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Reconfiguration of Supply Chain at Volkswagen Group to Develop Global

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Abstract

This paper attempts to summarize development elements in the supply chain modifications in the car manufacturing industry by examining the case of the Volkswagen Group. It provides a general explanation of the stages of modularization and an overview of the development in modularized production that enabled Volkswagen to secure the second most prominent position among global automobile manufacturers. Its methodology is based on empirical analysis to discover the development and system modifications of the supply chain at Volkswagen. The analysis identifies the strategies from modularization (including the development from modular consortium to industrial condominium) that contributed to Volkswagen's success in catching up with – and potentially overtaking – Toyota, the leader of the automotive industry. Further elaboration should serve to depict of current state of integration as well as localization of services carried out by Volkswagen Logistics.

Keywords: Automotive industry, Modular toolkit, Supply chain, Sharing knowledge, Market development, Volkswagen

1. Introduction

In the first section of the paper, a brief historical overview is provided to depict the main steps in the evolution of the Toyota Production System, commonly known as Lean Management. At the beginning of car manufacturing, the most important objective was to establish capacities and reduce costs so as to offer cars at low prices. Later, customers became increasingly aware of their purchasing power, and as a result manufacturers had to develop individual features. The responses of the assemblers varied according to their organizational structure and cultural diversity. Assemblers were eagerly looking for a solution to combine standardization with differentiation, and thus combine mass production and customization within one supply chain. After World War II, Toyota was initially compelled to concentrate on the small-lot problems on the domestic market, whereas other assemblers carried on with mass production. Following the emergence of the Toyota Production System, many Western assemblers tried to implement individual elements of this system, but their attempts mainly ended in failure.

The strategic alliances between assemblers inspired the idea of the modular product. Modularization could be implemented in three different stages. The first stage is the product stage, in which products are designed and optimized for logistics. The second stage, modular production at a product group level, extends the design for logistics in the respect that manufacturers and/or assemblers collaborate and share the same platform. In the third stage, not only products are modularized but also production as such. It dissects the manufacturing process into primary transformation processes, during which inputs and raw materials are transformed into generic modules and components. Subsequently, a secondary assembly process combines the output of the primary transformation process in various ways in order to maximize the number of finished goods. Several combinations of platforms and modules (new-new, new-old, old-new) rendered possible the rapid and inexpensive localization of products. The subject of our case study, Volkswagen Group, experimented in Brazil with the "modular consortium" production model in a green-field project that yielded promising results.

2. Historical overview of the automobile industry

The following brief historical introduction outlines the main changes that triggered innovation in the entire automotive industry. Through production practices, the companies' objective is to generate a proportional return on investment. Accordingly, they cut costs, and look for increasing efficiency in their activities by means of innovations in their processes. The steps forward include regional modifications based on the influence of cultural diversity in organizations.

The predecessor of mass production was the so-called "Scientific Management," an early management theory formed by F. W. Taylor through which labor and managerial tasks gained a clear distinction. During the 1920s, the automobile industry faced immense demand in an increasing competitive environment. High production costs hindered a rise in sales. Only a revolutionary idea could lead to extensive availability and higher profit generation. In his search for economic efficiency, Ford introduced mass production by deploying assembly line production for the first time. The introduction of the assembly line significantly reduced the cost of the human work force. This system was not just a practical implementation of Taylor's "Scientific Management" but also the result of the urge to standardize and simplify operations (Wildemann 2013).

By the 1970s, the limitations of this production method had become apparent, as customer demand for diverse product features was growing. Following the two global oil price crises (1974 and 1979), members of the automotive industry started to diversify their product portfolio in order to minimize their vulnerability. At the same time, Toyota launched its offensive on the US market. From the 1950s on, Toyota had been challenged by the demand for high variety of products in small-lot sizes. The corporation was in a great need for a production system that would enable it to operate on the basis of incoming orders, rather than of forecasts. In contrast with the management systems influenced by the ideas of Taylor and Ford, at Toyota not only the management was responsible for continuous improvement but the

entire work force. This principle became one of the pillars of the so-called Toyota Production System (TPS). Thus, the individual employee stands in the focus of TPS. Thanks to this empowerment, each employee feels responsibility for his or her own work, and s/he is willing to make an active contribution to the company's efforts to become the largest automotive manufacturer of the world. In TPS, any kind of human input that does not contribute to the value proposition is regarded as wastage. Wildermann (2013) distinguishes between seven different types of wastage: overproduction, queue time, redundant transportation, inappropriate processes, excessive storage, unnecessary operations, and the assembling of defective parts. Many of these problems can be attributed to overstraining labor and/or mechanical equipment, mismanagement, and an inadequate exchange of information. Consequently, uncertainties might arise, leading to safety problems at work and loss in quality level. Thanks to the advantages of TPS, Toyota was well prepared to serve customers' requirements at a time of rising demand for individual features. Toyota is still the leading automotive company in profitability, customer satisfaction, and quality.

Lean management, which represents the next step in the evolution of management systems, can be interpreted as the American response to TPS. The principles of lean management account for the differences between Western mass production and Japanese lean manufacturing. Womack et al. (1992) summarized the fundamental elements of TPS as follows: The level of automation must be robust and appropriate to reach high process safety and availability. Setup times between model changes must be short, and the organization must be flat with lean administration. Work teams must be not just flexible but also semiautonomous to facilitate total quality management and just-in-time production. The work force must be strongly motivated and responsible for quality improvement. All these elements must be considered by other assemblers if they want to reach Toyota's level of efficiency in holistic process and customer value proposition. Thus, Toyota's organization structure and its production system serve as a benchmark for most other automotive manufacturers, including Volkswagen, the subject of this article.

The success of TPS induced other manufacturers to implement a few of its principles in their operations. Nevertheless, many Western manufacturers mistakenly believed that they can select and implement individual principles in isolation, such as creating a lean assembly system in conformity with Western organizational culture (Wildemann 2013). Their failure to see the necessity of holistic application led to very poor results. Assemblers were increasingly seeking for ways to combine standardization with differentiation so as to enable mass production and customization within one supply chain. This approach received a strong boost from the economic integration within the European Union and from the conclusion of free trade agreements (FTAs). Globalization created an innovative concept known as "world-car," in which the components are produced worldwide. European manufacturers responded by utilizing flexible and multi-purpose manufacturing systems and developing modular production systems and modular organization.

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3. Modular production concepts using dynamics of supply chain

The rising costs of production and the challenge posed by TPS compelled other automotive manufacturers to search for solutions to combine the differentiation demanded by customers with a high level of standardization (Fisher et al. 1999). The occurring cost of co-ordination, obtainment, and (re-)distribution of information are difficult to estimate. According to the subjective perception of employees who work in related fields, it accounts for up to 80% of their official working hours. The development process of a single automobile was an isolated system, and components were continuously developed or improved. Rather than keeping it isolated, an integrated multi-model development emerged as a solution for sharing components (Schneider and Rieck 2012). As a result, strategic alliances emerged, of which only some survived over the time. Volkswagen used another path of designing modules, modular toolkits. Volkswagen achieved a modular integration of suppliers and modular production system in its plants.

The concepts of modular production strategies have been recognized since the 1960s, but practical implementation started only considerably later. The implementation required an overall reconfiguration of the supply chain, and allowed manufacturers to integrate suppliers and distributors in the chain. The pre-requisite of supplier involvement is the modularity of product. In the modular production system, the goal is not to select a leading supplier but to involve suppliers in the system. If a single supplier had a privileged position, its high negotiation power would be opposed both by the other suppliers and by the manufacturer itself. Furthermore, it is a factor of great advantage if final modifications (i.e., localization of a specific product) can be performed when the product is still in the distribution channel (van Hoek and Weken 1998).

Feitzinger and Lee (1997) defined three advantages of a modular production system design: standardization and postponed product differentiation; the shortening of total lead-time due to modules manufactured simultaneously; and the isolation of potential quality problems. Modular production targets the potentials that can be generated from using different modules and components to be built on the same platforms. Van Hoek and Weken (1998) argued that modular production was based on product platforms and a product architecture, which could be seen as input material in manufacturing differentiated final products using a variety of modules, while maintaining commonality and interchangeability of components. In the application of modularity, three levels can be distinguished. The first level is the product level, which requires products designed for logistics. It results in savings in the inventory and transportation costs associated with the work-in-progress, while product customization can be improved. The second level, modular production at a product group level, extends the design for logistics in that manufacturers collaborate and share the same platform for automobiles or computers. Sheu and Wacker (1997) consider different effects of commonality at product-group level and at the level of a single product. The increasing customer demand for high variety in a product can be then satisfied with a large number of product combinations achieved through modularization. The third level, modular production at process level, separates the manufacturing process into a primary transformation process (which transforms

inputs and raw materials into generic modules and components) and a secondary assembly process (which combines the output of the primary transformation process so as to maximize the number of finished goods). This way companies are able to satisfy the demand for variety with a large number of assortments of final products (van Hoek and Weken 1998).

Sugiyama and Fujimoto (2000) considered four basic strategies that may be pursued in product design. For the design of a "world-car," global-standardized platforms were newly produced (1) and later localized (2). A new design did not necessarily mean that the old platform was useless (3). Indeed, in many cases the components were newly developed and then installed on the old platforms. The components could be further localized (4) for the old platform. The old platforms also meant the use of well-known technologies to reduce potential problem sources. Volkswagen followed the fourth strategy, with minor modifications.

4. Volkswagen: Developing Modularized Production

Volkswagen made an effort to push forward in modular organization and modular production by establishing its Resende plant in Brazil that started to operate in 1996. It has not only modularized products but also modularized operations. As Volkswagen successfully adopted the "modular consortium" production model in green-field projects, other companies like Fiat, Ford, GM, and Mercedes followed suit (mainly in brown-field projects). Thus a development process can be observed in the process of modularization, too.[1]

Marx et al. (1997) showed that modular arrangements in automobile industry took a new form, that is, a relationship among assemblers and suppliers that reconfigures the boundaries of the entire industry and defines clear responsibility points. The findings of Volkswagen's "modular consortium" stimulated debates about modularization among scholars. Following the end of Volkswagen's joint venture with Ford, Volkswagen began experiments in 1995, which were followed by the partial operation in Resende in 1996.

Salerno and Dias (2002) explain the importance of VW's pioneer role and the changes in its operation. The model is characterized by the absence of a blue-collar work force and by the operations carried out by the suppliers' work force. The factory itself consists of seven sub-contracting companies, and it has become a collection of international (mainly American, Japanese, and German) suppliers that share the responsibility for the supply of components and the final assembly of all vehicles. In each module, the suppliers – the so-called modulists – undertake sub-assemblies of the components assigned to them, and actually deliver the assembly of the final product. The agreements between modulists and Volkswagen are confidential. Instead of having Volkswagen involved in the organization of deliveries and supplies from one to another company; the companies must independently coordinate the workflow, and install components on the chassis. The activities of suppliers were extended by the operations during the production process, by which they became sub-contractors. Modular

[1] The development also can be seen by the three levels of modularization described by van Hoek and Weken (1998).

organization rendered it possible to reduce the complexities of co-ordination, for communication remained at the level of the associated companies. The example of the Resende plant reveals the advantages that Volkswagen could gain by focusing on strategic functions and questions of quality, rather than being extensively involved in the production process. To avoid quality control problems, the "maestros" (i.e., employees directly hired by Volkswagen) were responsible for the quality of a particular component or product. As the result of further development, suppliers took over the responsibility for delivery and technical assurance. If a problem was discovered, it could be traced back easily to its origin (Ramalho and Santana 2002). While assembly was carried out by the suppliers, VW initially followed a centralized strategy in design operations. Only later, when it realized the high costs of tropicalizing engines and components in a centralized process, did the corporation adopt a more decentralized strategy of design (Salerno and Dias 2002).

Luquet and Grinbaum (1996) discovered an additional potential advantage provided by the system of modular organization: a much lower level of investment. In case of GM in Brazil, the total direct investment was 32% of the capital that would have been required by a fully-owned plant. VW was no longer compelled to provide all the capital costs (for suppliers also had to invest), and it could sent payments only after the vehicles had been sold. Transfers from Volkswagen are divided into a fixed payment associated with the amortization of investment and a variable fraction that depends on the production. The former part is fully independent of the production volume, while the latter part of payment will be made once Volkswagen's quality requirements were audited for compliance. The investment made by modulists is kept at the minimum level to cope with the requirements set by Volkswagen. This system guarantees work-in-progress at an optimal level. (Salerno and Dias 2002).

Volkswagen's achievements did not remain without attention. Other Western manufacturers were also willing to implement cost reductions, and they progressed even further in introducing the model known as "industrial condominium". Inspired by GM's mixed arrangements in Brazil, Volkswagen also opted for industrial condominium, the next level of supplier integration. In this system, the assembler fully controls the suppliers' location, too. The remaining tasks of the assembler involve negotiations with the local authorities, acquiring or renting land and infrastructure, designing production systems with modularization, and defining internal and external (outsourced) modular operations. Thus, the condominium model is different from traditional industrial parks or regional concentrations of industries (Salerno and Dias 2002).

VW's standardization and modularization emerged at other plants as well. Standardized modular toolkits were used at such VW subsidiaries as Skoda in the Czech Republic and Seat in Spain. The roll-out of toolkit started in 2012 for Audi A3, VW Gold, Seat Leon, and Skoda Octavia. The common use of the modular toolkits among brands accounts for high efficiency. Thus, modular toolkits are not only used within a single plant but also across plants and brands, between which co-operation intensified, and knowledge was shared. Rugraff (2012) pointed out that Volkswagen's success lay on the "creation and sharing of knowledge between the different affiliates of the company." The use of cross-brand platforms greatly contributed to the increase of efficiency, as Volkswagen comprises of eight passenger car brands and three

commercial vehicle brands, with a high model variety. Accordingly, efficiency could be "increased by stimulating synergies between models in one series and across all series and brands." The modular strategy enhanced co-operation between plants and brands, which in turn enabled Volkswagen to produce not only different models but also different brands at the same plant.

Schneider and Rieck (2012) described the MQB (Modularer Querbaukasten) architecture, i.e., the modular toolkit in phases reached by Volkswagen (Figure 1). Phase 1 (platform strategy) shifts the implement ation of scale economies via a wide application of standardized modules in different automobiles. The target is to reach common use of a maximum number of covered or hidden modules within this strategy, and only the "hut" should become a design element with different configuration setups to maximize the value to customers. In Phase 2, the number of standardized modules will be increased through the diverse automobile segments in order to reach synergies not only horizontally (by products of similar basic architecture) but also vertically (by products related to differing basic architectures). Phase 3 is the MQB (modular toolkit) strategy, which represents a linkage built on common-part strategy of platforms through the integration of visible parts.

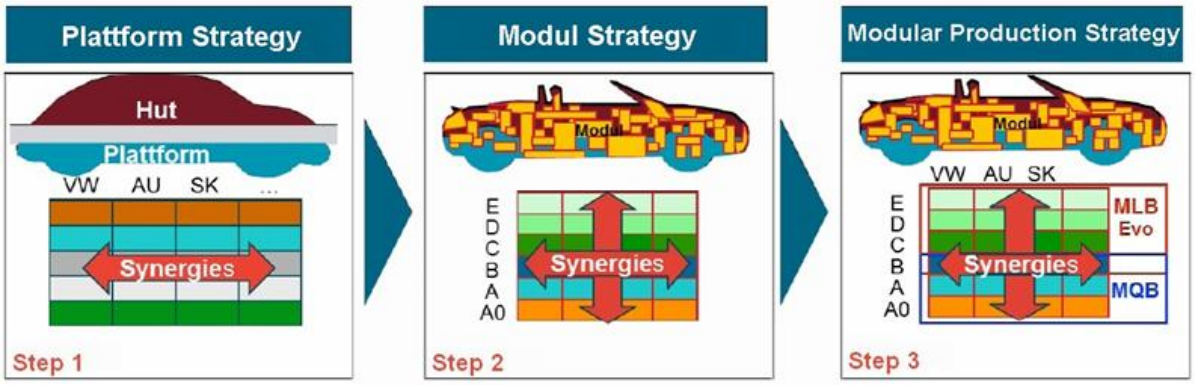

Figure 1: Phase development of product architectures in the automotive industry from the module strategy to modular strategy (Schneider and Rieck 2012).

Communication complexity in the design phase reached a high level. To combat this problem, transparent rules had to be established by contracts and agreements within the entire group. Schneider and Rieck (2012) discovered the following relationships between complexity and variant diversity within a module:

- The lower the number of variants is, the higher the cost of co-ordination will be.
- The higher the number of variants is, the higher the cost of logistics, tools, distribution, and experiments will be.

The implementation of modular product architecture offers a feasible solution. The goal is to reduce co-ordination costs that arise through the reduction of number of part and module variants. Through the modular production tooling, Volkswagen's facility layouts will be planned

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to provide customers with various individual features of automobiles. The facilities will share similar layout to reduce tooling times, when different brands should be produced in small lot sizes (Wildemann 2013). A new advantage appeared by being able to serve niche markets and localization in an efficient way.

5. Beyond Common Practice in Logistics

Similarly to Hyundai Kia Automotive Group's relationship with its logistics company (Hyundai Glovis), Volkswagen Group allows internal supplies to be conducted by a subsidiary, named Volkswagen Logistics. The high degree of shared knowledge enables both groups to integrate their own logistics provider, rather than to contract a Third Party Logistics (3PL) provider. The operations of both companies consist of managing the brand and model logistics and deals in procurement, and arranging future transportation-related functions.

To increase the potentials of scale economies and its purchase power, Volkswagen Group seeks to develop in-house expertise in logistics, rather than to outsource this function. Due to the importance of logistics, even a new board position was established. Although brands are responsible for their operational logistics, there are some processes that have been centralized. Consequently, Volkswagen attempted to start a comprehensive approach to standardize, synchronize, and stabilize logistics operations prior to the implementation of MQB toolkits. The group logistics manager is responsible for functions planning, and for capacity planning for all brands and regions. The logistics manager is also responsible for arranging the material and information flow for vehicle production. Volkswagen Logistics attempts to implement a standardized process to manage the material and information flow for the entire group production, and to improve order-fulfillment process across the group (Elkin 2008).

It is important to bring together plant managers to co-ordinate logistics with the ultimate goals to meet delivery dates, reduce the time-to-delivery and achieve a target delivery date for individual customers. The new organization with the core competence logistics at Volkswagen improved the system-wide stability across the group. Besides standardization and stabilization, such a large group with a relatively high number of brands needs to realize high-level flexibility to be capable of rapidly responding to market changes. It is important to co-ordinate operations between brands and models build-to-order and build-to-stock. Volkswagen Logistics can operate as a balancing unit to maximize savings and product differentiation across the group. Volkswagen Group realized the power of standardization of visibility and communication earlier than other manufacturers, and this element is regarded as an essential factor in its competitive advantage.

Thanks to these methods, markets and regions that had not been tapped before finally became accessible. Volkswagen Logistics began to operate in the Middle East, which evolved into a promising market with an annual increase of 6% to 10%. The VW subsidiary is responsible for the transportation of vehicles (mainly VW, Audi, and Porsche) to the dealers. It is inevitable to synchronize intermodal transportation to achieve on-time deliveries to customers. The average storage time at dealers could be reduced to four weeks. Volkswagen also attempts to minimize

air transportation of vehicles to the region. This form of transport should be utilized mainly for launching new models, for exhibitions, and for VIP customers, on the grounds that sea transportation usually takes 2-4 weeks. The special circumstances of the region (extremely high temperature and desert terrain) require creative solutions for road transportation, such as the mandatory use of covered trucks for transporting cars from the port to the dealers. VW Logistics and its partner, EUKOR, handle deliveries to the Middle East where the non-standardized import requirements create complications for importers. Saudi Arabia has the strictest rules on car imports. For instance, each car must be equipped with a fire extinguisher, or it will be rejected. To avoid rejection, check-ups are carried out at factory sites and loading ports in Europe before loading the vehicles into the vessels. VW opened a regional logistics office in Dubai to centralize orders, use a standardized delivery system, and reduce the handling costs of vehicles. The regional office enables Volkswagen to maintain closer contacts with its dealers, and to provide services efficiently, while administrative costs were reduced and port activities rationalized (Coia 2006).

6. Recent Sales and Future Potentials

The financial data provided by Volkswagen Group shows a solid improvement as a result of the aforesaid changes in management. From 2012 to 2013, Volkswagen Group increased the number of sold cars by 22.5% in Japan and 16% in China. In China, capacity limits are to blame for a lower growth, which is expected to reach 10% in 2014 (VW; Miller 2014). Even in Europe, where deliveries have been sluggish for a long time, group-wide growth from 2013 to 2014 was 9.3%, according to the data provided by the European Automobile Manufacturers' Association, ACEA (Rosemain 2014).

The goal of Volkswagen's Strategy 2018, announced in 2007, is to become the leader of the global market, both in terms of the number of sold vehicles and of the group's operating margin (reaching 10%). While VW's targeted operating margin seems to be far-fetched (it reached 5.6% in 2007, in contrast with the industry leader Toyota that reached 9.3% during the same period of time), the number of its deliveries may overtake Toyota's in the near future. Between 2016 and 2019, the number of Volkswagen's assembled light vehicles is expected to be the highest among automotive manufacturers (Stoddard 2013).

Nevertheless, Volkswagen has delivered far less automobiles to the North American markets than Toyota did. Schmid and Grosche (2008) suggested that VW should focus on the North American markets with models designed for local conditions to avoid low performance in terms of sales in the future. In the 1980s, Toyota was compelled to assemble cars in the United States because of the high import tax imposed on cars. It gained a high market share, for its cars were recognized to be domestically assembled. Although American customers are well known for their preference for products made in the U.S., this fact was ignored by Volkswagen when it discontinued the operation of its US assembly plant in Westmoreland, Pennsylvania. Decentralization of manufacturing was also required by a second factor, that is, the fluctuating and unfavorable exchange rate. Cars and engines, imported from Europe, generated high losses over the time. Prior to Volkswagen's decision to establish an assembly plant in Chattanooga

(which has been operating since 2011), the group tried to meet the North American demand with supplies from Mexico and Brazil.

Recently, the Chattanooga plant has made a major contribution to the growth of Volkswagen's sales in the US. The plant assembles automobiles specifically designed for the US market. The most recent data of deliveries by the two giants are 833,624 (VW) and 2,529,000 (Toyota) (Toyota 2014). These sales figures describe that in the North American market, Volkswagen is still far from catching up with Toyota.

7. Conclusion

The Volkswagen Group consists of twelve different brands, and each brand contributes to its financial results. The activities of suppliers were extended by the operations during the production process, and they became sub-contractors. The modular organization enabled the reduction of complexities of co-ordination. The communication between suppliers intensified but it could be simplified. Suppliers could be successfully integrated in the assembling process. The modular consortium, and later the industrial condominium, is characterized by responsibility and knowledge share. In the latter model, the car assembler is able to determine the location of its suppliers. The new approach of using modular toolkit (MQB) Volkswagen reached a holistic phase of modularization. This strategy represents a linkage built on common-part strategy of platforms through the integration of visible parts.

While modularization supports the group to generate higher profits and to decentralize manufacturing, there are still operations which could be further decentralized. It needs to be mentioned that the operations of logistics subsidiary are core activities within the entire group. These activities allow the company to serve remote markets and niche markets. Besides standardization and stabilization, such a large group with a relatively high number of brands needs to realize high level flexibility to be able to response to market changes rapidly. It was wise to establish a plant in the USA again and to launch models designed for the local markets eventually. The number of brands and the belonging administrative, design and research and development staff may still be expensive in the long-term. Brands whose financial contribution is continuously negative may disappear in the future. It remains to be seen what other strategic approaches have to be developed or implemented to remain one of the most successful car assemblers worldwide.

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