Case 3

The Global Automobile Industry in 2004

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Some fifty years ago renowned management author Peter Drucker called the automobile industry the "industry of industries." In many respects his characterization is still true today. The industry makes some 60 million cars and trucks a year, employs millions of people in factories scattered around the globe, and accounts for about 10 percent of the gross domestic product in rich countries. The top ten global producers collectively sold $1.1 trillion worth of vehicles in 2003. The industry consumes nearly half the world's output of rubber, 25 percent of its glass and 15 percent of its steel.[1] Its products are responsible for almost half of the world's oil consumption and are a major source of rising carbon dioxide levels in the atmosphere, the greenhouse gas implicated in global warming. Modern cities with their attendant suburban sprawl have been designed around the automobile. The automobile has shaped our landscape, changed our atmosphere, and exerted a profound influence on the global economy. It is indeed, still the industry of industries—and today the industry of industries is going through wrenching changes.

Background

The emergence of the modern industry can be dated back to 1913 and Henry Ford's first implementation of the production technology that would revolutionize so much of industrial capitalism over the next few decades, the continuously moving assembly line. Ford quickly became the master of mass production, churning out thousands of black Model T Fords from his Highland Park plant in Michigan. Mass production dramatically lowered the costs of building cars and paved the way for the emergence of a mass consumer market. It was not Ford, however, but Alfred Sloan, the CEO of General Motors, who in the mid-1920s realized that the key to success in the industry was serving the customer by offering them "a car for every purse and purpose."[2] Under Sloan, GM segmented the market, producing a differentiate range of models to consumers. In doing so, the company seized market leadership from Ford and has not relinquished it since.

By the 1960s, General Motors, Ford, and Chrysler dominated the U.S. market; then by far the world's largest. GM at one point made over 60 percent of all automobile sales in the United States, and collectively the three companies accounted for over 90 percent of sales. Moreover, the companies were now multinationals with significant operations outside of North America, and particularly in Europe, the world's second biggest car market. This, however, was all about to change. Riding the wave of economic disruption caused by the OPEC oil price hikes of the 1970s, foreign manufacturers of fuel efficient cars began to invade the U.S. market. First there was Volkswagen, with its revolutionary VW Beatle, and then a slew of Japanese manufacturers including, most notably, Honda, Nissan, and Toyota.

It was one of these foreign invaders, Toyota, that was to usher in the next revolution in car making.

Faced with a small and intensely competitive home market, and constrained by a lack of capital, Toyota started to tweak the mass production system first developed by Ford. Engineers tried to find ways to build cars efficiently in smaller volumes and with less capital. After years of experimentation, by the 1970s a new production system was emerging at Toyota. Later dubbed "lean production," it was based upon innovations that reduced setup times for machinery and made shorter production runs economical. When coupled with the introduction of just-in-time inventory systems, flexible work practices, an organization-wide focus on quality, and the practice of stopping the assembly line to fix defects (which was the antithesis of Ford's continually moving assembly line), the lean production system yielded significant gains in productivity and product quality. In turn, this lowered costs, improved brand equity, and gave Toyota a competitive advantage.

As was the case with mass production, Toyota's innovation of lean production was imitated, with varying degrees of success, by other volume car makers. Japanese competitors were the first to try and adopt Toyota's innovation. During the 1990s the American volume car makers jumped on the bandwagon. Despite this, Toyota still enjoys a competitive advantage in the automobile industry that is based upon production excellence. Just as significantly, the sluggish American response to Japanese and European invasions of their home market allowed the foreigners to capture ever more market share.

By the early years of the new century, America's big three (now often referred to as the Detroit Three) were rapidly losing their grip on their domestic market. Collectively, GM, Ford, and Chrysler (now part of the German-owned Daimler Chrysler Corporation) accounted for just 47.1 percent of passenger car sales in 2003. The other 52.9 percent of sales were attributed to foreign producers, up from 34 percent in 1988.[3] Moreover, in stark contrast to the situation in the 1980s when most foreign cars were imported into the United States, by 2003 most foreign nameplates were built in "transplant" factories located in North America.

What saved the Detroit Three during the 1990s were robust sales of light trucks, and particularly sports utility vehicles (SUVs). Foreign manufacturers had been caught off-guard by the American appetite for SUVs, which surged as oil prices remained low and the economy boomed. In 2003, GM, Ford, and Chrysler still accounted for 74 percent of light truck sales. This pumped up their overall market share of U.S. light vehicles to 61.8 percent in 2003. But here, too, market share was eroding (it had fallen from 66.8 percent in 2000) due to gains made by Japanese and European SUV models.[4] Making matters worse, rapidly rising oil prices during 2004 hinted at an end to the decade long boom in SUV sales. With competition in the passenger car segment intensifying, the outlook for the Detroit Three looked increasingly grim.

Competition in the U.S. Market, 2004

Demand and Supply

Total sales of passenger cars and light trucks in the United States peaked in 2000 at 17.35 million units before declining for three consecutive years to 16.64 million units in 2003 (see Exhibit 1). In total, U.S. dealers sold some $400 billion worth of vehicles in 2003. The decline between 2000 and 2003 was pronounced in the passenger car segment, where volume fell from 8.85 million units in 2000 to 7.61 million in 2003. Light truck sales, however, continued to expand from 8.5 million units to 9 million units between 2000 and 2003, driven in large part by America's continuing love affair with SUVs.[5]

The decline in overall vehicle sales was a product of the economic slowdown following the long boom of the 1990s and September 11, 2001. The sales decline has left the American industry with too much productive capacity. Estimates suggest that in 2003, the industry had the capacity to build some 18 million cars and light trucks in the United States, but actually only made 13.33 million units (the balance of sales was accounted for by imports).[6]

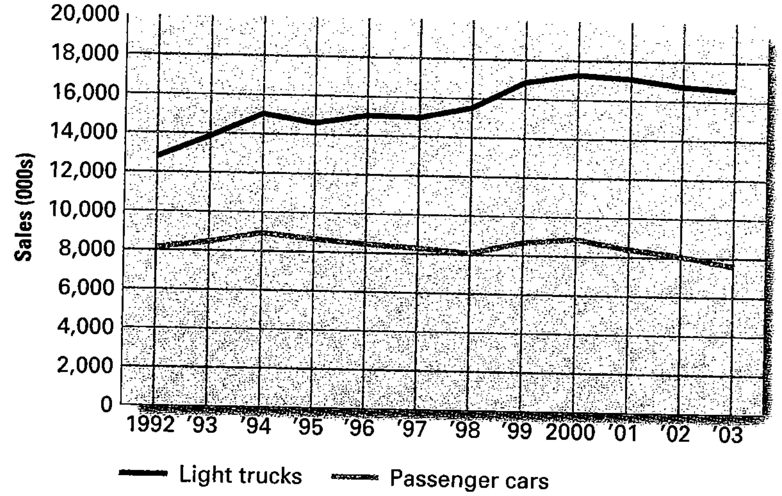
In large part, the excess capacity situation has been created by foreign car makers, who have made significant investments in the United States over the last twenty years. Japanese investments began in the early 1980s as a response to the threat of import controls on exports from Japan. By the early 2000s, foreign owned producers had the capacity to build some 3 million automobiles in the United States, up from zero in 1981.[7] (The figure excludes the Chrysler division of Daimler Chrysler, which is counted as one of the Detroit Three, even though it is now owned by a German firm).

The foreign investment shows no sign of slowing down. Hyundai will open its first U.S. factory in

EXHIBIT 1

Sales of Cars and Light Trucks, 1992–2003 (000s)

Source: Standard & Poor's.



Montgomery, Alabama, in 2005, making it the first Korean car company to build in North America. Meanwhile, Toyota will open its sixth North American factory in San Antonio, Texas, in 2006. Collectively, foreign-owned auto factories accounted for 26 percent of U.S. automobile production in 2003, and that percentage seems set to rise.

Many states offered financial incentives such as tax breaks in an effort to attract inward investment by foreign producers, and the associated jobs. Estimates suggest that by 2003 the cumulative value of incentives given to attract new factories amounted to between \$1.2 billion and \$2 billion, which translates into an investment incentive of \$1,000 for every car built by a foreign-owned factory.[8]

Price Competition

In the aftermath of September 11, 2001, sales slumped at American car dealers. Faced with excess capacity, high fixed costs, and an inability to quickly shutter capacity due to commitments made to labor unions, General Motors responded with aggressive sales incentives. These included 0 percent financing deals and cash back rebates on certain vehicles that reached as high as \$3,000. Very quickly its rivals were forced to respond, and incentives became the industry norm. The size of incentives, however, varied from producers to producer. While the Detroit Three have been offering incentive packages that have exceeded \$4,000 per vehicle, the big Japanese producers, Honda, Nissan, and Toyota, have been less aggressive. Toyota, for example, offered incentives of just over \$2,000 per vehicle in 2003, compared with GM's average incentive package of \$4,300 a vehicle.[9]

The incentives have had the effect of making cars more affordable. In 1973, the average U.S. citizen needed 17.5 weeks of annual family earnings to purchase an average priced car. By 1994, that figure had risen to 24 weeks, but by 2003, it had declined to 20.7 weeks. The signs are that the downtrend continued in 2004.[10]

In late 2003, GM tried to cut back on incentives, only to find that sales declined as consumers bought cars from those who kept incentives in place. In part, GM noted, two years of incentives had conditioned consumers to expect them, and breaking that habit was proving difficult. By February 2004, GM had gone back to offering a full range of sales incentives—indeed, it had even boosted them slightly in an effort to shift unsold inventory that was starting to accumulate of dealers lots.[11]

One effect of sales incentives has been to get consumers to sell their used vehicles at a higher rate than would otherwise have been the case. This has hurt the price of used cars. An index of used car prices, for example, fell from 115 in 2002 to 102.4 by April 2003.[12] Ironically, falling used car prices can hurt demand for new cars as more consumers purchase

EXHIBIT 2A

Market Share of U.S. Dealer Passenger Cars (%)

Manufacturer	2000	2001	2002	2003
General Motors	28.6	27	25.5	25.7
Ford	19.1	17.8	16.4	15.4
Daimler Chrysler	7.3	6.6	6.5	6.0
Toyota	11.0	11.3	12.2	13.1
Honda	10.0	10.7	10.3	10.8
Nissan	4.8	4.9	6.1	6.6
Volkswagen	4.9	5.1	5.1	4.8

EXHIBIT 2B

Market Share of U.S. Dealer Light Trucks (%)

Manufacturer	2000	2001	2002	2003
General Motors	28.0	29.7	31.5	30.5
Ford	28.9	27.8	25.8	25.1
Daimler Chrysler	22.0	19.7	19.3	18.5
Toyota	7.6	9.0	8.8	9.6
Honda	3.3	3.5	4.7	5.9
Nissan	3.9	3.3	2.9	3.2

Source: Standard & Poor's.

used cars, trapping the car producers in something of a vicious cycle. Moreover, the fall in used car prices is of direct concern to the automobile companies, who have expanded their leasing programs in the last decade. Ford in particular took a financial hit in 2001 when it found that vehicles coming off lease were worth less than originally projected.

Market Share

The launching of incentives by GM was not sufficient to stem market share losses during the early 2000s (see Exhibit 2). Between 2000 and 2003, GM saw its share of passenger cars fall from 28.6 percent to 25.7 percent. Ford and Chrysler also experienced significant declines in passenger car share, while Toyota, Nissan, and BMW made significant gains. Toyota, in particular, captured 13.1 percent of U.S. passenger car sales in 2003, more than twice as much as Chrysler.

While GM was able to offset losses in the passenger car segment by gains in the light truck segment where it held 30.5 percent of the market in 2003, Ford and Chrysler experienced market share declines here, too. Toyota and Honda were the largest gainers. Both companies introduced new SUVs in this time period and were reaping the gains. In 2003, Toyota held a 9.6 percent share of the U.S. light truck market, up from 7.6 percent in 2000.

Quality seems to be an important factor explaining market share changes in the industry. J.D. Power Associates produces quality rankings for automobiles sold in the U.S. market. According to these rankings, Toyota and Honda consistently have the best quality rankings in the industry. In 2004, J.D. Power's Vehicle Dependability Study, which measures quality after cars have been on the market for three years, ranked Toyota and Honda one and two, with 207 and 210 problems reported per 100 vehicles respectively, compared to an industry average of 269 (see Exhibit 3). J.D. Power's Initial Quality Study, which measures problems reported in the first 90 days after sale, similarly ranked Toyota and Honda one and two in terms of quality, with scores of 101 and 102 against an industry average of 119. GM came out best of the Detroit Three on both surveys.[13]

However, tracking of quality improvements since 1998 suggests that the Detroit Three are closing the quality gap between themselves and foreign producers and may ultimately achieve parity (see Exhibit 4). If the trend continues, differentiation on factors other than quality—such as styling, design, and technology—will come to the fore. Also of major note in Exhibit 4 are the poor performance of Korean manufacturers in 1998 and their rapid improvement over the next six years.

Profitability and Labor Productivity

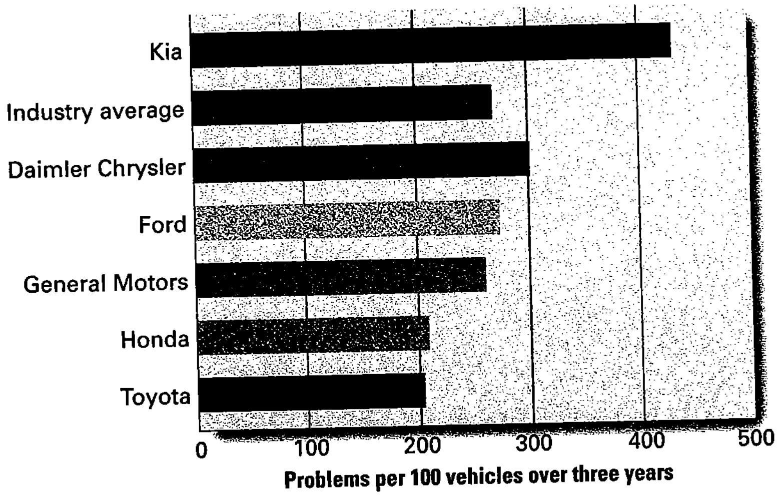
The combination of falling demand, excess capacity, and incentives hurt profits, particularly for the Detroit Three, all of whom saw their profits slump in 2001, and despite a recovery, have seen their profits remain below through to 2004 (see Exhibit 5). Toyota, on the other hand, made record profits in 2003 and 2004. Indeed, in both years it made more than the Detroit Three combined.

What is not evident from Exhibit 5 is that Toyota's earnings were held back by weak conditions in Japan. In the United States, the company has been very successful in recent years. According to a 2004 study by

EXHIBIT 3

J.D. Power 2004 Vehicle Dependability Study

Source: J.D. Power Associates.



Harbour & Associates, in 2003 Toyota made $1,742 in profit on every vehicle it manufactured in North America. Nissan did even better, making $2,402 on every car sold in North America, while Honda made $1,488. General Motors, in contrast, made only $178 profit per vehicle, Ford lost $48 and Daimler Chrysler lost $496 per vehicle (Ford was profitable in 2003 only due to the success of its foreign operations).[14]

As noted earlier, Toyota has the best reputation for quality in the industry. The higher quality translates into a higher value and allows Toyota to charge 5 to 10 percent higher prices than General Motors for equivalent cars. Historically, Toyota and other Japanese manufacturers also benefited from superior labor productivity in their North American plants, but according to the Harbour Report, the labor productivity gap in North American plants has narrowed significantly in recent years. In 2002, the last year for which full data are available, Nissan was the productivity leader in U.S. assembly operations

EXHIBIT 4

J.D. Power Initial Quality Study, Trends in Quality 1998–2004

Source: J.D. Power Associates.

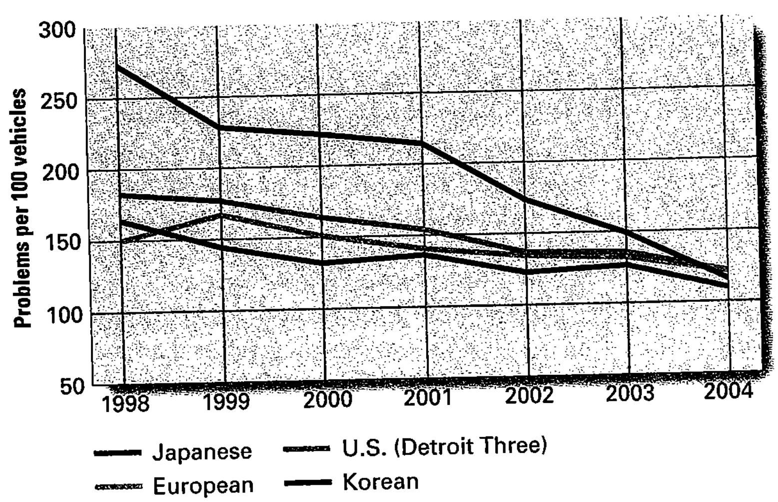


EXHIBIT 5

Net Income 2000–2004 (Millions)

Company	2000	2001	2002	2003	2004
General Motors	$4452	$601	$1736	$2862	$3990
Ford	$4823	–$5443	$284	$921	$4000
Daimler Chrysler	$3338	–$589	$5114	–$526	$2945
Toyota	$5447	$4177	$6247	$10995	$11800

taking just 17.92 employee hours to build a car. Honda took 19.78 hours, Toyota 22.53, General Motors 26.10, Ford 26.87, and Daimler Chrysler 30.82 hours.[15]

The 2004 report revealed that improvements continued across the board. Nissan's assembly plant in Tennessee led the way, building a car in 15.33 hours of labor. The most improved automaker was Daimler Chrysler, which increased labor productivity at its assembly plants by 7.8 percent over the prior year. General Motors also registered improvement in its assembly operations, and on average took 23.61 hours to build a car, down from 26.10 in 2002.[16] Since neither Honda nor Toyota fully participated in the 2004 study, data for them are no longer available. Still, the author of the Harbour Report, Ron Harbour, has noted that over the 1999–2004 period productivity gains at Japanese plants in North America have been relatively modest, and lagged the gains made by the Detroit Three. The problem for the Detroit Three, according to Harbour, is that the variance of productivity across their plants is much greater than at Japanese manufacturers.[17]

For their part, American manufacturers argue that their profitability has been hurt by huge pension burdens. General Motors, for example, has 2.4 pensioners for every current employee. The more that these companies lay off older workers, the more they add to their burden of pensions and health care costs. The collapse of the stock market in 2000–2001 didn't help matters either, since it reduced the value of company pension funds. Both Ford and GM had to issue bonds worth billions of dollars just to plug the holes in their pension funds. GM now has to pay out $1 billion a year in interest payments just to service these bonds. Moreover, the company has to pay out some $3 billion a year to cover health care costs for retirees. Just as troubling, GM may have to increase funds going into its pension plan if the fund does not earn a long-term return of 9 percent per annum.[18]

Industry Trends

In an effort to cope with the tough competitive conditions in the North American market and elsewhere, automobile companies are looking hard at additional ways to take costs out of their system or to capture more of the available demand. Among the most notable initiatives underway have been an industrywide attempt to streamline product development, offer a wider range of niche cars, work more closely with suppliers, develop systems for building cars to order, and introduce a new breed of hybrid cars.

Market Fragmentation and Product Development

Historically it took four years and cost as much as $1 billion to develop a new car model and prepare a factory for its production. To recoup those fixed costs, automobile companies needed high-volume sales, which required selling the car without a major update for four years and sometimes as long as seven years. To attain maximum economies of scale, automobile companies tried to run their plants at full capacity, producing 240,000 units a year. The ideal was to have each plant produce just one model.

In recent years the automobile market has become increasingly fragmented. Models are now updated more frequently to keep pace with changing consumer tastes and competitive pressures, shortening product life cycles. Customers have demanded more variety, and automobile companies have been willing to give it to them, bringing a wider variety of niche cars to the market. The Ford Taurus, for example, was once the best-selling passenger car in America with annual sales of around 500,000 (equivalent to two plants running at full capacity). As sales have slipped, Ford has decided to kill the Taurus, and replace it with two models, one smaller than the Taurus and one bigger.

To recoup the costs of such offerings, development and manufacturing costs have to be reduced. Automobile companies are trying to do this by using a common platform and parts in a wider range of cars. An example of the industry's new philosophy is GM's 2005 roadster, the Pontiac Solstice. Under the old economics, the Solstice would never have made it off the drawing board. The car is forecasted to sell only 25,000 units a year. With a projected sticker price of $20,000 the volume was insufficient under the old paradigm to recoup costs. To make the car economically, GM has had to revolutionize its product design philosophy. By digitalizing much of the design of the car and tools, GM was able to cut $50 million out of design costs. It used to take 12 design engineers 3 months to produce a clay model, an essential step in the design process. Now a single designer can take an idea on a computer screen to an animated video of a vehicle in three weeks. GM saved another $80 million by designing the car so that it could use existing tools at its factory. More money was saved by a decision to base the car on a common platform architecture called Kappa, which will be used for other small rear drive cars. According to GM Design Chief Bob Lutz, GM can make an almost unlimited number of bodies on the Kappa architecture, and each vehicle will be profitable with a volume of 20,000 to 25,000 a year.[19]

Using the same platform across a wide model range is fast becoming industry standard practice. As with so many other industry trends, the Japanese pioneered the practice. Honda, for example, builds its Odyssey minivan, and Pilot and Acura MDX SUVs on the same platform, and has added a pickup truck to the mix. Currently Chrysler bases its vehicle fleet on thirteen distinct platforms. The company is trying to bring this down to just four platforms, in the process reducing the product development budget from $42 billion to $30 billion. Ford and General Motors have similar aims. The Kappa platform for GM's Pontiac Solstice will also be used for its new Saturn coupe and at least one more GM car. As GM develops its next generation Chevy Silverado and GMC Sierra pickups, it plans to reuse much of the existing platform, cutting development costs in half to nearly $3 billion. Over the next eight years, Ford plans to use its Mazda 6 sedan platform (Ford owns Mazda) as the basis for ten new vehicles. The idea, according to Ford's head of operations, is to engineer it once, use it often.[20]

Another design goal is to try and use the same parts in a wider variety of car models and where appropriate use parts from old models in new cars. Detroit auto designers used to boast that new models were completely redesigned from the floor up with all new parts. Now that is seen as costly and time consuming. At General Motors the current goal is to reuse 40–60 percent of parts from one car generation to the next, thereby reducing design time and tooling costs. At Ford, the number of parts has been slashed. For example, Ford engineers now choose from just four steering wheels, instead of contemplating fourteen different designs.

As a result of all these changes, the costs and time for bringing new cars to market is shrinking. Most of GM's new development projects are now on 24-month schedules—a far cry from the late 1980s when GM engineers celebrated because they were able to bring out the Chevrolet Corsica in *just* 45 months![21] Ford has reduced its product development time by 25 percent since the late 1990s, and is still getting better by 10 percent per year.

Flexible Factories

Hand in hand with changes in design philosophy, automobile companies are retooling their factories to reduce costs and make them capable of producing several car models from the same line. By doing so, they hope to be able to reduce the break-even point for a new car model. With the Solstice, for example, GM cut design costs by using a common platform and parts. It has cut tooling and production costs by investing in flexible manufacturing technologies that can be used to produce multiple designs based on the Kappa platform from the same basic line. GM has also worked hard to get unions to agree to changes in inflexible work rules. Assembly line workers now perform several different jobs, which reduces waste and boosts productivity.

Ford hopes to have 75 percent of its production built on flexible assembly lines by 2010. If successful, its investments in flexible factories could reduce annual costs by some $2 billion a year.[22] Ford spent $400 million modernizing an eighty-year-old assembly plant in Chicago. This plant is now capable of making eight models from two different chassis.

Reengineering their plants to accommodate a wider range of models is not cheap. In 2003, GM spent some $7.3 billion on capital improvements at its automobile plants, up from an average of $5.4 billion in the early 1990s. A In the early 1990s, Ford spent some $3.5 billion annually on capital improvements. More recently its capital spending has been running at a $7.5–$8 billion annual rate. Chrysler, too, has increased its spending, while Toyota planned to spend some $9 billion upgrading its factories in 2004.[23]

Supplier Relations

At one time the American automobile companies were highly vertically integrated, producing as much as 70 percent of their component parts in-house. Those parts that were not made in-house were often purchased using an annual competitive bidding process. The last decade has seen enormous changes here. Both Ford and GM have sold off a major chunk of their in-house suppliers. GM spun out its in-house suppliers in 1999 as Delphi Automotive. Delphi took some 200,000 former GM employees with it, about one-third of the total, many of who were union members. Ford spun out its in-house suppliers the following year as Visteon Corporation. Delphi and Visteon are now the number one and two auto parts suppliers in the United States. In an effort to assert their independence, both companies are moving rapidly to build a more diverse set of customers.

The Detroit Three have also been reconfiguring their relationships with independent suppliers. The automobile companies are now expecting their Tier 1 or major suppliers to produce modules—larger vehicle parts that comprise several components such as fully assembled chassis, finished interiors, and "ready for the road" exterior trim. These modules are then bolted and welded together to make finished vehicles, rather like toy models being snapped together. For such an approach to work, the suppliers have to get involved earlier in the process of designing and developing new models and engineering assembly tools. To create an incentive for them to do so, the automobile manufacturers have been entering into longer term contracts with their Tier 1 suppliers. At the same time, Tier 1 suppliers face intense price pressures and requirements for quality improvements. If they don't meet these, the automobile companies have shown a willingness to walk away from long-term deals. In 2003, for example, Daimler Chrysler pulled a $90 million contract from a supplier of interior products, Collins & Aikman, because of poor product quality.[24]

Another trend has been to encourage major suppliers to locate new facilities next to assembly plants. Ford's refurbished plant in Chicago has a supplier park located next door. The idea is to get suppliers to deliver inventory to the assembly line on a just-in-time basis. At the Chicago plant, the average component now needs to travel only half a mile, as opposed to 450 miles in the past. The proximity has saved suppliers transportation costs, which are passed onto Ford in the form of lower prices. In addition, Ford has reduced inventory on hand at its Chicago plant from two to three days' worth to just eight hours' worth.[25]

Dealer and Customer Relations

Once a car is built, it spends between forty and eighty days sitting in factory lots, distribution centers, and dealers' forecourts before it is actually sold. This represents a huge amount of working capital that is tied up in inventory. To make matters worse, one of the biggest problems in the automobile industry is predicting what demand will be. To a large extent, repeated rounds of price cutting (disguised as incentives) in the American automobile industry have been initiated in an attempt to move slow selling inventory sitting on dealers' lots. If automobile companies could predict demand more accurately, they might be able to reduce the mismatch between inventories and demand—and hence the need to resort to incentives.

In an effort to improve this end of the value chain, the automobile companies have been trying to reduce the time between ordering and delivery. The ultimate goal is to have cars built to order, with cars being assembled and shipped to a dealer within days of a customer placing an order. This is similar in conception to the way that Dell sells computers, with customers ordering a computer, and paying for it, online, while the machine is shipped out within days. Nissan has calculated that if it could move to a build-to-order system with a short cycle time, it could reduce costs by as much as $3,600 a vehicle.[26]

Achieving this goal, however, is easier in theory than in practice. One obvious problem is that if the flow of orders is lumpy or seasonal, so will be the output of a factory, which might result in periods where capacity is not being fully utilized. Another problem involves changing buyer behavior. In America, at least, many consumers look for instant gratification and expect to be able to purchase a car when they walk onto a dealer's lot, which is the antithesis of a build-to-order system. Still, there are some signs of a shift away from this mentality. Honda, for example, has been building its best-selling MDX SUV to order—although the delivery time is more like two months than two days. In Germany, BMW now builds some 60 percent of its cars to order, but once again the delivery time can be as long as two months. Toyota, too, is trying to build more cars to order. In late 2004, the automaker claimed that it was building about 11 percent of the cars it sold in the United States to order, with a build time of just fourteen days.[27]

New Technologies

For years automobile companies have experimented with alternative power sources, most notably fuel cells. These investments have been driven by national and local government demands for lower emissions of carbon dioxide, carbon monoxide, and nitrogen oxides. Of particular concern has been the global buildup of carbon dioxide, the greenhouse gas implicated in global warming. In Europe, the European Commission has persuaded car makers to agree to a voluntary deal to cut overall emissions across their car fleet by 25 percent by 2008, or face the imposition of strict emission rules on specific models. In California, draft regulations may require car manufacturers to reduce emissions of carbon dioxide by 30 percent, starting in 2009. In addition, California already has regulations in place that require 2 percent of a car maker's fleet to be zero emission vehicles (ZEV) by 2005 (although this requirement is proving to be a "soft" one).

The only conceivable ZEV at this juncture is a car powered by an electric motor that runs on a fuel cell. A fuel cell combines hydrogen with oxygen from the air to produce water. The process generates an electric current strong enough to power a car. For all of their promise, however, fuel cells have drawbacks. It costs about ten times more to produce a fuel cell than an internal combustion engine, the range of cars using fuel cells is still too limited for most customers, and replenishing hydrogen will require a network of hydrogen filling stations, which is currently not available.

Automakers have also been experimenting with modified internal combustion engines that use hydrogen rather than gasoline as a fuel. Here too, however, progress has been held back by the total absence of a network of hydrogen filling stations and serious technical problems associated with storing liquid hydrogen (which requires very cold temperatures).

More promising in the short to medium term are hybrid cars. In hybrid cars, at low speed the power comes from an electric motor which gets electricity from an onboard battery. At higher speed, the internal combustion engine kicks in and provides power, while simultaneously recharging the battery through a generator. When braking, energy from the slowing wheels is sent back through the electric motor to charge the batteries. The result can be substantial savings in fuel consumption, with little in the way of a performance penalty. Toyota's Prius hybrid can go from standstill to 60 mph in 10 seconds, averages 60 mpg in the city, and 51 mpg highway driving. This makes the Prius an ideal commuting car. The big drawback is that the hybrid propulsion system adds about $3,000 to $5,000 to a vehicle's sticker price, and the battery has to be replaced about every 100,000 miles at a cost of around $2,000. At an average gas price of $2 a gallon, it takes some five years for a hybrid to repay the additional investment.

Introduced in 1997, Toyota had sold some 200,000 Prius cars by mid-2004. Sales started to increase rapidly in 2003 and 2004 as higher fuel prices made consumers more concerned about fuel economy. In 2004, sales in the United States were limited only by supply constraints to 47,000 units. For 2005, Toyota is planning to sell 100,000 Prius cars in the United States and some 300,000 units worldwide. The company will introduce hybrid versions of its Lexus SUV, Highlander SUV, and Camry sedan in 2005. In addition to Toyota, Honda also had a hybrid on the market in 2002, its Honda Civic hybrid, which was expected to sell over 40,000 units in 2004. Ford introduced a hybrid version of its Escape SUV in late 2004. Priced at $27,000, the hybrid version of the Escape costs $6,000 more than the regular version. GM and Daimler Chrysler also have plans to introduce hybrids in 2006 and 2007.

J.D. Power has estimated that the U.S. market for hybrids could reach 500,000 units by 2008. A more aggressive forecast from Booze, Allen, and Hamilton suggests that hybrids could capture some 20 percent of the U.S. automobile market by 2010 (assuming that gasoline prices stay high), which would represent unit sales of about 3.4 million.[28]

International Developments

Over 80 percent of the world's cars and light trucks are sold in just three markets—North America, Europe, and Japan. Europe is a close second to North America in terms of size, with total sales estimated to be around 16 million units in 2004. The two largest automobile companies in Europe are Volkswagen and PSA Peugeot Citroen with 17.5 percent and 14.4 percent of the market, respectively, in the first half of 2004. Ford had 11.5 percent, Renault 10.4 percent, GM 9.7 percent, and Fiat 9.7 percent. Collectively the Japanese companies held 13.4 percent of the European market in the first half of 2004 (Toyota had a 5.1 percent share).[29]

In some respects, these figures understate the degree of market concentration in Europe. GM, for example, owns 20 percent of Fiat, and Renault owns some 44 percent of Nissan. The Renault/Nissan alliance is particularly close. Renault took its stake in Nissan in the late 1990s when the Japanese company was in deep financial trouble. For Renault, the move was designed to give it access to the large American market where Nissan has a significant presence. For Nissan, it was a matter of survival. Renault invested some $5 billion in Nissan, effectively stabilizing the Japanese company's balance sheet and helping to engineer a turnaround. Although the two companies are continuing to keep their separate identities, their plans call for them to share common car platforms across both companies and to reduce the number of platforms from 40 in 2000 to 10 by 2010, saving some $500 million in costs.

The competitive picture in Europe is not that different from the picture in North America. A combination of inward investment and market share gains by Japanese automakers, and slowing export sales to North America due to the strong euro, have hurt demand and helped to create an excess capacity situation. As in the United States, automakers have responded by introducing sales incentives to try and shift inventory. Consequently, profits are down across the board.

Globally, the big story has been the continued rise of Toyota, which in 2003 passed Ford to become the world's second largest automobile company after GM (see Exhibit 6). With Ford now firmly in the rear view mirror, Toyota is setting its sights on GM. Toyota's plans call for the company to capture 15 percent of the global market for automobiles in 2010, up from 10 percent in 2003. If that goal is attained, Toyota will surpass GM to become the world's largest auto company (it is already the world's most profitable auto company—see Exhibit 5).

EXHIBIT 6

Global Sales in 2003

Company	Vehicle Units Sold (millions)
GM	8.59
Toyota	6.78
Ford	6.54
Volkswagen	5.02
Daimler Chrysler	4.36
PSA Peugeot Citroen	3.29
Hyundai	3.05
Nissan	2.97
Honda	2.91
Renault	2.39

Source: Company Reports, Automotive News.

The most rapidly growing automobile market in the world is China. Production and sales of cars in China have soared since the country joined the World Trade Organization in 2001. Some 4.1 million cars and light trucks were sold in China in 2003, a 37 percent rise over the prior year, and China seems set to surpass Japan as the world's third largest automobile market in 2004.[30] With just 8 vehicles per 1,000 residents in 2003, versus 940 in the United States and 584 in Europe, many think that China is set to continue growing for years to come, and could potentially become the world's largest automobile market by 2020.[31]

The majority of these vehicles were made locally, often by joint ventures between foreign automobile companies and Chinese enterprises. Collectively, foreign automobile companies invested some $19 billion in China between 1994 and 2003. In 2004, General Motors, Ford, Volkswagen, and Toyota all announced plans to invest in new factories in China, with some $13 billion of investment planned for 2005–2010. The largest foreign player in China in 2003 was Volkswagen. Volkswagen was the first foreign manufacturer to set up operations in China, and has reaped the benefits of its early investments. Its two joint ventures with Chinese companies accounted for about 35 percent of total sales in 2003. GM and its local joint venture partner, SAIC, were second with about 11 percent of the total market.

Investments by foreign companies should increase production capacity in China to some 5.4 million units by 2006. If the demand continues to grow at its torrid pace, this will not be enough to serve local demand—but if local demand softens, the result could be excess capacity. Some think in such circumstances, China might start to become an export base for car makers.

ENDNOTES

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