Automotive Electronics Business

by

Yoshiko Hase

Master of Electrical Engineering, Doshisha University, Japan 1997

Submitted to the MIT Sloan School of Management
in partial fulfillment of the requirements for the degree of

Master of Business Administration

at the

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ABSTRACT

In the automotive industry, due to the trend to introduce active safety systems, concerns about protecting the environment, and advances in information technology, key automotive manufacturers are eager to acquire new enabling technologies which can provide solutions for these issues. As a result, the demand for automotive electronics is increasing. Meanwhile, due to strict requirements for demanding specifications, as well as low volume commitment offered by car manufacturers as compared with consumer electronics products, many electronics manufacturers have so far avoided entering this business. However, as the requirement for high technology grow, the technology of the electronics companies becomes indispensable for the car manufacturers. Currently, there are some electronics companies who provide automotive parts, mostly on the components level and not on the solution level, but only few of them are truly successful.

The automotive electronics business requires various types of components as well as demanding specifications for safety and operating conditions. Offering solutions for this demanding industry often requires cross-organizational initiative. Despite the difficult challenges, many electronics companies, including semiconductor and fabless companies, have already penetrated into this industry, and its market is becoming more and more competitive.

The purpose of this work is to discuss the potential of Toshiba Corporation to become a major player in the automotive electronics industry. While it seems to be attractive, there are also many challenges which would face Toshiba as a new player attempting to penetrate this market. The work will focus on the understanding and analysis of these challenges.

The work will start from a general description of the current automotive electronics industry. Following, I will discuss the future technological trends of automotive electronic systems and the demands and requirements of the different geographical markets. Following this general background, Toshiba's current market position and a comparison to the key competitors is presented. The work will be concluded with a discussion of the optional strategies which can be adopted by Toshiba if it decides to focus on the automotive market.

Thesis Supervisor: Michael A. Cusumano
Title: Sloan Management Review Distinguished Professor of Management

Content

1. Introduction

The automotive industry has become one of the most influential industries in modern economies, in particular in US, Germany and Japan. A big difference of the automotive business from other manufacturing sectors is that it involves wide range of industry groups such as components suppliers, material makers, consumable products suppliers, dealers, advertisement and marketing industry. Since all these elements are required in order to complete the car production, it means that this industry largely influences economic trends and employment of workers.

This industry has influenced electronics business as well. Due to the replacement of mechanical structures with electronic components for safety, regulation for environment, fuel consumption efficiency, and product differentiation from competitors, the demand for electronic components is increasing. In particular, given the current good position of Japanese automotive manufacturers and their demanding quality requirement, there is a good opportunity for Japanese electronics companies, which excel at providing high quality products, to break into this market. On the other hand, it is also a fact that many electronics companies including semiconductor and fabless companies have already broken into this industry, and its market is becoming competitive[1].

The purpose of this work is to discuss the potential of Toshiba Corporation to become a major player in the automotive electronics industry. While it seems to be attractive, there are also many challenges which would face Toshiba as a new player attempting to penetrate this market. For example, the automotive business is very different from Toshiba's traditional consumer

products business, not only in quality requirement, but also in business practices, product cycles, logistic requirements, etc. In order to participate in this business, Toshiba would have to understand customers' strategy, environment, technology trends and regulations. All these elements determine trends and directions of electronic components business. In order to succeed in this business, Toshiba would have to establish its own business methodology, not following the traditional prototype. In other words, without understanding of customers' strategy, there would be no success.

Furthermore, Toshiba would also have to consider the opportunities in the global market. Nowadays, BRICs (Brazil, Russia, India, and China) are becoming a huge market for automotive business. How to break into these markets and adjust business methodology to their requirements can also be a key for success.

The work will start from a general description of the current automotive electronics industry, including key customers, who are automotive manufacturers, and key competitors, who are other automotive electronics component and system companies. Following, I will discuss the future technological trends of automotive electronic systems and the demands and requirements of the different geographical markets. Following this general background, Toshiba's current market position and a comparison to the key competitors is presented. Japanese Electronics Companies' strengths and weaknesses will then be discussed. The work will be concluded with a discussion of the optional strategies which can be adopted by Toshiba if it decides to focus on the automotive market.

2. Automotive industry Trends

While the "Big Three" (GM, Ford, DaimlerChrysler) are struggling in their business during recent years, Japanese manufacturers increase their sales in the world, and Korean manufacturers are accelerating the penetration into the market, especially in North America and Europe. I would like to describe the changes causing this situation from the aspects of technology and economy trend.

2.1. Technology Trend

2.1.1. Process innovation and modularization of components

In order to make the products competitive in the market, it is a key to develop and launch attractive products in a shorter period with lower cost, and for that, car production efficiency and cost reduction are essential. With the advance of information and digital technologies, it became possible to achieve the above objectives by incorporating digital development systems in the design and manufacturing processes. Furthermore, these years, the trend to modularize some components into a unit, such as cockpit or door module, has also promoted cost reduction and production efficiency. However, this also brings issues, such as Toyota's recall these days, which resulted in from excessive modularization[2]. In an attempt to increase efficiency, Toyota has successfully reduced the cost by modularizing. On the other hand, due to using simplified common module for various models without optimization to the requirements of the specific vehicles, there were problems in the operation of the modules in some vehicles, and as a result Toyota had to recall these vehicle models.

2.1.2. Increase of fuel efficiency and safety requirement by technology advances

Due to the advance of technology, in particular the replacement mechanical structure with electronics, it became possible to control engines and add more functionality for efficiency or safety. For example, not only by the requirement of passive safety, but also by that of Active Safety[a], ABS (Anti-lock brake system), Inter-vehicle distance monitoring, Lane deviation detection, Back-up monitoring have been developed[3]. Nowadays, car navigation system function is not only indicating the map or the place the car is located, but also the car's speed or traffic information. Additionally, by connecting to the internet, you can get various types of information such as the location of restaurants, services or entertainment places.

2.1.3. The regulations or concerns for environment

The concerns or the regulations for environment (WWFC : The World-Wide Fuel Charter[b], Euro V[c]), such as the decrease of gas emission, CO_2 emission create a new demand and promote a trend for new types of cars, such as hybrid, fuel cell and electric car.

Of all these new types of cars, fuel cell car is considered to be the favorite solution for an "eco" car. However, the introduction of fuel cell car is being delayed by far more than expected, and it is now estimated to occur in 20-30 years. In the meanwhile, the performance of hybrid car with respect to energy efficiency was proven to exceed even the expected performance of the

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[a] To help prevent accident occurrence

[b] On the basis of automotive users requirement and technology for emission gas control, universal and recommended standard for fair quality fuel.

[c] EURO V is a set of emission standards applying to new road vehicles sold in the EU from 2009 or later. The standards do not mandate the application of specific technologies, but it is widely expected that diesel particulate filters will need to be fitted in diesel vehicles to comply with the PM standard.

fuel cell car[4]. Therefore, though the hybrid car is still less ecological than the fuel cell car, its image has been changed from the transit technology until the introduction of fuel cell car, to a favorite technology for the foreseeable future.

In the following table the next generation ecology cars are compared. Though some of them have been already commercialized, many challenges such as mileage or cost still remain, and currently are used in limited applications and region. For practical use in the future, in addition to the improvement of technology, improvement of the infrastructure for fuel supply is required as well.

Figure 1 - Comparison table of ecology cars

	Features	Development situation and challenges
Electric Car	● Less gas emission ● Less noise, turbulence	● Power performance ● Short distance
Hybrid car	● Less emission of CO_2 ● Less gas emission	● Higher performance ● Lower cost of battery
Natural gas car	● Use Methan, CNG ● Less emission of CO_2 or NOx (partly used for bus or delivery car)	● Difficult to load ● Short distance
Methanol car	● Easy to preserve ● portability	● Durability of injector, ignition plug, and glow plug ● High temperature starter ● Emission of Aldehyde

LPG car (replacement of diesel)	• Using liquid fuel such as propane or butane • Cheaper fuel cost	• Used for taxi, and now replacement of diesel to reduce NOx and PM
Fuel Cell Electric car	• Electric car with fuel cell • Fuel can be Hydrogen	• Preservation of Hydrogen fuel • Durability
Hydrogen Car	• Clean energy	• Difficult to load • Safety • Short Distance

(Reference : Japan Automotive Institute website)

2.2. Economy Trend

2.2.1. The inflation of the oil price

One of the biggest reasons for the success of Japanese manufacturers and the failure of US manufacturers is the inflation of the oil price. This drove consumers to buy more efficient cars, and as a result, the demand for compact cars, which is the strength of the Japanese car industry, has been increased in the US.

2.2.2. Emergent markets

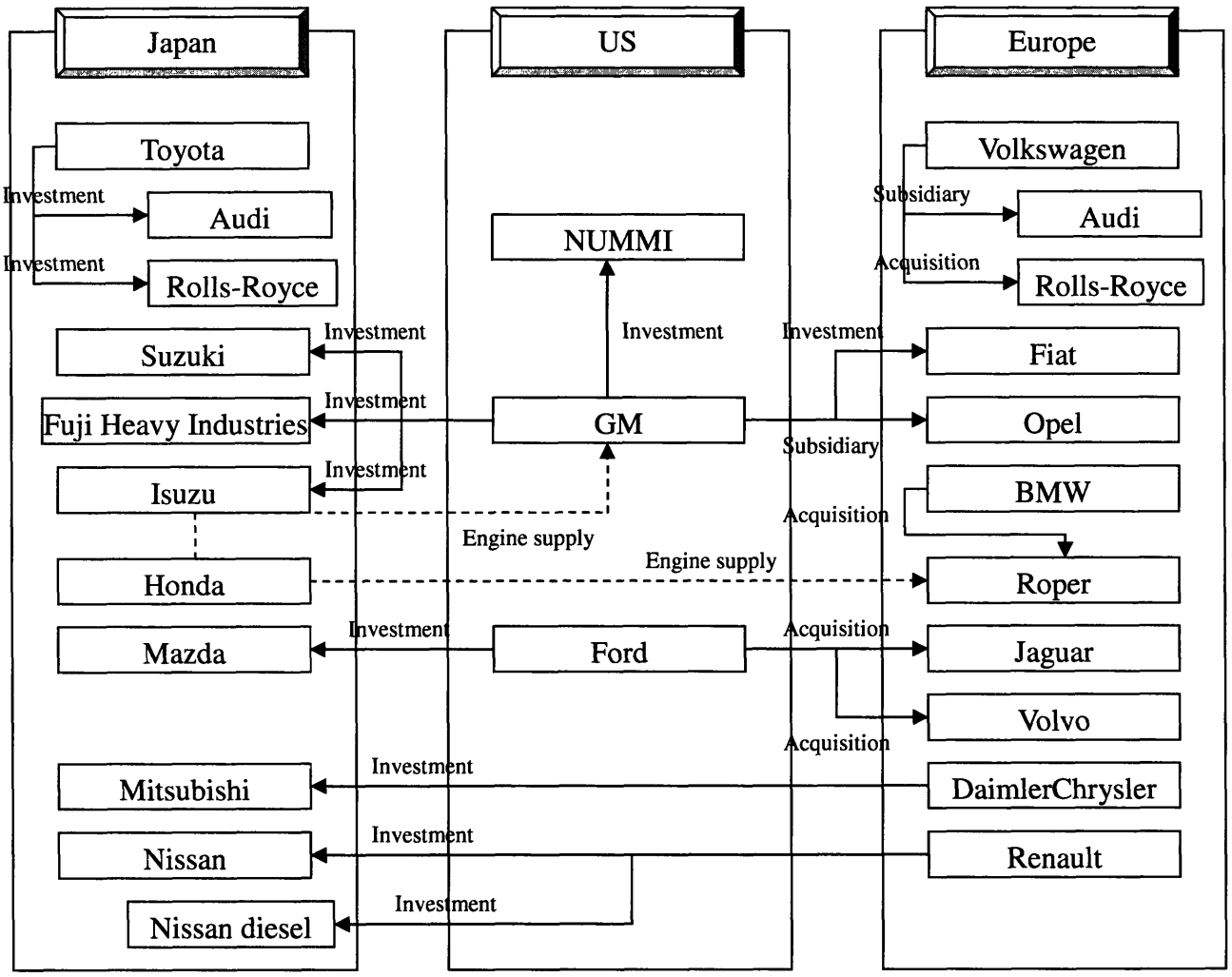
In addition to the major market, such as the US and Europe, growing demands in developing countries such as India, China also drive automotive sales. According to the Nikkei Business Online, it is estimated that Chinese Automotive market will expand by 11% annual growth, and grow by 900 million cars by 2010. Asian market except Japan, China, and Korea, India and Thailand will expand by 10%, and grow by 600 million cars. In particular India will grow from current 160 million to 300 million[5].

2.3. Industry Trends

2.3.1. Market reorganization

The impact of the strong M&A activity of the last decade in the automotive industry is still affecting the industry. This trend will probably continue for quite some time. Some component manufacturers who spun off there parent company managed to become strong independent companies. On the other hand, some of them did not succeed to build a strong independent business and are now being acquired by financial institutions. In Japan, except for Toyota and Honda, all manufacturers became affiliated with foreign capital.

Figure 2 - Market reorganization in worldwide automotive industry



(Reference : JRI news release)

2.3.2. Japanese manufacturers and trade friction

The market share of Japanese cars exceeds 30% in US market in these 10 years. On one hand, GM and Ford have suffered from a slump in business. Localization of the Japanese car manufacturing helps to avoid trade friction so far, in particular the fact that Toyota has chosen new manufacturing sites located on "barren areas" in the Southern part of the US, became the

primary factor in eliminating the friction. In a similar fashion, HONDA chose a location in Alabama, and NISSAN in Mississippi. However, if the share of Japanese car continues to increase, the trade friction between the US and Japan may return.

3. Automotive Electronics industry

Due to the demand for efficiency and safety, the car mechanism has been computerized and as a result, the role of electronics companies became essential in automotive industry. For example, nowadays automotive technology strongly depends on the various sensor or control technologies. By the advance of communication technology or digital consumer technology, ITS or dual direction car navigation system became possible.

The requirement of performance for environment such as hybrid car also drives the demand of electronics components. Seeing these situations, in addition to the saturation of consumer products market, many suppliers or electronics companies have already tried to enter the automotive market, developing the products for "automotives", expanding the production line, and increasing new products lineup.

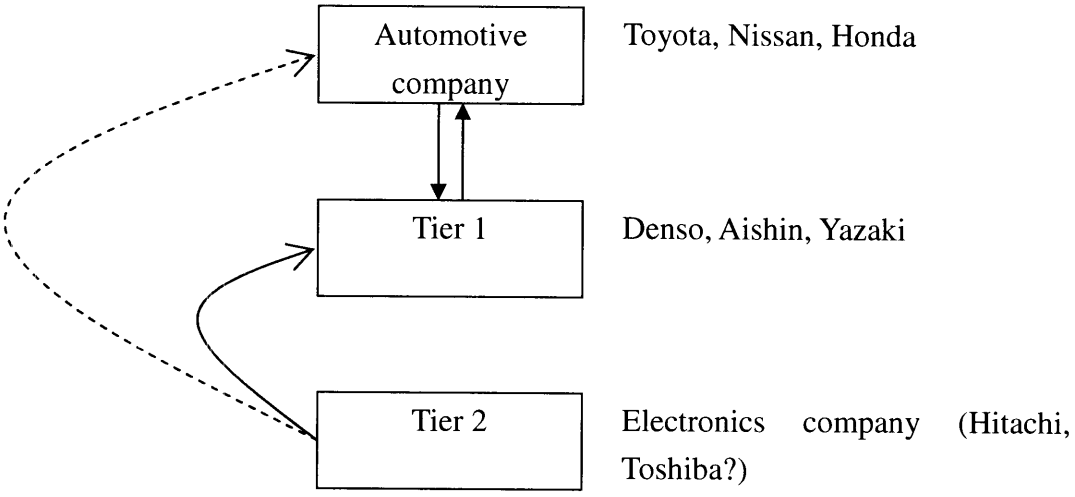
While electronics suppliers or companies are eager to break into the market, automotive companies started to establish their own software companies or joint ventures with suppliers due to the lack of software skills or resources for emergent demand.

As I mentioned earlier, in the new market such as China, Russia and India, it is expected that the number of electronic parts per one car will increase dramatically due to the safety and fuel efficiency improvement. World demand of the semiconductor in 2007 is estimated to be two times that of 2002, approximately 2,300 billion Yen.

3.1. Customer - Supplier Relation

Currently the relations of customers (Automotive companies) and their suppliers are getting stronger. This is not only because of the trust developed by long relations and experience, but also because of production efficiency and cost reduction considerations, customers tend to choose the modularized technology, and as a result, suppliers are required to provide not components, but system solution including assembly line considerations as well as functionality. Suppliers understand and adopt their major customers' technical standards very well, and it is not easy for a new participant to reach such level of intimate cooperation. In a meanwhile, by modularization, customers cannot avoid developing strong dependency on the suppliers' technology, and therefore the suppliers gain more power in their business.

Suppliers are categorized into Tier 1 and Tier 2 in the following figure. Tier 1 is directly connected to the automotive company, and they provide the products according to the customer's specifications. Tier 2's positioning is more complex. Since customer's requirement includes more electronics solutions nowadays, sometimes the automotive companies may directly approach Tier 2 suppliers. Tier 1 suppliers can also approach Tier 2 suppliers, therefore, for a Tier 2 supplier, both automotive companies and Tier 1 suppliers can become customers. However, when a Tier 2 supplier tries to sell directly to automotive companies, it needs to assume the risk of becoming a competitor to Tier 1 suppliers, who may be his customers as well. This may damage the relations of that company with its customers of the "Tier 1 supplier" category, therefore a Tier 2 company should approach this business carefully.


Automotive company
Toyota, Nissan, Honda
Tier 1
Denso, Aishin, Yazaki
Tier 2
Electronics company (Hitachi, Toshiba?)

4. Description of Selected Customers and Suppliers in the Automotive Electronics Industry

4.1. Selected Customers (Automotive companies) (Partial List)

In the following, we present some automotive companies, who serve as examples of potential customers for a component and system company.

4.1.1. General Motors (GM)

Company Summary

General Motors Corporation is the world's largest car manufacturer. Founded in 1908, in Flint, Michigan, GM employs approximately 284,000 people around the world. In 2005, 9.17 million GM cars and trucks were sold globally under the following brands: Buick, Cadillac, Chevrolet, GMC, Daewoo, Holden, Hummer, Opel, Pontiac, Saab, Saturn and Vauxhall.

2006 Situation

GM announced that the balancing of accounts of 2006 4th quarter. According to that, net income is surplus of 950 million dollar. In whole financial year of 2006, net loss has become the deficit of 2 billion dollar[6]. Though they improved sales in 4th quarter, the heavy deficit continues from 1992.

Strategy

Due to the oil price rise, consumers prefer fuel efficient compact car or hybrid car to full-size car. GM does not have its own technology for compact car, and as a result the market was

occupied by Japanese car. Furthermore, while Toyota or Honda promoted hybrid car, GM persisted to sell Fuel Cell Vehicle (FCV). After the September 11, 2001 attacks, because of the consumer's depression, GM promoted "discount sales". This brought them more deficits in their sales. Historic pension underfunding, also caused them a severe pension and benefit fund crisis. GM is targeting to increase its sales by introducing Hydrogen Fuel Vehicle.

Alliances

In February 2005, GM successfully bought itself out of a put option with Fiat for $2 billion USD (€1.55 billion). In October 2005, GM sold the stake in Fuji Heavy Industries to Toyota. In March 2006, GM divested 92.36 million shares (reducing their stake from 20% to 3%) of Japanese manufacturer Suzuki, in order to raise $2.3 billion. GM originally invested in Suzuki in the early 1980s. GM sold its 8% stake in Isuzu on April 11, 2006, to raise an additional $300 million.

- Collaboration with Toyota, for NUMMI (New United Motor Manufacturing, Inc.) in California, development of Fuel Cell Vehicle
- Co-development with BMW, DaimlerChryslerAG for Hybrid system

Global market

General Motors is the second top-selling foreign auto maker in China, operating under the name of "Shanghai GM", with a 12.5% market there. The Buick brand is especially strong, led by the Buick Excelle subcompact. Cadillac initiated sales in China in 2004, starting with imports. GM pushed the Chevrolet brand there in 2005 as well, transferring the formerly-Buick Sail to that marque. The company manufactures most of its China-market vehicles locally, through its

Shanghai GM joint venture. The SAIC-GM-Wuling Automobile joint-venture is also successful selling trucks and vans under the Wuling marque.

Suppliers

GM and Ford had developed many automotive components internally, but their manufacturing costs are higher than those of Japanese manufacturers, it had been challenging to improve components costs. In 1994, GM shed internal components business and established Delphi. Though Delphi has tried to increase the sales from non-GM or Ford, its ratio is still low, and they strongly depend on the business with GM. In 2006 by the impact of GM's sluggish situation, they expanded deficit to 5.5 billion dollars.

GM and Ford tried to adopt "online supply system", establishing components transaction website, "market site" and new company, "Covisint" in order to reduce components procurement cost. However, these transactions are limited to components whose spec is simple, therefore, it does not seem to be effective[7].

Other suppliers for GM are Freescale Semiconductor Inc, Continental Automotive Systems, Mitsubishi Electric Corporation and its U.S. subsidiary, Mitsubishi Electric Automotive America, Inc, and Siemens VDO.

Unlike those of Japanese manufacturers, business pattern of American car manufacturers such as GM is not based on "long term relationship" and "mutual trust" so strongly, it is possible for new participants to join the market if they can provide unique and attractive technology including prices.

4.1.2. Toyota

Company Summary

Toyota is a No.1 automotive company in Asia, and No.2 sales in the world. It is also a parent company, Daihatsu, and Hino motor, and a largest stockholder of Fuji Heavy Industries.

In 1950, due to the deflation, Toyota faced the financial crisis, but by the demand of track for Korean War from US, it was avoided. After the crisis, it established the know-how for production or business such as "Kaizen", "Just in Time", "Toyota manufacturing way". It is called "Toyota Bank" since they have more than 6000 billion yen of Retain Earnings.

2006 Situation

Based on Toyota financial report, Total consolidated vehicle sales in Japan and overseas increased by 175 thousand units, or 8.9%, to 2,155 thousand units in FY2007 third quarter (the three-month period from October 1, 2006 to December 31, 2006) compared with FY2006 third quarter (the three-month period from October 1, 2005 to December 31, 2005). Vehicle sales in Japan in FY2007 third quarter decreased by 30 thousand units, or 5.2%, to 541 thousand units compared with FY2006 third quarter under the declined market in Japan compared to the same period of the prior year. With the efforts of dealers nationwide, however, Toyota's share of the market excluding mini-vehicles was 47.5%, and its share of the market including mini-vehicles was 42.3%, both figures remaining at high levels. Meanwhile, overseas vehicle sales increased significantly by 205 thousand units, or 14.5%, to 1,614 thousand units in FY2007 third quarter compared with FY2006 third quarter, because sales in North America, Europe and other regions steadily increased.

Strategy

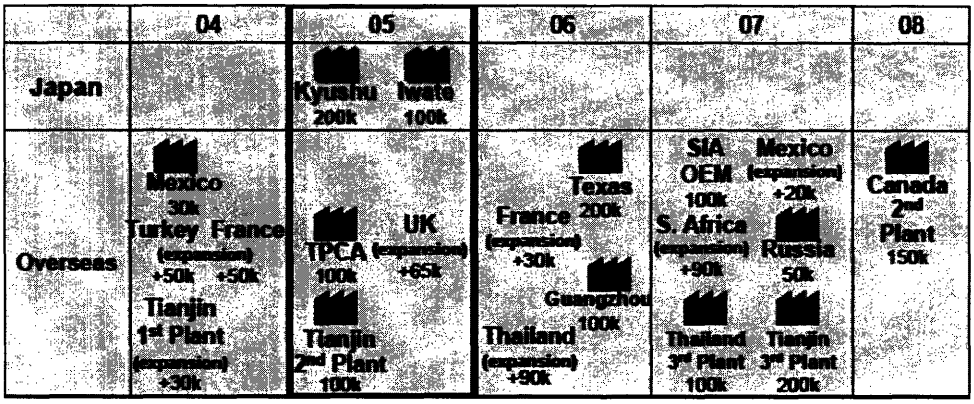
- Products / Technology
  - ➢ Taking in market growth through improvements of Tech. and products

According to Toyota's presentation of FY2006 Financial Results, they define the "Strength of Product" equals Quality, Performance, Fuel Economy, Safety Technology, Environmentally Friendly Features, Price, and Design. In particular, Toyota is famous for pursuing the higher or demanding quality on products among suppliers. If supplier's products do not meet their requirement, they develop the components by themselves. They also pursue low cost, in addition to high quality products. However, due to pursuing lower cost, they have many recalls these days. This is because they started to make a components platform over whole type of cars, not depending on each car type.

In Hybrid System, They continue to improve power performance and reduce cost by expanding models. It shows that Toyota expects the period of Hybrid car will continue, and the penetration of Fuel Cell Vehicle or Hydrogen Car will take time. In fact, the performance of Hybrid car already overtook the one of Fuel Cell Vehicle. It is also estimated that Hybrid market will achieve 5,370,000cars in 2015.

- Supply
  - ➢ Increasing production capacity to respond flexibly to global demand growth

Toyota increased production capacity in Japan due to the exceeding demand. They also expand the production in overseas as follows.



(Reference : Toyota's presentation of FY2006 Financial Results)

- Marketing and Sales

  - Global Core Models

They also develop Appealing 'Global Core Models', IMV, Vitz-Yaris, Camry, and Carolla. Based on these models, they adopt the local market needs in design and upper body development. It means that by providing core models, they develop global common platform and key components, and they can develop products efficiently and globally. Toyota is now establishing Luxury cars image by development of Global Premium Brand 'Lexus'. So far, Toyota's sales in North America depend on the small compact car, "Carolla". Big size car is GM's territory, and now they are challenging new markets.

  - Target at BRIC's (Brazil, Russia, India and China)

In China, Toyota started production from 2002. It also collaborates with China FAW Group Corporation. In 2004, Toyota established Joint venture with Guangzhou Motor Group.

Toyota-Daihatsu started production of small car in India, planning 100,000 cars manufacturing in 2007.

It also starts production in Russia in the same year, expanding to the emerging

market, BRIC's.

- Others
  - Avoidance of trade friction

    They are very sensitive trade friction with US due to the bad experience 20 years ago. To avoid this, they try to contribute to the local site by building undeveloped site and by the employment of local people and have been successful so far. However, as sales increase in US, it will be more difficult to avoid the trade friction.

Alliance

In 1990, it is more common to co-develop with group companies, for example, the new design of engine for small car with Daihatsu, the development of truck with Hino. Concerning the development if Fuel Cell car or Hybrid car, Toyota collaborated with Matsushita. Toyota also participates in F1 to develop the cutting edge technology.

Following is major collaboration of Toyota.

- Fuji Heavy Industries - The largest stockholder (8.7%).
- Yamaha Motor Co., Ltd. – the stockholder (4.39%). Collaboration of engine development, manufacturing and marine business.
- GM – Joint Venture of NUMMI in California. Development of Fuel Cell Vehicle
- Volkswagen - Sales collaboration in Japan.
- PSA/Peugeot Citroen – established the JV, Toyota- Peugeot Citroen Automobile for production of small car.
- Nissan – Technology transfer of hybrid car.

Suppliers

Compared with the pattern of relationship between car manufacturers and suppliers in American or Western business, that of relationship in Japanese business is quite different. Followings are features of Japanese components transaction system.

1. Order competition among fewer suppliers

Unlike American or Western bidding competition, which is mainly decided by price, Japanese bidding is held among fewer suppliers and its competition is decided not only price, but also Quality, Cost, and Delivery capacities. Therefore, Japanese suppliers are required to fulfill their versatile capabilities.

2. A series of works consignment including detail design

In Japanese components transaction, suppliers are usually ordered not only manufacturing, but also designing, testing by car manufacturers. It means that this business pattern strengthens the relationship between car manufacturers and suppliers.

3. Long term business relationship

Once suppliers get purchase order for mass production, the business relationship continues until the production ends. This shows that suppliers can focus on next investment or new technology. At the same time, it is very challenging for new participants to enter the market and acquire purchase order.

4. Mutual trust between car manufacturers and suppliers

Due to the above long term relationship, mutual trust is also important factor when car

manufacturers choose suppliers. It means that for new participants in the market, making efforts to get trust from car manufacturers is crucial as well as capability as a supplier[8].

Japanese car manufacturers in Japan deal almost exclusively with Japanese-owned suppliers. The main suppliers for Toyota such as Aisin, Denso are historically Toyota's internal development division, and after 1949, those spun off from Toyota. Toyota tends to invest in "Keiretsu" suppliers, and this feature is different from Nissan.

Due to the localization of manufacturing and global procurement, Toyota started to use some non-Japanese suppliers, but this is one of the reasons for recent recall because of lower quality and not enough mutual understanding of the requirements.

Given all above situations, even though Toyota still tends to use "Keiretsu" companies, if new participants in the market can respond to their demanding quality requirement and satisfy with local procurement, they still have chance to get the inquiry.

4.1.3. Nissan

Company Summary

Nissan is a Japanese enterprise which belongs to the Fuyo group (old Fuji bank series), In 1999, Nissan entered an alliance with Renault S.A. of France. Nissan is among the top three Asian rivals of the "big three" in the U.S. Due to historical background, it has strong relationship with Hitachi, Ltd.

2006 Situation

Nissan announced financial results for the third quarter of fiscal year 2006. In the third quarter, consolidated net income after tax came to 104.4 billion yen (US $0.90 billion, euro 0.72 billion), down 22.6% compared with the same period a year ago.

Net revenue rose 1.8% to 2.343 trillion yen (US $20.16 billion, euro 16.24 billion). Nissan's operating profit totaled 183.1 billion yen (US $1.58 billion, euro 1.27 billion), down 16.6%, while its operating profit margin came to 7.8%. Ordinary profit amounted to 177.1 billion yen (US $1.52 billion, euro 1.23 billion), down 15.6%.

Nissan sold a total of 795,000 vehicles worldwide in the October-to-December 2006 period, down 3.0%.

Globally, Nissan sold a total of 2,504,000 vehicles in the first nine months, down 5.7% compared with last year. Sales declined in major markets such as Japan, U.S. and the mature markets of Europe. Nissan saw growth in markets including China, Russia and the Middle East, driven by new products and local economic growth.

(Reference: Nissan Quarterly report, 2006)

Strategy

Nissan began development of FCVs (fuelcell vehicles) in 1996 and launched limited lease sales of the X-Trail FCV in Japan in fiscal year 2003.

On May 17, 2006 Nissan releases Atlas 20 hybrid truck in Japan. It releases a Cabstar hybrid truck in 2006 Hannover Fair.

Environment

- Introduced six compact cars in Dec. 25, 2006 for Japan (increased fuel efficiency, reduced CO2 and cleaner exhaust emissions)
- Introduction of gasoline engine with CO2 reduced to a comparable level with current diesel engines from FY2010
- Introduction of "3 Litter Car ""targeted during FY2010
- Original Hybrid Electric Vehicles /Plug-in HEV
- New Lithium-ion battery in development
- Clean Diesel Vehicle (Starting in Europe)
- Bio Ethanol Vehicle (Mainly in US and Brazil)
- Hybrid Electric Vehicle (Starting from US and Japan)
- Fuel Cell Vehicle (Starting from US and Japan)
- Electric Vehicle (Starting from Japan)

(Reference: Nissan 3rd Quarter Review)

Alliances

- In 2002, Toyota and Nissan agree to tie up on Hybrid Technologies and in 2004, Nissan unveils Altima Hybrid Prototype.

- On June 30, 2006, General Motors convened an emergency board meeting to discuss a proposal by shareholder Kirk Kerkorian to form an alliance between GM and Renault-Nissan. On October 4, 2006, however, GM and Nissan terminated talks because of the chasm between the two companies related to compensation to GM from Nissan.

Global marketing

Nissan North America relocated its headquarters from Gardena, California to Nashville, Tennessee in July 2006. A new headquarters is being built in Franklin, Tennessee, due to be complete in the summer of 2008.

Nissan also produces cars at its factory at Roslyn, near Pretoria, South Africa.

Supply

Unlike those of Toyota, main suppliers of Nissan are not historically belonged to Nissan. Most of them are formed by business or capital ties and as a result they established as a joint venture to improve the product quality. Nissan tends to invest in less "Keiretsu" companies than Toyota or Honda does. In other words, Nissan tries to have relationship with suppliers independently. Nissan has long and strong relationship with Hitachi. Nissan might be a challenging customer for new participants of electronics technology.

4.1.4. Honda

Company Summary

Honda is famous for its automobiles and motorcycles, but it also produces a long list of other products: trucks, scooters, robots, jets and jet engines, ATV, water craft, electrical generators, marine engines, lawn and garden equipment, and aeronautical and other mobile technologies.

2006 Situation

Based on Honda's financial report, Honda's consolidated net income for the fiscal third quarter ended December 31, 2006 totaled JPY 144.8 billion (USD 1,216 million), an increase of 8.8% from the corresponding period in 2005. Consolidated net sales and other operating revenue (herein referred to as "revenue") for the quarter amounted to JPY 2,768.6 billion (USD 23,244 million), an increase of 12.0% from the corresponding period in 2005. This increase was due mainly to the increased revenue in automobile business in North America and Europe. Consolidated operating income for the quarter totaled JPY 205.1 billion (USD 1,722 million), an increase of 5.2% compared to the corresponding period in 2005. This increase in operating income was primarily due to the positive impact of the increased profit attributable to higher revenue in automobile, power product and financial services business segments and higher revenue in all regions, the effect of newly consolidated subsidiaries, the decreased amount of unrealized profit in inventories, continuing cost reduction effects and the currency effects caused by the depreciation of the Japanese yen, which offset the negative impact of the change in model mix, the increased sales incentives in North America, the soaring raw material costs, the increased SG&A expenses mainly because of quality-related expenses, freight and storage costs due to the increase in sales, and the increased R&D expenses. Consolidated income before

income taxes and equity in income of affiliates for the quarter totaled JPY 191.5 billion (USD 1,608 million), an increase of 15.3% from the corresponding period in 2005. This increase was primarily due to the difference between transaction rates and average rates and proceeds from sales of securities.

(Reference : Honda's 3rd quarter report)

Strategy

- Technologies for Environment

Honda has worked to address the environmental challenges at the early stage. They define that hybrid technology is an important component to reduce CO_2 emissions. In the future, Honda also plans to introduce advanced gasoline and clean diesel engines.

- Gasoline vehicles: improve fuel efficiency, through such technologies as advanced VTEC and the Variable Cylinder Management system.
- Hybrid vehicles: Honda is developing a new dedicated hybrid vehicle that will achieve further advancement of fuel efficiency with a reduction in cost. They plan to introduce this hybrid vehicle in 2009.
- Diesel vehicles: Honda is developing a new super-clean 4-cylinder diesel engine, which Honda plans to introduce to market within the next three years.
- Fuel cell vehicles: Honda is stepping up the development of a fuel cell vehicle featuring the ultimate in clean performance, emitting no CO_2 or other harmful substances during operation. Honda plans to begin sales of this new fuel cell vehicle within three years.
- Honda Establishes Solar Cell Subsidiary Company, Honda Soltec to Make Full-Scale Entry into Solar Cell Business
- Honda to Build a New Engine Plant in Japan Establishing Production Systems and

Capabilities for Advanced Engines to Achieve Further Reduction of CO_2 Emissions

- Safety Technologies

Honda is committed to making products that provide high levels of safety. Honda has developed Honda ASV-3, Advanced Safety Vehicle equipped to exchange positional information with other vehicles using Inter-Vehicle Communication technology. This was a central objective of the five-year (April 2001-March 2006) ASV (Advanced Safety Vehicle)-3 Project*4 led by the Ministry of Land, Infrastructure and Transport. Additionally, Honda ASV-3 vehicles feature several new advanced safety technologies developed by Honda, including a system that uses cameras and millimeter wave radar to provide drivers with information on approaching vehicles and obstacles on the road; a system that offers driver support through steering and brake assist; and an emergency response system designed to aid in rescue efforts in the event of an accident. Honda plans to conduct further research and development of technologies deployed in the ASV-3 research vehicles with a view to implementing them in mass production vehicles.

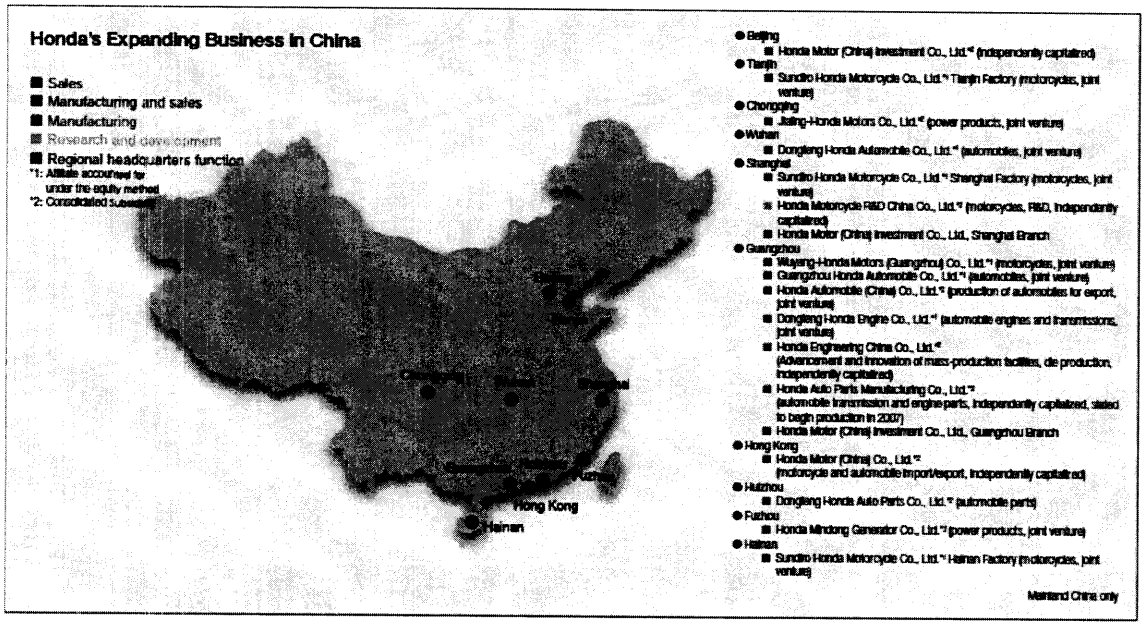
- Establishing advanced manufacturing systems and capabilities

They are constructing a new automobile plant in the United States and an automobile engine plant in Canada to strengthen our business in North America. Honda is also setting our sights on Asia and South America, which in recent years have experienced remarkable growth.

- Strengthening the foundation for overseas growth
  - China

Honda has been successful among manufacturers competition in China. In 1973, they started export of motorcycle. In 1982, they collaborated with manufacturer in Zhong jin

and started production of components for motorcycle, and in 1993, they established Honda Motor China in Hong Kong though it is only for imported vehicles. In 1994, they started automobile production in Joint Venture with Dongfeng Automobile (Wuhan), "Dongfeng Honda Automobile Co, Ltd.". In 1998, collaborated with Guanzhou Automobile (Guanzhou), taking over the factory of Peugeot, and started production of Accord, and Fit.



(Reference : Honda's 06 annual report)

Global marketing

- HONDA Increasing Capacity, Investment and Employment At Automobile and Motorcycle/Parts Plants, And Starting CR-V Production in Mexico.
- Honda Siel Cars India's second car plant to be located in Rajasthan
- Honda to Build New Motorcycle Plant in Peru

Expansion of annual production capacity in Brazil

Supply

Similar to Toyota, Honda tends to invest in "Keiretsu" suppliers.

In terms of components supply, Honda has strong relationship with NEC Electronics, and Nisshin in addition to internal development in Honda. Honda established a joint venture, "Honda Elesys" with NEC and Nisshin, which supplies electronics components and its systems. Other suppliers are TI Automotive, Delphi, Mitsubishi Electric, DuPont, Metaldyne, Grede plant and Urban Science.

4.2. Suppliers (Automotive Electronics manufacturers)

4.2.1. Denso (Tier 1)

Company Summary

Denso is a global automotive components manufacturer headquartered in the city of Kariya, Aichi Prefecture, Japan. DENSO is a member of the Toyota Group companies. Originally, DENSO was the electrical component manufacturing division of TOYOTA Motor Mfg. However, after spinning off from Toyota in 1949, it supplies their products not only domestic customers, such as Honda, Suzuki, Mitsubishi, Daihatsu, Mazda, Hino, Isuzu, Fuji Heavy Industries, but also foreign customers, such as DaimlerChrysler, GM, Fiat, Ford, Audi, Volkswagen, expanding its business.

2006 situation

The financial results in 2006 October-December period was pretty good due to the increase of Japanese automotive exports. Gross sales are 927,884 million Yen, 14.7% increase compared with those of the previous year, and Operating Income was 89,096 million Yen, increased 3.3%.

The automobile components sales achieved the increase of revenue in all product sections. In particular, thermal systems, such as automotive air conditioner increase the profit by 10%, Power train systems, such as engine or valve increase the profit by 18%, and Information and Safety, such as sensor, or car navigation increase the profit by 17%.

Geographical sales also increased in whole regions. In particular the demand of air conditioner in Europe increased by 26%. In US market, though "Big Three" was slump in sales, Japanese cars export made up for the loss, far larger than expected.

Strategies

- Products strategy

Sales breakdown by segments in 2006 is as follows. Though electronics or information technology business is increasing, their key products are mainly thermal systems and power systems.

- Thermal Systems 32.4%
- Power train Control Systems 24.1%
- Electronic Systems 15.3%
- Electric Systems 11.4%
- Small Motors 7.0%
- Information and Safety Systems 4.7%
- Non Automotive 2.2%

- Geographical strategy

Expecting the increase of diesel demand in Europe, Denso will start to increase the production capacity in Hungary from 2007. This production is devoted to common rail system, which reduces gas emission of diesel engine. Denso plans to produce 1 million systems per in 2009.

- Other strategy

Denso established Joint Venture "Advanced Driver Information Technology", which develops LSI and software for car multi media, such as car navigation, with Robert Bosch in May 2003. By this collaboration, Denso can utilize car navigation technology which is major in Europe.

In May 2005, TD Automotive Compressor Kunshan, Co., Ltd. was established in Kunshan, China, as a manufacturer of compressors for car air conditioners. This new supplier is a joint venture between DENSO, Toyota Industries Corporation and other partners.

Alliances/Global marketing

As shown in following recent press release, Denso has aggressively expanded the global site not only to South Asia, China, but also to Eastern Europe, Russia and South Africa.

- 2006
  - Establish Captive Insurance Company in Hawaii
  - Establish New Company in Tianjin, China to Produce Instrument Clusters
  - Build New Facility at Daian Plant
  - Expand Air Conditioner Production Capability in Turkey
  - Build New Facility for Electronic Products at Agui Plant
  - Establish Branch Office in Moscow, Russia
  - Establish Joint Venture to Develop and Manufacture Diesel Particulate Filters with Robert Bosch
  - Announces Major Expansion of Manufacturing Facility in Hungary

- 2005
  - Establish Engineering Center for Diesel Engine Components in Germany
  - Establishes New Company in Tianjin, China to Produce Heat Exchangers
  - Acquires 25 percent of Automotive Air Conditioner Company in the Republic of South Africa
  - Establish Joint Venture to Produce Car Air-Conditioning Compressor in China with

Toyota

- Establish Filter Manufacturing Company in China with Toyota
- Establishes New Company in Tianjin, China to Produce Car Navigation Systems

- Collaboration with Bosch

Blaupunkt GmbH (Bosch subsidiary) and DENSO have founded a new joint venture to develop technologies, standards and platforms for high integrated vehicle navigation systems. Product development work on driver information systems and navigation components will continue to be performed by Blaupunkt and DENSO separately. The main benefit of the cooperation will be the development of a high integrated navigation system platform that can be used world-wide. By this collaboration, both companies intend to further enhance their competence as suppliers of driver information systems to the markets of the world.
This collaboration is quite unique since originally they are completely competitors as Tier 1 suppliers with similar technologies.

They also agreed to set up a fifty-fifty joint venture in Eastern Europe to develop and manufacture diesel particulate filters (DPF). The joint venture is planned for establishment in early 2007.

Customers

As shown in Fig.3, DENSO supplies worldwide automotive companies widely and dependence on Toyota sales decreases gradually though almost half of its sales still come from Toyota group. DENSO expands the factories out of Japan aggressively and collaborates with other suppliers including competitors such as Bosch, it seems that it will not take time to get out of "Keiretsu" color in the future. And in such situation, there might be a business opportunity for

new participants to get into the market.

Figure 3 – Denso: Breakdown of Sales by Customer

	03/2004	03/2005	03/2006	09/2005	09/2006
TOYOTA	46.9%	45.2%	44.6%	44.4%	44.5%
DAIHATSU	2.6%	2.9%	2.7%	2.7%	2.8%
HINO	1.5%	1.4%	1.3%	1.4%	1.2%
TOYOTA Group sub-total	51.0%	49.5%	48.6%	48.5%	48.5%
HONDA	7.9%	7.8%	7.6%	7.6%	7.5%
SUZUKI	3.0%	3.0%	3.0%	3.0%	2.9%
FUJI	1.3%	1.9%	1.8%	2.0%	1.6%
MITSUBISHI	2.5%	1.7%	1.7%	1.6%	1.6%
GM	2.6%	2.6%	3.4%	2.9%	4.0%
ISUZU	1.6%	1.4%	1.4%	1.4%	1.3%
FORD	1.3%	1.1%	1.0%	1.0%	1.3%
JAGUAR	0.6%	0.4%	0.4%	0.3%	0.3%
VOLVO/LAND ROVER	0.5%	0.6%	1.0%	1.0%	1.0%
MAZDA	1.6%	1.4%	1.4%	1.4%	1.5%
CHRYSLER	3.1%	2.5%	2.4%	2.6%	2.0%
BENZ	1.0%	0.8%	0.7%	0.7%	0.6%
FIAT	2.8%	2.5%	2.4%	2.2%	2.4%
HYUNDAI/KIA	1.3%	1.5%	1.5%	1.4%	1.5%
VW/AUDI	1.5%	1.2%	1.2%	1.3%	1.4%
BMW	0.5%	0.5%	0.7%	0.7%	0.6%
RENAULT/NISSAN	0.6%	0.8%	0.8%	0.8%	0.8%

PSA	0.3%	0.3%	0.2%	0.2%	0.2%
OE Sales for others	-	5.9%	6.0%	6.1%	6.5%
OE Sales sub-total	-	87.4%	87.2%	86.7%	87.5%
After Market, New business & others	-	12.6%	12.8%	13.3%	12.5%
Others	15.0%	-	-	-	-
Total	100.0%	100.0%	100.0%	100.0%	100.0%

(Reference: Denso factbook, 2006)

4.2.2. Bosch (Tier 1)

Company Summary

Robert Bosch GmbH is one of the world's top manufacturers of automobile components, including antilock braking and fuel-injection systems, starters, alternators, and auto electronics. The Bosch Group comprises some 280 subsidiary companies.

In 2004, Robert Bosch GmbH was 17th on the list of "Top 20 Patent Winners" in the United States, with 907 new patents. Total worldwide sales were around $50 billion in 2005, with about $8 billion in US sales. Bosch has a reputation for building products that are top quality, priced a little higher than their competitors, but built to last a lifetime.

2006 situation

Bosch's core business, Automotive Technology sector, which occupies 62% in group gross sales, increased its sales by 3.5 %, to 27.2 billion euros. The diesel share of new car registrations in Europe rose to nearly 50 %. Due to the struggles of American car manufacturers and higher cost of raw materials, they had to raise the prices. On the other hand, since the business in Asian regions was good condition, they barely could improve the situation[9].

Strategies

Bosch currently works on the approximately 30 engineering project in application field of Diesel injection system with some automotive manufacturers in India. In China about 50 similar projects are under development. Bosch anticipates that the technology "Clean Diesel" is promising even in North America, and due to the rise of fuel price and the revival of environmental discussion, the American Diesel car demand will increase largely. They estimate

that electronic stability control (ESC) will also contribute to Bosch sale increase. In the US ESC installation ratio in the new model car will rise from 36% in 2006 to 72% in 2010. Bosch plans to increase the production of ESC in the US to 3 times, targeting at 3,000,000 system production per year.

Alliances/Global marketing

Bosch strongly focuses on China market and business. They plan to invest 200 million Euro in the development of latest diesel system in China by 2007. They already invested in business in China 550 million Euros in these 2 years.

Bosch estimates that the share of sales in Asian Pacific region will increase from current 14% to 25% in 10 years. Therefore, in addition to the investment for China, they especially strengthen their business in Asia. For example, Bosch plans to invest about 100 million Euros in production for Common rail diesel system in India. They also plan to invest about 100 million Euros in products of new diesel technology in Korea.

Bosch also expanded the production for third generation common rail system in Turkey in 2006. Bosch has started the business in Turkey since 1910, and its sales became 567 million Euros.

As I described in Denso section, Bosch collaborates with Denso in terms of vehicle navigation systems.

Customers

Bosch supplies "Night Vision", which enable us to recognize people walking ahead using infrared camera, to DaimlerChrysler's Mercedes-Benz S class. Bosch also provides ACC, Adaptive Cruise Control to BMW 3 series.

4.2.3. Hitachi (Tier 2)

Hitachi has long history in automotive business after the establishment of automotive division in 1964. Utilizing all resources and technologies as a conglomerate company, they successfully positioned in automotive market, and highly evaluated by car manufacturers. Due to historical background (Belonged to Nissan Konzern), they have strong and long business relationship with Nissan.

Automotive business positioning in Hitachi

Hitachi focuses on power electric systems / components, and 25 percent of their sales come from this industry. Automotive business is one of their key businesses in Hitachi. Due to the regulation for environment and safety, automotive components are required to change from mechanical structure to electronics one, therefore they are anticipating that automotive electronics components market will grow rapidly, especially in the area of technologies such as motor/inverter control, semiconductor, information and telecommunications, HDD and new material as well as growing market such as in China. Hitachi estimates that half of automotive components market is Hitachi's target market and it will grow in the future. As a solution provider, they are targeting to be in a strong position since they have wide range of technologies, from power components to information technology.

Hitachi classifies market into 3 categories, "Environment", "Safety", and "Information", and established 4 business categories for those market needs.

- Environment(Engine management system business, Electric Power train system business)

Market needs: gas emission reduction, improvement of fuel consumption

Required technologies: Engine control, motor, inverter, and battery for Hybrid car, Fuel Cell Vehicle

- Safety(Drive Control system business)

Market needs: prevention of accident

Required technologies: ACC (Adaptive Cruise Control), Lane keep, Electric brake, Electric power steering, and suspension.

- Information(Automotive information system business)

Market needs: Convenience, Comfort

Required technologies: Car Navigation, VICS, Telematics, dual direction communication

Positioning in market

Hitachi has strong position in the Japanese automotive electronics market, in particular, engine management system business. They occupy no.2 or no.3 position of some components such as Power steering and Car Navigation System as well as Control unit in Japanese automotive electronics market.

Distribution

They have 14 distributors, manufacturing site, or Technical centers in Europe, 26 in Asian region, and 11 in North/South America. They also transfer their technologies to some companies.

Strategies

Hitachi estimates the automotive electronics market to be 1,000 billion yen in 2010.
In particular, they assume that "Electric power management system business" and "Automotive information system business" market will be growing to 500 billion yen.

➢ Products strategy

As I mentioned, they categorize into four types of system business in three fields. One is "Engine management system business"/"Electric power management system business" in Environment field. Second one is "Drive control system business" in safety and comfort field, and last one is "Automotive information system business" in information field.

- **"Engine/Electric power management system business"**

  Nowadays, due to the requirement for environment regulation, car manufacturers are required to reduce the car exhaustion of CO_2, for example in Europe, Euro V. Therefore, they focus on gasoline engine control system, applying the existing technology such as the nuclear power station, gas turbine, and combustion analysis. Additionally, foreseeing the increasing hybrid car market, they provide the major components such as motor, inverter, and lithium-ion secondary battery, utilizing their advantage of existing technology for transportation system.

- **"Driving control system business"**

  Hitachi focuses on next generation drive system for safety, such as milli-meter wave radar, Brake or Steer by wire utilizing existing technology, transportation control technology and semiconductor technology.

- **"automotive information system business"**

  Hitachi estimates that this business market size will double in 5 years. Thus they are focusing on the automotive information system, such as car navigation system, portal

system and next generation telematics service, utilizing their owned technology, high speed data communication technology, and storage technology (HDD).

- Customer strategy

Though they are targeting at expanding the top ten customers, such as GM group, Ford Group, and Toyota, other than Nissan group, their main customer is still Renault/Nissan(55%), followed by GM(20%), Ford(5%) Honda(5%) in 2003. Since the patterns of Japanese automotive business are "trust" and "long term relationship", it is not easy to change the previous relationship. Rather, it seems that automotive manufacturers out of Japan are more potential customers for Hitachi.

- Geographical strategy

Due to the demand for global procurement from car manufacturers, they located their sales office and manufacturing sites for technical support and local procurement in Europe, Africa, Asia, and North/South America. They especially focus on China market, established joint ventures with local manufacturer and opened manufacturing site and sales branch in Zhangsha, Suzhou, Guangzhou, and Shanghai from 1995 to 2003. Other than that, due to the environment regulation, assuming the demand for environment products will increase, Hitachi has expanded the local manufacturing or sales site in Europe, such as in UK, Germany. Hitachi is targeting at increasing the share of their oversea business sales to 50% in whole sales in 2010[10].

Others

As mentioned above, Hitachi has historically strong relations with Nissan. In 2002, they have merged Nissan's major components maker, Unisia Jecks and provide products to Nissan, or merge Nissan group components provider, collaborating with Nissan.

In 2004, Hitachi merged Clarion, the automotive car navigation or audio system provider in order to strengthen the automotive information system business. As I described, it is estimated that this market will increase rapidly in the future, this M&A will strengthen the Hitachi's position in the market.

Hitachi's strength in this business is not only extensive product lineup, but also the establishment of reliability and trust from customers by long term commitment to business and its experience. For new participants in the automotive market, to be the same level as Hitachi is quite challenging. However, if utilizing the changes of market trend by environment regulation, safety and the increasing demand for electronics technology, there might be still chance to participate in this conventional market.

5. Automotive Electronics Technology Distribution

The distribution of technologies employed for implementation of the various car functions are listed in the tables below for the cases of Basic Car Functions and Advanced Car Functions. With respect to each car function, the technologies being employed are classified into the categories of semiconductor, sensing, lighting, communication, recognition, and Audio/Video (A/V). As the technical solution of each supplier may vary, the actual technologies in use are listed independently for each of the major suppliers.

5.1. Basic functions

For basic function of cars, such as go forward, turn, and stop, the required parts or systems are shown in each function.

5.1.1. Semiconductor

Currently, basic functions are realized mainly using discrete and MCU. In the future those will be replaced with ASSP (Application Specific Standard Product) in order to reduce cost and the number of components. However, suppliers are required to fully understand automotive systems and bear initial investment cost for development of solutions. Power semiconductor technology is also essential for future systems in this category.

5.1.2. Sensor

This includes engine control system, safety-comfort system, and communication system. Due to the advance in car electronics, and the demand for safety, this market will be growing in the future. The performance, size, weight, and cost will be also improved.

Figure 4 - Distribution of technologies for Basic Functions

				semiconductor				Sensing		Light			Communication		Recognition			AV			
				Discrete	ASSP	MCU	Power	radar	sensor	HID	Halogen	LED	GPS	Network	vision	Sound	bio	display	sound	storage	computer
Basic function	Forward	Engine	Throttle By Wire																	
			Engine Electronics Control			♦♠														
			Gasoline Engine System	♦♠♥☆		♦♠	♦♠♥☆		♦♠♣											
			Hybrid Drive System	♦♠♥☆		♦	☆													
			Fuel Cell System	♦♠♥☆		♦														
		Transmission	AT/MT/CVT	♦♠♥☆		♦♠♥	♦♠☆		♠♣											
			Shift By Wire																	
		Body	Front Rea End Module																	
			- Lamp	♦♠☆		♦♠				☆	☆	☆								
			- Gas emission cleaning system																	
			Door w indow roof module	♦♠♥☆		♦♠	♦♠☆													
			Seat module	♦♠♥☆		♦♠			♠											
			Cockpit module	♦♠☆		♦♠	♦♠♥☆					☆								
			Air conditioner	♦♠☆		♦♠												♦♠♣♥			
			Others															☆			
			- Air bag	♦♠☆	♥	♦♠♥	♦♠☆		♠												
			- Interior light unit			♦♠						☆									
			- LAN											♦☆							
	Turn	Steering	Electric pow er steering	♦♠♥☆		♦♠	♦♠☆														
			Active Steering			♦♠			♣												
			Traction Control	♦♠☆		♦♠			♦♠♣												
			Steer By Wire																		
		Suspension	Electronics Control Suspension	♦♠♥☆		♦♠															
			ABC			♦♠			♠												
			Tire air pressure monitoring			♦♠♥			♠												
	Stop	Brake	ABS	♦☆		♦♠♥☆			♦♠♣												
			Electronic Stability Program			♦♠☆			♦♣												
			Electric hydraulic Brake	♦♠♥☆		♦♠☆			♦♠												
			Brake By Wire																		

♦♥♣♠: Japanese competitors, ☆: Toshiba

5.1.3. Light

This is also essential equipment for automotives. Surprisingly, no Japanese competitor participates in this market, though this demand will not decrease. There are several kinds of lump other than head light, such as fog lamp, xenon lamp, halogen lamp, tail lamp, hazard lamp, and cornering lamp.

5.1.4. Communication (LAN)

Originally this technology was adapted to control of window or seat, door, wiper, and light. But by the advance of "Information technology" in automotives, such as car navigation system or ITS, this demand is increasing. Unlike other technologies, this is easier to install in the car. As the demand increases, the standardization including wireless will be required.

5.2. Advanced functions

5.2.1. Semiconductor

Unlike basic function, this function is realized mainly by ASSP or MCU rather than discrete. Since suppliers apply ASSP for consumer products to automotives, advanced function is an easy entry area for electronics companies.

5.2.2. Sensor

This is utilized for active safety. Considering the trend, sensor technology demand will increase.

5.2.3. Recognition / Audio Video

These technologies play a crucial role in advanced function. At the same time, this area is very attractive market for electronics companies. Due to the existing technology for consumer products, the reusability is very high and we have better understanding than automotive companies or Tier 1 companies. In order to break into the market, this area is a great opportunity for backup group in the industry.

Figure 5 - Distribution of technologies for Advanced Functions

			semiconductor				Sensing		Light			Communication		recognition			AV				Infor matio
			Discrete	ASSP	MCU	Power	radar	Sensor	HID	Halogen	LED	GPS	Network	vision	sound	bio	display	sound	storage	computer	
Advanced function	Active safety	Monitoring System																			
		- Distance			♦♠		♦♠														
		- Night Vision		♦☆			♦♠♣							♦♠♣☆			♦♠♣♥☆				
		- AFS			♦♠			♣		☆											
		Drive Assist System																			
		- ACC	♦♠♥☆		♦♠		♦♠	♦													
		- Lane Keep Assist			♦♠		♦♠♣	♦♣						♦♠♣☆							
		- Brake Assist			♦♠			♦♠													
		- Parking Assist			♦♠		♦♠♣							♦♠♣☆			♦♠♣♥☆				
		- Automatic drive			♦♠		♦♠	♣													
		- Auto parking						♣													
	ITS	VICS																			
		- VICS/Car Navigation	♦♣♥☆	♦♠♣♥☆				♦♠♣♥					♦♠♣♥				♦♠♣♥☆	♦♠♣♥	♦☆		
		- Car Navigation communication service																			♦♠♣
		- Car Navigation software																			
		ETC																			
		- ETC terminal	♦♣☆		♦♠♣							♦♠♣♥			♦♠♣☆						
		Entertainment																			
		- Car Audio	♦♣♥☆	♦♠♣♥☆									♠♣								♠♣
		- external AV connection																♦♠♣♥	♦☆ ♦		
		- mobile DTV		♣♥☆													♦♠♣♥☆		♦☆		
		- DVD player etc.		♦♠♣♥☆													♦♠♣♥☆		♦☆		
	Security	Theft proof																			
		- Key less entry			♦♠♥																
		- Key less go			♦♠																
		- immobilizer			♦♠																
		Authentication																			
		- Smart Key			♦♠																
		- Biometrics																			

♦♥♣♠: Japanese competitors, ☆: Toshiba

6. Trends of Automotive Electronics Systems

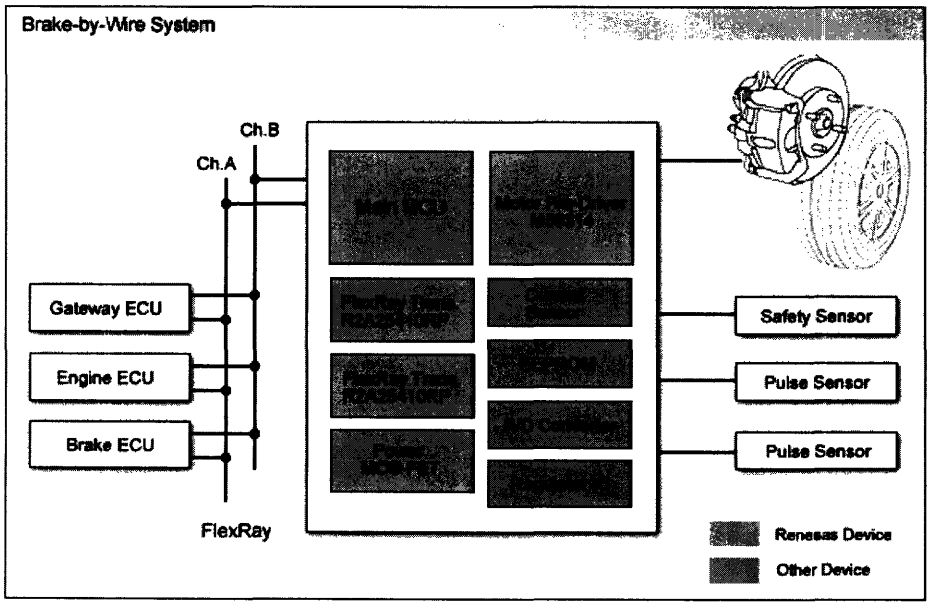
6.1. Technological Trends

6.1.1. Active Safety

X-by-Wire(SBW : Steer By Wire, BBW :Brake By Wire)

X-by-Wire is the technology which controls the functions, such as steering or braking by electronics, such as actuator or motor. Since this technology can enable the system to control meticulously, it can improve the safety, and weight saving. Typical example is "Fly-by-Wire" in aircraft, "Brake-by-Wire", "Steer-by-Wire" in automotives. "Safe-by-Wire" is standardized for optimization of safety equipment, such as airbag or seatbelt.

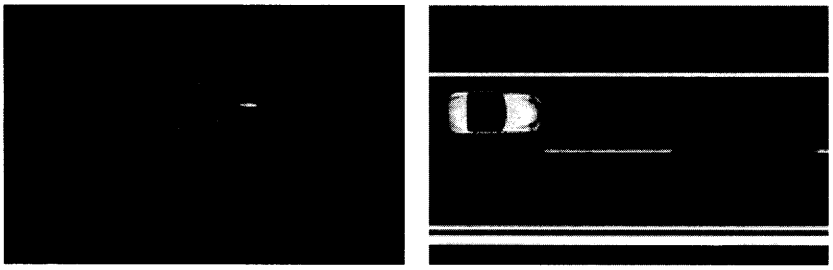
Currently for the motor control unit to wire the mechanical structure brake, it is required the communication interface with other CPUs, high performance CPU, high capacity memory, high speed, high accuracy A/D converter. The following is a example system introduced by Runesas Technology (The Joint Venture for semiconductor by Hitachi and Mitsubishi).



ACC(Adaptive Cruise Control)

ACC is a technology that can keep a certain distance from the car ahead by the radar information. ACC uses either a radar or laser setup to allow the vehicle to slow when approaching another vehicle and accelerate again to the preset speed when traffic allows.

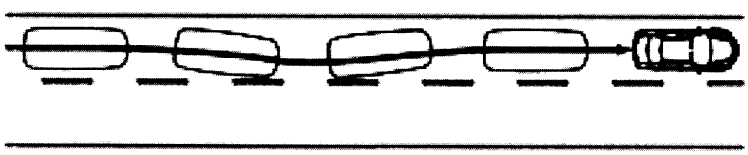
ACC technology is widely regarded as a key component of any future generations of smart cars, as a form of artificial intelligence that may usefully be employed as a driving aid.



LKAS (Lane Keep Assist System)

LKAS is a system that can support the control force for drivers handle, to keep driving in the lane along the highway or less sharp curve road.

When the car tries to get out of the lane, LKAS controls the handle to keep the car within the lane.



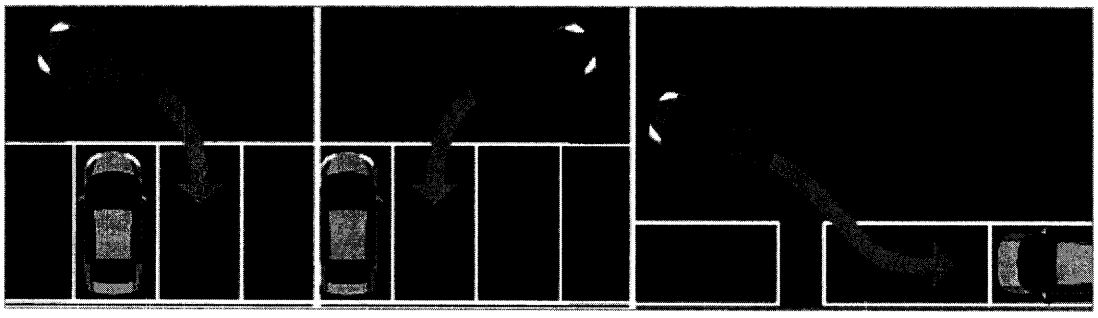
Brake assist

Brake assist is a system that can control the brake automatically by recognizing the emergency situation from driver's brake operation when the drivers are likely to meet the accident. When the drivers panic, it is said that they can brake quickly but not strongly, or once they brake and release immediately. This system recognizes emergency situation when the driver brakes quickly, and then it assists the stopping power by higher brake pressure than usual. When drivers release pedal intentionally, the system also stop assisting.

Parking assist

Parking assist is a system that assists the parallel parking or back parking. By following voice guidance, drivers can park without difficulties.

Honda's example



back parking from left side | back parking from right side | Parallel parking

6.1.2. ITS

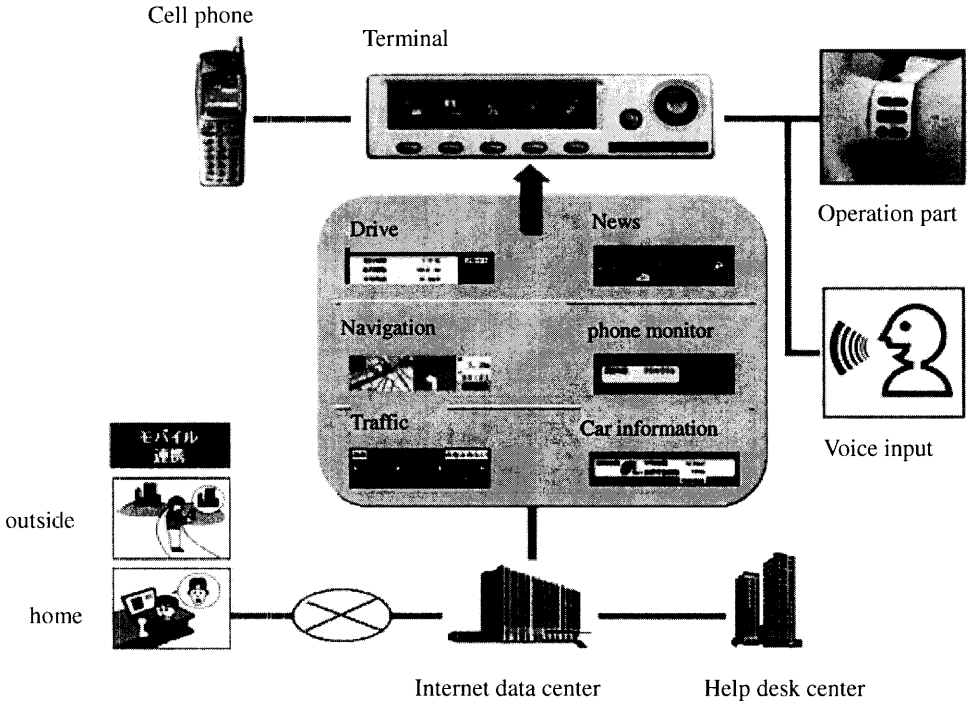
Telematics (Telecommunication and Informatics)

Telematics is a system for collecting road tolls, managing road usage (ITS : intelligent transportation systems), pricing auto insurance, tracking fleet vehicle locations, recovering stolen vehicles, providing automatic collision notification, location-driven driver information services - and more particularly, dedicated short range communications DSRC in-vehicle early warning (car accident prevention) notification alerts.

This system is also increasingly used to provide remote diagnostics; a vehicle's built-in system will identify a mechanical or electronic problem, and the telematics package can automatically make this information known to the vehicle manufacturer service organization. The telematics monitored system can notify any problems to the owner of the vehicle via e-mail. Other forthcoming applications include on-demand navigation, audio and audio-visual entertainment content.

The only issue or limitation to automotive Internet connectivity and its associated information is driver distraction. To avoid this, voice recognition will be incorporated.

Telematics System example(from Hitachi's automotive system website)



OnStar

OnStar is Telematics, a subscription-based communications, monitoring and tracking service provided by General Motors. The service is available for all vehicles that have the factory-installed OnStar hardware. It consists of both communication, through AMPS (primary) or CDMA (secondary) mobile phone networks, and location information using GPS technology. Drivers and passengers can use its audio interface to contact OnStar representatives for emergency services, vehicle diagnostics and directions. OnStar equipped vehicles with an active subscription will also contact representatives, in the event of a collision where the airbags are deployed. This new service is called Advanced Automatic Collision Notification (AACN) and is designed to greatly enhance emergency response efforts. When a driver presses the Red OnStar Emergency button or Blue OnStar button, current vehicle data and the user's GPS location are immediately gathered. This information is then sent to OnStar. OnStar Emergency calls are routed to the OnStar Center with highest priority.

VICS (Vehicle Information and Communication System)

VICS is an information communication system that transmits the traffic information or regulation edited and processed in VICS center in real time, and indicate in automotive equipment such as car navigation system.

ETC (Electronic Toll Collection)

ETC is a system that enables us to pass through the tollbooth without stopping at there for paying toll by the wireless two way communication between ETC equipment in the car and antenna placed at tollbooth. The toll is recorded in the ETC card in the equipment of the car and computer in collector, and then the payment will be completed. This system enables not only to mitigate the traffic congestion, but also to regulate the air contaminants around tollbooth.

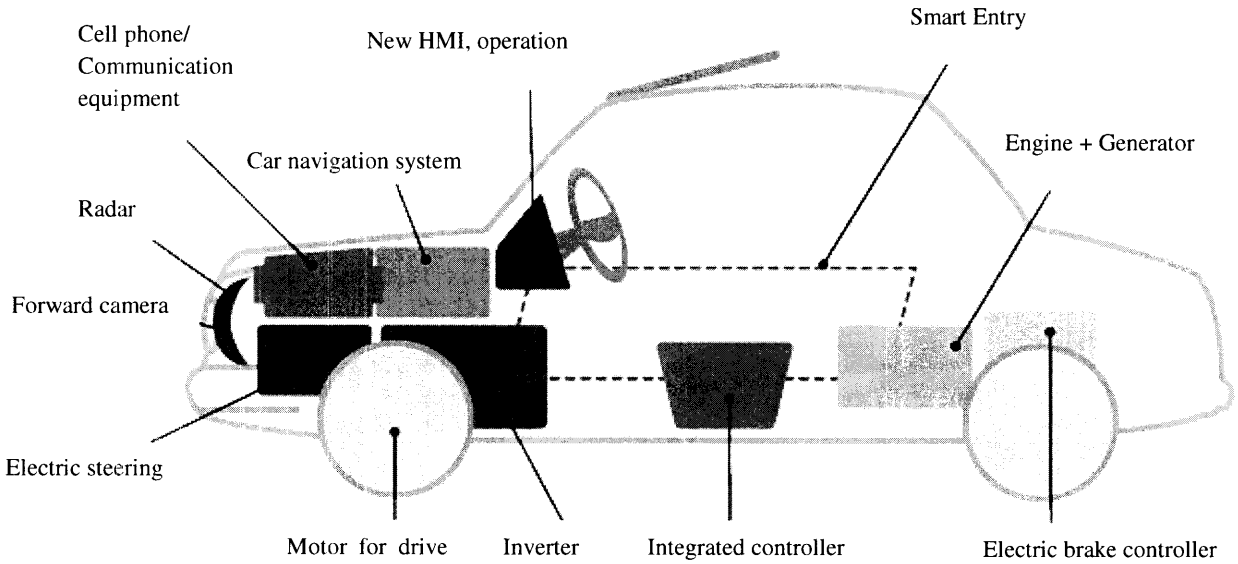
Communication (LAN, wireless network)

Automotive LAN is also one of the future trends. By connecting "Information" and "automotive equipment", it can bring the new function or convenience, performance improvement of these equipments. This technology is to connect vehicle with engine and motor with car navigation system, and detecting slope or traffic jam in advance, control the charge of battery, then improve the fuel consumption.

This technology does not require the additional complicated work to install in the car. Without additional hardware development, only software installment is required.

In order to realize this technology, we need to overcome the standardization of connectivity between equipments, or the complexity of software for control. In particular, for automotive systems, it is strictly required to avoid error, simplified or noise proof connector.

Main electronics equipments connected by automotive LAN

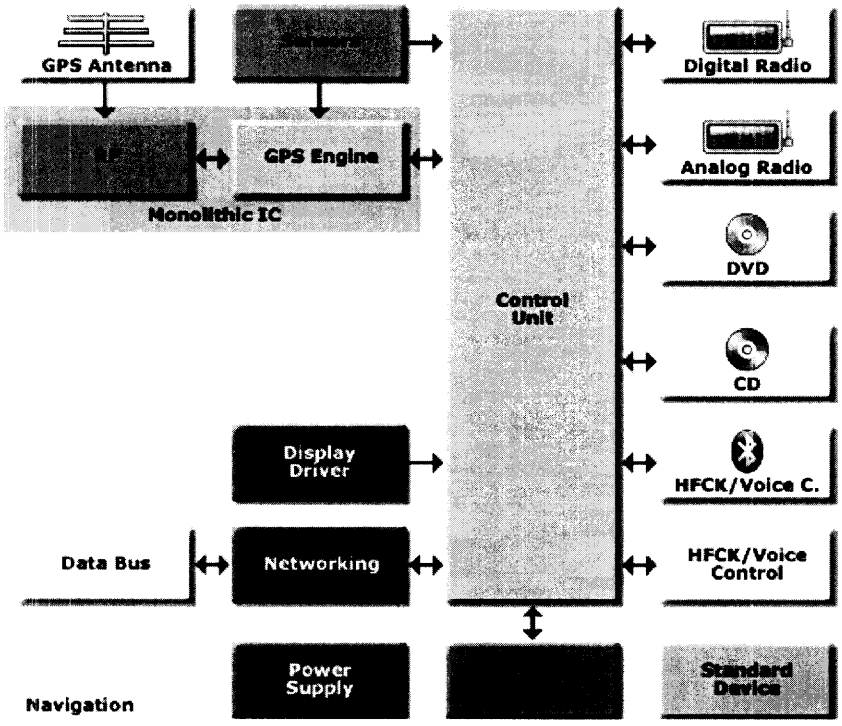


6.1.3. Entertainment

Automotive entertainment system

Automotive entertainment system includes various kinds of functions, such as wireless communication, voice recognition, digital radio, digital TV, and DVD player. It also includes the functions which can navigate, make a reservation for parking, and initiate an emergency call in case of accident by combining the GPS application, cell phone, and traffic information.

The following is a ST Micro's block diagram for entertainment systems.



6.2. Geographical demand

6.2.1. China

Not only for consumer products, but also for automotives, China is a huge market. The sales volume of cars in 2006 achieved 5.5 million cars, from 4.5 million cars in 2005. It is estimated to be 10 million cars in 2012 with the growth of 10% per year[11].

Customer segment expansion

One of the boom reasons in China is because the expansion of customer segment. So far, the customers were limited to the "wealthy people", but these years, 30s and 40s started to buy their own cars on credit after the home purchase. It is estimated that the motorist population will increase 50-55% a year.

Import tariff reductions[12]

Another reason is China's participation in WTO. The import tariff reduced from 80% to 25%, and by this change, worldwide automotive manufacturer started to collaborate with local manufacturers.

Alliance

The collaboration with foreign car makers has been promoted. For example, China FAW Group collaborates with Toyota, Mazda, Daihatsu, and Volkswagen. Dongfeng Motor with Nissan, KIA, Peugeot and Citroen, and Shanghai Automotive Industry Corporation with GM, Isuzu, and Fuji Heavy Industries.

Beijing Motor Group with DaimlerChrysler, Mitsubishi. Guangzhou Motor Group with Honda,

Zhangchun Automobile with Suzuki, Ford. Chinese big three is China FAW Group, Dongfeng Motor, and Shanghai Automotive Industry Corporation[13].

Automotive electronics

For automotive electronics as well as automotive itself, China is an attractive market. Electronics manufacturers have shifted their focus to China these years. By these manufacturers technology launching, it is expected that Chinese automotive components level will be improved and competitive in the world.

Concerns for environment

Due to the concerns for environment, China is a potential market for hybrid car. If the demand of hybrid car increases, electronics components demand will be increasing.

6.2.2. India

According to the Society of Indian Automobile Manufacturers (SIAM), Total sales of passenger vehicles were 641,341 cars (20.7% increase) from April to September in 2006.

In 1982, Suzuki started production of Multi 800 with Indian government. This initiated automotive industry in India, and Suzuki's subsidiary, Maruti Udyog Ltd still holds more than 50% share of the market.

In the late 1990, due to the liberalization of industry, Japanese, European, and US automotive manufacturers including Toyota, Honda, and Mitsubishi launched in India. However, the mainstream in the market is compact cars.

Compared with in China, rather than the improvement of quality, the increase of production is more required in India. It is estimated that compact car continue to be the mainstream in the market in future.

7. Customer Expectations from Automotive Electronics Suppliers

Following is a summary of comments from customer interviews which were conducted in order to analyze the expectations from suppliers of electronic systems for the automotive industry. Customer interviews were performed with the two types of customers, the automotive companies and the Tier 1 supplier companies.

7.1. Automotive company expectations from suppliers

- Automotive companies are expecting suppliers to understand whole automotive system, not electronics parts only.

- Automotive companies look for suppliers who agree to share long term risks due to the long business cycle in automotive industry. This long term risk sharing is not typical in electronics industry.

- Automotive companies need engineers who understand electronics and automotives, not engineers who understand mechanics and automotives. By the origin of automotive structure, they have more mechanical engineers than electronics engineers in the company. They want electronics companies to have attitude beyond the barrier between mechanics and electronics.

- Automotive companies look for electronics capability in current Tier 1 suppliers. Due to

the increase of electronics system in cars, Tier 1 suppliers currently cannot catch up the demand for electronics technology.

- Automotive companies want suppliers to understand business relations, such as long term, thin margin relations in automotive industry. Automotive business is traditionally long term, strong relations with thin margins. This is also why many electronics company hesitated to participate in this market. Electronics companies look for profit in the short term, therefore, this gap creates the difficulties in business establishment.

- Automotive companies want suppliers to understand differences of product requirement between automotive and electronics companies, such as just-in time supply, quality, model change period. Since electronics products require less quality than automotives, if supplier provide their original products as it is, it is not acceptable for automotive company. This difference also occurs in supply timing and model change period, without commitment to this business, suppliers will lose the business opportunities.

- Automotive companies need software development tool or human resources. Due to the increase of software needs in automotive systems, some automotive companies or suppliers have started to establish software companies. They mainly focus on software development, manufacturing, sales, consulting, and training.

7.2. Tier 1 Suppliers expectations from the electronics company

- Tier 1 suppliers need system engineers who understand whole systems including hardware and software. In automotive systems, the part of software is increasing, and as a result, it is very difficult to manage the whole systems.

- Tier 1 suppliers need quality guarantee for software from electronics companies. Due to the software increase, it will be the key how to manage the quality guarantee for software.

- Tier 1 suppliers don't think electronics companies can be a Tier 1 supplier. Even though electronics companies can handle information or entertainment technology, they cannot manage the mechanical part.

- Tier 1 suppliers are suspicious of electronics companies' commitment to automotive business. Considering the automotive business structure, they don't think electronics companies can commit to this business. After all, supplier's mission in this business is to combine the mechanical and electronics and provide the solution.

- Tier 1 suppliers are expecting from electronics companies as semiconductor Tier 2 companies. They need hardware solution rather than software. If basic functions are implemented in a semiconductor chip and their work is only to incorporate applications, it will be easier.

8. Analysis

8.1. Toshiba's current Position

Toshiba's current business for automotive is as follows.

	Business type	**Products**
System solution business	HEV business	Motor, inverter
	Car navigation/Entertainment	HDD, LCD
	Safety	Night vision
Components business	Semiconductor	MCU
	Others	Ramp
		CMOS camera
		ASSP for digital terrestrial broadcasting
		Handheld PC
		NAND flash memory
		ASSP for car audio

Toshiba's automotive business experience is very short, compared, for example, with Hitachi's 41 years business experience. Toshiba is obviously in the group of backup suppliers. I listed below some of the characteristics describing Toshiba's automotive business:

1. Toshiba's automotive electronics business is currently dispersed across the company, depending on the specific technology.
2. Products lineup is also dispersed; it means that Toshiba applied only existing

technologies, and not committed as a solution provider.

3. Within those businesses, sales depend on electronics such as semiconductor or HDD/LCD, rather than power electronics business.

The following is the author's impression of automotive business in Toshiba.

1. The recognition of Toshiba as automotive business supplier by customers is very low.
2. In Toshiba, automotive business recognition itself is very low.
3. The business of automotives in each company is small size, and position is relatively low.
4. Toshiba has some competitive products. However, since it has not committed to this business, ambitious sales increase in a few years is very challenging.

8.2. The strength of Japanese Electronics Companies in Automotive Business

As I discussed before, while the market trends require the changes of business pattern, the established relationship between car manufacturers and suppliers still continues. In order to participate in such challenging market, it is necessary to understand advantages and disadvantages as a new participant.

Followings are advantages of Japanese Electronics Companies when they consider the participation in the automotive market.

- Brand name

In order to start new business and marketing, it is very important to establish the brand image. Japanese Electronics Companies already has a certain extent of brand image in the area of PC or semiconductor. It will help the credibility of new products marketing.

- Reliability of technology

By existing products or experiences, such as PC or semiconductors, Japanese Electronics Companies have earned the reputation of highly reliable technology from customers. Like brand image, reliable technology is crucial for suppliers.

- Existence of good software engineers

In Japanese Electronics Companies, due to the demand for not only system components such as DVD, PC, TV, or cell phone, but also semiconductor components, many good engineers are trained internally. In Automotive industry, it is clear that customers requires high quality software engineers, therefore, it will be one of their advantage for this business.

- Existence of technology which can be applied for automotive

Considering the start of new business, it is also advantage that Japanese Electronics Companies have already some products or basic technology which can be applied for new business. It would be very difficult to develop new technology from scratch given the investment for equipment or human resources for development.

- Existence of automotive business in components level

The experience of doing business in the industry is also essential. If someone or organization has experienced in this industry, it will help to gain a sort of insight for the business.

- Leading position in semiconductor, consumer electronics technology

Given the future trend in automotive industry, the information technology will be indispensable. For this requirement, electronics company capability will play an essential role, rather than automotive manufacturers' internal development. Japanese Electronics Companies already have owned a lot of ASSP, or ASICs for digital components such as digital TV, DVD players/recorders, or cell phone. I believe this area will be the most required technology for Japanese Electronics Companies.

- Worldwide network

When it comes to the supply chain or sales for global companies and global business, local site establishment is one of the most demanding issues. Japanese Electronics Companies already have established group companies in worldwide, and even if customers require global supply, this existence will support the potential business.

- Potential to be a solution provider

From customers' point of view, not only automotive companies, but also other industry companies should require the total solution due to the cost efficiency and convenience. As a solution provider, Japanese Electronics Companies have a potential to provide a various range of products by company's technology nature.

8.3. The weakness of Japanese Electronics Companies in Automotive Business

As well as advantages of Japanese Electronics Company, I would like to describe the disadvantages. Followings are advantages of Japanese Electronics Companies when they consider the participation in the automotive market.

- Short term commitment (easily give up)

It is common idea for most private companies that short term output is the most crucial benchmark for future investment. When the company is in good condition, it has no problem to continue the long term business, however, if the company faces the financial difficulties, the business which requires long term commitment became the first target to be cut. In particular the company which strongly depends on the consumer products for sales tends to be this characteristic due to the less stability of the business. In order to participate in the automotive market, long term commitment to this business is definitely required, therefore, if we cannot commit to this business for a long term, it is smarter choice not to join in this business from the beginning.

- Hesitation to adapt new technology

Even though Japanese Electronics Companies recognize the value of new technology, it takes time to adapt into our products. One reason is the reliability of technology, and second is reliability of the company itself. Most cases these technologies are coming from start up company, and convincing all people who have authority to make a decision is not easy. As a result, we choose safer option, such as replacement technology by companies which has relationship in the past. This hesitation interrupts diving into the new market.

- Hesitation to the Merge and Acquisition

Historically, Japanese Electronics Companies are not good at M&A. One reason is the limited experience on that. Second is due to the conservatism, this was always last choice. It means, considering huge investment, we cannot spend much money for uncertain return. However, it is true that this conservatism has kept our business from risky business, but on the other hand, it is also true that we missed so many excellent business opportunities.

- Slow decision making

This is also Japanese companies' nature. As I mentioned above, Japanese companies always watch the peripheral environment, competitors' behavior, and waiting for the others action, then make a decision. Of course, this brings a delay to the participation in an emerging business, and sometimes, they miss the huge opportunities. If we target at being winners, quick but right decision is indispensable, and for that, wide aspects for markets and understanding of the various types of business way are essential.

8.4. Concerns for participation in the Automotive Business

Even though market trend changes can provide a tailwind, there are some concerns for new participants to join the market. These are chronic and crucial issues, therefore, if there is no solution for these issues, it would be better not to participate in the market.

- Many suppliers have already targeted at automotive market (ARM, Freescale)

Since consumer electronics business is competitive and low margin business, foreseeing the expansion of automotive business, many electronics companies including semiconductor companies try to break into the automotive electronics market. If the market becomes competitive, new participants cannot avoid cost competition and eventually same situation in consumer electronics will happen. As a solution provider, how to differentiate their products or services from other companies is the key. Considering the large number of new participants in this market, such differentiation is becoming very challenging.

- Software development company by manufacturers => higher requirement

According to the interview from customers or their establishment of software house, they obviously lack software engineers or solutions. As a matter of fact, it should be noted that this shortage is also critical issues for electronics companies. Nowadays, within high technology systems, software design occupies a large part of the product development work, and the investment for software development is huge. In such situation, it is questionable if electronics companies can supply the required services. Additionally, considering that customers started to establish software houses, it means that in the future they may not require the whole solutions to electronics. As a result, automotive electronics suppliers may only need to provide the hardware components. Such hardware business is not sustainable considering new participants' position.

- Less acknowledgement as a automotive business player in the industry

As I mentioned before, it will take time for customers to recognize new participants as an automotive electronics provider. Furthermore, customers believe that automotive industry is commonly understood as long term, low margin business, in that sense, not only difficulties on participation in the industry, but also changing customer's established mind is very challenging.

- Huge initial investment and long term thin return

Due to the strong relationship between automotive manufacturers and suppliers, they already established the prototype of business, "long term relationship, and thin margin". Can new participants get into this business and be a winner among them? Or can they change this traditional business style with breakthrough innovation in business?

8.5. Strategies

When new participants consider the optional strategies for penetrating the automotive business, they need to define how to deploy in the market in terms of customers, products, and regions. I categorized strategies into three, customer strategy, products strategy, and geographical strategy.

8.5.1. Customer strategy

The business of any supplier strongly depends on the customer's business condition. To minimize the impact by customer's situation, a supplier should make customer segmentation and define which customers should target in the market. In the following I discuss the options for customer categories.

Automotive company or Tier 1 supplier or both?

- Automotive company only

  In case that the target customer is an Automotive company only, this is less complicated business since the supplier does not need to get involved in the contractor-subcontractor politics and can contact the customers' requirements directly. This business is also higher margin business than as a subcontractor. Additionally, new participants can have a whole system picture in technology aspects and propose system solutions to the customers. On the other hand, responsibility for warranty or guarantee is higher than as a subcontractor, and furthermore, they need to be careful about balancing the relations with the automotive company and with the Tier 1 supplier since there is a possibility that they will become a competitor of Tier 1.

  The following is a Pros-Cons table for each customer segmentation.

	Pros	Cons
extreme high end (Toyota)	✓ Stability on business ✓ Higher commitment for quantity ✓ Possibility of participating in business due to the demanding spec	✓ No long term commitment ✓ Demanding quality requirement ✓ Hard to get the inquiry due to the existing relations
High end	✓ Less quality requirement than extreme high end	✓ Hard to get the inquiry due to the existing relations
Low end	✓ Easier to get the inquiry ✓ Less quality requirement	✓ Lower commitment for quantity ✓ Lower success rate on business
Combination above segment	✓ Less risky on the impact by customers business	✓ Various Product lineup requirement due to the different demand ✓ Different company culture

- Tier 1 only

This business is also simple since the relation is as a subcontractor for a Tier 1 supplier only, not getting involved more than 2 parties politics. New participants don't need to care too much about the automotive companies and Tier 1 relations. Moreover, since Tier 1 takes responsibility as a system, new participants only have to take responsibility as components. However, this business is limited and more difficult to be a solution provider since new participants cannot capture the final products or systems by end users (Automotive companies). It is also lower margin business.

- Both

  In most cases, this pattern is the current typical structure. Due to the lack of electronics technology in Tier 1, automotive company looks for their requirement directly, on the other hand, as a system provider, Tier 1 is also looking for that technology, and then, Tier 2 sometimes got the same inquiry from both parties. This brings a lot of complications on business due to the inconsistent requirements from both parties. One to one business is easier, but in reality, because of the lack of electronics company's understanding for systems including mechanics, new participants cannot avoid this complicated structure.

Given the above conditions, an electronics company aiming to become a supplier for the car manufacturers, should consider the following:

1. Target at Automotive company, rather than Tier 1 suppliers due to higher margins
2. It may be advantageous and with less competition to focus on extreme high end company rather than targeting other companies, provided that the company can respond to the extremely high quality demand
3. In case of targeting other companies, even including "standard" high end companies, cost competitiveness or differentiated technology is required
4. To be sustainable, it is better to be a solution provider, rather than components provider
5. In any case, the focus on the initial stage should be to make a best practice or best product

8.5.2. Product strategy

As well as customer segmentation, product strategy is also important. As shown in Figure 5, there are many business opportunities for electronics companies. However, without consistent policy and philosophy for technology, this business will easily fail. In the following, I discuss some of the key questions related to product and business definition which faces any company in this market.

Components supplier or Solution provider?

For new participants in the industry, it is an easier way to break into the market with possessing technology. However, such business is usually competitive and lower margin, and will not be sustainable in a long term. Even though the business starts as a components provider, new participants should aim to be a solution provider.

	Pros	Cons
Components provider	✓ Limited range of warranty(no responsibility as a system) ✓ Simple business ✓ Easy entry	✓ Difficult to have a big picture as a system ✓ Easy to be replaced ✓ Cost competitive ✓ Lower margin
Solution provider	✓ Difficult to be replaced by competitors ✓ Higher margin ✓	✓ Well understanding of system is required ✓ Additional investment ✓ Takes time to be able to provide solution

Basic function product or advanced function product?

As shown in Figure 4 and 5, there are more new business opportunities in advanced function than in basic function. For new participants who are good at consumer products, these areas are familiar and easier to be in the strong position in the industry. However, the market is still not matured, therefore the company needs patience for some time.

	Pros	Cons
Basic function product	✓ Similar spec products ✓ Higher demand ✓ Consistent technology among all car manufacturers	✓ Competitive market ✓ Difficulty of participation ✓ New big investment
advanced function product	✓ Higher participation possibility ✓ Lower investment(Enable to use the existing technology) ✓ Higher margin	✓ Different requirement ✓ Limited demand

How to supplement the technology?

Given the wide range of technology in automotive industry, other options will be M&A, Joint Venture as follows. These are faster way than the development by stand alone. However, there are also risks new participants need to take, such as huge investment, different culture management.

- M&A

  This is the fastest way to participate in the new market. However, it requires huge initial investment and management skills for new organization and its culture.

- Joint Venture

Enable to define the responsibility allocation by ownership percentage. Broader scope, new brand image,

- Co-development

Easier approach than above two strategies. However, balance of responsibility, ownership decision, and limited scope.

9. Conclusion

In the automotive industry, due to the trend of active safety, concerns of environment, and advance of information technology, automotive key manufacturers are eager to acquire the new technologies which enable to solve all above issues. As a result, the demand for electronics is increasing. So far, Tier 1 automotive component and system suppliers have supplied electronics technologies to car manufacturers. However, as the requirement for high technology grow, electronics companies' technology becomes indispensable. Currently, though there are some electronics companies who provide automotive components, but those are mostly components level, not a solution level, and very few companies are successful in this business. This is because of a lack of understanding of whole automotive technologies including mechanical structures by electronics companies, a gap of concept between automotive products and consumer products in terms of quality and quantity and differences in business culture. However, there is no doubt that this market is attractive market for electronics companies.

In order to be successful in this business, at first electronics companies need to change their position in the automotive industry. Not following traditional business practice, they should target at the equal position to Tier 1 automotive suppliers and thus, they should provide not only components, but also the technologies or solutions which customers are eager to acquire. To be a solution provider, M&A or Joint Venture will be one option to supplement the missing technology. Another option is the collaboration with competitors. Rather than competing on similar technology, making electronics companies higher position than just subcontractor position, they can make this business more profitable by changing the orthodox business structure. To achieve that, it is necessary to fully understand what customers really need. If customers say that there is a gap of understanding between electronics and mechanics, electronics companies should strive to make efforts to fill this gap by understanding mechanics.

If customer needs "Just In Time" supply, they should supply in this methodology. But, the electronic companies can also initiate and they do not need to subordinate to the customers. If they have crucial technology or solutions, the car manufacturers will be eager to buy. Electronic companies should not be only suppliers, they should become solution providers. As a component supplier, there can be no real success in this business.

Exhibit 1 Numbers of car production in each region

(Unit : car)

Region	CY2004	CY2005	CY2006	CY2007	CY2008	CY2009	CY2010	CY2011	CY2012	CY2013
Europe	19,981,579	19,947,323	20,388,906	20,815,629	21,267,504	21,881,905	22,506,501	23,087,345	23,548,239	23,896,813
Greater China	4,069,464	4,758,091	5,973,086	6,909,860	7,974,547	8,710,969	9,423,116	9,984,305	10,486,678	10,752,403
Japan/Korea	13,001,057	13,658,692	14,350,521	14,467,623	14,717,918	15,086,480	14,986,372	14,845,200	14,729,740	14,687,637
Middle East/Africa	1,229,735	1,398,906	1,573,866	1,614,314	1,724,476	1,832,801	1,942,202	1,987,589	2,045,082	2,063,297
North America	15,785,096	15,794,562	15,318,172	15,382,120	15,546,322	15,648,740	16,289,244	16,717,767	16,691,582	16,819,027
South America	2,472,629	2,816,322	3,039,241	3,249,632	3,451,177	3,549,212	3,769,987	4,055,092	4,279,230	4,466,226
South Asia	3,347,561	3,902,823	3,929,730	4,523,465	5,336,065	6,199,947	6,783,854	7,287,968	7,740,587	8,033,893
Total	59,887,121	62,276,719	64,573,522	66,962,643	70,018,009	72,910,054	75,701,276	77,965,266	79,521,138	80,719,296

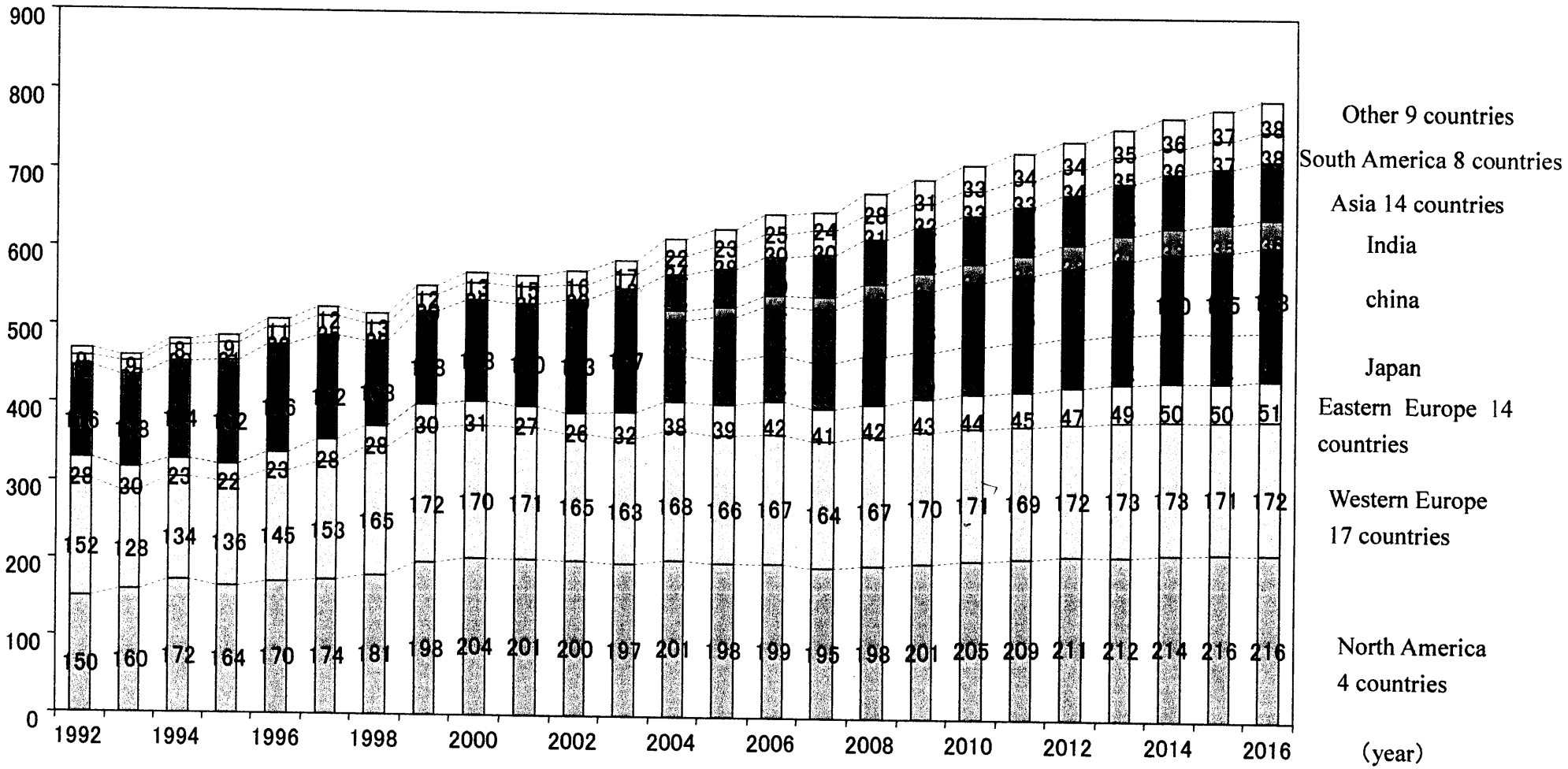
*Reference : CSM Worldwide Inc.

*The above numbers are for less than 3.5t Light Vehicle

Exhibit 2 Car sales volume and forecast in worldwide

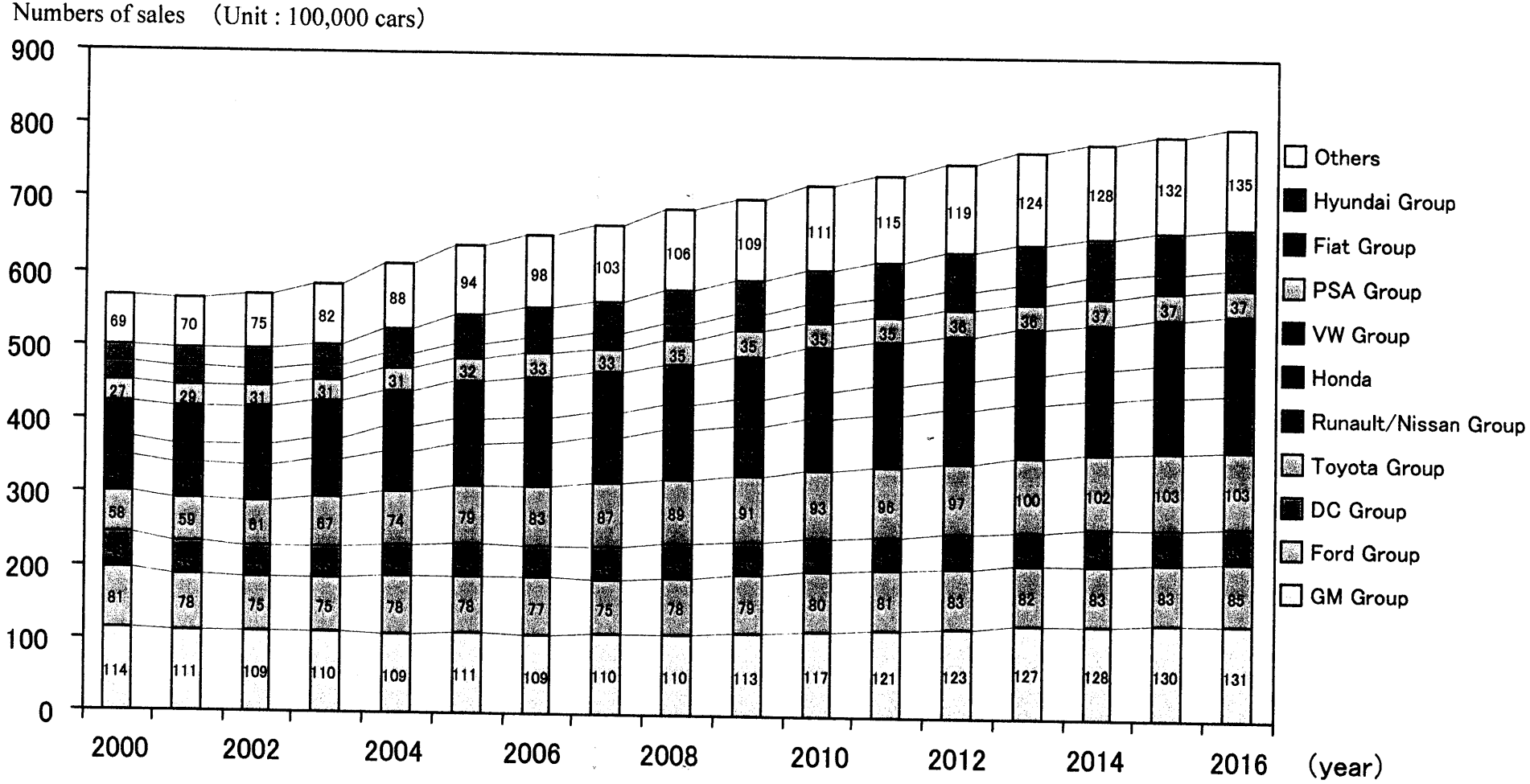
Numbers of sales

(Unit : 100,000 cars)



Reference : FOURIN

Exhibit 3 Automotive sales result and forecast in worldwide



Note : GM Group : GM, Suzuki, Subaru, Isuzu, Saab

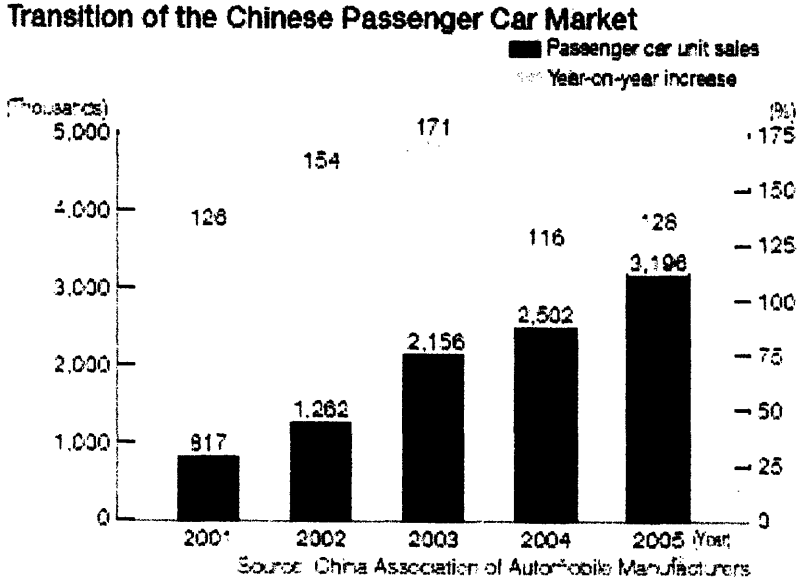
Ford Group : Ford, Mazda, VolvoCars, LandRover, Jaguar, AstonMartin

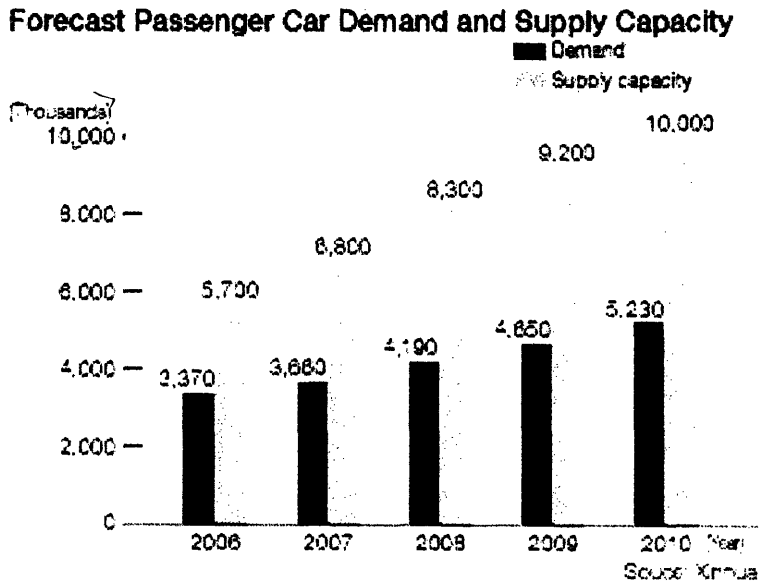
DC Group : Chrysler, MercedesBenz, Smart, Maybach

Toyota Group : Toyota, Lexus, Daihatsu, Hino

Reference : FOURIN, GlobalInsight database, BCG

Exhibit 4 China market trend and forecast





(Reference : Honda 2006 annual report)

Exhibit 5 The estimate of automotive electronics market in each region

1. Environment (Unit : million yen)

	2004	2005	2006	2007	2008	2009	2010	2011
Japan	2,201,065	2,331,410	2,435,620	2,523,510	2,610,410	2,675,590	2,766,705	2,854,140
	—	106%	104%	104%	103%	102%	103%	103%
NAFTA	2,429,473	2,493,877	2,554,535	2,620,345	2,688,940	2,786,860	2,867,725	2,928,080
	—	103%	102%	103%	103%	104%	103%	102%
EU	2,536,110	2,614,412	2,686,340	2,778,705	2,840,790	2,920,825	2,978,205	3,041,830
	—	103%	103%	103%	102%	103%	102%	102%
Others	2,955,456	3,377,033	3,803,833	4,111,924	4,370,472	4,613,617	4,808,752	4,981,943
	—	114%	113%	108%	106%	106%	104%	104%
Total	10,122,104	10,816,735	11,480,331	12,034,487	12,510,615	12,996,895	13,421,390	13,805,996
	—	107%	106%	105%	104%	104%	103%	103%

2. **Safety** (Unit : million yen)

	2004年	2005年	2006年	2007年	2008年	2009年	2010年	2011年
Japan	790,040	848,330	904,445	973,620	1,057,440	1,126,690	1,200,465	1,271,518
	—	107%	107%	108%	109%	107%	107%	106%
NAFTA	836,225	881,590	938,328	1,006,814	1,053,619	1,103,700	1,155,395	1,224,052
	—	105%	106%	107%	105%	105%	105%	106%
EU	1,111,426	1,179,885	1,260,268	1,352,336	1,460,495	1,576,360	1,706,746	1,824,937
	—	106%	107%	107%	108%	108%	108%	107%
Others	480,708	549,064	600,238	653,711	706,552	754,263	802,737	842,772
	—	114%	109%	109%	108%	107%	106%	105%
Total	3,218,399	3,458,872	3,703,282	3,986,484	4,278,109	4,561,016	4,865,346	5,163,282
	—	107%	107%	108%	107%	107%	107%	106%

Total (Unit : million yen)

	2004年	2005年	2006年	2007年	2008年	2009年	2010年	2011年
Japan	2,991,105	3,179,740	3,340,065	3,497,130	3,667,850	3,802,280	3,967,170	4,125,658
	—	106%	105%	105%	105%	104%	104%	104%
NAFTA	3,265,698	3,375,467	3,492,863	3,627,159	3,742,559	3,890,560	4,023,120	4,152,132
	—	103%	103%	104%	103%	104%	103%	103%
EU	3,647,536	3,794,297	3,946,608	4,131,041	4,301,285	4,497,185	4,684,951	4,866,767
	—	104%	104%	105%	104%	105%	104%	104%
Others	3,436,164	3,926,097	4,404,071	4,765,635	5,077,024	5,367,880	5,611,489	5,824,715
	—	114%	112%	108%	107%	106%	105%	104%
Total	13,340,503	14,275,604	15,183,610	16,020,968	16,788,721	17,557,908	18,286,733	18,969,275
	—	107%	106%	106%	105%	105%	104%	104%

Except Japan	10,349,398	11,095,864	11,843,545	12,523,838	13,120,871	13,755,628	14,319,563	14,843,617
	—	107%	107%	106%	105%	105%	104%	104%

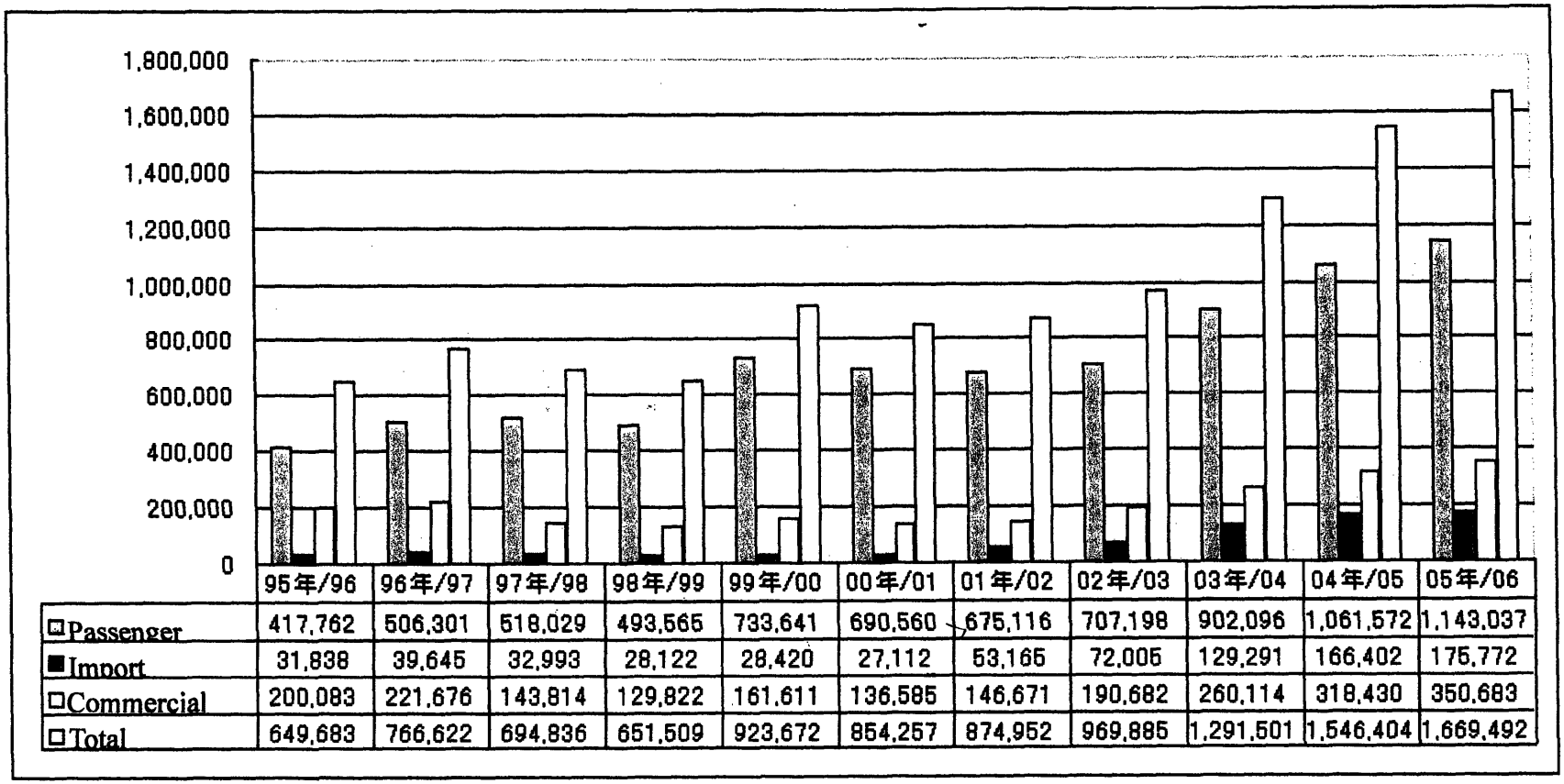
The rate in each region

Japan	22%	22%	22%	22%	22%	22%	22%	22%
NAFTA	24%	24%	23%	23%	22%	22%	22%	22%
EU	27%	27%	26%	26%	26%	26%	26%	26%
Others	26%	28%	29%	30%	30%	31%	31%	31%

* Reference : Automotive electronics device & Components Select 2006 / Fuji Kimera Research Institute

- NAFTA : US, Canada, Mexico
- EU : 25 European countries

Exhibit 6 The sales trend of passenger, import, and commercial vehicle (1995～2006)

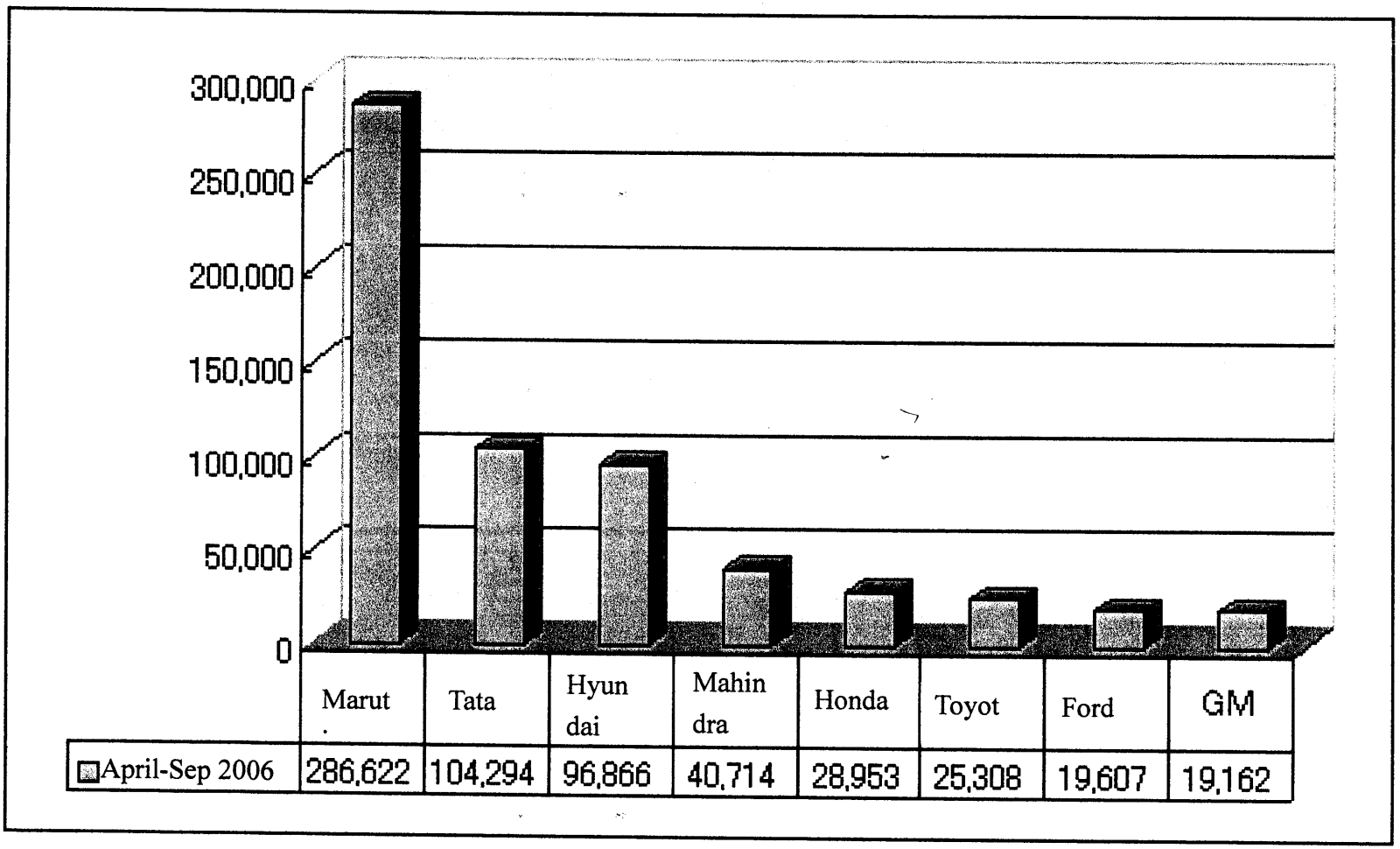


	95年/96	96年/97	97年/98	98年/99	99年/00	00年/01	01年/02	02年/03	03年/04	04年/05	05年/06
□Passenger	417,762	506,301	518,029	493,565	733,641	690,560	675,116	707,198	902,096	1,061,572	1,143,037
■Import	31,838	39,645	32,993	28,122	28,420	27,112	53,165	72,005	129,291	166,402	175,772
□Commercial	200,083	221,676	143,814	129,822	161,611	136,585	146,671	190,682	260,114	318,430	350,683
□Total	649,683	766,622	694,836	651,509	923,672	854,257	874,952	969,885	1,291,501	1,546,404	1,669,492

(Reference : SIAM)

Exhibit 7 Sales of passenger vehicle in India

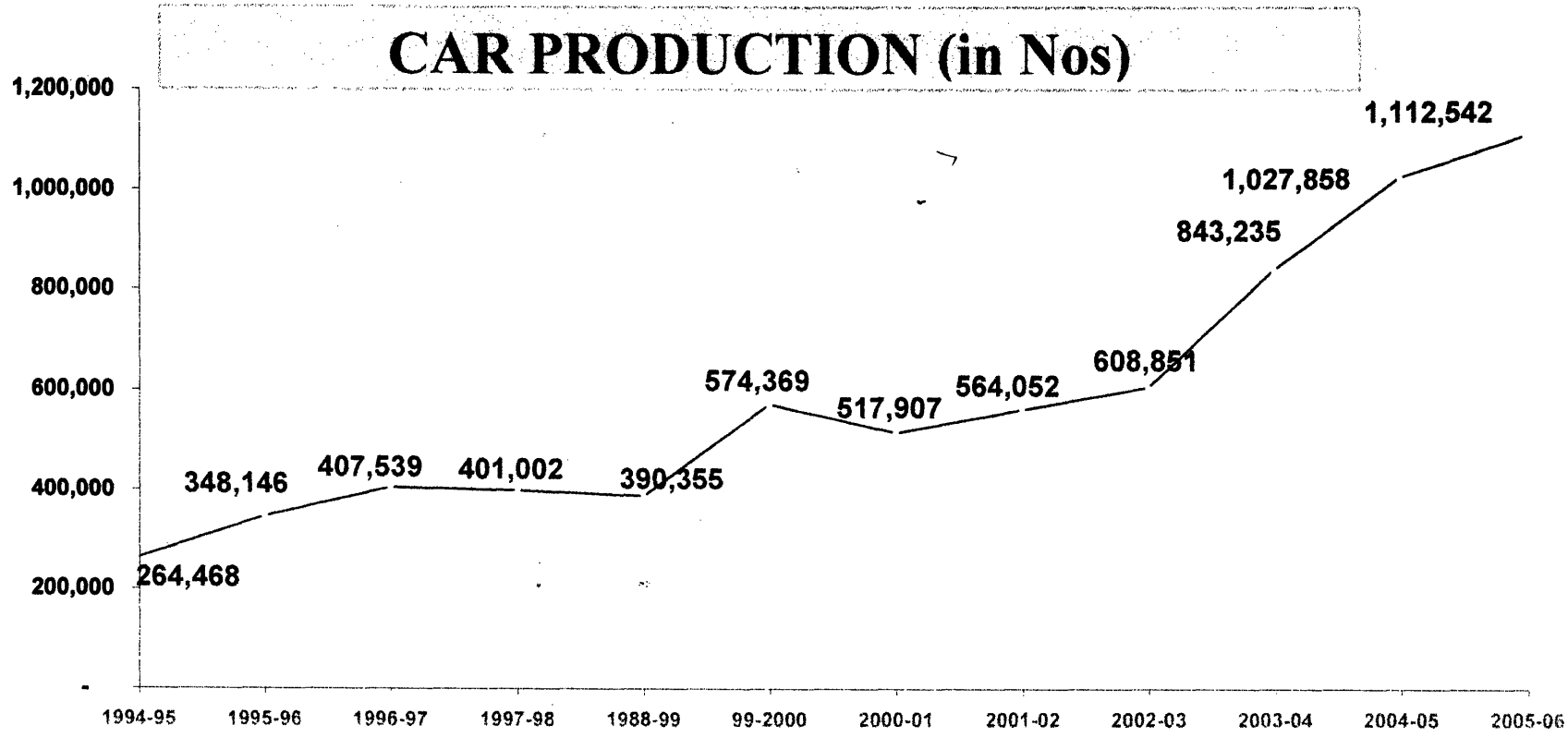
Exhibit 7 Sales of passenger vehicle in India



	Marut	Tata	Hyun dai	Mahin dra	Honda	Toyot	Ford	GM
April-Sep 2006	286,622	104,294	96,866	40,714	28,953	25,308	19,607	19,162

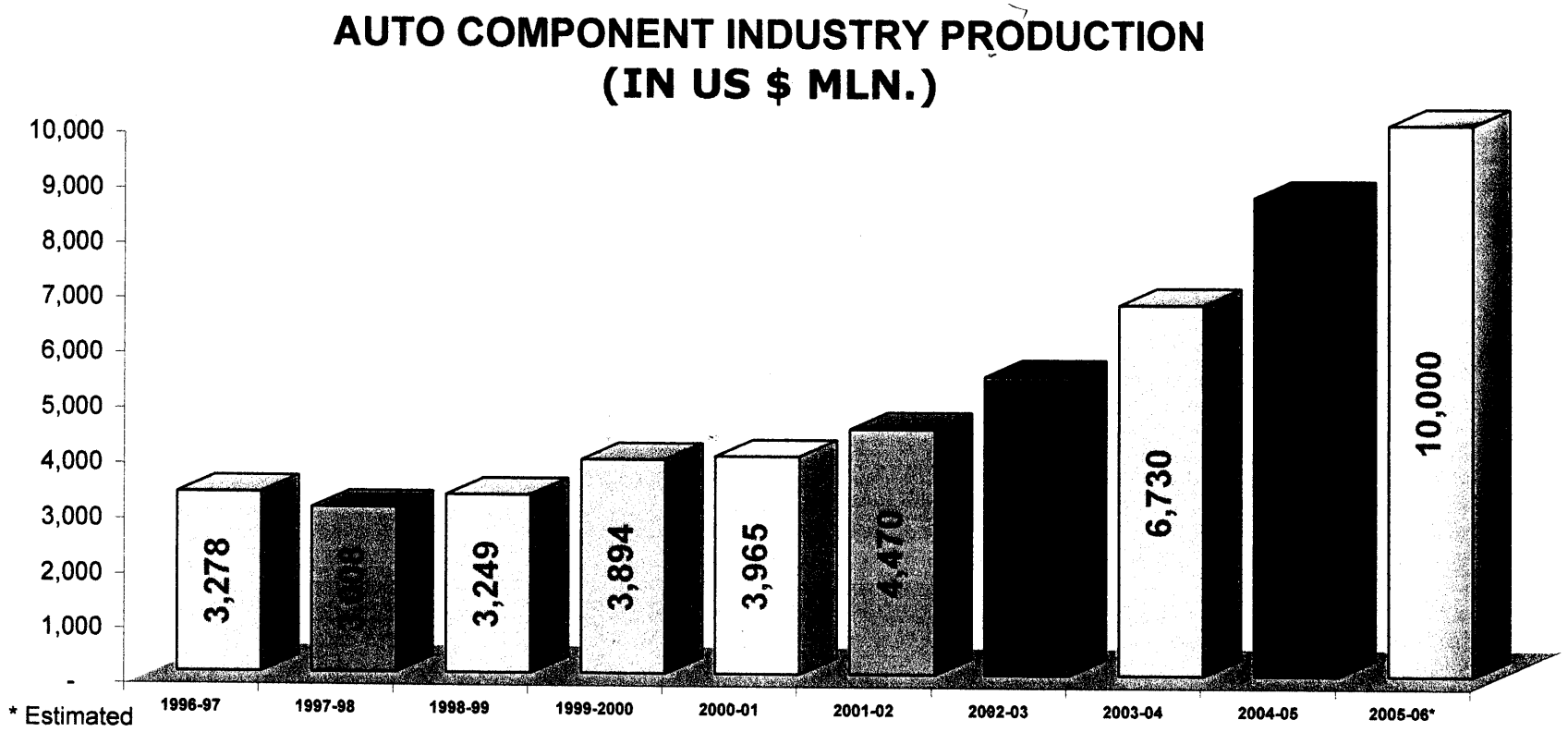
(Reference : SIAM)

Exhibit 8 Car production in India



(Reference : SIAM)

Exhibit 9 Automotive component industry production in India



(Reference : SIAM)

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