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Asian Journal of Management Cases 2008 5: 57

DOI: 10.1177/097282010800500203

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Lead Article

CHANGAN AUTOMOTIVE CO.—MAKING SUPPLY CHAINS WORK

Mark K.H. Goh

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The car has evolved from being a horseless carriage to becoming a sophisticated engineering marvel. Accordingly, the challenges of modern day automotive supply chain management have become increasingly complex. This article describes the situation faced in a Chinese automotive supply chain by ChangAn Auto Co. Ltd (ChangAn)—China's fourth largest automotive manufacturer. The article elaborates upon the supply chain visibility and speed-to-market issues for ChangAn in the context of China's fast growth market realities and institutional environment.

Keywords: Chinese automotive sector, supply chain visibility, speed-to-market, domestic growth, internationalization, auto-logistics

'Quality and customer service are moving targets'

J.D. Powers Automotive Research

MAJOR DRIVERS IN THE AUTOMOTIVE SUPPLY CHAIN

The automotive supply chain has witnessed several paradigm shifts over the years. Henry Ford first ushered in the era of mass production by creating the first 'moving assembly line' in the early twentieth century. His invention reduced the time required to roll out the Model T from 728 hours to 1.5 hours. The Japanese then revolutionized the industry in the 1970s, rewriting the rules of production, shifting the focus from mass to lean manufacturing and from economies of scale to economies of scope and speed. The tale of the automotive industry is a saga of growth, evolving from craft production to mass production, and from mass manufacturing to lean supply chain management. A significant contributor to the Gross Domestic Product (GDP) of any economy, the automotive sector

Acknowledgements: The authors wish to thank Mr James McAdam of NOL for making the necessary introductions, Mr Rick Li for graciously providing the interviews, and NOL for funding the research under the NOLF Grant (Grant number R-385-000-017-720).

leads all other sectors in Research and Development (R&D) expenditure and is marked by above average labour productivity and high capital intensity. The automotive industry forms a major chunk of the manufacturing sector and supports several other upstream and downstream industries such as the production of components, procurement of raw materials, after-sales services, dealerships and car financing. An average car consists of between 3,000 to 7,000 parts, 65 to 75 per cent (by value) of which are manufactured by component suppliers (Financial Times 1995). From a supply chain perspective, the automotive supply chain is highly complex, with a mesh of several tiers of suppliers, long product development and planning cycles, extensive production and assembly processes and a widespread network of independent dealers. During lean production, the responsibilities of design and sub-assembly of modules are increasingly being transferred to Tier 1 suppliers. Entire sub-assemblies have relocated to be close to final assembly lines, to ensure a continuous stream of parts, to shorten the supply chain and to decrease the lead time and reliance on logistics (Edmonson 2003). At the same time, component manufacturers have to comply with various technical standards to ensure that quality is assured in the components as well as the finished product, since any defect may lead to costly product recalls and can result in large financial losses to the car manufacturer.

The need to respond to an increasingly diverse set of customers has generated a large proliferation of segments and models, fundamentally reshaping the automotive supply chain. Car manufacturers today compete on accelerating the rate of new-model introductions and by offering greater add-in features to woo and delight customers. Spoilt for choice, customers are increasingly choosing products based on consumer attributes such as style, reliability, performance, fuel efficiency, safety features, emission compliance, on-time delivery and after-sales service. The automotive supply chain is largely producer driven rather than buyer driven. As such, information technology plays a critical role in coordinating the vast network of suppliers and logistics service providers by improving supply chain visibility. When compared to the after-sales service supply chain, the manufacturing supply chain has a relatively predictable demand with limited Stock Keeping Units (SKUs), homogeneous offerings and a possible requirement of multiple transport networks for delivery. The automotive dealers often attempt to shape demand to overcome the supply-demand imbalance since the costs of holding inventory are high, especially for land-scarce city locations.

TO THE LAND OF THE YANGTZE RIVER—PRODUCTION

The automotive industry is currently witnessing slow growth and low value creation in the developed economies. The risk of excess capacity, decreasing product life cycles and

increasingly razor-thin margins (as low as 18 USD per unit on low-end cars in the US) are coercing automakers to seek new avenues for growth and speedier ways to produce and deliver vehicles 'by taking out the lead time' (Potterf 2005). To take advantage of the low wages and to tap the attractive markets, the world's largest automakers have globalized and are flocking to emerging markets such as India, China and Eastern Europe.

China, with a population of over 1.3 billion, high economic growth and low per capita car ownership rate, presents an attractive opportunity to the world's leading automotive manufacturers. Such huge business opportunities are rare and the opening of the Chinese automotive market was harnessed by the government, which declared it as a 'pillar industry' in 1985 and infused it with financial aid.

China has now emerged as a major manufacturer of finished vehicles. It is expected to overtake Germany and become the world's third largest automotive manufacturer after the US and Japan (Xinhua 2006). The world's leading global automotive manufacturers; Ford (US), Toyota (Japan), Volkswagen (Germany), Daimler Chrysler (Germany-US) and Suzuki (Japan) have already partnered, in various forms, with the domestic automotive players; the 'Big Five' of China—SAIC (Shanghai), FAW, Dong Feng Motors (Wuhan), ChangAn (Chongqing) and Chery Automotives, to cater to the large customer base.

ALLURE OF THE FOUR WHEELER—CONSUMPTION

Owning a car (either an indigenous brand, a domestically manufactured foreign brand or an imported brand) is perhaps the most expensive purchase in an individual's life, second only to owning a house. It is a status symbol in China. Imported cars such as the Audi, Ferrari and BMW dominate the high-end luxury car segment in terms of appeal and quality, while domestic brands are fast catching up in quality by organizing new market launches in the compact, low and mid-size segments. The consumption patterns are shifting from company sponsored to privately owned vehicles as the 'bicycle kingdom' transforms and the purchasing power of the Chinese middle class grows. About 90 per cent of the cars sold in China are manufactured within the country. However, the Chinese customers in almost all segments are price sensitive. Nevertheless, market penetration is much lower than the world average. Almost 80 per cent of the customers are first time purchasers (Webb 2006). The market for high-end imported cars is relatively small and is confined to larger cities such as Shanghai, Beijing and Guangzhou. The price of imported cars and components is expected to fall even further, given China's entry into the World Trade Organization (WTO) in 2001; a radical event expected to influence the domestic and imported automotive manufacturing industry.

With the combined presence of over 100 automotive manufacturers in China, the risk of production overcapacity especially among the domestic players, decreasing margins and decreasing tariffs on imported cars has led to intense competition in the marketplace. The accelerating demand in the domestic market and a small but developing export market is already coercing Chinese manufacturers to develop clean technology and cheaper and faster cars. In the fast moving auto business environment, where the customer is in charge, automotive technology is evolving at a breakneck speed and regulatory issues are pressing for speed-to-market in the delivery of components and finished vehicles as a potential source of competitive advantage for automotive manufacturers such as ChangAn, China's fourth largest car manufacturer.

COMPANY BACKGROUND

Established in 1957, ChangAn was a successful arms manufacturer jointly set up by the People's Liberation Army and the Chinese people. Located at Chongqing, on the Yangtze River, it entered China's car manufacturing industry with the launch of its first jeep, called Yangtze River. ChangAn began manufacturing minicars in 1983 and has since grown to the enviable position of China's number one mini-vehicle manufacturer.

ChangAn develops both cars and car engines. Its product range includes minicars, sedans and buses. It has three production bases located in Chongqing, Nanjing and Hebei where nine car making ventures and independent companies that manufacture military products are situated.

ChangAn is a fast expanding group. Since its establishment, its production and sales of cars have increased by 30 per cent annually and reached 580,000 cars in 2004.¹ It produced 708,000 vehicles and achieved sales of Renminbi (RMB) 43.2 billion in 2006, a 43 per cent increase from 2005, with a net profit increase of 252 per cent annually to RMB 2.29 billion (China Business Daily News 2007a). The brand value of ChangAn rose to RMB 13.358 billion in 2005 from RMB 2.5 billion in 1998, and it was ranked among the ten top most valued domestic brands in China (<http://www.chagan.com>). Akin to its competitors, ChangAn's rapid growth may be attributed to astute and strategic tie ups with global leaders such as Ford, Suzuki and Mazda, keen on penetrating China's promising and unexplored automotive market.

ChangAn caters to the large Chinese market and has launched its own indigenous brands, as well as a wide range of vehicles (basic, SUVs and special vehicles such as police vans)

1. Retrieved from <http://www.changanauto.com/group/about.htm> on 8 May 2007.

in the high, mid and low-end segments with its collaborators such as ChangAn Ford, ChangAn Suzuki and ChangAn JMC (Jiangling Motors Company).

ChangAn Ford

ChangAn Ford, set up in 2001, manufactures Ford Focus, Fiesta and Mondeos for the domestic Chinese market. The Ford Motor Company, a late entrant into China's burgeoning automotive sector partnered with ChangAn, in a fifty-fifty, USD 98 million joint venture. The ChangAn Ford facility, located in Chongqing's northern industrial zone employs 1,600 workers. The facility began production of the Ford Fiesta in 2003. It consists of a body shop, paint shop, a technical development centre (which works on integrating and localizing products) and a final assembly line (Gallagher 2006).

ChangAn Ford initially targeted the small and mid-sized car segment in China. ChangAn cars were tailored for the family and the small business entrepreneur. Depending on the engine and transmission, the Ford Fiesta was priced between USD 10,725 and USD 15,435 and catered to the 25-35 year old Chinese customer.

ChangAn Suzuki

Set up in May 1993, the 287,000 m² Chongqing ChangAn Suzuki facility was built with an initial investment of USD 170 million and a registered capital of USD 59.98 million. In the beginning, ChangAn Suzuki produced the Alto Hatchback (SC 7081) and Gazelle Sedan (SC 7130) in the price range of USD 5,342 to USD 7,551 (Gallagher 2006: 29). Today, ChangAn Suzuki has 380 dealerships and a sales and service network which covers 210 large and medium-sized cities in China. The ChangAn Suzuki manufacturing plant focuses on the production of economical cars (below 1.3 liters) with low emission and high emphasis on quality (Gallagher 2006: 29).

ChangAn JMC

Located in Nanchang, ChangAn JMC, a tie up between ChangAn and Jiangling Motors Co. (a local Chinese company) was established in 2004 to produce the Jiangling Landwind SUV. Since then, ChangAn has bought over JMC.

ChangAn's Indigenous Brands

The transfer of expertise and technology from foreign partners has benefited domestic automotive manufacturers in China and has helped them to speed up the development

of indigenous brands. ChangAn follows the strategy of the 'Four Borrows'—borrowing technology, capital, dealers in overseas markets and production space with collaborators.² Like most Chinese manufacturers, ChangAn has adapted its products to suit the tastes of the Chinese customer. In 2004, ChangAn launched ChangAn CM8, its first indigenously developed vehicle at the Beijing International Auto Show. Other models designed and manufactured in-house are the Chinese Dragon, City Rainbow, SC6360 Series, SC6391, SC6350C and SC6371 Sports Series.

ACCELERATING AHEAD

In spite of quality concerns, Chinese manufactured cars are likely to flood the international market in the future. Chinese car exports, which exceeded imports for the first time in 2005, have doubled (173,000 units in 2005 and 78,000 in 2004).³ China exported more than 340,000 units in 2006 valued at USD 1.58 billion, an increase of 120.5 per cent as compared to 2005. Again, this was much higher than the import of 160,000 units in 2005 which rose by just 8 per cent (Chinadaily.com). The promising growth of China's domestic automotive market and a consistent increase in the export of finished vehicles suggests that China will emerge as a global giant in this sector. ChangAn is already a strong player in the local market and has its sight set on the international arena with expansion plans into the United States in the finished vehicle export category:

Expansion into the US Market

Globalization is the new challenge for Chinese firms keen on establishing an internationally recognized brand name and a global footprint. ChangAn entered the US market by establishing the company Tiger Truck to manufacture, import and distribute trucks based on its own designs from its first assembly plant in Jasper, Texas. Its strategic location is well-suited for vehicle shipments to destinations throughout North America, Central America and the Caribbean basin. The first vehicles produced by Tiger Truck with the 'Made in U.S.A.' label will be launched in 2008 (China Business Daily News 2007b).

2. Retrieved from <http://www.changanauto.com/group/about.htm> on 8 May 2007.

3. 'China doubles auto exports in 2006'. Retrieved from http://en.ce.cn/Industries/Auto/200701/01/t20070101_9963593.shtml on 12 April 2007.

Export to Other International Markets

ChangAn exported more than 20,000 vehicles in the first nine months of 2006 as compared to 15,000 vehicles in 2005. The export of vehicles is expected to grow five-fold to 100,000 by 2010 (Shen and Liu 2006). The export of finished vehicles is handled by ChangAn's logistics joint venture with Minsheng Industrials and APL called ChangAn Minsheng APL Logistics (CMAL). The customs clearance process coordinated by CMAL requires approximately 24 to 48 hours and uses Roll On-Roll Off (RO-RO) vessels for the export of finished vehicles from the port of Shanghai.

CHANGING GEARS

The major manufacturing sites of ChangAn and its joint venture partners are located away from the city, in the industrial parks of Chongqing, Nanchang and Nanjing. Chongqing is surrounded by steep-sided hills and is located at the confluence of the Yangtze and Jialing Rivers. At the same time, Chongqing, with access to natural resources, close proximity to the Three Gorges hydroelectricity project and availability of low cost labour not only has a history of engine and vehicle manufacturing (Chongqing is China's motorcycle production capital) but also has the required resources to be an ideal site for automotive manufacturing (Gelb 2004). While it lags behind its coastal counterparts such as Tianjin (Toyota) and Shanghai (Honda), the city inaugurated as a municipality in 1997, is upgrading its status to that of an 'Autotown'. This is favoured by the Chinese government's 'Great Western Development Policy', which supports the progress of China's western region and has attracted foreign investors such as Ford to the region (Gelb 2004). Despite the preferential treatment by the Chinese government, the rocky topography and an unusually large number of bridges and tunnels deter easy and smooth transportation by road. Due to its hilly geography and proximity to the Yangtze and Jialing Rivers, supply chain management and the transportation of vehicles and parts pose a serious challenge for ChangAn supply chain managers and logisticians. The immediate burning question is obvious: should ChangAn relocate to the coastal areas of Tianjin (northeast China) or Shanghai (central China) to be close to the rich base of automotive suppliers as observed in the case of its competitors such as Toyota, FAW and SAIC (see Exhibit 1) or, should ChangAn continue to operate from its current inland location around Chongqing, and exploit the comparative advantage of natural resources, cheap labour force and favourable government policies to develop an edge over its competitors through efficient supply chain management? In

the following section, we discuss how supply chain managers overcome the challenges posed by ChangAn's unfavourable location, and determine a supply chain strategy for ChangAn.

BEHIND THE WHEEL/CHANGAN'S SUPPLY CHAIN STRATEGY

To cope and survive in a competitive industry environment, an efficient supply chain strategy is imperative since supply chain management requires the effective flow of materials, information and finances within the supply chain. For ChangAn, the two-fold objectives of supply chain management are:

1. Link all the customers (dealers), suppliers, factories, warehouses, distributors, carriers and other trading partners, i.e. create a smooth physical flow of goods.
2. Connect all the customers, suppliers, factories, warehouses, distributors, carriers and other trading partners so that there is an efficient (cheap) and effective (timely and accurate) flow of information.

LINK ALL CUSTOMERS, SUPPLIERS, FACTORIES, WAREHOUSES, DISTRIBUTORS, CARRIERS AND OTHER TRADING PARTNERS (PHYSICAL FLOW)

ChangAn has a vast network of component suppliers and finished vehicle dealers. Most of ChangAn's component suppliers are located within China, which has emerged as a large manufacturer of components and was the second largest component exporter to the US after Mexico in 2006, with exports valued at USD 6.9 billion, an increase of 28.1 per cent from 2005 (Chappell 2007). The first challenge that the managers at ChangAn face is the detailed coordination of procurement of supplies from its numerous suppliers located throughout China and also abroad. To overcome this location disadvantage, river transport by barge is used as an alternative to road and rail transport. This is because Chongqing is the biggest inland river port in inland China and much of ChangAn's transport of supplies and finished vehicles is on barges using the Yangtze River. Table 1 compares the cost, distance and time required for each mode. ChangAn adopts a Just-In-Time (JIT) strategy for the procurement of components. JIT implies that long lead times are out and speed is in. This naturally requires a shift from a labour intensive to a material intensive business model with a propensity to buy rather than make the components. The adopters of the JIT strategy stress on lean inventory and strive to procure the right material at the right time and in the right quantity. We now discuss how ChangAn coordinates the inbound and outbound logistics for its automotive supply chain and creates a physical flow of goods.

Table 1
Cost, Distance and Time Required by Different Modes

<i>Chongqing- Wuhan</i>	<i>Road</i>	<i>Rail</i>	<i>Barge</i>	<i>Chongqing- Shanghai</i>	<i>Road</i>	<i>Rail</i>	<i>Barge</i>
Distance (km)	700	1,000	1,280	Distance (km)	2,150	2,600	2,400
Transit Time (Days)	3	6	4 (6 upriver)	Transit Time (Days)	3-4 (40 hrs)	7-10 days	8 (11 upriver)
Cost	\$0.10 per ton/km	\$545/TEU	\$340/TEU	Cost	\$0.10 per ton/km*	\$770/ TEU*	\$395/TEU

Source: Kwan and Knutsen 2006.

Inbound Logistics

The logistics costs constitute a large percentage of the total production costs of a car, particularly in China. ChangAn joined with APL and Minsheng Industrials in 2002, to ensure speedy and effective transportation, storage, distribution, import and export of supplies and finished vehicles (CMAL Annual Report 2006). CMAL has identified several supply chains within the area of inbound logistics and coordinates the flow of parts from the suppliers for ChangAn (Exhibit 2):

1. For the remote suppliers, several milk runs are undertaken. In a milk run, the auto parts are cross-docked and transported to the Container Yards (CY) located at Shanghai, Wuhan and Nanjing by truck. The average milk run from Shanghai for inbound parts takes about 10 days.
2. In the dedicated milk runs, the auto parts are collected and directly transported to the container yard.
3. The auto parts are then transported to the Regional Distribution Centre (RDC) located at Chongqing, through the Yangtze River. Depending on the specifications for spare parts, the RDC holds about 1.5 to 7 days of inventory.
4. In a few cases, the auto parts are delivered using a Vendor Managed Inventory (VMI) system to the Chongqing RDC. The VMI holds approximately one month of inventory. From the Chongqing RDC, the parts are supplied to the respective assembly plants by truck.
5. Some supplier parts are delivered directly to the assembly line using a technique known as sequenced delivery. This just-in-sequence approach is usually meant for

those suppliers who are located within the municipality of Chongqing. Exhibit 2 gives the details for the inbound logistics process.

Outbound Logistics

ChangAn uses several modes of transport for the movement of finished vehicles. ChangAn dealers are located in coastal cities such as Shanghai, and other regional cities and locations such as Chengdu, Kunming, Urumqi, Xinjiang, Wuhan, Hubei, Hunan and Changsha, in addition to Chongqing. For the distribution of finished vehicles to Shanghai and Beijing, both located about 900 miles away, ChangAn Ford typically ships cars by river to Wuhan, where they are trucked to Beijing or Shanghai. For transportation to Shanghai, cars are sometimes transshipped down the Yangtze River. They are transported by truck to Guangdong, Guangzhou which is more than 100 miles closer to Chongqing than it is to Shanghai (see Exhibit 3).

ENABLE SUPPLY CHAIN AS WELL AS MANAGE THE CONVERGENCE OF IT AND BUSINESS MODELS INTO A NEW INTERACTIVE, INTERCONNECTED AND SCALABLE STRUCTURE

ChangAn implemented the Oracle E-Business Suite to communicate with its large network of suppliers and increase supply chain visibility for better inventory management of components and parts. Supply chain visibility extends from what inventory the supplier holds to inbound logistics, WIP, inventory levels, production processes, to what the customer demand is. Supply chain visibility suggests visibility across the three basic flows in a supply chain: information, products and finance. Complete supply chain visibility implies that clear demand signals are shared amongst all parties, there is seamless flow of information on inventory levels, WIP, finished goods and financing. In other words, complete supply chain visibility can be described as perfect information, perfect execution and perfect orders.

The degree of supply chain visibility refers to the ease with which one can transfer information within the enterprise and beyond its four walls. There should be better information sharing from logistics service providers, who are vital partners for the success of the supply chain. The enterprise must be able to track the inventory and product throughout the process (for example, from ordering, to picking, to shipping and delivery). To gain better visibility, several enterprise wide IT applications such as ERP, RFID, order fulfillment software, Transport Management Systems (TMS) and Warehouse Management Systems (WMS) have been adopted. The key question for ChangAn is whether it should

invest billions of US dollars for the creation of an efficient IT system. A few areas where IT plays a significant role are:

1. Efficient inbound logistics requires the effective flow of information between suppliers and logistics service providers to ensure the efficient and speedy delivery of component parts. Efficient IT systems will help ChangAn to reduce inventory storage costs and cycle counting. They will also help to collect accurate information regarding the inventory and eliminate waste at the factories.
2. By adopting efficient IT systems, ChangAn can integrate and centralize the management of human and material assets, production, supply and sales and form a real-time supply chain involving more than 2,000 suppliers and distributors (Potterf 2005: 2). This will improve the flow of information within the organization by augmenting supply chain visibility for parts procurement, inventory management, production and quality control, order fulfillment and attainment of shorter lead times in the dispatch of vehicles.
3. Rapid product development is a crucial source of competitive advantage in the automotive sector as firms race to beat competition and introduce new models that cater to the requirements of the targeted market segment. Gaining greater visibility in production has helped ChangAn achieve shorter turnaround time in concurrent modifications on vehicle parts from 30 to 7 days. ChangAn has already adopted Oracle's bill of materials function to execute their Engineering Change Orders (ECOs). An ECO is used for changes in documents such as processes and work instructions. Infact, ChangAn's ECO turnaround time for new vehicle parts has reduced from 120 to 65 days, thus achieving greater speed-to-design in production (Potterf 2005: 3).
4. Efficient IT systems will also help enhance production capability by decreasing the time required for processing such ECOs. Oracle's E-Business Suite has also helped ChangAn in improving the quality of its finished products and reducing the lead times in shipping by automating the order fulfillment process for the dispatch of vehicles, thus achieving speed-to-market.

Enhancing IT capabilities within ChangAn has improved the flow of information in the supply chain leading to great savings in operational cost. However, do these savings in cost justify the heavy investment in IT systems? As ChangAn's supply chain managers decide on this crucial aspect, the above overview of the benefits of IT in automotive supply chain management provide the decision variables that must be kept in mind.

They reflect the role of IT in achieving improved speed-to-market by saving time across different stages of the supply chain.

Speed-to-market is critical for time sensitive products and in China the automotive industry is no different. A mix of various supply chain strategies related to transport, location, technology and facilities is needed for a sustained optimal outcome for ChangAn.

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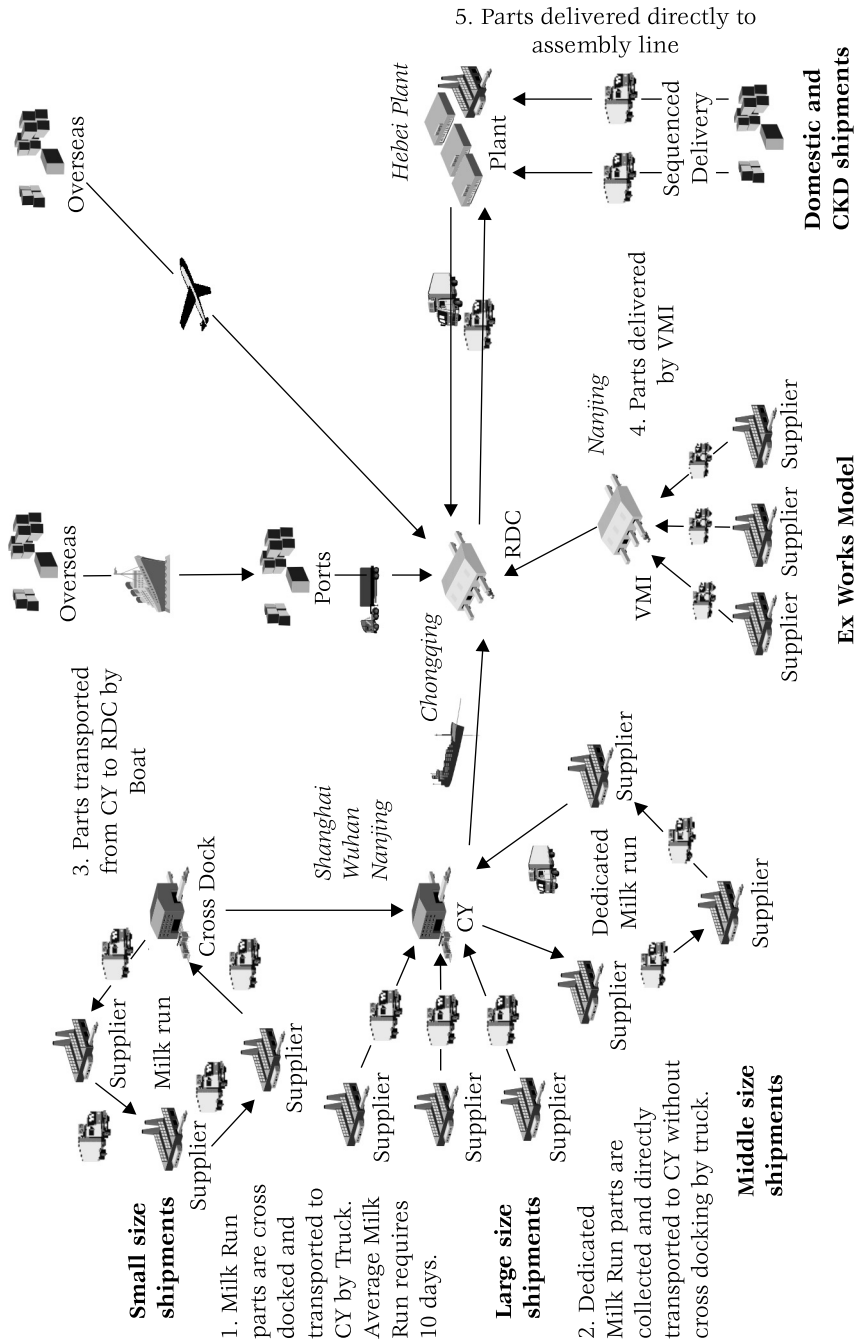
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Exhibit 1
Location of Major Vehicle Manufacturers in China



Source: Reuvid and Li 2003.

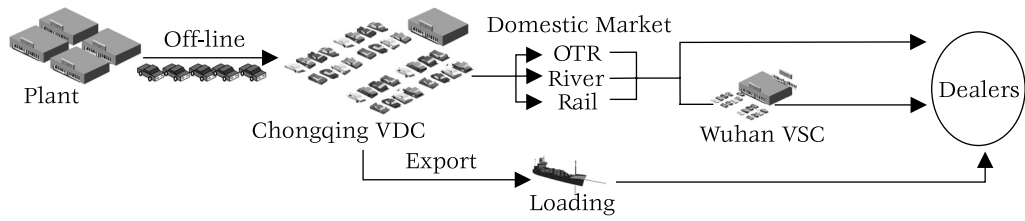
Exhibit 2
Process Map for Inbound Logistics



Ex Works Model

Source: Personal communication with Rick Li, Deputy General Manager, CMAL.

Exhibit 3
Process Map for Outbound Logistics



Source: Personal communication with Rick Li, Deputy General Manager, CMAL.