TWO WAYS OF MODULARIZATION STRATEGY IN JAPAN

TOYOTA - HONDA VS. NISSAN - MAZDA

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Today, as the end of the 20th century draws closer, European and US auto industries are several years ahead of Japanese counterpart in their effort for modularization. However, of all European and US automakers, the modularization effort made by the Big Three in the US is not so conspicuous, because of obstructions such as opposition from UAW.

Meanwhile, German automakers are mainly leading the modularization effort made by European auto industry, of which threshold centered around 1996 and 97. When we study how the modularization process was generated and then evolved over the years, we can find that it occurred in the process of auto industry’s effort in pursuing lean production. Today, modularization is highly evaluated as an innovative cost reduction method, which transcends production system improvement in a traditional sense. Nevertheless, as we are going to discuss in this paper, there seems to be still some need for consideration as to the validity of such a high evaluation, which is given to modularization as a method of achieving cost reduction.

➢ The aim of this paper is, in the end, to examine the effort made by Japanese automakers with respect to modularization. The effort is now becoming more concrete, and it begins to predict its future scope as well. But, before clarifying the characteristics of Japanese-style modularization, we consider it necessary to elucidate the characteristics of modularization by European auto industry, especially German auto industry, as well as the background with respect to how it was formed in advance to Japanese counterpart. So, this topic is discussed firstly in this paper.

➢ It was conventionally considered that the Japanese auto industry had more advanced supplier relation system than that of European auto industry. But, Japanese auto industry fell far behind its European counterpart in the case of modularization. So, the reasons for that are examined in the second part of this paper. Unlike European-style modularization, Keiretsu (business group composed of affiliated suppliers and their main customer) supplier system, which is specific to Japanese auto industry, has played a unique role for Japanese auto makers to conceive “corporate community”-
style modularization system concept, with an automaker playing the central role in the community. We will examine the reasons in the next step.

- Across the board, Japanese auto industry, which had fallen behind European auto industry with respect to modularization, actually embarked on its effort toward modularization on full scale since 2000. This was triggered by the recent dissolution and reorganization of Keiretsu supplier relationship initiated by the international tie-ups between Ford and Mazda, and Renault and Nissan. Curiously enough, the rationalization procedures of Nissan and Mazda is actually encouraging further actualization of “corporate community” style modularization by Keiretsu suppliers of Toyota and Honda, which stand at the polar opposite of modularization style led by Nissan and Mazda. As a result, it is considered that there are two opposite types of modularization evolving in Japan at present. One is the European-style modularization led by Nissan and Mazda, and the other is so-called “Corporate community”-style modularization led by Toyota and Honda.

In this paper, we will also examine characteristics and future scope of each of these two types of modularization evolving in Japan.

- What is expected from modularization differs subtly by times, countries and companies. Even so, there seems to be some rough common expectations concerning introducing modularization into Japan at present and also concerning planned introduction in future, which is different from what is expected of modularization in Europe and the US. In an attempt to clarify the difference of expectations between the two groups, we would like to define modularization as follows.

Modularization in general sense means, “Auto makers’ action of outsourcing development / assembly by larger component units than traditional sized component units.” The difference between European/ US and Japanese modularization lies in the fact that, while both groups seek outsourcing parts in the form of larger component units than traditional size, European and US modularization is focused on ‘assembly’, whereas Japanese modularization is focused on ‘development’.

CHARACTERISTICS OF MODULARIZATION BY EUROPEAN AUTO INDUSTRY

Evolution of Module Production Led By German Automakers

Since 1990’s, European automakers, especially German automakers have been promoting introduction of a new policy of parts procurement practice aimed at cost reduction\(^1\). The key element of this new policy was that automakers aimed to utilize the capability of leading international parts suppliers with whom automakers were procuring parts directly. More specifically, automakers hoped to make the best out of those selected parts makers’ capability of development and of suggestions, and to use it as a springboard for

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\(^1\) Concerning the general outline of this: see IKEDA Masayoshi, “Ohshu Jidosha Meika No Buhin-Chotatsu-Seisaku No Dai-Tenkan (The Conversion of Parts Procurement Policy in European Automakers)”, Annual of the Institute of Economics of Chuo University, No.28, March 1998.
themselves to stabilize their own profit structure, to reduce cost and to strengthen their own international competitiveness.

However, even if automakers had reduced down all of a sudden the number of their suppliers to a small group of Tier 1, it would have been impossible to get a remarkable result if the traditional parts procurement structure were left unchanged.

As it is well known, unlike Japanese auto industry, the ratio of European automakers’ dependency on outsourcing parts was not only low, but also, even when components were outsourced, the subassembly of those purchased components prior to their supply to the final automobile assembly line was carried out by automakers themselves in most cases.

If we take the case of seat assembly for example, even when all components needed for seat assembly (e.g. seat frames, urethane foams, seat covers, mechanical parts, etc.) were outsourced, the task of subassembly of those components to make them into a seat module still remained in the hands of automakers in most cases.

By contrast, in the case of Japanese auto industry, the division of task in the production system had been already well established some time ago by the way in which, while substantial part of unit parts were procured from Tier 2 and Tier 3 suppliers, the Tier 1 suppliers assumed the function of subassembly of those unit parts into larger component units and supplied them to the automakers’ final assembly plants. Moreover, in response to the request of automakers, Japanese Tier 1 suppliers have been already supplying components to automaker’s assembly lines by “just-in-time” method (hereinafter referred to as J.I.T.) and also have adopted more advanced synchronized delivery system.

In Europe, the conventional practice of separate parts supply system inevitably resulted in increased number of suppliers for automakers to deal with and in more complicated procurement structure than that of Japanese counterparts. For example, *Daimler Chrysler* (then *Mercedes Benz*) used to have 5,000 parts suppliers including small and medium-sized companies, and *Volkswagen* (hereinafter referred to as *VW*) presumably was dealing with 2,500 suppliers until 1980’s. Ever since 1980’s, European auto industry has been reducing the number of Tier 1 suppliers in an attempt to rationalize procurement system, but even so, the total number of suppliers for each automaker amounted to 800 to 1,000, which was much more numerous compared to that of Japanese counterparts.

As a result, automobile assembly plants in Europe that procured unit parts from outside sources, large logistic centers had to be built next to the plants in order to stock those procured parts. Naturally management of parts procurement and quality control of procured parts became very complicated tasks. For these reasons, it seemed extremely difficult for European automakers to rationalize the logistics between automakers and suppliers even if they would have introduced Japanese-style J.I.T. unless some change was brought about to the traditional production and procurement system.

Under such circumstances, since the depression set in during 1993, German parts makers started to make a great effort in building up their development capability and

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1 We have another examples to indicate how many suppliers the European automakers used to deal with. At the beginning of the 1990s, the number of suppliers of PSA or Renault was between 800 and 1,000.
reinforcing their function as Tier 1 suppliers. At the same time, German automakers’ aspiration boomed to abolish current procurement system and establish a new procurement management system in its place.

As a result of this trend in Germany, module production was started from 1996 to 1997 at MCC-Hambach plant by Daimler Chrysler’s subsidiary, and at VW’s Mosel plant.

Now, at this period, the module production system introduced to Germany had common characteristics, which can be roughly summarized as follows.

Module suppliers’ assembly plants are installed inside of automakers’ automobile assembly plants, or built in peripheral areas of automobile assembly plants (in suppliers’ park within the distance of 20~30 km from automobile assembly plants). There, components are supplied by sub-module makers and assembled into module parts, and then they are supplied to the automobile assembly lines by J.I.T. Here, the function of module plant is only the assembly operation of modules. So, parts production is not involved. Panorama of EU Industries (1995~1996) indicates the following formula based on the actual situation in Europe.

“Module system is a new key theme in parts industry. Module suppliers assemble various kinds of components into modules and supply them to the final assembly plants of automakers J.I.T. The advantage of this process is that it not only alleviate the complexity of work on the part of automakers, but also production labor cost is reduced because the larger part of labor cost is shouldered by module suppliers, of which labor cost is lower than that of automakers. Unlike system suppliers, module suppliers need not to manufacture any components to be supplied. Their responsibility is restricted to assembly, and logistics capability.”

As explained in the above, module suppliers’ plants are only responsible for the production of modules, and they need not be involved in manufacturing of any unit parts. Therefore, module plants are equipped with nothing but minimum number of operators and small-scale equipments. The authors would like to refer to this kind of module system as “Light-type module” to distinguish it from “Heavy-type module”, which includes manufacturing process of unit parts.

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1 EU publishes periodically Panorama of EU Industries. We quote the part on the automobile industries of the version 1995/96.

In Japan, manufacturing and sub-assembly of unit parts are both carried out in a same place in a same plant of Tier 1 suppliers (sometime such sub-assembly can be regarded as modularization as in the case of seat modules). Therefore, for Japanese manufacturers it might be hard to understand the reasons why module suppliers of European automakers, MCC and VW for instance, have two separate facilities: one for assembly of module parts, and the other for manufacturing of unit parts.
According to survey studies conducted a couple of years ago with Japanese automakers regarding modularization, every company expressed in the interview the following view concerning module production in Europe:

“Modularization in Europe basically is mere transfer of sub-assembly process from automakers’ facility to suppliers’ facility, which does not involve development responsibility. Therefore, it involves no change in terms of the level of individual parts compared with the traditional system. So, European makers are merely putting together traditional parts. With this method there is little chance of creating new added value.”

The question is why then, are European automakers putting their effort in “light-type modules” across the board? Why do they have to adhere to the method, which requires “needless” investment? To understand this point, it is necessary to review the special circumstances in Europe.

As we mentioned earlier, many German automakers traditionally conducted sub-assembly process of unit parts by themselves inside or peripheral areas of their automobile assembly plants. As a result, German automakers were required to spend huge amount of management cost and labor power in order to manage parts procurement and to operate parts assembly process. Therefore, it became a large part of management improvement task for these German automakers to rationalize this parts procurement management and parts assembly. As the main avenue to achieve this task, German automakers embarked on outsourcing of “assembly” of parts by larger parts unit than before. This was the starting point of modularization in Germany.

In this effort toward modularization, however, if automakers used their current plants (Brown field), tremendous amount of investment would have to be made to complete the environment for modularization. In addition, an opposition by the labor union would have to be anticipated. In view of such circumstances, most of modularizations were introduced to new plants (Green field) or foreign plants, where they were less hindered. There are examples such as Daimler Chrysler’s Rastat Plant for mini/compact A-type automobiles, VW’s Resende Plant in Brazil for VW’s commercial vehicle production, Skoda’s Boleslva Plant for passenger cars, Mosel passenger plant in East Germany. As shown by these examples, many of modularization projects were carried out outside of Germany or otherwise rural areas in Germany.

However, even in case of existing plants, if the environment for modularization was completed, modularization could be implemented as in the case of VW’s Wolfsburg plant\(^1\). Also, in the case of French and British automakers, since they do not have any “green field”, they either do not adopt modularization or delay their plan of modularization. Another background as to why modularization has been promoted particularly in Europe is strongly connected to the situation, which was emerging since the late 1980’s. Ever since the late 1980’s, European automakers had been encouraging leading international auto parts makers to

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\(^1\) The old plants in Wolfsburg are now under total refurbishing from the end of 1990s and a suppliers park is said to be under construction in the neighborhood. This will make it possible to convert to modularization.

\(^2\) Any French or British automobile makers didn’t start production by modules in the 1990s; among them, only Renault decided to begin vehicle production by modules from 2000 in Sandouville (France) and Curitiba (Brazil).
build auto parts makers’ production facilities in the vicinity of automobile maker’s assembly plants, whereas in the past, it was regarded as a norm for auto parts makers to deliver auto parts to automobile assembly plants from their parts production facility often located far-away. In other words, these parts assembly plants were built for the purpose of promoting synchronized production in the beginning. However, due to the change of policy on the part of automakers, these parts assembly plants were further developed and remodeled into module assembly plants. Renault’s Sandouville plant, which started module production in 2000, is a case in point.

Advantages And Disadvantages of Module System

As Japanese automakers point out, European-type module system based on assembly does not generate any new added value. Then, for what purpose are the European automakers making such an effort to promote module production? The following six points can be pointed out as advantages of European-type modularization.

Automakers can reduce time and labor hours required for assembly process as well as investment.

For example, by introducing modularization system, MCC Hambach plant reduced its in-house production ratio of automobile assembly (for complete automobile) by 20% points from 45% to 25% all at once. Now, this assembly plant with a scale of 200,000 annual production units has 1,900 employees (one third of the same capacity plant level) and makes 750 million DM of investment (one third of the same capacity plant level). Similarly, VW’s Mleda Boleslav plant, which formerly belonged to Skoda of Czech Republic, after introducing modularization, has 950 employees with an annual production volume of 90,000 units with 2-shift operation (94.7 units per worker). By contrast, the former Skoda plant had 16,853 employees with annual production volume of 265,000 units with two-shift operation (16.7 units per worker). This means its productivity increased by 6 times today compared to the time previous to the introduction of modularization. It requires 20 to 25 hours to assemble one unit of automobile at Boleslav plant, and it is said this means 4,000 labor hours was reduced from the former Skoda plant.

Reduction of Labor Cost

In Europe, there is a substantial gap in wages between automakers and parts makers. It is said that automakers’ wages are higher by 20 to 30% than those of parts makers. This means that automakers can reduce their labor cost radically by the introduction of module production system on the part of suppliers to assume the responsibility of parts assembly process and parts purchasing task, which traditionally were assumed by automakers.

Completion of Just-In-Time System

At VW’s Mosel Plant, module assembly process is distributed among facilities throughout the peripheral industrial complex. It assigns its 13 module suppliers for the supply...
of modules J.I.T\(^1\). Specifically speaking, the data of automobile types and the number of units lined up in the paint shop is transmitted to the assembly plants of module suppliers. Based on this information, the module parts assembly plants assemble unit parts so that they can be supplied to the automobile assembly line by J.I.T. when vehicles come out of the above-mentioned paint shop and arrive at the automobile assembly line to be assembled with the matching modules. The time needed for the delivery of module is about 6 hours (360 minutes). This is far more efficient than the traditional way, in which automobile plants carried out parts assembly process.

**Cost Reduction Effect**

VW’s Mosel plant has been requesting its 13 module suppliers (which would increase to 15 module suppliers in 1998) annual 2% cost reduction. If any of the module suppliers fails to meet this request, that module supplier will be replaced with another new module supplier. This type of cost reduction measure would have been impossible to put forward if sub-assembly process had remained to be carried out in the automobile assembly plant.

**Concentration of Procurement Instead of Complicated Procurement System**

As it is mentioned earlier, automakers used to procure great number of unit parts. In addition, automakers used to carry out sub-assembly of these unit parts in their own plants. Therefore, in order to manage supplied parts, which were growing by number, they had to build logistics centers next to assembly plants. In addition, the quality control and delivery management of supplied parts became very complicated, which put heavy burden on automakers. By relegating entirely such complicated management work to module suppliers, automakers made management of purchasing efficient for themselves.

**Reduction of Investment in New Market**

VW newly started production of commercial vehicles in its Resende Plant in Brazil. As of 1998, it produced 100 trucks per day with two shifts. Time required for assembly of one unit of chassis and cab was 35 hours, which was a substantial improvement of productivity over 52 hours of Piranha’s former plant. At Resende plant, the entire assembly process was left in the hands of 7 module suppliers, and VW’s employees were only responsible for management such as quality control and purchasing control. This method was apparently aimed at reducing investment cost in new market such as Latin American market, and was expected to spread to other newly emerging market such as Asia in the future.

Here, we have listed six advantages of module system. Beneficiary of all of these six advantages are only automakers, but as far as module suppliers are concerned, which take over the actual operation, only benefit for them might be an increase of sales. None of the advantages taken by automakers would be equally beneficial to module suppliers. Taking into account the investment of new module-plants and increased load of management of modules transferred from their customers, module suppliers can’t expect as much as benefits proper to automakers.

\(^{1}\) Concerning the Mosel Plant and its J.I.T. program conducted by Module suppliers, please refer to the article above quoted: IKEDA, “Ohshu Jidosha…”, *Annual of the Institute of Economics of Chuo University*, No.28, March 1998.
Moreover, as it is clearly indicated by the example of VW’s Mosel plant, automakers in general, or VW in this case, has the authority in selecting sub-module suppliers, which supply unit parts, and in the arrangement of price of parts. Therefore, the module suppliers must comply with the arrangement made by VW in all of these aspects. Nevertheless, module suppliers are obligated to reduce cost by 2% annually, and to observe strict delivery time and quality control of module parts including unit parts supplied by sub-module suppliers.

In light of these conditions, it is clear that the modularization effort pressed forward by European auto industry, especially by German auto industry today was made possible by the strong initiative of automakers, and its advantages do not necessarily permeate into module suppliers. This point is clear also from the fact that modularization effort was started by German automakers suddenly around 1996 without little preparation period. In particular, it is said VW realized its modularization by the strong initiative of Mr. Lopez, who became VW’s vice president in charge of purchasing after he moved from Opel. As it is well known, Mr. Lopez had forcibly promoted supplier rationalization policy for the purpose of rationalization of purchasing. He introduced modularization to complete this policy.

As we have explained so far, the advantages of modularization mentioned above are sought by automakers, and the suppliers do not necessarily receive substantial profit from this effort. Nevertheless, the fact remains that leading suppliers would be eliminated by competition and cannot survive in the market unless they accept modularization. As far as this fact holds true, they will have no choice but to become module suppliers and try to survive even though that is not profitable for them. This the reason why module suppliers in Europe and USA proceed currently to evolve their modules from assembly-typed simple modules to development-typed / function-integrated modules in order to get more added value.

Now, then, are there any disadvantages for automakers of adopting modularization? The answer is yes, and it is “the development and engineering capability of automakers will become black box”.

Traditionally, automakers insisted on keeping their know-how on parts mounting on vehicle as technological know-how specific to automakers even though they relegated parts production know-how to their suppliers. However, the adoption of modularization increases the possibility that development technology of automakers such as parts mounting would be transferred to their suppliers. Having black box of development and technology means that automakers will have a great risk of losing the cost control capability against their suppliers and becoming mere assembly makers. European automakers do not seem to have such a sense of crisis on this point, whereas Japanese automakers have a very strong sense of crisis in this regard. This is one of the reasons why some Japanese automakers are firm to avoid an all-out modularization.
CHARACTERISTICS OF JAPANESE-STYLE MODULARIZATION

The Reason Why European-Style Modularization Is Not Applicable In Japan

As we have mentioned in the previous section, European-style modularization focuses on outsourcing of “assembly” without development. In Japan it is difficult to find any advantage in this type of modularization. Four reasons can be pointed out as follows to explain why it is so.

Adoption of Japanese-style modularization

Japanese automakers have already adopted modularization based on “assembly” with respect to quite a few parts. This is what we call “Assembly typed modules”. For example, in the case of parts for seats assembly, automakers are pushing Tier 1 suppliers not only to supply components but also to assemble seat modules and to supply the modules to the final automobile assembly plants by J.I.T. This is also true with exhaust system and wiring harness. (In Europe, up until recently, sub-assembly of seats and wiring harnesses were carried out in automobile assembly plants of automakers in many cases.)

We have a case of an instrumental panel supplier of Fuji Heavy Industry (Subaru). Subaru has been getting the supplier’s plant to assemble instrumental panels with all of the related parts such as gauges and harnesses to make cockpit modules and to have the module supplied to its automobile assembly plant since 10 years ago. But the idea itself has its own long history. The concept of modules was already developed and concreted into Subaru 360, a small car launched in 1958. This supplier has been supplying instrumental panels in somewhat primitive module. Judging from such conditions in Japan, it is unnecessary to build new module plants in a Suppliers Park, and it is unlikely that Japanese makers would make such an excessive investment to build new plants, which is the case in Europe.

The Issue Of Wage Gap

As mentioned above, since there is no such wage discrepancies between automakers and parts makers in Japan as in Europe, there is no substantial advantage in terms of labor cost reduction by setting up module plants. Moreover, in many cases, Japanese automaker’s final assembly plants and suppliers’ plants are already located in close proximity. Therefore, there is little to gain by building new module plants. Even when the two locations are far from each other, since already advanced ingenious measures are taken (common delivery system), it leaves no problem in this respect either.

Large Variety, Small Lot Production System

There is another reason why “assembly- type modularization” is not applicable in Japan. This is very different from the cases in European and the US production system, where one plant is almost entirely devoted to the production of one model, whereas automobile production in Japan is characterized by larger variation with smaller lot production. Japanese plants have often adopted completely mixed assembly lines.

For example, in Europe and the US, shock absorber, coil springs, brake disc and so on are assembled into front axel modules and they are put to actual use\(^1\). Unicia Jecs in Japan tried to realize assembly of shock absorber and coil springs into a module as well. In the

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\(^1\) Above-mentioned NIKKEI MECHANICAL, No. 532, p.32.
current process, both of these two parts are selected and assembled on the assembly line matching with the model and mounted on the body of the vehicle. In this way, by supplying pre-assembled modules, the process can run without switching the lines. However, as we mentioned earlier, since the number of variations of parts used for various models of automobiles in Japan is great, the number of variations of modules to be assembled would naturally be numerous as well. As a result, piles of stock would have to be kept beside the assembly line. So, if the cost for the space is taken into consideration, there is scarcely advantage in terms of cost.

This example reveals that, even though modularization is advantageous in Europe, where production lot size of a model is large, it is not very advantageous in Japan, where production lot size is smaller and with larger variation. In relation with that, mixed production line system in Japanese plants, where two or three, even more variations of models of vehicles are assembled on the same line, is also another factor obstructing an introduction of modularization. For example, let us assume three models of vehicles; models A, B and C are assembled on the same line. Even if modularization is adopted for the vehicle model A in an effort to shorten the lead time, the efficiency of the line as a whole would not be achieved unless modularization is completed for the other models B and C as well.

Avoidance of Black Box

As mentioned above, European automakers seem to be moving toward delegating the whole development and production process to module suppliers in the future. This might amplify a “black box character” of the technology on the part of automakers. And there might be much greater risk to lose control of technology and of costs over module suppliers and, in a word, to be at the mercy of module suppliers. In the case of Japanese automakers, for the most part, they thought that automakers must adhere to their policy of keeping independent development technology and definitely avoid technological black box. It seemed up to two or three years ago that Japanese automakers would proceed to modularization process only under such a policy.

The Aim Of Introducing Modularization By Automakers

Two or three years ago, Japanese automakers had fallen behind European automakers in the course for modularization. They started to show strong interest in modularization since around 1998 with special attention to development aspect, which is different from European and the US-style modularization, and have been promoting specific modularization projects by mobilizing Keiretsu suppliers. The background for this change was, for one thing, the evolution of the international competition such as rapid development of modularization by European automakers. But, basically it should be attributed to internal factors of Japanese automakers themselves. Three points can be listed as follows as the reasons for Japanese automakers’ effort toward the introduction of modularization across the board today.

Cost Reduction and Creation of Added-values

The first and foremost reason is “substantial cost reduction and creation of added-values by design improvement through creation of module as a unit”. As the depression settled in during 1990’s, Japanese automakers have been requesting parts makers’ drastic cost reduction by 20 to 30%. But under the condition of year-to-year diminishing sales, parts makers found reduction of cost through cost reduction of individual parts almost impossible to continue. As a solution to this situation, design improvement brought by modularization is
proposed as an alternative method for radical cost reduction of parts. This improvement is expectedly regarded as another chance of new added value. In another words, they are seeking solutions for:

- Improvement of functions, which is approaching to maturation as far as development stays in individual unit parts level,
- Creation of new added value through implementing design improvement on the level of larger unit of module parts.

**Alleviation of Development Responsibility**

The second factor is “alleviation of development responsibility on the part of automakers”. Today, automakers are faced with heavy development responsibility related to shortening of product development period, to environment, to safety and to next generation technology such as information communication. With an introduction of modularization, automakers plan to outsource development based on current technology so that they can shift their management resources to next generation technology.

**A Countermeasure Against European & US Makers**

The third factor is “a countermeasure against European and the US makers’ trend”. Two aspects can be pointed out with respect to this factor.

One aspect is a precautionary measure to a possible innovation of some kind as a result of further advancement of modularization in Europe. At present, modularization is most advanced in European auto industry, but it is rather a simple kind of modularization, where sub-assembly process is outsourced, whereas it used to be carried out in-house by automakers in the past. However, there still should be a possibility so that it might generate some kind of innovation in the future. Japanese automakers are carefully prepared for such possibility.

Another aspect is related to the destiny of suppliers. Today, automakers in Europe and the US are shifting their parts ordering system from a unit base ordering to a module base ordering system. On the other hand, Japanese automakers’ order system is still primarily based on unit base. With the progress of modularization in Europe, a serious eventuality emerges for Japanese Tier 1 suppliers to diminish or even lose their European market if they stick to the conventional manner of parts supply. To cope with such trend of European and the US makers, it should be necessary for Japanese makers to strengthen their effort toward modularization to sustain indirectly Japanese parts industry. Weakening of their suppliers will not naturally be a positive element so that modularization newly pushed by Japanese automakers should be a countermeasure against such an eventuality.

**Joint Development Method by Tier 1.5 System**

Now, let us examine the up-to-date situation of modularization based on an outsourcing of development, which is now aggressively promoted by Japanese auto industry. Newspaper articles have covered since 1998 the modularization efforts jointly promoted by automakers and parts makers, or among parts makers themselves. We regard these efforts as the modularization based on the outsourcing of development.
For example, the module developed jointly by Toyota Gosei, Sumitomo Electric and Sumitomo Denso is called “integrated center cluster”, which integrates car audio switches and control circuits installed on air condition panel on one piece of circuit board. This module has been mounted on Toyota’s “Harrier”. In this case, modularization was carried out on the level of design and development, which resulted in reduced parts and reduced labor hours.\footnote{IKEDA, Masayoshi “Jidosha Meka no ‘Sekai Saiteki Chotatsu’ to Shisutemu / Mojuru Ka (‘World Optimal Procurement’ and Systematization /Modularization of Automakers)”, Keizai-gaku Ronsan (Collected Economic Papers), Chuo Univeristy, Vol. 39, No 3-4, Feb. 1999.}

In another case, when Honda group developed fuel pump module, Toyo Rozai, an oil filter maker, became the coordinator (namely, module supplier), and four leading parts makers of Honda group gathered their forces to work on the joint development of fuel pump. As a result, they succeeded in accomplishing radical cost reduction.

As it is clear from these cases, automakers act as the main promoter of joint development of module parts with the cooperation of several parts makers belonging to the Keiretsu (automaker’s business group) to realize drastic cost reduction and to create new added value through new product development. In this effort, four or five suppliers are selected as Tier 1 suppliers and the remaining suppliers become the Tier 2 suppliers. In this sense, this system will expedite the selection and restructuring of suppliers. But, since development is usually carried out on project-by-project basis, it is expected that there will be few fixed module suppliers. For example, above-mentioned Tokyo Rozai, an oil filter maker, is a small-sized company with annual sales of 16 billion yen. But, thanks to its successful development of fuel pump module, it has won the position of module supplier outstripping other leading parts makers such as Kehin, Nippon Seiki and Yachiyo Industries. Nevertheless, its position is coordinator only, which is not a permanent position, and nothing more. So, in this sense, the real Tier 1 maker in the true sense can be regarded as the automaker, which is the promoter of the project.

In this way, the existence of uniquely Japanese Keiretsu system and the leadership of automakers to lead their own Keiretsu group of parts makers and to coordinate module development procedures plays an important role in the background of formation of the structure where several parts makers can work together on joint development by forming “corporate community”, while each of them remains as an independent company.

Since this type of community development is carried out between Tier 1 and Tier 2 suppliers, it seems suitable to refer to this system as Tier 1.5 system. Tier 1.5 system is very appropriate to Japanese companies, which emphasize on modularization accompanying development. The following three points can be enumerated as characteristics of this system.

- Unlike European and the US-style Tier 1 companies, it is a “corporate community”, where companies join hands through technological tie-ups, without merger or fusion.
- The behavior of the community has the similar pattern to that of Tier 1.
- Regarding the size of the module, if the development of a large-scale module unit was sought after, it would require a number of companies to be working jointly, and it would be too difficult to coordinate them. Therefore, this type of modularization policy will be effective as far as the module size remains within the...
range where several companies are involved, for which coordination will not be so difficult.

Currently at the cross road of centuries, many of Japanese automakers have pressed forward with modularization based on development by inviting Keiretsu parts makers to join hands. Most of this effort has been realized as the form of this Tier 1.5 system.

Conditions of Module Suppliers and Sub-suppliers

So far in this paper, we have examined conditions of modularization pressed forward, or about to be pressed forward soon, under initiatives of automakers in Europe and Japan. In Japan, although certain efforts are being made toward modularization, no concrete effort is being made for large-scale systematic modularization led by automakers. Modularization effort by Japanese auto industry is still on the stage of partial and sporadic basis and no full-scale effort is being made yet. This is because large-variety, small-lot production system in Japan is acting as bottleneck and preventing European and US-type large-scale module production system from evolving in Japan.

In Japanese cases, as clearly demonstrated by modularization effort made by Toyota group, Nissan group and Honda group since 1997 and 1998, its characteristic is that several suppliers of the same Keiretsu work jointly from the development stage. Clearly, they are not assembly-type modularization based on the level of production process.

This characteristic might be fundamentally different from that of German VW’s case, where by the strong request of the automaker, leading suppliers were selected to locate in the supplier park and to start immediately module assembly. In other words, in Japanese cases, a modularization takes place when suppliers make some suggestions for modularization, and when some of the specific separate suggestions are accepted; this is the mainstream case of modularization in Japan.

Now, some of the requirements of module suppliers expected by automakers can be listed as follows.

- To have a wide range of product line with an emphasis on functional parts;
- In case that the range of its own product line is limited, to have evaluation and verification capability of peripheral parts of its own products;
- To have a capability to work jointly with other manufacturers swiftly;
- To have more than a certain amount of sales (turnover) and development budget. (For example, sales amount of 100 billion yen, development budget 10 billion yen or more);
- To have world’s top-class engineering capability of its core product.

In the next step, the requirement of Tier 2 parts makers (sub-assembly module suppliers) expected by automakers can be listed as follows.

- To have world’s top-class engineering capability of its core products;
- To have knowledge about related parts of its own products;
- To have uniqueness and independence with respect to production technology.
What is clearly indicated by these requirements, whether it is module supplier or sub-module supplier, is a very rigorous condition that if they are to take part in module development and module production by cooperating with automakers, they must have world’s top-class engineering capability of its core products, and to have more than a certain amount of development budget. This means, when modularization is introduced, the group of suppliers that will survive the screening process of the traditional Keiretsu suppliers will be rather limited. This in turn suggests that a substantial fraction of Japanese parts makers will face the possibility of entering into merger or capital tie-up with international companies to clear the hurdle of becoming module suppliers or sub-module suppliers. This kind of movement will be encouraged when the needs of both parties, on one side, parts makers, and the other side, international companies, meet.

In addition to this trend of selection and restructuring of parts makers through the introduction of modularization, suppliers screening conditions are reinforced through the purchasing aspect of “world optimal procurement”, which automakers are starting to put into practice.

For example, *Honda* has been promoting new procurement policy virtually aimed at “world optimal procurement” since the model change of Civic in August 1995, and *Honda* is brushing it up by the introduction of “4 polar consolidated best sourcing” purchasing system in 1998. With the addition of this new purchasing policy, it is expected that *Honda’s* Tier 1 suppliers will be screened and that they will be divided into module suppliers and the rest of other suppliers group.

**Transformation of Japanese-style Modularization and Bi-Polarization**

*On-going Situations of Module Production and Future Direction*

First, in order to sort out the points illustrate so far in this paper, we would like to clarify the current situations and characteristics of module production by Japanese automakers by comparing them with those of European and the US makers in the following table.

<table>
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<tr>
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<th>Japanese Automakers</th>
<th>European &amp; US Automakers</th>
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</thead>
<tbody>
<tr>
<td><strong>Production System</strong></td>
<td>Large variety, small lot production/ Mixed production line</td>
<td>Mass production line, which is close to one model vehicle per one plant</td>
</tr>
<tr>
<td><strong>Modularization Trend</strong></td>
<td>Parts made into units by Tier 1 makers are modularized on the sub-line/ Primarily small and medium size module</td>
<td>Parts makers’ module plants are located adjacent to automaker, so that the supply of large-scale modules is possible.</td>
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<tr>
<td><strong>Relationship with parts makers</strong></td>
<td>Cooperative work on design stage is established to certain extent thanks to the established Keiretsu group belonging to each automaker</td>
<td>Emergence of system integrators through M &amp; A</td>
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As indicated in Table 1, many European and the US automakers are preparing new plants for module production, where modules are produced for almost just one model of vehicles at each plant. In addition, in such a case, supply of large-scale module is possible since module suppliers’ plants are located near automakers’ assembly plants.

By contrast, in the domestic production plants of Japanese automakers, introduction of modularization is restricted to small and medium scale modules because of large-variety, small-lot production system (mixed production lines) in Japanese plants. In addition, unit parts are modularized on the sub-line. Also, there is a strong inclination on the part of automakers to avoid black box of technology as a result of leaving modularization entirely up to parts makers. In this sense, the movement of European and US automakers makes contrast to that of Japanese counterpart.

Some of European and the US parts makers, by repeating large-scale mergers and acquisitions of other parts makers, are emerging as system integrators, which independently develop modules. On the other hand, there are no such large-scale suppliers, capable of coordinating parts procurement and design, among Japanese parts makers yet. And even if such a supplier emerged in the future, since there would not be enough space for it to relocate adjacent to an automaker’s facility, it would be difficult to make modules bigger than small and medium-sized ones (Since large-sized modules would boost physical distribution cost, it could prove to be disadvantageous).

However, a global supply system of parts makers is needed today in accordance with the promotion of communization of platforms, world strategic car production, and joint development of engines. Under such circumstances, formation of system integrators such as in the case of Europe and the US is desired in Japan as well. Partly owing to such situation, drastic change of Japanese auto industry has started at the turn of the century from 20th to 21st, in which majority of Japanese automakers including Nissan, Mazda, Mitsubishi and Fuji Heavy Industry drew up under the leadership of foreign automakers. These Japanese automakers, which are trying to strengthen international tie-ups, seem ready to shift their direction from Japanese-style module system, which they have pursued so far, to one that is closer to European and the US-style modules.

Dissolution of Nissan Keiretsu and Track Shift toward European-type Module

Nissan announced the “Nissan Revival Plan” in October 1999, in which it laid out the policy of reducing purchasing cost by 20% in three-year period, and also the number of suppliers by half. In the midst of these efforts, Nissan’s Keiretsu is undergoing dissolution process very rapidly.

Dissolution of Nissan Keiretsu is progressing in two aspects. One is adoption of common platforms with Renault automobiles. The first project starts with March / Micro / Clio. The automakers will concentrate the orders to suppliers, which are excellent in responding to their global strategy to reduce parts procurement cost. Since the beginning of 2000, suppliers in Japan, France and the US have been involved in fierce competition to get their market. Traditional Keiretsu ties have been completely ignored so that suppliers are forced to undergo a limitless price down competition. For example, Calsonic, which used to be a top class Nissan Keiretsu maker and had been supplying air-conditioners to March, lost out to the united Valeo-Zexel’s low cost tactics.
Dissolution of Keiretsu is also progressing in a form of sell-out of Nissan’s shares in Keiretsu companies’ stocks. Nissan’s move is facilitating Keiretsu suppliers to enter into international tie-ups, by which Nissan hopes that its Keiretsu suppliers will establish relationship with global suppliers and obtain world-class technology, quality and cost competitiveness. Already, Ikeda Bussan became a wholly owned subsidiary of Johnson Control (US) and 30% share of Nissan in Calsonic Kansei was planned to sell to Delphi.

With such move toward dissolution of Keiretsu, Nissan’s modularization is shifting direction toward European-style modularization. New “Module Development Group” was set up with about 40 engineers inside the Technology and Development Department of Nissan in July 2000. And new modules were planned to introduce to the new models, which are to be developed in 2001. These are, for instance, “cockpit modules”, which integrates parts comprising drivers seat and its peripheral areas, and “front-end-module”, which combines front body parts surrounding lamp / radiators.

Similarly, with respect to above-mentioned March / Micro / Clio model, Nissan and Renault plan to work jointly on modularization of 6 or 7 different modules including “front end”, “cockpit”, “suspension”, “rear end” and “door”. And they plan to introduce them to countries such as Japan, Europe and South America, where this model is produced.

However, unlike Europe, where there are many major suppliers competent in integration of parts for each functional unit, there are few suppliers in Japan capable of coordinating modularization of parts from procurement of components through designing of modules. Therefore, as far as March is concerned, since it will be produced in Japan, its module production will be separated from the joint work, and only small and medium-sized modules are likely to be used for it.

Incidentally, as an attempt to solve such discrepancy of modules between Japan and Europe as we have discussed above, Nissan announced a launch of new production system to transfer partially vehicle assembly to parts makers; this system is said to start in June 2001. Nissan’s Tochigi plant, in preparation for the launch of the new model sedan starting in June, plans to adopt six to seven kinds of modules including cockpit and front-end door modules. It plans to leave the work of assembly, development, quality control and component procurement for the production of each module up to its module suppliers. By introducing this division-of-labor type production system, it expects to reduce production costs including labor cost and inventory cost by around 10%.

Calsonic Kansei, which used to be the most leading module supplier and the largest supplier in Nissan Keiretsu, will be responsible for cockpit module consisting of 10 to 15 components such as air-conditioner, gauges and audio equipments, and front-end module consisting of nearly 10 components such as radiator, lamps and bumper. Calsonic Kansei will set up its own production line by installing its production facility within Nissan’s Tochigi plant, and also dispatch production personnel. Following after Tochigi plant, Nissan is said to have a plan to introduce the same system into all of its other plants in and out of Japan. At Nissan, module assembly shops will be installed in the space inside of the automobile assembly plant, which is different from European-style plants, where module assembly plants

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are located in the peripheral area of automobile assembly plants. Nevertheless, the idea is basically the same. In this sense, Nissan can be regarded to have finally embarked on the introduction of European-style module system on full scale.

Incidentally, along with introduction of module systems into automobile plant, it will be necessary to screen Tier 2 suppliers (sub-module suppliers), which provide unit parts used for assembly of modules. At this point, it is not clear whether the screening method will be left up to automakers or control of Tier 2 suppliers will be delegated to module suppliers.

At any rate, when this procedure is accomplished, some of the Tier 2 suppliers, which used to supply parts directly to automakers, are to supply unit parts to module suppliers. So, as the result of implementation of module system on full scale, a polarization of positions of suppliers will occur inevitably. In this sense, introduction of module systems today signifies the end of Keiretsu parts production system in Japan at least as far as the Nissan group concerned, which has been solid for so long time, and a fresh start of structuring new parts procurement system will begin.

**Mazda’s Introduction of FSS and Modularization Effort**

Ever since the Ford Motor (US) increased its capital share in Mazda in 1996, Mazda has reinforced its role as a fraction of the global strategy of Ford. In this way, along with the cooperative relation between Mazda and Ford is strengthened, then the idea of sharing common platforms (body) for models of both companies is becoming concrete. This is aimed at sharing the common body framework such as chassis, which requires huge development cost, and main parts such as engine and transmission, as well as sharing development work at the same time to achieve further reduction of development cost. At Mazda as well, modularization and introduction of the “full service supplier (FSS)” system, in which parts makers take partial responsibility of development, have been carried out since 1999.

FSS has already become the mainstream system among the US automakers including Ford. With FSS, the traditional practice of placing orders to parts makers after automakers’ completion of planning and design was replaced by the method of leaving everything up to parts makers from the planning and design stage.

As a result, majority of parts excluding engine, transmission and vehicle framework called white body will be outsourced. Quality guarantee was traditionally shouldered by automaker, but this responsibility will also be transferred to parts makers. Mazda is expected to continually take the responsibility of basic interior and exterior design as before, and at the same time to concentrate its management resources on future technology in the area of environment and safety, and automobile design, which will be the key elements of brand strategy.

Incidentally, for a parts maker to be recognized as FSS, it must have sophisticated development and design capability. As a prerequisite, it is therefore required to have

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1 “Gaishi ni ‘Iitoko Dori’ sareta Mazda no Higeki (The Tragedy of Mazda, Best Part Of Which Was Taken Advantage Of By Foreign Capital), WEDGE June, 2000, p.9.

2 Chugoku Shimbun, Nov. 17, 1999 issue.
sophisticated information technology centering around three-dimensional CAD/CAM today. In this regard, there exists a large technological discrepancy between parts makers and automakers like Mazda. Mazda has implemented “Mazda Digital Innovation” (MDI Plan) for introducing information technology in development and production. This is a highly motivated effort to drastically review the whole process of design, development, production start-up, purchasing, and production of new models, and to digitize the whole process by fully utilizing state-of-the-art information technology and equipments. The total investment amount is said to be 23.5 billion yen up to 1999.

Naturally, to be recognized as FSS of Mazda, it is necessary for the supplier to make investment in information technology corresponding to MDI Plan. Consequently, Tier 1 suppliers aiming at becoming FSS have been reinforcing investment in information technology focusing on CAD/CAM and training of CAD/CAM operators.

Under the condition of diminishing orders and declining sales turnover, parts makers cannot really afford to continue to make investment for machines and equipment, but if they are to survive as Tier 1 suppliers, it is indispensable for them to achieve the requirement of making investment in information technology. In addition to high development and design capability, it is also indispensable for parts makers wishing to become FSS to have accumulation of comprehensive technology for modularization.

However, since Mazda is located in a quite provincial area as of Hiroshima, the scales of Keiretsu suppliers and of cooperative makers are much smaller than those of Toyota and Nissan, and many of them are small and medium-sized companies with sales amounts of 40 billion yen and somewhat more at the most. Therefore, Mazda has been strongly requesting its Keiretsu and cooperative makers to enter into merger or capital tie-ups among themselves in order to be able to become its FSS and module suppliers. Nonetheless, up until now, Mazda only managed to sell Jatco (Fuji City, Shizuoka Prefecture), a transmission maker and Naldec (Fuchu-cho, Hiroshima Prefecture), an electronic auto parts maker. And the restructuring of its local suppliers has been scarcely started.

But, when it became highly probable that Mazda was to drop in red ink by 12 billion yen in terms of consolidated net profit in the mid-term financial settlement in September 2000, and that its annual automobile production was to drop under 700,000 units (compared to annual production of about 1.4 million units in 1990), the action toward restructuring of the group suddenly became intensified. Specifically, in June 2000, a statement on two mergers was published, namely between Yamako (sales: 19.4 billion yen) and Sanyo Kogyo (Sales: 14.3 billion yen) on one hand, and Kurata (sales: 16.7 billion yen) and Miura Kogyo (sales: 9.5 billion yen) on the other hand.

Among them, Yamako and Sanyo are good at structural frames, and Kurata and Miura are good at press parts around body compartment. Since Mazda is reinforcing the policy of procuring parts from internationally competitive companies, it is supposed highly likely that its parts order will be intensively placed to both of these merged companies as top press parts suppliers. In response to such trend, mergers and capital tie-ups between local cooperative

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makers are expected to increase radically. Also, in relation to such effort, and through tie-ups with international leading parts makers, which are related to Ford, the move toward module production through the business group system is expected to materialize in the future.

**Toyota’s System / Module Centered Around Keiretsu Suppliers**

Since the beginning of 2001, Toyota has launched a new effort for cost reduction which is called **CCC21** (Construction of Cost Competitive). It is aimed at cost reduction by 30% starting from the next development model. To achieve this goal, Toyota plans to shift its method by transferring a lot of tasks traditionally carried out by the automaker to selected system suppliers. Those tasks include interior, cockpit, body, and so on.

In this case, main components are divided into systems / modules, and the tasks of manufacturing from the stage of development through delivery of products are relegated to system suppliers. In this sense, it is the same as those of Nissan and Mazda. However, in the case of Toyota, it plans to select its system suppliers by screening Toyota’s Keiretsu suppliers, and develop them to make them powerful suppliers so that they will grow up to be competitive among large-sized international Tier 1 suppliers. In this aspect, it is clearly different from the future scope of such company as Nissan, which has resolved Keiretsu.

The total picture of Toyota’s planned effort toward system / module method is not yet opened to the public, so that it is hardly possible to explain in its details, but, we’d like to try to clarify the plan as far as we know by citing an example of seat components.

For example, for the seat component development, Toyota exercised great power by conducting market research and drawing basic design. Also, Toyota drew blueprints such parts as seat track adjuster, reining and metal frames, and designated parts makers to be employed. Then, some seat assembly makers were selected out of several Keiretsu seat makers, to assemble seats with cooperation of some seat makers and using parts manufactured by designated specialty parts makers. The selected seat assembly makers were responsible for designing of details based on the basic design provided by Toyota, but the responsibility and initiative given to them were quite small.

With the introduction of the new system in 2001, however, the traditional development system was entirely modified. First and foremost, two seat makers were screened out of several Keiretsu seat makers; they were made into system seat makers, and the rest of Keiretsu seat makers were downgraded as Tier 2 suppliers. Also, the seat makers were given the responsibility to assume such tasks as market research and basic designing entirely, which Toyota had traditionally carried out by itself. Furthermore, seat makers traditionally used parts manufactured by parts makers designated by Toyota, but, in the future, seat suppliers themselves will assume responsibility of development and design of parts, selection of parts makers and evaluation.

Because of these shifts of roles, it will become indispensable for system seat suppliers to be equipped with two capabilities. One is the planning and development capability of the total seat system. This ability will be necessary to reinforce development and evaluation of vehicle concept. And the other is management capability of joint works, which will be necessary to strengthen the links and leadership in working with other cooperative seat makers and parts makers.
To satisfy the former need, Toyota may dispatch personnel who are already equipped with such skills and experiences from Toyota to system suppliers, or the suppliers may make intensive investment in equipments and human resources for development in-house. As for the measure to satisfy the latter need, system suppliers may set up equipments and organizations to strengthen cooperative working system with Keiretsu seat makers and parts makers.

Now, what kind of objectives will the seat system suppliers, who are equipped with the planning and development capability and joint work management capability to create total seat system, try to achieve through their activities?

- The first is to strengthen commercializing capability of their seats by adding new functions and new features to their seats;
- The second is to achieve super-radical cost reduction by streamlining of production, reduction of variations of parts, and adoption of common parts;
- The third is to make more sophisticated efforts toward work efficiency through upgrading of CAD, CAE and elimination of redundant works.

In this case, as pointed out in the above, the common task of Toyota group across the board is 30% cost reduction of CCC21. So, if any of the system suppliers fails to achieve this goal, such system supplier will be eliminated. Furthermore, since these system suppliers are responsible for supplying parts to Toyota plants located around the world, the possibility of their going into joint venture or merger and integration among system suppliers themselves is also considered great.