to 90 kmph and the test temperature requirement of -10 C was eliminated since it is not particularly relevant to India.

[31] These are Delhi, Mumbai, Chennai, Kolkata, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra.

[32] The timeline for these steps is to be reviewed in 2006.

[33] Notably, the trajectory of the implementation of the BS-III and BS-IV standards recommended by the AFP Report was much less aggressive than that proposed by the Society of Indian Automobile Manufacturers (SIAM) in 2000, which recommended moving passenger cars to BS-III by 2003/04 and to BS-IV by 2005/06 (see Gandhi 2001). The slow pace of introduction of BS-III and BS-IV norms resulted in severe criticism from a number of quarters. See, for example, Times of India (2003).

Table 5b: Passenger car (diesel) emission norms in India (g/km)[†]

Standards	CO	HC	NOx	HC + NOx	PM
1992	14.0	3.5	18.0		
1996	5.0-9.0			2.0-4.0	
2000	2.72-6.9			0.97-1.7	0.14-0.25
BS II	1.0			0.7	0.08
BS III	0.64		0.5	0.56	0.05
BS IV	0.5		0.25	0.3	0.025

Source: CPCB (1999), AFP (2002)

[†] Note that the range allowed for a particular pollutant under some standards represents emission limits for vehicles of different sizes. The emission norms for most passenger cars and MUVs are the lower limit of the range.

At the same time, the government has also mandated a reduction of a number of critical pollutants from automobile fuels. In the case of sulfur, it began by requiring the sulfur content of gasoline being sold in the four metros of Delhi, Mumbai, Chennai, and Kolkata and the "Taj trapezium" to be below 5000 parts per million (ppm) by April 1996. In 1997, it subsequently tightened this limit to 2500 ppm – by April 1998, this fuel was to be made available for all the major metros, and by April 1999, throughout the country. The sulfur content of the fuel being sold in the NCR was further ratcheted down to 500 ppm by mid-2000, with the other three major metros following suit by early 2001; by 2005, the sulfur content of gasoline in these four areas (NCR+ three major metros) is mandated to be 150 ppm. The rest of the country is receiving gasoline with 1000 ppm sulfur content from April, 2000, to be brought down to 500 ppm by 2005. In the case of diesel, the maximum allowed sulfur content was reduced to 5000 ppm for the metros by 1996, to 2500 ppm by 1998, and down to 500 ppm in the NCR and the other three metros during 2001 (and to be brought down to 350 ppm in 2005). For the rest of the country, the diesel norm came down to 2500 ppm from the year 2000, to be reduced further to 500 ppm by 2005.

At the same time, the levels of benzene in gasoline were first regulated down to 3% and 5% (on a mass basis) for the metros and the rest of the country, respectively. This was subsequently lowered to 1% for Delhi by October 2000, and for the NCR and Mumbai by 2001.

Meeting India-2000 and BS-II standards required the implementation of some combination of technologies such as fuel injection, multi-valve engines, catalytic converters, and fixed exhaust gas recirculation (EGR). Moving to BS-III would require additional technologies such as on-board diagnostic systems and variable EGR (AFP

2002), and moving to BS-IV may require a substantial change in engine design. SIAM estimates that producing vehicles that are compatible with the proposed BS-III and BS-IV emission norms and timetables will require an investment of Rs. 250 billion (i.e., approx. $5.5 billion at current exchange rates) by the automobile industry (AFP 2002).[34]

5.3.2 Other policies

A number of other government policies have had direct and indirect effects on the automobile industry. A prominent example is the policy decision of 1997 that restricted the import of cars and automotive vehicles as completely-built-unit (CBU), completely-knocked-down (CKD), or semi-knocked-down (SKD). Licenses to import components in SKD or CKD forms were issued only on the execution of a memorandum of understanding (MoU) with the government that required the firms to

- establish actual production of cars and not merely assemble vehicles;
- bring in a minimum foreign equity of US$ 50 million if it was a joint venture involving majority foreign equity ownership;
- localize components to at least 50% in the third and 70% in the fifth year or earlier from the date of clearance of the first lot of imports; and
- neutralize foreign exchange outflow on imports through export of cars and auto components. This obligation was to commence from the third year of start of production and to be fulfilled during the currency of the MoU. From the fourth year imports were to be regulated in relation to the exports made in the previous year.

While eleven firms signed this MoU, parts of this policy (the last two conditions) were eventually struck down by a panel of the disputes resolution body of the World Trade Organization on the grounds that it breached articles of the Uruguay Round of the GATT (WTO 2001). In any case, India phased out Quantitative Restrictions (QRs) on imports in April, 2001.

Another important policy of the government has been the highway component of its infrastructure development scheme. Under two ambitious schemes, the "Golden Quadrilateral" and the "North-South-East-West corridor," the government plans to add about 13,000 km of highways in the country. At the same time, it is also embarking on a process of upgrading and developing rural roads. These are all intended to improve inter-city road transport, as well as improved access to rural areas. This extension and improvements of India's roads is likely to provide a major stimulus to the auto industry.

[34] Given that the annual turnover of the auto industry is over Rs. 500 billion (and expected to grow at about 7-10% per year), the investments for meeting these emission norms represents about 3-5% of the industry's cumulative turnover during this period. SIAM estimates that moving from BS-II to BS-III would add, on average, about Rs. 50,000 to the cost of a vehicle.

Meeting Indian vehicle safety and other performance standards also requires substantial attention to various elements of the car, such as brakes, lights, interior fittings, active and passive safety, emission control, and structural reliability. Ensuring that these standards are met may often require modification of the vehicle itself or of the components. While many of these design and engineering changes may be minor, in the aggregate they have significant influence on numerous technological aspects of the vehicle (Deb 2004).

Environmental, safety, and health (ES&H) concerns have also been driving changes in manufacturing processes in automobile plants. As a result, in many plants, there are concerted efforts to improve ES&H performance through a variety of programs such as those aimed at reduction of hazardous waste generation and energy use.[35] General Motors India, for example, has reduced its energy consumption per vehicle down from 2000 kWh to around 800 kWh (Ramesh 2004). Modifications in manufacturing processes and operations are a natural consequence of these activities.

5.4 Global strategies of Indian manufacturers

Two aspects of the global strategies of the Indian auto makers influence technological evolution of the sector:

5.4.1 Global sourcing of vehicle, components, and skills

Most Indian auto manufacturers have an MNC linkage, either through JVs with such global players, or by virtue of being subsidiaries of such firms. This allows the manufacturers access to models as well as specific technologies from the worldwide operations of these MNCs which, in turn, gives them greater latitude in introducing models that are specifically targeted towards perceived customer needs in various market segments. Sourcing pre-existing products also helps reduce the costs associated with introduction of the new models. In many cases, firms have chosen to introduce fully imported vehicles in the form of CKD units as DaimlerChrysler does with many of its models, Ford does with the Mondeo, and GM with the Vectra.

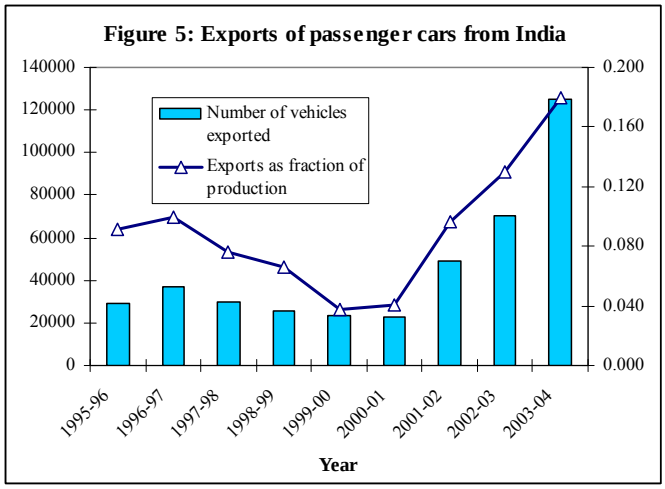
Generally, the SKD/CKD route is preferable in cases where the volumes justify some local assembly/indigenization – this offers a financial benefit since under the tiered duty structure, CKDs/SKDs (and components) are levied a duty of 25%, while CBUs are charged 60%. Ford went this route with their first product in the country, the Escort, and GM is doing the same with the Optra. Over time, the local content may increase, as Ford expects with the Endeavor, their latest MUV offering in the country

Manufacturers may choose to begin with a lower level of indigenization and source many of the key components (such as engines) from their overseas operations and

[35] In the case of MNC subsidiaries, the ES&H requirements of their parent company serve as an additional motivation for such measures.

suppliers but, over time, ramp up the indigenization as the local supply chain is built up. For example, in the early stages of Ikon's production, Ford chose to import engines from the U.K. and South Africa,[36] but eventually moved to sourcing them within the country from HM.

In other cases, firms may source knowledge from abroad. Tata Motors, a major Indian automobile engineering firm, entered the Indian market with the country's first indigenously-designed car in 1998. The car was designed for Indian conditions and consumer needs: it was a small car but with a fair bit of space inside, and had a diesel version that offered very low running costs (a feature that Tata Motors felt was key to success in the target segment). While 90% of the design effort was indigenous, Tata Motors hired the IDEA Institute of Turin for the design of the body, and was assisted by Le Moteur Moderne of France in configuring the gasoline engine. It went to Japanese firms for assistance with instrumentation and electronics.



5.4.2 Exporting vehicles and components

Using India as an export base, especially when sending cars to competitive markets such as Europe, requires being on the cutting edge of automotive technologies.[37] Exporting to such markets also gives manufacturers feedback from discriminating customers that, in the end, substantially helps in product improvement. Further-more, exporting to European and other industrialized countries also requires car manufacturers to be completely up-to-date on emission control technologies in order to meet the tight regulations there. Thus manufacturers such as Tata Motors, Hyundai India, and Maruti already have experience with meeting Euro III standards on some of their production vehicles (i.e., the export models).

While exports of vehicles from India are rather small in absolute numbers, these constitute a not insignificant fraction of the total production in the relevant segments, especially in the case of cars and three-wheelers. The value of exports by auto OEMs

[36] Ford sourced the Endura diesel engine from the U.K. and the RoCam gasoline engine from South Africa.

[37] Also, success in exports normally depends on healthy domestic sales. This gives manufacturers with major export aspirations further incentive to develop their domestic sales.

crossed the $1 billion mark for the year 2003-04 (SIAM 2004). Furthermore, these exports have been growing significantly in recent years (see Figure 5).

Maruti has been exporting vehicles since 1986 (and it did so despite high and unmet demand in India at that time) – although in the earliest years its exports were to Eastern-bloc countries like Hungary as well as India's neighbors (Venkataramani 1990), it now sends vehicles to Western Europe which is the most competitive small-car market in the world. Suzuki has also taken a decision to make MUL a hub of manufacturing and exports for its small cars for all markets except Japan (Pareek 2004).

Other automakers have also been following suit. Hyundai, already the second-largest car exporter from India, is cranking up its annual export capacity so that by 2010 it can export 500,000 small cars like the Santro and the Getz from its production base in Chennai (Rajshekhar 2004). In fact, Hyundai has indicated that India will serve as a global export hub for small cars (Hyundai Motor Company 2003) and is also in the process of shifting its small-car R&D to India. And Ford is exporting the Ikon as knocked-down kits to Brazil, Mexico and South Africa. It is also exporting auto components to China.

Tata Motors recently signed an agreement with MG Rover of UK to sell it 100,000 cars over five years. Rover, in turn, is badging them under its own name (as CityRover) and selling them in Europe. Riding piggyback on the tie-up, Tata Motors will also sell the Safari and spare parts through subsidiaries of Phoenix Venture Holdings, MG Rover's parent company (Surendar 2003). This is a major step for Tata Motors, and getting feedback from Rover and its customers will add feedback from a European market to our customer feedback and put Tata on a steeper learning curve (Sumantran 2004). The agreement with Rover is also a major validation of the work of its engineers, and therefore such a step helps boost their morale, which in turn enhances the quality of their work (Sumantran 2004).

6 Technological change in the industry

The various factors mentioned in the previous section – intense competition, customers' price sensitivity and increasingly sophisticated demands, progressively tighter emission standards, and the global sourcing and exporting strategies of Indian auto manufacturers – have all acted in concert to place a tremendous pressure on the manufacturers to reduce costs as well as offer an improved and wider range of technological features to their Indian and global customers. This, in turn, has resulted in a series of changes in the technological landscape of the industry.

6.1 Mainstreaming of contemporary technology

First and foremost, contemporary technologies have now become very much part of mainstream Indian car market. Gone are the days of the early 1990s when many

manufacturers were offering cars that were adaptations of superseded generations of technology. Even in the mid-1990s, some of the MNC entrants introduced cars that were slightly dated. Now a significant fraction of the models available in the country have technology that is at par with what is available in rest of the world, including industrialized countries. While many of the global firms that are in India have often introduced models that already have been launched in other countries but over time, the lag between the first launch of the product and its introduction in India has been generally reduced, or sometimes eliminated – for example, the Hyundai Santro Xing's first launch worldwide was in India.

Maruti started with a variant of its SS80 Alto/Fronte series that was launched in Japan in 1980 (Venkataramani 1990: p. 39) – this was introduced as the Maruti 800 in India in late 1983. While this short lag between the introduction of products by Suzuki in Japan and by Maruti in India existed in the early years, the Indian variants were the latest generation, and still being sold in Japan when brought to India. But now Suzuki has moved to the strategy of global platforms for its vehicles and hence the launch of a new car is coordinated globally (Pareek 2004). This will further align the technology in MUL's operations and products with global standards.

GM initiated their presence in India in 1996 with the Opel Astra from Europe that was in production in Europe when it was introduced in India.[38] It continues to sell vehicles that have current-generation technology (although maybe a bit dated at times). For example, the Tavera, GM's MUV offering of 2004, is based on the Isuzu Panther that was developed mainly for developing countries as a reasonably priced, high- reliability vehicle and launched in late 2000 (Isuzu 2000). The Chevrolet Optra (a variant of the Daewoo Nubira) was brought to the Indian market in mid-2003 within 6 months of its global launch.

Ford started in India in 1995 with the Escort that had already been introduced in Europe but was still in production there (Friedman 2004), and the diesel variant had Ford's most modern engine. It then introduced the Ikon in 1999 – this car, based on the Ford Fiesta platform, has been designed specifically for Indian conditions and tasks.[39] The Ford Endeavour, an SUV that is its latest offering in the country, is being imported from an Auto Alliance (an equal JV between Ford and Mazda) plant in Thailand. This vehicle, developed on the Ford Ranger pick-up truck platform, has also been tailor-made for the Asian market (Economic Times 2003) and was launched in Thailand in March, 2003.

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[38] This was seen as an older product and was not very successful in the market (Kothari 2004).

[39] Even in the case of the development of a new automobile such as the Ikon, the availability of pre-existing platforms and components such as power-trains to help reduce development costs of new models and increase the capacity utilization of their factories.

HMIL's first release in India in 1998, the Santro, was developed using the Atos platform (that itself was launched in 1997). The Indian launch of the Santro was the first worldwide; only subsequently was it introduced to different parts of the world. In fact, from its earliest days in India, HMIL's strategy has been to release its latest global products in India as a way of overcoming the low perception of Korean automobiles (Mukerjea and Dubey 2003).[40] In 2003, it launched the Santro Xing as Hyundai's latest "global" car that is intended for export to Europe, Asia, and Africa (Hyundai Motor Company 2003).

6.2 Improvements in manufacturing practices

Many of the Indian manufacturers have been emphasizing improvements in manufacturing processes that increase productivity and/or quality. For example, in its initial years, MUL focused on assimilating Japanese shop-floor practices. It subsequently has redesigned its assembly layout (from a straight line with inspection at one end to a "U-shaped" configuration that improves interactions and feedback among workers). It has also moved towards greater automation (a move it could afford because of its higher production volumes).[41] It has increased its productivity from 550 vehicles/person/year to its present level of 1800 vehicles/person/year (Pareek 2004). In its continuing attempt to improve productivity, it recently implemented an effort that, beginning April 2002, intended to improve production by 50% and reduce costs by 30% within in 3 years (Pareek 2004). GM has moved towards robotic application in paint shop because of high volume, reduction in paint consumption, improvement in paint quality, as well as improved appearance and employee health (Srinivasan 2004). The fact that many of the Indian manufacturers have either an MNC partner, or are an MNC subsidiary, helps in improving manufacturing practices since these global players are able to draw upon their knowledge and deep experience.

6.3 Higher level of indigenization

The need to reduce costs has provided an impetus to manufacturers to move toward greater indigenization (although, as mentioned earlier, government policies had already tried to promote indigenization with some success). Maruti had an aggressive plan for indigenization right from the inception of the JV – in its first year of regular operations, it intended to have a cumulative indigenization level of 31.5%, and raising it to 95.3% by 1988-89 (although it missed its targets by a small amount – it reached 86.2%

[40] Before launching their first vehicle in India, Hyundai conducted a national survey where it asked the consumers to choose automobiles by country of origin. Korean products ranked below Indian ones (Mukerjea and Dubey 2003).

[41] For example, in the welding shop, it now employs a combination of manual welding, 2-axis robots, multi-spot welders and 2-3D robots.

in its cars by the latter date) (Venkataramani 1990). But such high levels of indigenization helped give MUL an enormous cost advantage when other players entered the Indian market later. Ford initially started with the Escort that had about a 50% local content to begin with. Its next car, the Ikon, had a 70% local content at time of launch that has risen to 90% now[42] – Ford finds this essential for maintaining its cost structures (Friedman 2004). Similarly, when looking at the business case for introduction of new vehicles into the country, GM realizes that it cannot compete on costs without local sourcing (Veerapaneni 2004). Its MUV, Tavera, has an 85% local content that is expected to rise to 93% as the company ramps up its production (Economic Times 2004a) – in fact, the business case for selling the Tavera was not supported without localization (Deb 2004). Tata Motors' Indica has about 95% local content for both the petrol and diesel version (Sumantran 2004).[43]

6.4 Deepening of technological capabilities

Over the past few years, there has been a substantial enhancement of technological capabilities within the automobile sector.[44] The process of indigenization has played a major role in this, since this involves reviewing design in relation to local needs and conditions and then making suitable revisions. It also involves sourcing components, and therefore assessing their performance. And the process of validating all components, sub-systems, and the vehicle for Indian standards, and getting approval from ARAI, also requires a fair bit of technical effort. Merely adapting vehicles to Indian conditions can require a significant amount of modification. For example, the suspension systems on Indian cars have to be able to deal with the rugged road conditions – even seemingly small features such as non-standard speed-bumps can prove to be a challenge for suspensions.[45] If the requisite modification is somewhat complex, it may require collaborative effort between local engineers and those from the parent company. At Maruti, for example, the team charged with helping its cars meet BS-III specifications has Japanese and Indians (with the project leader being Japanese), and the testing is taking place in India (Maitra 2004).

There has also been a slow move towards building design and development capabilities in the country. For example, in the recent past, MUL carried out in-house a

[42] Ford's imports for the Ikon include engine castings as well as electronic management control systems that so far are not available in the country.

[43] As in the case of Ford, Tata also imports engine management control systems, and also some other components such as skin panels.

[44] Maruti, of course, has been making progress on this front for almost two decades now.

[45] As an interesting aside, Ford found that for their Mondeo, the suspension best suited to Indian roads was very similar to that required by Norwegian police where the cars often have to go on unpaved roads in the northern part of the country.

minor facelift of one of its largest-selling cars, the Zen.[46] It now plans to take on major facelifts next, followed by full-body changes by 2007 (Maitra 2004). While earlier the designs of new models were frozen, even though MUL did some local development for adaptation, now MUL expects to be doing iterations of the vehicle design and more – in fact, it is developing a small car ground up in India for the local market and is working with parent Suzuki for an Asian car (Rajshekhar 2003). To build capabilities for this, it sends workers to Japan for two years to work there as part of teams in Suzuki (Pareek 2004). While Ford does most of the design changes for its Indian vehicles in other countries, it still has about 20 engineers in India for minor changes in product designs. It also has a few engineers stationed in Australia as part of the design team there – these engineers give inputs on Indian road conditions while also gaining knowledge of design schemes over the two-to-three years that each batch spends there (Friedman 2004). GM India also has over 40 engineers in its product engineering group who are involved in localization of new vehicles, engineering change management, supporting manufacturing and sales for continuous improvement, systems design, as well as homologation (Deb 2004).

Tata Motors, of course, has by the most comprehensive research, development, and design capabilities of any car manufacturer in the country. Its Engineering Research Center (ERC) was established in 1966 and has been involved in product development and engineering for Tata's commercial vehicles division from the very start. Over time, it has set up a substantial design and testing infrastructure–for example, in 1994, Tata invested a substantial amount in a CAD/CAM facility at the ERC (Akarte 2004). With the Indica program, the ERC ramped up its plans to upgrade its facilities through the development of infrastructure and expertise in various areas pertaining to passenger cars, including noise, vibration, and handling, safety, dynamics, refinement, and durability (Akarte 2004). Among other things, it has a crash-test facility, an emissions testing laboratory, test tracks, and test beds. The ERC currently has 1400 employees, and is increasing the number of engineers with advanced degrees. It is also attracting some expatriates back to the country: the current head of the ERC (as well as of the Passenger Cars Division), Dr. V. Sumantran, spent over 15 years with General Motors before joining Tata Motors to lead the Indica effort; and Dr. Pawan Goenka, who led the design team for Mahindra and Mahindra's Scorpio, had spent 14 years with General Motors before returning to India.

A number of automobile manufacturers, including Hyundai, Suzuki, General Motors, DaimlerChrysler, and Fiat, have either established R&D centers in the country, or are in the process of doing so. In some cases, such as for GM, the R&D center has limited interactions with the car manufacturing unit, but in other cases, such as

[46] The main dies for this were sourced from Korea, although some of the smaller components were sourced from India (Pareek 2004).

Suzuki/Maruti, the R&D operations are intimately connected to the vehicle design, development and engineering operations. Such R&D activities, especially the latter kind, will serve to further deepen the technological capabilities of car firms in the country.

6.5 Improvements in service and maintenance practices

The increasing sophistication of vehicles also necessitates improvements in service and maintenance facilities and practices. In the past, Indian cars with their simple technologies could be repaired and serviced by mechanics, who did not have much specific training in automobile maintenance and often engaged in (and learnt from) hit-and-miss attempts. But over time, as technologies incorporated in vehicles, especially their engines, have become increasingly complex, the trial-and-error techniques of untrained mechanics are unsuccessful and may damage the vehicle. For example, MUL found that the inappropriate ministrations to their vehicles often resulted in damage to the microprocessors in their engine management systems (Pareek 2004). Thus, for suitable maintenance and repairs, it has become necessary to go to car dealers or their authorized service centers that have the appropriate equipment as well as suitably-trained staff (and often customers have learnt this the hard way (Pareek 2004)).[47] This allows the vehicle to be better maintained. The density of servicing networks is also a differentiating feature among the manufacturers.[48]

Manufacturers also collect data from its dealer service centers to better understand the problems revealed during servicing or warranty failures. Maruti, in fact, treats servicing as part of its Engineering division since this facilitates effective transfer of such information to its engineers (Pareek 2004).

6.6 Increased local sourcing

Given that Indian manufacturers outsource about 80% of their components (ICRA 2003a), the indigenization imperative also necessitates a focus on vendor relationships. The entrance of MUL into the Indian market began a transformation of the auto-component supplier landscape. It launched a vigorous "vendor development" program and helped its suppliers improve their ability to deliver components of suitable quality at the right time (Venkatramani 1990).[49] MUL recognized that the supplier base was very

[47] Car manufacturers thus have to invest significantly in the training of their service personnel to ensure appropriate maintenance and repair of their vehicles.

[48] MUL has by far the largest network in the country: it has 342 dealer workshops and 1,545 service stations covering the country. Tata Motors has the second-largest network with almost 500 service centers.

[49] Maruti did this in multiple ways by providing facilities test samples, assistance in improving production processes, loans for tool purchases, and advances for product development. It also facilitated interactions between local vendors and its Japanese suppliers. (Venkatramani 1990: pp. 51, 150-159).

fragmented and diverse, and moved to improve upon this continuously – it now has 220 suppliers, down from 340 earlier (Pareek 2004).

MUL also continues to help its suppliers improve their manufacturing performance and upgrade their capabilities (as in the case of zone-hardened windshields), including through setting up four-way JVs between Maruti, Suzuki, and the relevant Indian and Japanese suppliers, if needed (Maitra 2004). Tata Motors itself set up Tata AutoComp Systems, a component supplier that has JVs with a number of firms. In many cases, firms have also brought in their preferred suppliers – for example, Hyundai brought in their own suppliers during their initial setup in India (and Ford has been able to source many components from them). Similarly GM brought in Delphi and Ford brought in Visteon. Other suppliers such as Bosch and Lear themselves have set up subsidiaries in India to supply their customers.

The Automotive Component Manufacturers Association of India has over 400 members with an aggregate turnover of almost $7 billion for the year 2003-04. These manufacturers are involved in supplying a range of components to the OEMs, including forgings, suspension and brake elements, steering and transmission parts, and electrical systems. It should be noted that even items such as engines are sourced locally sometimes – for example, the engines for the GM Tavera are based on an Isuzu design, and are being supplied by HM (Business Line 2004)

Local sourcing can also reduce the inventory needed by the original equipment manufacturer (OEM), which in turn reduces costs. MUL, for, example, is moving towards a just-in-time (JIT) supply model. Seventy percent of its suppliers are close by; hence they deliver components three or four times a day. And in fact, MUL does not have a store for keeping o.k. components after inspection as the company has changed over to self-certification by the vendor and feeding the components directly to the station on the line (Maitra 2004).

6.7 Technological change in associated sectors

Automotive component suppliers have deepening their technological capabilities and significantly improving the quality of their products – in 2002-03, 337 of the 416 members of the Automotive Component Manufacturers of India (ACMA) had ISO 9000 Certification. Three auto component manufacturers from India (Rane Brake Linings, Brakes India (foundry division), and Sona Koyo Steering Systems) received Deming awards last year. Increasingly, auto component manufacturers are also becoming partners in the component development process.[50] For example, MUL insists that its

[50] This is consistent with the global move towards component suppliers becoming active partners in the design process. In fact, rather than giving suppliers component or subs-system designs, OEMs now give performance specification to their suppliers, leaving the hard design, the manufacture, and often even the assembly of the sub-system, to the suppliers. There is generally a hierarchy of suppliers, with Tier-I

suppliers have design capabilities. Indian suppliers (such as Sona, Asahi India, Munjal Showa) are also now beginning to invest in R&D.

The enhanced technological capabilities of these component manufacturers, the improvements in the products, and quality enhancements across the board have led to a significant growth in exports from the auto-components industry. The total value of auto components exported from the country in 2003-04 exceeded $1 billion (Business Line 2004).

The oil-refining industry, similarly, has had to improve the quality of its fuels not only in terms of keeping advanced engines running smoothly, but also in terms of helping automobiles meet the emission standards. It is estimated that the move to India-2000 standards has required an investment of Rs. 100 billion by the refiners[51]– just the adoption of diesel-hydro-desulphurization plants (for producing diesel with 250 ppm content for the whole country and 50 ppm for the four metros) in 9 refineries required an investment of Rs. 55.7 billion (AFP 2002). Further improvement in petrol and diesel quality will require investments in additional secondary processing and treatment facilities – it is estimated that the total investments required in the oil refining sector will be Rs. 180 billion by 2005, and an additional Rs. 120 billion by 2010.

7 Barriers and future issues

The Indian passenger car industry has had some heady times recently. But the manufacturers also note that they face a number of barriers to the upgradation of technologies and their successful dissemination and use. These include:

- Testing facilities: At present, the country has testing facilities at the Automotive Research Association of India (ARAI) and the Vehicle Research and Development Establishment (VRDE).[52] But the need for additional and more extensive test facilities has become clearer in the past few years,[53] and SIAM has been working with the government to establish two more testing facilities.
- Inspection, maintenance, and certification systems and infrastructure: Inspection and maintenance (I&M) programs can help reduce pollution from in-use vehicles. While India does have an I&M policy (termed "Pollution Under Control" (PUC)), it is widely regarded as having only limited

suppliers being directly interacting with, and responsible to, the OEMs, with Tier-II suppliers working with the Tier-I firms and so on.

[51] At present, Rs. 45 ≈ US$1

[52] Tata Motors also has significant testing facilities, including a test track and a crash-test facility.

[53] Many other developing countries, such as China and Thailand, for example, have extensive testing facilities. The lack of domestic facilities is less of a problem with MNCs – Ford, for example, has facilities in Australia, Europe and the US – but even they feel that it would be very helpful to have additional facilities in the country.

effectiveness. It is felt that an upgraded inspection, maintenance and certification system with improved testing procedures and facilities and better enforcement is urgently needed (AFP 2002). SIAM has been doing a fair bit of work on this front, including the design of a computerized system that reduces the chances of error and tampering with results (Gandhi 2002).

- Supply and retention of manpower: While the country produces a large number of engineers, there is stiff competition from other sectors (and other countries) for the graduates of the country's engineering schools. This constrains, to a large extent, the supply of high-quality manpower for research, development, and design activities. Retention of staff is also sometimes a problem, especially after stints outside the company for study leave.
- Improving the auto-component supply chain: While many auto-component suppliers have significantly enhanced their technological capabilities, a majority of the suppliers in the country remain small in scale and technologically backwards. As the supply chain eventually segments into different tiers, the second- or third-tier suppliers will also need to focus on strengthening their design, manufacturing, and quality-control capabilities (Rajshekhar 2004).

India's auto manufacturers will likely have to face a number of challenges in the coming years. First among these, perhaps, are the potential challenges that might be posed by India's commitments to the World Trade Organization (WTO). From April 2001, Quantitative Restrictions (QRs) on vehicle imports have been removed, and automobile manufacturers do not need import licenses either to import cars in kit form or as completely-built units (CBUs).[54] As the Indian market opens up fully, the threat of second-hand automobiles is of particular concern. So far, the Indian government policy has been to apply a high import duty on these vehicles (with the effective duty being 180%). As these tariffs are brought down, import of these vehicles could change the competitive landscape dramatically.[55] In addition, major global auto manufacturers could also source their new vehicles directly from other countries, offering a range that just cannot be matched by domestic manufacturers. Still, many Indian firms believe that imported vehicles will still have a high cost of ownership, and often a weak support and service infrastructure. There also may be non-tariff barriers since imported vehicles will

[54] The QRs have been replaced by tariffs with the tiered duty structure mentioned previously, i.e., components and CKDs/SKDs (25%), followed by CBUs (60%).

[55] In fact, the Indian government requested a group (that was led by David Friedman, MD of Ford India) to study the issues relating to the used-car market. The group suggested that the government should not support used-car imports.

have to meet a number of standards that are specific to India. Of course, for some MNCs, the used-car market could be a boon because they could offer Indian warranties for their imported products to attract customers. Some also look at the positive aspects of the WTO regime in that it makes it easier for manufacturers to procure globally. The potential competition provided by the Chinese automobile industry, both as a supplier of vehicles and a rival for attracting MNC operations, is also an issue of some concern.

To overcome some of these issues Indian government has come out, in 2002, with an Auto Policy that intends to help establish a globally competitive automotive industry in India (DHI 2002). Among other things, this policy intends to

- promote India as a hub for manufacturing small, affordable passenger cars;
- ensure a balanced transition to open trade while minimizing risk to the domestic industry;
- encourage modernization of the industry, and facilitate indigenous research, development, and design;
- assist development of alternate energy vehicles; and
- develop domestic safety and environmental standards at par with international levels.

The government seems willing to consider a range of policy options for meeting these goals, including enhanced incentives for R&D, alternative technologies such as hybrids, electric vehicles, and fuel-cell cars,[56] economic incentives such as age-based road tax, and terminal life policy for commercial vehicles (DHI 2002). Fuel-efficiency standards such as CAFE, however, are considered "not practicable or necessary for Indian conditions," although the AFP recommends mandatory disclosure of fuel economy for each model as a means of providing information to the consumer (AFP 2002, p. 167).[57]

If the government is serious about turning India into a hub for small cars, then it may also have to consider steps that expand the domestic market for such cars through policy incentives, which is a point emphasized also by Jagadish Khattar, the MD of Maruti Udyog (see Rajshekhar 2004).

8 Conclusions

The rapid structural transformation of the Indian industry over the last decade, coupled with a number of factors including intense competition, demanding consumer

[56] There are already some efforts in the country on many of these fronts. For example, a small car manufacturer, Reva, has developed, and produces, electric vehicles.

[57] Some in the industry feel that given India's high fuel prices, there is already a significant incentive for consumers to purchase smaller cars, and therefore fuel-efficiency standards will not add much value.

preferences, tightening emission standards, and the global strategies of the various players, has led to significant technological change in the industry. This has allowed the car manufacturers to meet the challenges of the market as well as public policy imperatives driven by environmental and other concerns. In this process, they have also developed significantly their technological capabilities, especially in design, development, and manufacturing (although to different levels among different manufacturers). Yet, there is much more to be done, if the industry is to meet its ambitious target (and the government's policy goal) of being a serious player on the global automotive stage, especially since exports and healthy domestic markets go hand in hand. At the same time, the industry will also have to face challenges such as those that might emerge as India moves to open its economy further under the WTO or as transportation-related environmental impacts become more severe, especially in urban areas. The ability to implement and manage new technologies will doubtless play a central role in meeting these challenges. Therefore, Indian automobile manufacturers, as well as related firms such as the auto-components suppliers and fuel suppliers, will have to build on their recent progress and continue to strengthen their technological capabilities. And, in turn, public policy that is designed to inculcate technological dynamism within these firms will need to pay particular attention to the drivers of technological change in this industry and target any programs accordingly.

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Appendix I: List of interviewees

Ford India

David E. Friedman	Managing Director and President
Kalhe Ganesh	General Manager, Quality & Technical Affairs

General Motors India

P. Balendran	Director & Vice President, Corporate Affairs
Satya Veerapaneni	Vice President, Manufacturing
Jayanta K. Deb	Director, Product Engineering
K.V. Ramesh	Deputy General Manager, Engg. Services
R. Srinivasan	General Manager, Production

Maruti Udyog

M. Pareek	General Manager, Corporate Services
Sudam Maitra	Chief General Manager, Engineering 1

Tata Motors

Dr. V. Sumantran	Executive Director, Passenger Car Business Unit & Engineering Research Center
R. R. Akarte	General Manager, Engineering Research Center

Society of Indian Automobile Manufacturers

Rajat Nandi	Director General
K.K. Gandhi	Senior Adviser

Appendix II: Company case studies

Ford India

Ford's latest entry into the Indian market began with its $800 million 50:50 joint venture with Mahindra & Mahindra (M&M) for the manufacture of Ford vehicles for the Indian auto market.[58] Ford contributed state-of-the-art automobile technology while its Indian partner, M&M Limited, offered deep understanding of the local market, which was critical for building dealership and distribution networks. In March 1998, M&M announced that it could no longer continue to invest in the JV. Growth did not match expectations, and intensifying competition was curbing the involvement of most local partners in similar relationships. In early 1999, Ford increased its equity participation to 85%.

Ford India's products

The JV began by assembling Escorts (from CKDs) in Mahindra's plant in Nasik starting late 1996. Based on a re-engineered Escort model that debuted in Europe in 1995, the Indian Escort was available with a choice of a gasoline or a diesel engine. Engine compression rates were modified to suit India's poor fuel quality while air-conditioning, brakes, clutch and horn were upgraded.[59] The company observed that nearly 80% of the cars booked were for the diesel version because it gave better mileage (18km/L vs. 13km/L for the petrol version). Also, for the first time, Indian customers were given the most modern diesel engine of Ford.[60] The original Escort complied with Euro-I norms and the company planned to offer the car with Euro-II compliance by April 1, 2000. But the Escort was not received very well in the country, despite ranking first in a JD Powers customer survey. Indian customers were highly sensitive to pricing and fuel economy; as John Parker, head of the JV, noted, "Our Escort, which in most markets is a family car, is an ultra luxury car in India."[61] The production of the Escort ended in 1999.

Ford's second car in India, the Ikon, is based on Ford's best-selling model in Europe, the Fiesta. The Ikon was designed for Indian conditions at Ford's small vehicle center in Germany,[62] but most changes were on functional rather than engineering aspects. For example, the wheel base was extended which creates more space. Likewise, the car's roof line was changed to increase headroom in the back. Modifications also were made to the Fiesta's suspension system. David Friedman, MD of Ford India notes that aside from the Tata Indica, the Ikon is the only other car designed

[58] Before linking up with Ford, M&M also held talks with Chrysler about assembling the Cherokee in India but concluded that this would be too high-priced for the Indian market.

[59] Mary Connelly, "Ford's India Joint Venture to be in Gin Escort Output," *Automotive News*, August 26, 1996

[60] V. Balasubramanian, "Ford upbeat on India, to unveil new model in '98," *The Economic Times*, Nov. 14, 1997

[61] Manjeet Kripalani, "A swarm of bugs in India: Auto markers are gunning for the only viable market: Minis," *Business Week*, January 19, 1998

[62] Lijee Philip, "Rash of mid-size cars to hit road soon," *The Economic Times,* September 20, 1999

specifically for India. The car is a 3-box notchback and was intended to be below the luxury segment but above the Maruti 800. Car testing and validation were performed in India and the company employed 20 engineers in product design to deal with local changes. The Ikon was Euro-II compliant at launch. The company targeted a production of 20,000-25,000 units the first year. As opposed to the company's experience with the Escort, most bookings for the Ikon were for the petrol versions.

The Endeavor, Ford's SUV offering in India, was introduced in Thailand as the Everest in April 2003 and debuted in India later, in November 2003. The Endeavor shares its platform with the Ford Ranger, which along with the Ford F-150, remains one of the best-selling pick-up trucks in the US and some Asian markets. Ford India is bringing the Endeavor as CKDs from its plant in Thailand and assembling them in India. With an initial local content of 20%, Ford India anticipates this number to increase with increasing sales. Powered by a 2.5L, turbo-charged, diesel engine, the Endeavor witnessed some demand in the Indian market. The company has ramped up production capacity to 200 Endeavors a month by introducing a second shift at its Chennai plant to bring down the wait period.[63]

The Mondeo, Ford's premium-segment offering, debuted on Indian roads in December 2001, about a year after its launch in Europe. It is imported as a CBU from the company's plant in Belgium and was introduced with two variants—the petrol and turbo diesel power with manual transmission. The car was also adapted for Indian conditions—it had stronger springs to cushion the ride on Indian roads and had a more spacious rear door and seat and rode higher on the road. Euro-III compliant at launch, the model also included a range of advanced technologies including side airbags, pyrotechnic pre-tension seatbelts, electronic brake-force distribution, an adjustable steering column, an anti-lock braking system, and advanced PATS immobilizer system for security.[64]

Manufacturing and indigenization

A key component of the JV deal between Ford and M&M was the construction of a greenfield plant. Following a nationwide survey to assess potential locations for such a plant, the JV focused on three centers: Delhi, Pune, and Chennai. In each location, the JV evaluated the labor force, the suppliers, cost structure, and the infrastructure in addition to proximity to ports if exports were a priority for a particular production line. In the end, the company invested in the creation of a new manufacturing complex near Chennai, at Maraimalainagar—in the heart of India's auto component supply industry[65]—where production began in 1998. The Maraimalainagar plant was capable of producing approximately 100,000 cars annually in the first phase and could be expanded to a capacity of 250,000 cars. While the plant would not have the same level of automation as in Ford's other plants, it was built to incorporate flexibility for automation.

At the time of launch, the Ikon had a 70% local content. Initially, Ford India sourced the 1.8L diesel engine for the new car from Britain, while the 1.3L and 1.6L

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[63] Girish Rao, "For your fave car, you are mostly in a queue," *The Economic Times*, July 1, 2004

[64] The company also sells the Mondeo in China. However, unlike China where consumers demand technology on part with most mature countries and are ready to pay for it, such technology is not yet regarded as a 'must-have' by Indian consumers (except in luxury cars).

[65] Hyundai had also set up a plant nearby and had brought in a number of suppliers.

petrol engines were sourced from South Africa and Spain. In January 2002, however, the company announced a partnership with Hindustan Motors to manufacture engine and transmission units for the Ikon. David Friedman, MD of the company, noted, "We are the first global company to source engines and transmission from a local partner…which will help us cut costs over a period of time."[66] Importantly, HM's engines and transmission would only be fitted into those Ikons for sale in India; Ford's German facility would supply these parts directly to the export markets serviced by Ford India. The first Ikons with locally made engines debuted in early 2003, raising the local content of these cars to over 90%. Importantly, HM's lines were to be flexibly designed so as to make derivative engines/gearboxes for new models that Ford India planned to launch in the future. The indigenization was also seen to insulate the firm from exchange rate fluctuations and consequent pricing pressure.

To produce its vehicles the JV tapped the existing supplier base which could be seen as being composed of three types of suppliers: One group represented the fully indigenous firms who supplied a variety of firms such as Tata Motors with 'simple' components such as fabrics for instance with the requisite durability, frame retardant, and sun-protection properties. The second group consisted of suppliers that had technical link-ups with MNCs. In addition, there also existed overseas suppliers who came as OEMs to India. Importantly, Ford's two subsidiaries in the auto components business also set up production facilities near the greenfield plant. The company also hoped to adopt just-in-time delivery of components from local manufacturers. David Friedman, MD of the JV in 2001, noted, "We expect suppliers to see the WTO regime as a catalyst to meet global standards. We would like to source from them at the same cost and quality as we can from anywhere else. Then we can build a business here."

Exports

A key advantage to designing the Ikon for India was that the same design was deemed by the company appropriate for other countries in South America such as Brazil and Mexico as well as in South Africa. As Philip Spender, an earlier MD of Ford India, explained, "Growth in emerging markets is so volatile that establishing a reliable export market helps you smooth your business and hedge your bets against the uncertainty of domestic sales."[67] Beginning in early 2001, the company exported Ikon CKDs to Africa and South America. Eighty percent of the company's car exports went to Mexico and the rest to South Africa. Cars then assembled in Mexico were then sent in built form to Brazil. Indeed, in 2001, only 768 of 2595 Ikons produced were sold on the domestic market.

In August 2002, Ford India became the first Indian carmaker to export car components to China, as the sole supplier for some parts for a clone of the Ikon sedan to be launched in that country.[68] The Chennai plant has also received teams from the company's JV in China who came to learn about various aspects of the assembly line.

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[66] "Hindustan Motors to make engines for Ford India," *Reuters*, January 14, 2002

[67] Melinda Ham, "India car boom stalls as local production overheats," Australian Financial Review, October 24, 2000.

[68] N. Ramakrishnan, "Car market shifting gear—end of road for Maruti 800?" *Business Line*, August 14, 2002

General Motors India

Following the deregulation of the India car industry, General Motors (GM) entered the Indian market in 1994 through a 50:50 joint venture with Hindustan Motors, called General Motors India. Total investment in the JV was approximately $100 million and with plants worldwide, the new JV in India fell under the firm's Asia-Pacific operations. Principal responsibility for the JV rested with GM and production began in 1995 at an existing Hindustan Motors plant at Halol, near Vadodara, in Gujarat. GM India was one of the few JVs that maintained equal equity ownership into the late 1990s, but on February 2, 1999, GM announced that it was buying the 50% stake held by its partner, the CK Birla Group (owner of Hindustan Motors).

GM India's vehicles

The JV focused initially on the production of Opel Astra passenger cars in India The Astra was launched in 1996 and was the same model that had been launched earlier by GM in Europe. Over time additional versions of the Astra offered different door formats as well as a sedan and sports coupe. Likewise, engine capacity for the new version ranged from 1200 to 2000cc. The company also launched a diesel version of the Opel Astra in late 1997. Ronald Nardi, then MD of GM India, explained that their "larger goal is to make a wider range of products using the same components."[69]

Subsequently, in 1998, GM India began planning the launch of its second vehicle in the Indian market called the Corsa. This was GM's 'global' car and was being sold in a number of countries such as Australia, Brazil, China, Germany, and South Africa. This was smaller than the Astra and represented the JV's "city mobile." It had a European design and provided a premium option in the small car market (rather than being aimed at first-time buyers). The model had been a hit in emerging markets such as China. While the company bought some parts from Brazil, others were sourced locally. Powering the Corsa was the Ecotec series of engines, with a capacity range of 1200-1600cc, all featuring four-valve-per-cylinder technology but the heavy weight meant a compromise on fuel efficiency.[70] The company chose to introduce the Euro II version of the Corsa rather than beginning with the Euro I. By 2001, the company had launched newer versions called the Corsa Royale and the New Astra Club 2001 (both in petrol and diesel variants). In 2001, the company also completed a "needs-based segmentation" study to identify which segments would grow. The study prompted the subsidiary to launch a station wagon variant of the Corsa, the Opel Swing, with luxury features. The wagon had features such as reinforced suspension, superior ventilation, air-condition and heating with two engine options (1.4 and 1.5 L).[71] By 2003, the company was also producing the Corsa Sail, a hatchback, at its Halol plant. In December 2002, the company also launched the Opel Vectra within a few months of its global introduction. With a 2.2L Ecotec petrol engine and interactive driving system, the car is imported as a CBU from Germany (and will be considered for Indian manufacture based on market demand).

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[69] Lijee Philip, "GM an absolute success in India," *The Economic Times*, August 11, 1997

[70] Bijoy Kumar, "The small mid-size car, anybody?," *Business Standard*, March 6, 1999

[71] Tutu Dhawan, "Roomy Opel Swing from GM Stable," *The Hindu*, July 9, 2001

In early 2003, GM India announced the introduction of the Chevrolet brand in India. GM India viewed its Opel brand as targeted to the premium segment while the Chevrolet brand was targeted to the mainstream market. In early 2003 the company launched the Forester (based on the Subaru Forester) in India as the first vehicle under this new brand. The Forester is being imported as a CBU from Japan, with the firm holding off on the decision to manufacture in India based on market demand. In mid-2003, the company also rolled out the Chevrolet Optra, which was an upgraded Daewoo Nubira and had been launched previously in Canada. The Optra was initially imported in CKD form from GM-Daewoo Automotive Technologies in South Korea. Following the market response to the Chevrolet Forester, the company began considering a more sturdy and economical MUV. The Tavera, launched in 2004 was based on the Isuzu Panther, and was positioned against Toyota's Qualis and Ford Mahindra's Scorpio. It had undergone major changes in preparation for entry into the Indian market – improvements such as superior shifter, improved handling for sudden moves were deemed particularly important to India. The Tavera, with a 2500 cc diesel engine had 85% local content and the company expected 93% indigenization by the end of 2004.

GM has reportedly expressed its intention to relaunch Daewoo's Matiz (a compact car that was very popular in India, before it went off the market due to Daewoo's bankruptcy) renamed Chevrolet Spark.

Manufacturing and indigenization

Year	Vehicle production at GM India
2002	8,000
2003	14,000
2004 (expected)	31,000
2005 (expected)	50,000

In the early years, the output of the JV peaked in 1997 at 10,245 units; in 1998, it sold only 3800 units while the Halol plant's capacity stood at 25,000 units. Even as GM bought out its JV partner, its sales had fallen to a low of 2483 by 1999. In recent years, GM India's production has picked up but only somewhat – in 2003, it produced only about 14,000 cars. Anticipating a production increase, though, in 2002 the company expanded capacity at its Halol plant to 50,000 units.

With 716 employees (and more than 95% of them local), the company's manufacturing plant functions as a unit. In terms of manufacturing engineering, GM focuses on technology processes that allow low-cost, high-volume production of vehicles. For instance, conveyors have been put in place to move cars in production from a point to another, allowing labor to add volume rather than to help move a car from A to B. Still, GM acknowledged that, "it is not economic to automate everything." Although counterpart firms such as Maruti use robotic weld guns, GM India employs manual welding to ensure good functionality. The company did not anticipate employing robots for this purpose till its output reached 80,000 units.[72]

The GM plant has almost no interaction on manufacturing issues with the GM R&D center in Bangalore. Instead, engineers at the plant interact with the engineering group that provided the product. So, for instance, in the case of Corsa, employees interacted with the Opel engineering group and for the Tavera, with the Isuzu engineering

[72] Veerapaneni 2004

group. To perform low-level prototyping and support, the company employs 33 engineers. Unlike other companies such as Telco or Mahindra & Mahindra which employ hundred of engineers, GM India believes it does not need as large a group because it was not designing new vehicles.

The low volume of production in the beginning did not justify any significant sourcing of local components. And because of the WTO, increasingly GM can procure supplies worldwide and, hence, ensure cheap pricing. As Aditya Vij, President and Managing Director of GM India since 2000, noted, "Whenever you introduce a product, as we have done in the past, we start with a low level of localization, but there is a clear localization plan to source more components out of India for this (Optra) program too. It is too early to hazard a guess on what the localization level will be three years hence."[73] Indeed, competitiveness on the cost front is the main driver of localization.[74] In 1997, the Opel Astra started with about 20% indigenization that increased to 80% by 2002 (with the engine and transmission yet to be indigenized). Meanwhile, the Opel Corsa had an indigenous content of 45% in 2000,[75] rising to about 75% by 2002;[76] the Tavera, in contrast, began with 85% localization. The Tavera, however, was unusual in that GM could not source globally since the product on which the Tavera was based was being produced only in Indonesia (Deb 2004). In the end, the degree of localization is determined on a model-by-model basis.

[73] N. Ramakrishnan, "India is one of three growth markets for GM," *Business Line*, July 18, 2003

[74] The Indian market is seen as being extremely price-sensitive and, for GM, this has to be taken into account in any company decision. This stands in contrast to what happened in China where state-of-the-art technology was used since the Chinese wanted to be technology leaders; initial prices in China, however, were higher than those in India. In a JD Powers survey that assessed manufacturing performance for GM Asia, GM India ranked lowest in cost per vehicle. However, because labor was cheap, the company likely spent more hours per vehicle. The company has interactions with its overseas counterparts on the manufacturing side of the business and shares best practices in manufacturing-related activities such as safety, quality, and cost reduction (Veerapaneni 2004).

[75] "GM India to expand used-car business, *Business Line*, May 3, 2000

[76] *Op. cit.* vii

Maruti Udyog

Maruti Udyog Limited (MUL) was incorporated in 1981 as a Government of India (GOI) owned company. After a worldwide search for prospective partners, MUL entered into a license and joint venture agreement with Suzuki Motor Company of Japan in October 1982 with the aim of manufacturing a low-cost, fuel-efficient "people's" car. Following the signing of the JV agreement, Suzuki acquired a 26% equity holding in MUL with an option to increase its shareholding at a later date. Suzuki increased its equity stake in MUL to 40% in 1989 and raised it further to 50% in 1992. Suzuki's share went up to 54.2% in 2002. In addition, Suzuki paid a control premium of Rs10 billion to the Government of India, so that it now has complete management control over MUL. In March 1994, MUL became the first Indian company to produce over one million vehicles, a landmark yet to be achieved by any other car company in India. Maruti is the highest volume car manufacturer in Asia, outside Japan and Korea, having produced over 4 million vehicles by April 2003.

Maruti's passenger cars

MUL created history by going into production in a record 13 months, rolling out its first vehicle, the Maruti 800, in 1984. This car was based on the Suzuki "SS80 Alto/Fronte" which was launched in Japan in 1980,[77] and had a 3-cylinder OHC (overhead camshaft) 796 cc engine. This was the first domestically produced car in the country with completely modern technology. Also, as a first in the Indian market, MUL introduced a new version of this car in March 1986 even though the sales of this vehicle were brisk (cumulative production reached 100,000 units in 1986). The second-generation Maruti 800 was based on the Suzuki Alto GA that was introduced in Japan in 1984.[78]

MUL also introduced the Omni in 1984. This was a van version of the Maruti 800, with the same engine. Maruti still continues to produce these vehicles – although their basic platform has remained the same, these vehicles have received some technical upgrades. For example, multi-point fuel injection (MPFI) engines are now standard, and a Euro II version has also been introduced. Together, approximately 2.5 million units of the two models (Maruti 800 and Omni) have been sold so far, representing almost 50 percent of all cars sold in India in the last two decades. The Maruti 800 still remains the best-selling car in the country since its low price makes it attractive as an entry-level car for those consumers graduating from two-wheelers.

In 1990, Maruti launched a three-box car, the Maruti 1000, which was eventually replaced by the Maruti Esteem, another three-box car, but with a larger, 1.3 liter, engine. Maruti also launched the Zen in 1993 – this was based on the 1991 Suzuki Cervo Mode, a Japanese-market-only model. The Zen was the first car in the country to have all-aluminum engine, electronic distributor pump, and electric fuel pump in the fuel tank.[79] Maruti continued to expand its vehicle line by launching the Baleno and the Wagon R in 1999. The Baleno, called the Cultus in Japan, is Maruti's largest car. It has an all-

[77] Venkataramani 1990

[78] *ibid.*

[79] http://www.domain-b.com/automotive/models/maruti/maruti_zen.htm

aluminum 1590cc, 16-valve SOHC engine with MPFI along with a number of other advanced technologies such a distributorless electronic ignition. Basically the Baleno, with cutting-edge technology, was introduced to compete with the Mitsubishi Lancer and the Honda City. In 2000, MUL further introduced the Alto,[80] Maruti's global car, which is being exported to Europe and is the best selling car in its class in the Netherlands. All of the cars mentioned so far (with the exception of the Maruti 1000) remain in production, along with a few other cars not discussed here. All in all, Maruti offers ten vehicles on six platforms.

While in the early years, there was some lag between the launch of cars in Japan and their introduction in India, over time this lag has disappeared and now Suzuki launches its new cars as global platforms.[81] It is also notable that Maruti has, by far, the largest range of offerings in the Indian market, spanning the three largest-selling segments that account for 97 percent of the total car sales in the country. While Maruti does not have the same kind of dominance in the Indian market that it had a decade ago, it still has over 50 percent of the car market. The fact that it does not have a strong diesel car stands out, though. Maruti had been importing diesel engine from Peugeot to satisfy consumer demand so far, but it is now attempting to rectify this situation by setting up a greenfield plant with a capacity to manufacture 100,000 diesel engines annually, with technology licensed from Fiat and Opel.[82]

Manufacturing and indigenization

Maruti's plant in Gurgaon (just outside Delhi) began with an initial installed capacity of 160,000 vehicles per year. In 1994, the capacity for an additional 90,000 vehicles was added, and in 1999, a further capacity expansion of 100,000 units per year was carried out, leading to a total capacity to produce 350,000 cars annually. Maruti has been making significant efforts to streamline and improve its manufacturing processes over the years. It has undertaken a redesign of the production line and changed its assembly layout. It has also moved towards greater automation – in fact, low-cost automation has played a central role in MUL's cost-efficiency and quality improvements. MUL has in-house development facilities for welding jigs, press dies and other equipment, and it has targeted a 60% reduction in its in-house die manufacturing cost and a cutback in the lead time for die manufacturing by almost half by FY2005. Optimum utilization of production lines, outsourcing of low-value-added jobs, and a substantial reduction in material handling have all contributed to improvements in productivity and the efficiency of operations.[83] Over the years, MUL has increased its productivity from 550 vehicles/person/year to its present level of 1800 vehicles/person/year. In its continuing attempt to improve productivity, it recently implemented an effort that, beginning April 2002, intended to improve production and quality by 50% and reduce costs by 30% within in 3 years.[84]

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[80] This was the fifth-generation Alto, although this was the first time this name was used in the Indian market.

[81] Pareek 2004

[82] "Maruti to set up diesel engine unit in Haryana," *Economic Times*, May 22, 2004

[83] "Best play on a booming industry," Morgan Stanley, August 19, 2003

[84] *Op. cit.* v

High levels of indigenization have also played a key role in helping MUL lowers its costs. In fact, indigenization has been always an important component of the firm's approach, as seen by the rapid rate at which it increased indigenization in its early years.[85] In recent years, Maruti has generally tried to use 75% local components at the time of introduction, increasing the level to 90% within three years of launch. MUL's aggressive indigenization programs are underpinned by its vendor development program, which also has been a key activity for Maruti right from the establishment of the JV. Vendors within 100 km of the plant supply about 70% of the components; this has allowed Maruti to move closer to just-in-time production, which has also resulted in the elimination of the store and further cost-savings. A number of vendors have JVs with foreign component suppliers (often Suzuki's suppliers), and many more have technical collaborations. More than 80 percent of its vendors have ISO 9001/2 certification.

Year	MUL's cumulative indigenization schedule
1984-85	31.5
1985-86	42.6
1986-87	57.3
1987-88	84.5
1988-89	95.3

Exports

Maruti has been exporting vehicles since 1986, and it remains the largest exporter of cars from the country. It presently exports to over 40 countries, with Europe accounting for over 70 per cent share. The top 10 destinations of exports from Maruti are Netherlands, Italy, Germany, Chile, UK, Hungary, Nepal, Greece, Bangladesh and France. In 2003-04, MUL exported just over 50,000 vehicles, and by mid-2003, its cumulative exports had exceeded 300,000.[86] Furthermore, Suzuki has taken an in-principle decision to make Maruti the sourcing base for its worldwide small cars requirements (except Japan).

[85] *Op. cit.* i

[86] Byas Anand, "Maruti clocks exports of 3 lakh units," *Times of India*, August 30, 2003

Tata Motors

Tata Motors was established in 1945 as the Tata Engineering and Locomotive Company (Telco) with the aim of manufacturing locomotives and other products. It entered into a technical collaboration in 1954 with Daimler Benz AG of West Germany (now DaimlerChrysler) for the manufacture of medium commercial vehicles. Daimler Benz also took a 10 percent stake in Telco (that is still owns today). Although the collaboration with Daimler Benz ended in 1969, Telco continued to make commercial vehicles, and over the years, the company began to develop its own products. For example, in 1986 Telco introduced the 407, its first light commercial vehicle, and followed this up with the passenger vehicles Tata Sierra and Estate, which were introduced in 1991 and 1992 respectively. The establishment in 1966 of an Engineering Research Center at Telco's facility in Pune was instrumental in the firm's ability to design and develop products.

Tata Motors' passenger vehicles

While Tata Motors' earliest passenger vehicles, the Sierra and the Estate, were both built on a pick-up platform, in 1993 the company decided to try and develop its own passenger car.[87] Since the car would be specifically designed for the domestic market, its characteristics were guided by the perceived needs of the Indian consumer. Particularly important was the requirement that the interior space be comparable to the old icon, the Ambassador, and the exterior dimensions be similar to that of the Maruti Zen, then the premier car in the compact segment. It was also decided that the price be comparable to the Maruti 800, by far the most dominant car in the Indian market at that time. And it was felt, given the Indian consumers focus on cost, that a diesel version of the car would be essential.

The car was designed mainly in-house, although Tata Motors received assistance from firms such as I.D.E.A., an Italian design consultancy, for the design of the vehicle body, from Le Moteur Moderne of France for the development of the gasoline engine. The project had an overall cost of Rs. 17 billion (development: Rs. 2.06 billion, tooling: Rs. 740 million, and manufacturing plant: Rs. 14.2 billion) and involved 700 engineers. A similar process of vehicle development, tooling and setting up of production facilities in an industrialized country would cost about well over $2 billion in comparison to the $400 million it cost Tata Motors.[88]

The overall process from the product concept to the manufacture of the vehicle took just over three years, and the vehicle was launched in December 1998 with gasoline and diesel variants. (See next page for a schematic of the Indica production schedule.) Tata Motors launched an updated version, the Indica V2, in 2001, with a redesigned suspension, some modifications in the engine as well as a host of other minor changes.[89]

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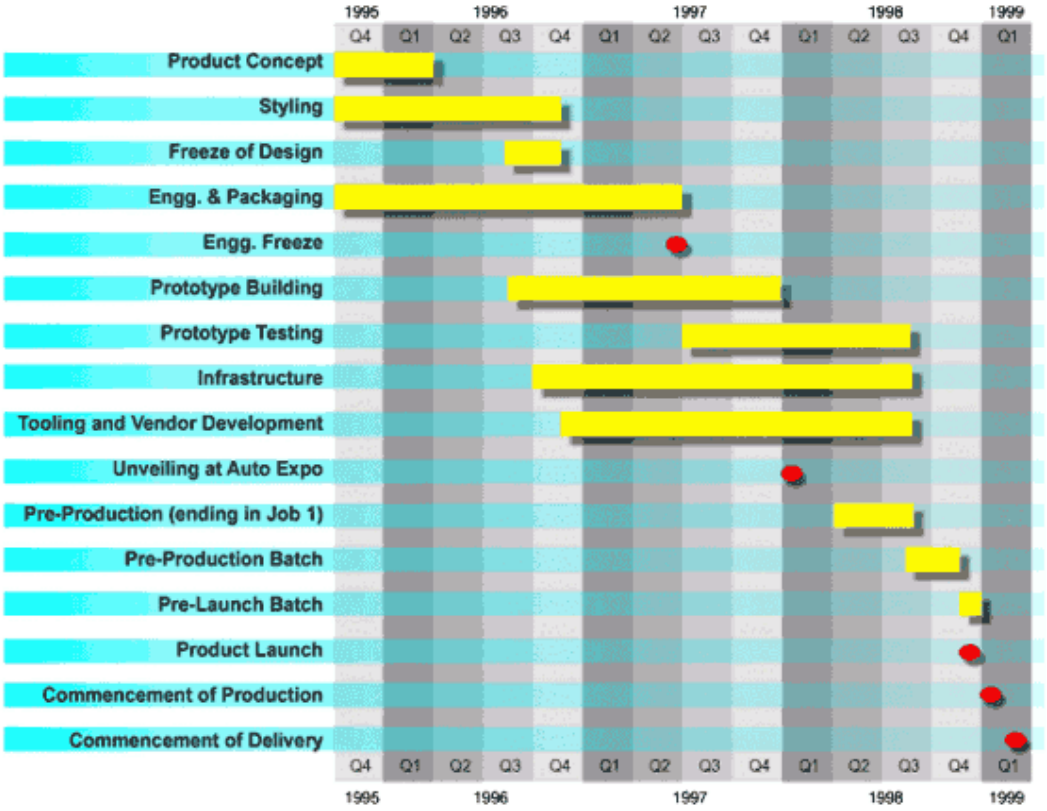
[87] Ratan Tata, the Chairman of Telco, had proposed the idea of an Asian car to be built as a collaborative effort by the Indian automobile industry. But upon receiving a less-than-positive response, he decided that Telco would build such a car on its own.

[88] A. Kumar, "Idea that have worked: The Indian Car," (http://www.tata.com/tata_engg/articles/20001031 indica_story_a.htm)

[89] "Return of the Indica," *Business World*, November 5, 2001

The Indica became the fastest-selling automobile in Indian history when it chalked up sales of 100,000 within 18 months of its launch; by October 2003, the cumulative production of Indica had topped 250,000. It is now the third-highest selling car model in the country (after the Maruti 800 and the Hyundai Santro). Tata Motors also launched the Indigo, a mid-size sedan, in December 2002, and the Indigo Advent, a crossover, in March 2004. Both of these vehicles are built on the same X1 platform as the Indica.

The Indica Project Schedule



Tata Motors is also developing a no-frills, "people's" car that will be launched within three years and will cost Rs. 100,000.[90] Such a car could potentially create a niche somewhere between a three-wheeler and a current small car – Ratan Tata, the Chairman of Tata Motors, feels that "the market potential for such a car in India and perhaps in the neighbouring countries is enormous."[91]

Manufacturing and vendor development

For manufacturing the Indica, Tata Motors bought for Rs. 1.03 billion an unused Australian plant from Nissan. This plant, along with other substantial additions, forms the manufacturing facility for the production of the Indica and the Indigo. The whole

[90] "Tata's Rs one lakh car in 3 years," *Indian Express*, June 30, 2004

[91] "Special group for work on people's car soon," *Financial Express*, July 22, 2003

task was enormously complex: it required, for example, the manufacture of 740 dies and the creation of 4,010 production fixtures just for the Indica.[92] The current capacity of the plant is 150,000 units per year, although Tata Motors is planning to expand this capacity by 50 percent during 2004-05.[93]

Tata Motors also heavily involved its vendors in the development process. At the time of launch, over 300 vendors supplied 1,360 parts of the Indica, comprising 77 percent of the vehicle's cost.[94] In December 1995, the Tata group also established a company, Tata AutoComp Systems (TACO), for facilitating the manufacture of auto-components. TACO is structured as a holding company with eleven JVs under its fold spread across five business group. Equity and technology partners include some of the global market leaders in the automotive component sector – Johnson Controls, Yazaki Corporation, Toyo Radiators, Ficosa and Faurecia among others. TACO is ranked within the top five Indian auto-component groups in the country.

Tata Motors is also involved with its vendors for its future products. For example, it is working on the common rail direct injection (CRDI) engines with Delphi, the large US-based auto component producer.[95]

Exports

In late 2002, Tata Motors signed a manufacturing and supply agreement with the MG Rover Group, UK. Under the agreement, the Tata will supply 100,000 Indicas, incorporating certain Rover-specific modifications, over five years. These cars are being marketed in Europe as the CityRover.[96] The first batch of CityRovers was rolled out in September, 2003. Tata Motors is now looking at other export possibilities including China, South Africa, Thailand and both East and West Europe.[97] In addition, TACO is also exporting auto components.

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[92] *Op. cit.* ii

[93] "Tata Motors to invest Rs. 800 crore this year," *Business Standard*, July 8, 2004

[94] *Op. cit.* ii

[95] *Op. Cit.* vii

[96] The Phoenix Holding Group, the owners of Rover, subsequently also signed an agreement to distribute in the UK and Ireland Tata's Safari offroad vehicle as well as Loadbeta, a pick-up truck

[97] "Tata Motors eyes new markets," *Financial Express*, June 15, 2004

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