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2000

document version

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citation for published version (APA)

Heng, S. H., & Wibbelink, R. (2000). *Evolution of Organizational Structure and Strategy of the Automobile Industry*. (Research Memoranda; No. 2000-12). Informatiekunde, Marketing en Logistiek (IML).

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Automobile industry

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Research Memorandum 2000-I 2

April 2000



Evolution of Organizational Structure and Strategy of the Automobile Industry

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Abstract: This paper is a historically oriented study of the automobile industry. It sets out to understand why have the structure and strategy of the dominant companies in the automobile industry changed in the way they have done. Our findings suggest three factors at work, namely the knowledge of car production and of customers, the capability of the technological system, and the business environment. The knowledge system represents the level of know-how and the availability of information. In a sense the knowledge system in the automobile industry refers to the level and the degree of diffusion of knowledge of how to make a car on the one hand and the know-how of customer demands on the other hand. In the history of the automobile industry the knowledge system has improved continuously and gradually. The technological system of car production consists of clusters of technologies that together form the technological base necessary to support or shape the car production. The business environment refers to the social system (economy, prosperity), the market system (the quantity and direction of the market demand), the intensity level of competition, the culture, the legislation, etc.

keywords: hierarchical organization, network organization, business environment, Ford, Sloan, structure, strategy, knowledge, technology, automobile industry

1 INTRODUCTION

The centennial history of the automobile industry may be seen as a history of continuous incremental improvement of a business system that goes through a few stages. The automobile industry has developed from craftwork in the 19th century into a very complex industry today. It has produced a series of innovative management practices that shaped and are still shaping the industrial landscape all over the world. Henry Ford invented the moving assembly line, which has become an enduring symbol of industrialisation. Later, Alfred Sloan reorganized General Motors into a model for the modern corporation with its operating divisions, marketing plans and planned obsolescence. More recently, Toyota's crafting of lean production ushered in a general revolution in manufacturing. Therefore it is no surprise that the industry has been a source of influential ideas for management researchers. Nowadays it is one of the most competitive industries and one of the highest export earners. Large automobile companies are becoming global players and with annual sales of around a trillion dollars, the industry accounts for at least one in ten jobs in the industrialized countries. Developing countries continue to see their carmakers as a symbol of industrial progress and vitality.

As observed by Rae (1984) and Womack et al (1990), there are stages in the evolution of the automobile industry. Each of these stages has been dominated by one type of organizational structure and strategy. Each time after a period of success the dominant type of organization is replaced by another. The central question in this paper is:

Why have the structure and strategy of the dominant companies in the automobile industry changed in the way they have done?

The beginning of the automobile industry was characterized by craft production. The organizations were extremely decentralized and many of the skilled craftsmen were their own bosses, serving as independent contractors within a plant. This mode of production was not efficient and was unable to introduce innovation. It was the genius of Ford to solve such problems while incorporating innovations and technological advancement then currently obtaining. His name is thus closely associated with vertically integrated and centrally controlled organizations evolved during the early years of the 20th century. The new form of organization for car production was so successful that it virtually eliminated the craft organization. The growth of the automobile industry brought about more technical know-how about automobile production and increased competition. These, together with other changes in the business environment, posed new challenges to Ford who somehow failed to respond effectively. He was to lose out to Sloan who introduced in the 1930s a more decentralized organization. The decentralized mode of mass production was to dominate the automobile industry for decades. This in turn failed to respond to the greater availability of knowledge of car production, the improved capacity of the technological system and the more competitive environment. The prize went to the lean production system which found favour among the major automobile companies in the 1980s. The lean producers introduced a pull concept of production and used extensive subcontracting in order to co-ordinate the supply chain. In the 1990s automobile companies are downsizing, focusing on their core business in order to become more efficient and more effective than ever before.

Our findings suggest three factors, namely, the knowledge of car production and of customers, the capability of the technological system, and the business environment. The knowledge system represents the level of know-how and the availability of information. In a sense the knowledge system in the automobile industry represents the level and the degree of diffusion of knowledge of how to make a car on the one hand and the know-how of customer demands on the other hand. In the history of the automobile industry the knowledge system has improved continuously and gradually. The technological system of car production consists of clusters of technologies that together form the technological base necessary to support or shape the car production. The business environment refers to the social system (economy, prosperity), the market system (the quantity and direction of the market demand), the intensity level of competition, the culture, the legislation, etc.

This paper is a historically oriented study of the automobile industry. The approach shapes the structure of the paper. The following sections (section 2 to 5) look at the craft production, the mass production, decentralised organization, lean production, and network organization. Section 6 concludes the paper.

2 CRAFT PRODUCTION

In the late 19th century, the first gasoline-powered cars were being built in Europe. The organizations were extremely decentralized; general purpose machine tools were used to perform drilling, grinding and other operations on metal and wood. The craftsmen hand built expensive cars in very small numbers; per year 1,000 or fewer cars were produced world-wide.

The automobile industry consisted of a large number of very small companies. The competition was not fierce and the automobile makers focused on expensive, custom-made cars. The type of organizational structure may be identified as a network organization. Exchanges

between organizations were conducted through the market using money as the medium of exchange and contract as the medium of co-ordination. Many of the skilled craftsmen in an automobile company were their own bosses, often serving as independent contractors within a plant, or as independent machine-shop owners with whom the company contracted for specific parts or components.

The network organization based on craft had a number of drawbacks. Contractors sometimes operated with guile, for them the need to provide exactly what the manufacturer expected was not particularly high (Clegg, 1990). After all there was no fierce competition. As a result it was possible for contractors to optimize their own short-term businesses without having to fear negative consequences. Control over the contractors was hard to establish. And if contractors did try to provide exactly what the automobile maker requested it was not always possible. Making cars meant prototyping; consistency and reliability were elusive. It was not possible to produce two of the same cars, even if they were built to the same blueprints.

Production costs per unit were high and did not drop significantly with volume. Because there was no systematic research it was hardly possible to develop new technologies. The low level of the knowledge of building a car and the limited tools and materials were also barriers for the network organization to function properly.

The network organizations then could not expand dramatically in their existing form because of another reason. At that time there was no mass demand for the cars produced. In fact the product was perceived as an expensive toy of the rich; it was their willingness to indulge in an expensive hobby that enabled the industry to get going.

3 FORD'S MASS PRODUCTION SYSTEM

By 1900 several companies were established with the aim to build commercial vehicles, with investors and craftsmen joining forces to achieve this. According to Chandler (1964), key problems were production and finance. One may add another, the creation of a mass market. During the early years of the 20th century Henry Ford found a way to overcome these problems. The second stage of the history of the automobile industry was characterized by the mass production system that was largely pioneered by him. The introduction of the Model-T in 1908 opened this period. A relevant question is: how did the mass production system take over the network organization?

During the 19th century the United States was transformed from an essential rural economy into an urban economy, based on the technological developments ushered in by the Industrial Revolution. There was an ample supply of workers who were used to work in factories like the one Ford later introduced. The Industrial Revolution was also responsible for a rise in per-capita incomes and a strong desire to improve living standards. Furthermore the fact that gold was found in several places in the United States together with the North American financial system made finance of new industries possible.

The population of the United States was growing rapidly. The growth was perceived by entrepreneurs as a chance to expand and justify costly improvements such as mechanization. In his *Wealth of Nations*, Smith (1776) explained the importance of an expansion of the market for the more intensive division of labour and specialization. The American population consisted for a great deal of immigrants; this was one of the reasons why the class structure of the United States had no sharp distinctions like in Europe. From the beginning, new habitants had a culture focused

on economic achievement as a means of acquiring social status (Rossem, 1991). Consequently mass production goods were quite compatible with the American class structure; large groups in the United States were willing to purchase identical or similar commodities.

The existing railroads did not offer the wanted flexibility and the horse-powered transportation was not fast and comfortable enough. Another problem of the existing horse-powered transportation was the polluting factor of the animals in the large cities. Around 1900 in New York 1,200 tons of horse shit and 15,000 litres of horse urine had to be cleared away every day (Rossem, 1991). The Americans saw the car as a healthy solution for these problems. Furthermore, petroleum in the United States was cheap and plentiful. The invention of the pneumatic tyre just before the turn of the century (Dunsheath, 1951) enhanced the appeal of the car as a solution further.

Having briefly surveyed the socio-economic scene, we now turn to the knowledge and technological systems associated with the automobile industry. In the craft production period certain production heuristics knowledge was confined to one worker or to one company. There was no basic knowledge where others could build upon and afterwards could improve it incrementally. A formal technical education to prepare one to become a car production engineer or technician did not exist yet. The production consisted of learning by doing and much “guess work” was involved. However, incrementally the knowledge of building a car improved. With the enhanced knowledge it became possible to teach others several functions and skills; it became possible to delegate some administrative responsibilities and to promote division of labour and specialize the workforce of an automobile making company.

Improvements in technology, like the universal availability of electricity in the late 19th century followed by very cheap oil in the early 20th century, led to an energy-intensive system of mass production. Electrical energy could be converted into mechanical energy, and electric motors could be controlled more quickly and accurately than the traditional power sources. The old factory system was based on one large steam engine; a breakdown involved the whole factory. A new system could be based on electric-group-drive and later on unit-drive, this meant one electric motor for each machine (Devine, 1983). As a result the factory system could be divided into a number of different platforms powered by independent motors. Furthermore, the technology involving material handling like steel developed further and was responsible for better and more efficient production of steel products, like the car.

The forces in the industrialized world and especially in the United States in the late 19th and early 20th century provided a setting that enabled Ford to pioneer a specialized mass production system, known later as Fordism. Because of the great impact Ford has made on the industrial history it is instructive to look at the person in some detail and to find out more about his ideas.

Partly because of his rural background, Ford realized that farmers formed an enormous market potential for the automobile industry. With the Model-T Ford and his technicians had designed a car that met the needs of a huge mostly rural public. Since the introduction of this model in 1908, Ford and his workers, who were pushed by a lack of capital, pioneered techniques to improve the efficiency of production without investing heavily.

In the early days of his company, Ford set up assembly stations on which a whole car was built, often by one fitter (Womack al, 1990). Around 1908, when he achieved interchangeability of parts Ford decided that the assembler would perform only one single task and that he would move from vehicle to vehicle around the assembly hall. The final step towards efficiency involved one of the biggest contributions of Henry Ford to the industrial landscape of today. In 1913 he

introduced the moving assembly line. In fact this may be seen as a result of the extreme division of labour. The division of labour, the interchangeability of parts, and the moving assembly line, together were responsible for the cut in cycle time performed by one worker from one day at the introduction of the Model-T in 1908 to 1.2 minutes in 1913 (Hounshell, 1984). Within several years after the introduction of the Model-T, Ford was dominating the American car market with a market share of around 50% (Nevins, 1954). Ford did not invent all the new methods and techniques. His achievement lays in weaving together elements of existing technologies into an efficient mass production system.

The Ford company was a very centralistic and vertically integrated company that believed in the push concept of production. All major decisions were taken centrally and the departments were functional departments. The standard in this period was to make everything connected with the car in-house, from the raw materials on up. The quality and security of suppliers at the time was low and prices were high. Moreover, the moving assembly line and the high costs of it called for security in supply of raw materials and semi-finished products; the expensive capital and labour had to keep moving. Ford owned and controlled the production and distribution of all materials and parts necessary to the production of cars. He bought steelworks, glassworks and rubber plantations, and owned railways to transport the needed supplies and to distribute the finished cars (Womack et al, 1990). A modern, bureaucratic, rational, vertically integrated, and centrally organized company evolved. Its superiority persuaded other companies and industries to become followers.

Theoretically, voluntary and reciprocally oriented transactions are regarded as the most efficient form of exchange (Clegg, 1990). Bureaucracy and vertical integration, rather than facilitating the market, interpose the heavy hand of centralized authority, which overrides freely contracting individuals. For all that, bureaucratized organizations began to replace market exchanges as the major mechanism of control, because it was a more efficient way of doing a greater volume of business in those days.

An explanation of this paradox is that the market was not functioning optimally in the craft era. The contracts between actors offered little control over quality and opportunistic behaviour (Clegg, 1990). Opportunism at that time did not directly result in bankruptcy. The competition was not fierce and customers were rich and patient. Furthermore, the control over the parts was minimal, poor quality was only discovered if and when the car broke down, and the contractors were paid for each part they delivered. This way they were not forced to improve quality when they made bad products.

Furthermore, the knowledge of the process of building a car was better developed at the Ford company than at his suppliers. The knowledge and economies of scale inside the Ford company enabled technology to develop any further. As a result, Ford was able to improve mass production techniques before his suppliers could. He could achieve substantial cost saving by doing everything in-house. Another reason for bringing everything in-house was the fact that Ford wanted parts with closer tolerances and on tighter delivery schedules. Instead of the arm's length idea of purchasing in the open marketplace, he decided to replace this mechanism with, what Chandler (1977) later called, the "visible hand" of organizational co-ordination.

4 DECENTRALIZATION WITH CO-ORDINATED CONTROL

During the 1920s several new developments transformed the automobile industry and

management and marketing replaced production and finance as the major challenge in the industry (Chandler, 1964).

In the 1920s the automobile technology made it possible to control assemblies and subassemblies so as to permit the customer an almost infinite latitude of choice in colour, chassis, model, equipment, and styling. Furthermore, an ever growing part of the Western society could afford to buy a car. Ford failed to capitalize on these developments. In 1927, the last year of production of the Model-T, for the first time more Chevrolets - which is the cheapest model of General Motors - were sold than Model-Ts.

General Motors found out that face-lifting each model once a year could boost sales. The result was that the marketing personnel could present brand new models to the public every year. In the 1920s, the first car buyers came back for the second round and bringing their old car as down payment. The creation of a used car market was kept to the mark by the ever-increasing supply of cars and for a large part by the annual model changes initiated by General Motors.

Because of the growth and because of the competition with Ford, General Motors had to deal with several problems of management and production. In the 1920s the company pioneered modern scientific management practice. Sloan quickly saw General Motors had two problems to solve if it was to succeed at mass production. The company had to manage professionally the enormous enterprise that the innovation of the mass production system both necessitated and made possible. And it had to satisfy the ever growing more diversified demand.

Sloan solved the problems facing General Motors with his solution of "decentralized operations with co-ordinated control". He distinguished policy from administration by creating decentralized divisions managed objectively by the numbers from a small corporate headquarters. He and other senior executives oversaw each of the separate profit centres - car divisions and component making divisions. To co-ordinate the financial organizations of the divisions and the central financial staff, Sloan introduced the principle of return on investment into one of the working instruments for measuring the operations of the divisions (Sloan, 1963).

To satisfy the growing market Sloan brought to the attention that General Motors had no explicit policy as to the line of cars as a whole. To provide a full range and to avoid duplication, Sloan introduced an integral car line. He developed a six-model product range that ran from cheap to expensive. It would accommodate potential buyers of every income throughout their lives. At that time General Motors was the only automobile maker that provided such an integral car line.

The organizational structure remained largely vertically integrated, though there was a great deal of decentralized control. The reorganization - from an extremely decentralized organization (in the case of General Motors) or from an extremely centralized organization (like Ford) - to a decentralized organization with central control, was pushed by the fact that the business environment was changing. The depression of 1920-21 resulted in precipitous drop in car sales. To survive, carmakers had to lower prices and reduce expenses, and to make out of whatever organisational resources. This was the essence of Sloan's reorganization of General Motors. He brought order and effective control into the sprawling structure without sacrificing the advantages of decentralization, namely flexibility and initiative at various level of management. To this end the assorted companies that constituted General Motors were converted into autonomous divisions, with overall policy making and control exercised through the president by an executive committee and a financial committee. There were also central agencies for research, advertising, product planning and so on; they were to have an advisory relationship with the divisions (Rae, 1984)." Sloan's management system was to become a model for large organization, and was

adopted by his competitors Ford and Chrysler.

Sloan was years ahead of his time in divorcing policy and administration and in linking strategy and organizational structure. In fact, Sloan was practising the theory of the French engineer and manager Fayol (1949). It is argued by Chandler (1962) that strategy leads to structure. If we look at the automobile industry and we think of Ford and Sloan, this argument seems right. But the next question is: what drives strategy? If we look closer, strategy is for a great deal market driven. Within 30 years, the automobile market had developed from some rich people, through the rural market, to a large part of society. Ford would not make a full range of cars right from the beginning because the market was not ready yet. When General Motors became successful in the 1920s and 1930s it was in essence a successful response to the new social conditions. Among other developments, the increase of prosperity, the product improvement, and the beginning of an used car market, played important roles in the automobile industry in the 1920s and 1930s. Consequently diversification could possibly prove to be a successful strategy.

A decentralized organization performs well when the strategy is focused on innovation and a more centralized organization performs well when the organizational objective is efficiency (Hage, 1965). Therefore, the fact that General Motors in the 1920s had more product-innovative ideas than Ford had, could be an explanation for the more decentralized organizational structure. Sloan did not ignore the developments in technology and the developments of the market. To address the more growing diversified needs he tried to adjust the company to the market.

The ideas of Sloan were an important step in the direction of the network organization of the 1990s. The creation of General Motors produced an integrated network of suppliers and different automobile makers. By treating the divisions as independent businesses, Sloan could better impose the efficiency discipline of the market, while still preserving the co-ordination advantages of a unified company.

The Fordistic mass production together with Sloan's management and marketing techniques helped the American automobile makers to dominate the world automobile industry for decades. Companies in practically every other industry adopted similar methods and the automobile industry became the global symbol of mass production. For this reason in 1999 Fortune voted Henry Ford best businessman of the century. During the 1960s the international competition in the automobile industry increased, for a great deal due to the development of the Japanese automobile industry.

5 LEAN PRODUCTION AND NETWORKING

The Japanese modified the mass production system to suit their domestic market and to increase their competitiveness by re-thinking the Western ideas of automobile making. The change was not just in production techniques but also in emphasis: in the way people think and act. Besides production there was attention for design, supply chain, and distribution (Womack et al, 1990). The Japanese philosophy of lean production may be seen as an improvement of the mass production system of Ford and Sloan and as a crucial step to the network organization of today.

In 1868, after two and a half centuries of isolation, Japan opened her frontiers to the Western world again. As it turned out, besides several disadvantages, the isolation brought with it several advantages that accounted for Japan's rapid transition into a modern industrialized

nation (Morishima, 1982; Takeo, 1983).

5.1 Road to Lean Production in Japan

When Japan came face to face with the West it acknowledged the technology gap. The Japanese aspired to build a modern state while retaining their way of life. During the 1880s the Japanese government decided to create a mix of Britain (navy, telegraph, railroads), the United States (universities), France (school districts, army, legal system), and Germany (constitution and civil code).

By adapting the imported knowledge and technology to its own cultural heritage and local conditions, Japan was able to pursue its own unique development. Its small-scale companies produced traditional commodities, while large companies produced Western goods. At the end of the 19th century large industrial capitalists (zaibatsu) arose when the government sold state-operated companies cheaply to the private sector. The large concerns in industries like machine manufacture and shipbuilding subcontracted heavily; the suppliers were medium and small-scale companies. These were independent companies, despite receiving technical guidance, financial assistance, and personnel involvement from the parent company.

The consistent aim of successive governments since the opening of Japan was to build Japan into a strong country with a top class industry. The government tried to achieve this aim by adopting a strategy of forming representative teams in the Japanese industrial world, raising them to the first rank, and then enlarging the level of the team to the rest of Japan, rather than improving the whole economy gradually. The large industries like steel, electricity, chemicals, shipbuilding and automobile making were pushed forward, leaving other sectors like agriculture lagging far behind.

To reduce dominance of foreign cars in Japanese market in the 1920s and early 1930s, the government decided to promote the automobile industry by stimulating vertical grouping of companies in the industry. The upshot was a fast expansion of zaibatsu. These large industrial networks, which were financially and politically tied to the government, proved to be very strong in the decades to come. These “mother-companies” searched and selected suppliers and brought them under their own auspices. The mother company supported the suppliers financially and technologically. All the important automobile makers in Japan were, and still are; part of a zaibatsu.

In response to disadvantages at home Japanese automobile makers became efficient producers at relatively low volumes of output. The small market demanded small and light cars that could drive over mountainous terrain and that were suitable for the narrow and bad roads. The Japanese adjusted the mass production system to their own culture, their own market, and improve it dramatically to compete internationally. Their strategy was to produce more economically and in greater variety, and to deliver at least as much quality. The government stimulated the automobile makers to import knowledge and technology of automobile making from the West. This was done through a number of tie-ups with British, French, and American automobile makers and through indirect technology transfer by “reverse engineering”.

5.2 Toyota

Japanese engineers began learning how to make military trucks during the 1930s. It took them decades to complete a transition to smaller cars that could suit the Japanese market. Lean

production was one of a number of reasons why the Japanese managed to match and sometimes even excel Europeans and Americans in the 1980s and 1990s. Other important developments that contributed to the success of the Japanese automobile industry were: the government policy, low capital costs, extensive transfer of technology, intensive competition within own market, the oil crises, etc.

In 1948, Toyota began deviating from the most fundamental production technique in the Western automobile industry. It decided not to push materials and components but to have final assembly lines pull them through the system. The workers moved backwards to previous stations to take only what they needed for their operation. In 1950, Toyota extended the pull concept to marketing through the policy of limiting the production to orders received from dealers. Because there was not enough work to keep all machines operating constantly, workers had to operate several machines each, rather than specialize. By 1953, Toyota introduced the just-in-time concept and a larger responsibility for the workers on the production line.

The Japanese automobile makers in the 1950s decided to refrain from vertical integration and to subcontract more components, rather than expand in-house capacity to meet new demand. This stands out as one of the most significant departures from Western practice. The supplier was given total responsibility for the fitted performance and design of its product. Extensive subcontracting brought with it the risk of poor quality; until the early 1970s this was a major problem of the Japanese system. Japanese managers solved this problem by organizing suppliers into groups and controlling them by detaching executives, extending long-term contracts, buying the entire output of factories, providing loans of money or equipment, and offering technical guidance in design, accounting, cost control, production management, automation, and quality control. The lean producers selected its suppliers on a basis of past relationship and proven performance rather than on a basis of price bids. The tier one suppliers were actively involved in the design process of the total car in an early stage. And often they were responsible for the design and production of a whole component, rather than being responsible for one of the many parts of one component, like in the West.

To a large degree Toyota built upon Taylor's work in process analysis, and Ford's efforts to create an integrated, smoothly running mass production system. It is following the spirit and applying it under different set of conditions. More widespread knowledge of car production and the available 'more sophisticated technological system provide the conditions for extensive subcontracting. Lean production includes teamwork, communication, efficient use of resources, and continuous improvement. It combines the best features of both craft production and mass production - the ability to reduce costs per unit and improve quality while providing a wider range of products. The Japanese decreased levels of in-house vertical integration between parts productions and final assembly while building up networks of suppliers. The relationship with suppliers involved a hierarchical network between the automobile maker, tier-one, tier-two and so on suppliers. The relationships were based on trust rather than on contracts.

5.3 Networking

Because of the success of the Japanese automobile makers European and American automobile makers adopted lean production in the 1980s and 1990s by learning from the Japanese. These decades also witness fierce global competition and many strategic alliances. Dynamic changes within global markets are creating a need for different strategies to gain

competitive advantages. In the 1990s the automobile makers are downsizing to become more efficient and more effective. What results are network organizations that focus on their core business.

Today, the automobile industry is in a stage that may be identified as an organizational network era. The strategy of today is to be a flexible organization that is able to satisfy the changing needs of the customer. Automobile makers come to realize that full competence in several areas is almost not possible. However, to stay competitive it is often necessary to possess in-depth competence and knowledge. In order to solve this dilemma, companies are downsizing, focusing again on their core competence. Related competencies, often in the value chain, are purchased or acquired by way of alliances and collaborative arrangements. Core business and the needs of the customer are the two central themes.

After a difficult period in the American automobile industry around 1990, the industry recovered well. The recovery of the American "Big Three" automobile makers (General Motors, Ford, and Chrysler) can be seen as a model for this period. They listen to the customers, focus on their core competencies, use smaller core teams - involving all departments to develop new products, and empower their workers; they strive to become learning organizations (Lienert, 1994). After re-organizing the traditional structures, companies became network organizations.

5.4 Outsourcing and Information Technology (IT)

Preferences and needs of the customer change in time. If it takes too long to bring a product to the market the customer is probably already looking for something else. Thus speed is important, that is the time between receiving information from the market, designing a product, producing the product, and selling it has to be as short as possible. This cycle time is now being reduced by two major trends in automotive design.

With the adoption of Japanese approaches, extensive subcontracting is brought back in operations. In the network organization of today the suppliers are becoming more and more important. Automobile makers are shifting more design and engineering responsibility onto suppliers in an effort to cut costs and chop new product development times (Winter, 1995). The first trend has to do with the involvement of suppliers.

Today the suppliers have the highest level of knowledge and technology in-house to produce their specific part of the car. As a result of the globalization of the automobile industry and the success of the Japanese, Western automobile makers are pushing hard to rationalize their supply chains and to upgrade the quality of their relationships with their suppliers, after the Japanese example. The supply chain management has penetrated all the major automobile makers over the world. The suppliers are trusted more and more, as a result a "store-within-a-store" concept evolves which gives the supplier total responsibility for the design, distribution, and fitted performance of its product, like in the craft era.

Early involvement of suppliers in product development can improve effectiveness and efficiency of the design process. Simultaneous development can reduce design time, and the advice and expertise of suppliers can push the development of design in an early stage into the right direction. It is no longer the most economic way for automobile makers to tell their suppliers exactly what to produce and how to do it.

The other trend involves the technology of the related industries, which has always been playing an important role in the automobile industry. If we look back, the meatpacking

industry, the chemical industry, the energy industry, et cetera have all been contributing largely to the development of the automobile industry. Also now related industries play important roles in the industry. The recent improvements in IT make possible huge improvements in effectiveness and efficiency of each component of the value chain of the car. Moreover they push radical changes in the automobile industry that are supportive to the structure of the network organization. Communication is one of the keys to success with the (global) networks. Electronic mail systems are used as a messaging backbone for the huge global corporate networks, to improve efficiency, effectiveness, and speed of communication (Schwartz, 1996).

Changes in the automobile industry require large-scale introduction of robotics, changes in organization of design, production, and distribution. Aided by computer-based control, diversity is made more manageable. More innovative and creative organizations have become commonplace. Industrial design and styling software tools are used to provide control over aesthetics, to improve quality, to lower costs, and to reduce development time in order to respond quickly to the needs of individual target markets (Snow, 1996). The number of prototypes can be minimized - almost all components and functions of a car can be modeled before building the whole car. Even a complete car can be modeled, the three dimensional models can be run through "virtual" wind tunnels and crash tests. The results almost perfectly match what happens when real prototypes out of metal and glass are being built.

6 CONCLUDING

In the early days of the automobile industry, the dominant organization form is that of a network organisation. The technology used then was essentially that of a craft industry, the knowledge then was not widespread, and the demand of cars limited to the social elites. The genius of Ford was to transform the whole industry by creating the centralised hierarchical organization which, under the obtaining conditions then, proved to be a more suitable form for incorporating related innovations, developing knowledge and techniques. Together with the advent of electricity, he and his associates were able to usher in the mass production based on the assembly line. The result was a much cheaper and higher quality car. This, together with economic and social change, was to mean the mass market for the industry.

However, time did not stand still and things changed. Technical schools conducted courses in mechanical engineering, knowledge improved and diffused to the wider circles in society. With increasing wealth and changing taste, people began to demand for more than Ford was prepared to offer. This provided the scope for Sloan to modify the business practice of Ford and to innovate the decentralized organization with tight financial control, and to create a used car market. The achievements of Ford and Sloan were such that the hierarchical organization was perceived to be the model modern organisation which was copied in other industrial and business firms, and its model role was to last until the entry of the network organisation.

An intermediate step to network organization was that of lean production, in itself an enormous improvement of the mass production system of the West. It is essentially a network of production carried by companies controlled by a mother zaibatsu company. The organizational structure and strategy evolved as a result of the market forces, the interventionist role of the government, and the traditional relationships in the Japanese industries. Relying on the imported knowledge and technology was not enough. In order to close the gap between itself and the West, the Japanese car industry has to continuously

improve existing knowledge and technology, to introduce new management practices, and to involve the suppliers. The result was that the technological level improved tremendously and a new system of production came into being. Western carmakers, operating in a fiercely competitive environment, they appreciated the virtues of the innovation of their Japanese counterparts. They successfully incorporated extensive subcontracting and a pull concept, but without their suppliers having to operate under the aegis of a zaibatsu. The operation of network organization is facilitated by advanced information and communication technology. As it turns out, we have come a big round to be back at the network organization which was in operation before the time of Ford. The case of the car industry suggests that the merits of a given structure and strategy are contingent on some existing conditions. Our study finds that the conditions for the car industry are business environment, knowledge system and technological system. Further research is needed to see if there are more forces at work, and if our ideas are applicable to other industries, as well as the their broader implications.

Before leaving this paper, we would like to observe that innovation in the car industry illustrates the powerful idea of Schumpeter(1934) that innovation consists of a new combination (*neue Kombination*) of existing practices and technologies. At the same time, the automobile industry provides a case that contradicts Schumpeter (1987)'s prediction that institutionalization of research and development did not decelerate innovation in modern economies; in fact it accelerated it.

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