WORKING PAPER NO. 15

COORDINATION BETWEEN PRODUCTION AND DISTRIBUTION IN A GLOBALIZED NETWORK OF FIRMS: ASSESSING FLEXIBILITY ACHIEVED IN THE JAPANESE AUTOMOBILE INDUSTRY

by

Banri Asanuma

Faculty of Economics

Kyoto University

Faculty of Economics,
Kyoto University,
Kyoto, 606 JAPAN

WORKING PAPER NO. 15

COORDINATION BETWEEN PRODUCTION AND DISTRIBUTION IN A GLOBALIZED NETWORK OF FIRMS: ASSESSING FLEXIBILITY ACHIEVED IN THE JAPANESE AUTOMOBILE INDUSTRY

by

Banri Asanuma

Faculty of Economics

Kyoto University

August 1991

Faculty of Economics

Kyoto University

Kyoto, 606 JAPAN

COORDINATION BETWEEN PRODUCTION AND DISTRIBUTION IN A GLOBALIZED NETWORK OF FIRMS: ASSESSING FLEXIBILITY ACHIEVED IN THE JAPANESE AUTOMOBILE INDUSTRY[*,**]

By

Banri Asanuma

Faculty of Economics
Kyoto University
Yoshida Honmachi, Sakyo-ku, Kyoto 606-01, Japan
FAX: +81-75-751-1532

August 1991

[*] Prepared for presentation to the conference on "Japan in a Global Economy - A European Perspective" to be held at the Stockholm School of Economics on 5-6 September 1991. Comments are welcome. Do not cite without a written consent of the author.

Abstract

Production and distribution of today's typical goods is conducted by a network of firms developed by a core manufacturer with its suppliers and dealers, and anatomy of this network is becoming an urgent task as transition toward more flexible manufacturing proceeds. Focusing on the process of order processing and production control, this paper investigates from a comparative viewpoint how coordination is made between the downstream and upstream sides in the operation of a globalized network developed by typical large automobile manufacturers. According to a measure constructed in the paper, it is suggested that domestic operation of one or two Japanese firms has achieved relatively high flexibility. The paper then addresses the following questions. (1) To what degree can production be based on orders entered by consumers ? (2) What elements are universally found in a network developed by large automobile manufacturers regardless of the country–origin of the core firm ? (3) What are the factors that enabled some Japanese firms to achieve high flexibily in their domestic operation ? (4) Why has their operations for overseas market lagged behind and what are the prospect of their offshore production from the viewpoint of flexibility ? The analysis on these points illuminates the role played by the organizational skill formed and accumulated in the constituent firms of a network.

JEL Classification Numbers: L14, L22, L23, L62, M11, M31

1. Introduction

Take any of those products of assembly type industries that we use in our daily life and are characteristic to the contemporary society. Be it a personal computer, a copier, or an automobile, each unit bears the brand of some company which has produced and supplied it. But, if we trace back the route through which a given unit in actual use came down to its user all the way from the retail outlet to the final assembly plant, and therefrom further upstream to the sources of parts and components, we are bound to find that, of all of these vertically related stages of production and distribution, only a limited part is carried out by the company which has given the brand to that product.

In other words, a typical manufactured good in today's economy is neither completely made by one single producer nor sold directly by him or her to final consumers, as is presumed in usual textbooks of microeconomics. It is produced and distributed by a network of firms, which a firm responsible for a specific brand (or a set of several specific brands) creates by initiating business relations with other firms. For later reference, let us name this organizing firm as the *core firm* of that network. The core firm typically contrives the key concept for the design of each model of its products, develops and determines the basic design, and provides quality assuarance for its products. In addition to these, the core firm also frequently operates in–house final assembly plants for its most important products, as well as in–house manufacturing plants for some key components. But, a substantial portion of the parts and components assembled into the final products is generally manufactured by and procured from other firms. At times, assembly or part of designing of some of the final products are carried out by other firms based on contractual arrangements. Further, most of the retail outlets are run by other firms. Regarding the sales activities in foreign countries, planning and coordination of sales and marketing in a relatively large national market is in many cases exercised by an overseas subsidiary created by the core firm as its direct extension in this market. But, here again, sales activities themselves are largely carried out by independently owned franchised dealers.

Thus, competition in manufacuring and sales of mass marketed durable goods characteristic to today's economy inevitably becomes competition between networks of firms. This fact is partially reflected when, in the discussion of trade and industrial policies, several writers refer to a close and cohesive type of relation that core firms in Japan frequently develop with their respective suppliers and dealers. But, unfortunately, most of the writers stop here with associating that kind of relation with a Japanese word *keiretsu*, assuming implicitly that such a close and cohesive relation is in every respect to be ascribed to Japan–specific factors. An underlying presumption is that, to give description of, or prescription for, interfirm relations in other countries, the ordinary notion of market would suffice.

It is worthwhile to note here the following three–fold tendencies in contemporary manufacturing recognized by Milgrom and Roberts (1990). First, manufacturing today is undergoing a fundamental transition from mass production of a standardized product to flexible production of diversified products. Second, extensive complementarities between the product, production, and marketing strategies involved in flexible production requires that, as production becomes more flexible, more coordination becomes necessary between the traditionally separate functions of design, engineering, manufacturing, and marketing. Third, to the degree in which use of flexible, general purpose equipment increases, necessity of vertical integration decreases. Combining these tendencies, Milgrom and Roberts predict that, in place of vertically integrated manufacturing of final products and their parts, "extensive use of independently owned suppliers linked with the buying firm by close communications and joint planning" will increasingly appear. This prediction by Milgrom and Roberts suggests that the network point of view will become increasingly more important to analyze production and distribution in any country, regardless of the country–origin of each individual core firm. The same prediction also suggests that, to conduct such analysis of production and distribution, it becomes indispensable to develop a conceptual framework with following features. First, unlike the term *keiretsu*, the concepts therein should be applicable universally to every network in a given product area, regardless of the country–origin of its core firm. Second, the concepts should have power to distinguish systematically various types and facets of intra– and interfirm relations, which the traditional concepts of the firm and market have failed to capture.

To develop a framework with such features, it seems of utmost importance to conduct focused empirical studies first, and then make generalizations based on the findings. Such efforts have already been made, to a considerable degree, regarding the upstream side of the network of firms. For instance, Asanuma (1984a, 1984b, 1988, 1989) has reported the findings from a series of field research on manufacturer–supplier relationships in the automobile and electronics industries. Based on these findings, Asanuma (1989) has presented a scheme to classify parts and suppliers and a related concept of *relation-specific skill*, which can be interpreted as an enrichment of the concept of bilateral governance submitted by Williamson (1979, 1985). Kawasaki and McMillan (1987) have shown econometrically that core firms in Japan absorb risks to a considerable degree in their transactions with suppliers. Asanuma and Kikutani (1991) have extended this work for the automobile industry, interpreting the observed behavior of core firms as a means to promote development of the relation-specific skill by suppliers. This interpretation implies that the attitude taken by Japanese core firms may have some applicability in other countries as well, especially in developing countries where conscious promotion of accumulation of organizational skill seems to be an urgent task for industrial development. Further, recent empirical studies by Clark and Fujimoto (1991) and other scholars will certainly contribute to refinement of the conceptual framework to analyze the manufacturer-supplier interface.

In comparison to this side, relatively more work remains to be done concerning the downstream side. To analyze the structure and workings of a network with symmetrical precision on both sides, we need to know, among others, following points. How does the core firm coordinate the sales activities with the manufacturing activities ? What kind of contractual devices are used by the core firm to govern the transaction with its dealers ? What are the incentives for dealers built in the contractual devices and how is the risk involved in the transaction shared between the core firm and its dealers ? What kinds of capabilities or skills are required on the part of dealers to enable the network to efficiently adapt to the changes in the network's environment ? What kinds of capabilities or skills are required on the part of the core firm ? How does the tendency toward more flexible production affect the intra- and interfirm interactions within the network ?

To promote the development of research in this direction, this paper reports findings from the field research that I made on the automobile industry during the period from April 1989 to January 1991. Setting aside discussions on relatively longer-term aspects of the manufacturer-dealer interface for later occasions, I spotlight in this paper intra- and interfirm interactions involved in the ongoing, daily operation of the network. Though this may seem focusing on a more humdrum aspect the network, it serves to illuminate how the transition toward more flexible production has been affecting interactions in the network, urging what kind of organizational skills to develop. In this regard, this paper provides a natural starting point from which one can proceed to longer-term aspects.

Regarding the issue of flexibility, it has recently come to be widely perceived that one of the competitive edges of Japanese automobile manufacturers must be in the degree of flexibility they have achieved.[1] Their practices in Japan therefore constitutes an important object of observation in this paper. But, to distinguish universal elements from country-specific ones, I try to keep a comparative viewpoint throughout, using the data that I collected in the United Kingdom in 1989 and the United States in 1991 on the operations of some Japan-based companies and a US-based firm.

Section 2 explains in what particular way product diversity proceeds in today's automobile industry creating what kind of new challenge for manufacturers. Section 3 expounds the general pattern of the solution that major automobile manufacturers in the world have found to meet this challenge, focusing on the methods of making the monthly production plan. According to the three stages recognizable in the evolution of the methods, I submit a measure of flexibility of a production system in this section. Further, using this measure, I present a rough picture of the current status of flexibility achieved by several firms. This suggests that one or two of Japanese core firms have indeed achieved relatively high degree of flexibility, as has been widely perceived, but the achievement has been limited to their domestic operation. Section 4 analyses how coordination is made between the distribution side and the vehicle production side regarding the formation and execution of the monthly production plan. The discussion sheds some light on the sharing of risks between the core firm and its dealers. Section 5 turns to how coordination is made between the vehicle production plants and the parts supplying plants including those of outside suppliers. I spotslight here some factors that seem to have been of critical importance for the few Japanese firms in achieving relatively high flexibility in their domestic operation. Section 6 discusses briefly the overseas operation of Japanese firms from the viewpoint of flexibility. Section 7 concludes the paper.

2. The Challenge Faced by Automobile Manufacturers

2.1 *The Nature of Product Diversity in the Contemporary Automobile Industry*

Production of the Model T car by Henry Ford is always quoted as a classical example of mass production of a single standardized product. Though Ford achieved dramatic success in the 1910s with his introduction of modern mass production lines, his company's position in the industry was superseded by GM in the 1920s. Chandler (1962) has ascribed this victory by GM to the multidivisional structure introduced by Alfred P. Sloan, which, in turn, enabled conscious implementation of the product diversification strategy; with different car-lines, Chevrolet, Pontiac, Buick, Oldsmobile, and Cadillac, GM was able to tap a broader range of market than Ford, addressing a spectrum of different market segments simultaneously.

Let us look at in this subsection in what form the product divesification strategy is pursued by major automobile manufacturers in today's world. Certainly these companies have followed the GM's strategy in the 1920s in that they typically offer a number of different car-lines simulataneously. But, a notable fact is that proliferation at the car-line level does not constitute the main facet of product diversification at the present stage.

As of January 1991, GM offers following 10 car-lines to the U.S. passenger-car market under the Chevrolet brand, or through the Chevrolet channel of dealers: Astro/GMC Safari, Beretta, Camaro, Caprice, Cavallier, Corsica, Corvetta, Lumina, Lumina APV, S-10 Blazer/GMC S-15 Jimmy. In addition, it offers 8 other car-lines under the Pontiac brand, 8 under the Buick brand, 9 under the Oldsmobile brand, 6 under the Cadillac brand, and 1 under the Saturn brand, totaling 42 for the corporation.[2)] In Japan, as of April 1990, Toyota offers 22 car-lines to the Japanese passenger-car market. If we include light-duty trucks, mini-buses, and so-called "wagons" sold through the same channels, the total number comes closer to the GM's figure.[3)] Forty car-lines may be expressible as a considerable degree of product diversification, but we will miss the point if we stop here.

< Table 1 about here >

Today, a far greater proportion of product diversity in the automobile industry is brought forth at the level of variations within each car-line. Let us look at Table 1. This table shows how many variations were offered by Toyota as orderable, within one single car-line of Crown, at two different time points in the past. We see there that, over the twelve years from April 1966 to April 1978, the number of variations orderable within this particular car-line underwent an explosive growth and reached the order of 100,000. Interviews that I made at large U.S. automobile manufacturers have revealed that the figure of 100,000 as the size of orderable variations within a single car-line does not constitute any surprise; managers of these companies testified that they frequently have even more variations. Thus, proliferation of orderable variations can be taken as a fairly universal phenomenon, at least among large automobile manufacturers.[4)]

We may note here that Table 1 provides a clue as to the way in which such a large number of orderable variations emerges. For each of the items, such as the body type, the engine, the transmission, and so on, the collection of which is used to determine the specification of a given unit of vehicle, the automobile manufacturer comes to offer a multiple number of choices. Though this number itself is typically not very large, the number of possible combinations of choices can become enormous, since the number of the items is substantial.

< Table 2 about here >

The number of variations that are actually produced in a given period of, say, one month or three months, is typically much less than the number of orderable variations. Nevertheless, it can become sizable, causing the average number of units of vehicles produced and sold per variation quite small. Table 2, which shows, for each of four car–lines selected from those offered by Toyota, the numbers of variations and of units of the vehicles actually produced in a certain three–month period in the past, illustrates this point nicely.

Further, going beyond the averaged figures, Fukuoka and Iwatsuki (1989) has conveyed the following facts. In one of the months in 1985, Toyota sold 153,569 units of vehicles in the domestic market, which units consisted of 19,349 different specifications of vehicles. Of these specifications, 9,544, or 49.3 percent, registered only one unit of vehicle sold per specification. The 9,544 units thus sold occupied only 6.2 percent of the total units sold. Further, 19.9 (14.9, 7.5, 1.9) percent of the 19,349 specifications registered, respectively, 2–3 (4–10, 11–30, 31–50) units of vehicles sold per specification. Finally, the remaining 1,289 specifications, or 6.6 percent of the total variations, registered more than fifty units sold per specification. The 76,745 units that belonged to this category occupied 50.0 percent of the total units sold in that month.

For good or ill, this is the way in which large automobile manufacturers in today's world have been pursuing product diversification, to tap the demand of consumers with very much individualized needs and tastes.

2.2 *A Dilemma Posed by Product Diversity*

With such proliferation of product variations, it becomes increasingly more difficult and complex for automobile manufacturers to achieve adjustment between their production and the market demand for their products. More specifically, automobile manufacturers come to face the following kind of dilemma.

In the case of the Model T production, any unit in the product inventory could be sold to any consumer, as far as he or she wanted to purchase a Model T car. Thus, the company was able to base its production plan solely on the anticipated aggregate demand for the Model T cars. In other words, the problem of matching supply to demand could be reduced to one single dimension of the total quantity. The same remark can be carried over to multiple car–line production, if the number of variations per car–line is small. But, once such enormous number of variations as we have seen is introduced, matching supply to demand comes to require, in addition to the matching at the total quantity level, precise matching has to be made in kind. For instance, the data we saw in the last part of Section 2 shows that, for nearly half of the entire set of different specifications of the products supplied by the company in a month, there appeared just one consumer in that month who wanted the vehicle with that particular specification. This suggests that it becomes quite risky for the company to build such cars without receiving orders from those who actually want to buy that particular version of vehicle.

On the other hand, as was in the Model T era, production still requires considerable lead time. Therefore, at least some part of the manufacturing activities necessary to produce a vehicle has to be begun prior to the receipt of the order from the consumer who finally purchases and uses that particular vehicle. Otherwise, the consumer would have to wait too long, which, except for the cars of especially luxurious kind, consumers today are not willing to bear.

How do automobile manufacturers solve this dilemma ? There seems to be a fairly general pattern of solution that major automobile manufacturers in the world have come to find in their respective search for the suitable solution. I outline this pattern in the next section.

3. How Manufacturers Have Been Coping with This Challenge

3.1 *Three Methods for Monthly Production Planning*

The Method 1. Let us first look back at Table 1 and think about how the full specification of a vehicle can be expressed in a general abstract way. The general form can be given as follows: $X = (X_0, X_1, ..., X_l, X_m, ..., X_s)$. Here X_0 denotes a set $\{x_{01}, x_{02}, ..., x_{0k}\}$ of different car-lines that this firm offers to the public. X_1 denotes a set $\{x_{11}, x_{12}, .., x_{1d}\}$ of body-types from which choice can be made when this firm is going to build a vehicle. Likewise, X_2 denotes a set of available engines to be mounted to a vehicle produced by this firm, X_3 a set of available transmissions, and so on. If one completes all of the permissible choices and fully specifies the components of the vector X, for instance, as $(x_{05}, x_{13}, ..., x_{l2}, x_{m6}, ..., x_{s9})$, the full specification of a concrete unit of vehicle is determined. Let us therefore name X as the *specification vector*.

Suppose now that a given automobile manufacturer is to make the monthly production plan for the month M. The most primitive way to do this is to fix, by some target date, based on the signal the company received from the downstream prior to this date and the company's own judgment, all of the units to be produced during the month M, with all of the components of the specification vector determined firmly for each unit in this list. Upon completion of this list of fully specified monthly requirements, the company proceeds to scheduling. Scheduling can gradually proceed as time goes by, beginning with allotment of the units in the monthly requirements list to each of the working days of the month, ending with completion of the assembly-sequence plan for each working day. Let us name this way of making the monthly production plan as the *Method 1*. The Method 1 is the most rigid (or least flexible) way of making the monthly production plan, as will become clear in the course of the following discussion.

If all of the items from X_0 to X_s require the same length of lead time prior to the assembly of a specific unit of vehicle, then, there would be no other choice than to use the Method 1 to make the monthly production plan. In reality, however, some of the items require longer lead time, while others can be prepared relatively more quickly. Taking this difference into consideration, the monthly production plan can be made up stepwise as time proceeds. This is the way to introduce elements of flexibility into the process of making and execution of the monthly production plan.

The item which has to be fixed first is X_0. More exactly, any given automobile manufacturer should determine, in the first place, by each car-line how many units they are going to build during the month in question, M. This is because the management of each of the vehicle assembly plants use the planned monthly volume of each car–line assigened to their plant as the signal, according to which monthly determination of the tact of their assembly–lines and monthly adjustment of the size and deployment of their work force are to be made prior to the beginning of the month M. After the number of the units to be built during the month M has been determined by each car–line, the planned units are allotted to each of the working days of the month. This provides the basic frame of the monthly production plan, and for each of the units in this frame plan, the specification items from X_1 to X_s can be filled later, since they need less time for preparation than X_0.

The Method 2. Thus, a second method to make the monthly production plan consists of the following two stages. At the first stage, by some target date, the number of the units to be built during the month M is determined by each car–line, and then the allotment of these units to each of the working days is made. The second stage is exercised repeatedly either for each of the weeks of the month or for each of the ten–day period of the month, depending on the practice of individual companies. Note here that, in Japan, it has been more customary in business practice to divide one month into three ten–day periods, while in the United States and Europe, it has been more common in business scheduling to rely on the concept of week. Suppose for the moment that the automobile manufacturer in question has chosen to use the ten–day system. Then, the second stage proceeds as follows. Upon completion of the first stage, the company allocates the planned units of vehicles to dealers, and asks them to send orders by some target date for the planned vehicles which have been allocated to them and are to be built during the first ten–day period of the month. The order has to specify for each unit of vehicle the items from X_1 to X_s based on the dealer's expectation and plan of sales. Based on these ten–day orders sent from the dealers, the automobile manufacturer makes the production schedule for the first ten–day period of the month. The same process is repeated for the second and third ten–day periods. The logic is unchanged under the system where a week is used instead of a ten–day period. We name this second way of making the monthly production plan as the *Method 2.*

< Figure 1 about here >

Let us compare the two methods at this point with the aid of Figure 1. Under the Method

1, all of the units to be built during the month M have to be determined with every detail by some target date. Denote the lead time between this date and the first day of the Month M by L_M. Assume for the moment that L_M is one month as is shown in Figure 1. This means that the monthly plan determined at the end of the month M−2 has to be entirely based on a demand forcasting which is to be finalized somewhat earlier than this date. It is easy to see generally that, the longer L_M is, the larger the probability of error will be, and vice versa.

On the other hand, under the Method 2, even if the length of L_M is kept the same as in the Method 1, the plan that includes specifications of the vehicles to be built can now be made three times a month for each ten–day period of production, each time with the lead time L_T meaured backward from the first day of the ten–day period. The merit is not solely in that L_T is generally smaller than L_M. The production during the second and third ten–day periods of the month M can now be based on demand forecastings that are made at much later dates in calendar in comparison to the Method 1. For instance, in the situation depicted in Figure 1, the plan on the final specifications of the vehicles to be built in the last ten–day period of the month M can now be made at the beginning of the month M, more than one month later in comparison to the Method 1. This means that this plan can be based on the demand forecasing and judgments formed more than one month later in comparison to the Method 1. Consequently, in comparison to the Method 1, the Method 2 can substantially reduce the risk of the system consisted of the automobile manufacturer and its dealers to make misjudgment as to which specifications of vehicles are easier to sell than others.

The Method 3. Upon completion of the vehicles–to–be–built list and production schedule for a given ten–day period, the automobile manufacturer lets each dealer know, for all of the vehicles the dealer has ordered at the cycle for that production period, which one has been scheduled to be built on which day. The Method 2 ends its planning cycle with this feed–back of information to the dealers. However, further flexibility can be introduced by adding some steps to the Method 2 as follows.

As previously noted, under the Method 2, the specification items from X_1 to X_s for individual vehicles to be built are all specified at the stage in which the automobile manufacturer makes the ten–day (or weekly) production plan. However, there are differences among these items as to the necessary lead time for production. Typically, the items like the body type, the engine type, the transmission type, and the grade of luxury have in fact to be fixed at this time point. Let us name the part of specification of a vehicle determined by these items as the *basic specification*. But, other items like options and the color need not to be finalized at the same time when the basic specification is determined. Let us name the part of specification that complements the basic specification as the *secondary specification*. A third way of making the monthly production plan, which I name as the *Method 3*, admits later changes of the orders concerning the items that belong to the secondary specification. Under this method, dealers are allowed, after the receipt of the feed–back information from the automobile manufacturer on the production schedule of the vehicles they had ordered at the cycle of making a ten–day production plan, to input orders daily regarding the changes that they may come to want to be made on the secondary specification of the vehicles they have got scheduled. This daily order has to be made with a lead time L_D, prior to the scheduled production date of the vehicle concerned. Figure 2 illustrates how the Method 3 works.

< Figure 2 about here >

In practice, the orders issued by dealers at the stage in which the automobile manufacturer makes the ten–day production plan are almost entirely based on the expectation and plan formed by these dealers; it is very rare at this stage that a dealer's order has as its backing an order actually placed by a final consumer. On the other hand, the daily order issued by a dealer on the change of the secondary specification is always traceable to a final consumer, who either has visited the dealer's store or has been visited by one of the dealer's salespersons, but has not been able to find in the dealer's inventory the car with the precisely same specification that he or she wants to buy. On this ground, the Method 3 serves to reduce the dealer's risk significantly.

3.2 *Comparison of Production Systems in Terms of Flexibility*

As should already be clear, a production system consisted of an automobile manufacturer and its dealers can be said to have achieved an evolution to a higher stage with more flexibility when the system comes to operate under the Method 2 instead of the Method 1. When the same system comes to operate under the Method 3, it can be said to have achieved a further evolution to a one step higher stage in terms of flexibility. Noting this, let us say that a production system is in the *Stage 1 (2, 3)* of evolution when it operates under the

Method 1 (2, 3) of making the monthly production plan.

We should also note that, within the Stage 1, a production system can be said to have achieved a higher degree of flexibility if the system comes to operate constantly with smaller L_M than it used to be. Likewise, within the Stage 2, a system can be said to be more flexible than another, if the former has achieved smaller (L_M, L_T) or (L_M, L_W) in the sense of vector ordering than the latter. Similarly, within the Stage 3, two systems or two states of an identical system can be ranked in terms of flexibility by comparing (L_M, L_T, L_D) or (L_M, L_W, L_D).

Combining these observations, I measure the degree of flexibility achieved by a production system by a three dimensional vector (L_M, L_T, L_D) or (L_M, L_W, L_D). When the system is in the Stage 1, I denote L_T (or L_W) $= L_D = \infty$. Similarly, when the system is in the Stage 2, I denote $L_D = \infty$. Let us concentrate on these measures for the moment in our discussion on the flexibility issue.

3.3 *Historical Developments Observable in Japan*

The evolution from the Stage 1 to Stage 3 via Stage 2 can clearly be traceable in the history of the Japanese automobile industry. According to Jidosha Kogaku Zensho Henshu Iinkai (1980), Toyota introduced the Method 2 in 1966 as a reform linked with the commencement of the "wide-selection" strategy in the car-line of Crown. Note that, as Table 1 shows, the number of orderable variations was still quite modest at this time point. By 1974, however, explosive proliferation of variations in several car-lines had come to urge the company to invent a new method that would enable to achieve a further progress in production flexibility combined with quicker delivery of completed vehicles to customers. Thus, in 1974, the company introduced the Method 3.

Though published materials avail little on this point, from interviews we can infer that Toyota must be the first firm regarding both the introduction of the Method 2 and that of the Method 3. Nissan introduced their version of Method 2 in 1971 and that of Method 3 in 1983. Other automobile manufacturers seem to have followed with longer lags.[5)]

Ever since they introduced the Method 3, both Toyota and Nissan have continually strived to further improve the operation of their respective networks, which have resulted in gradual decrease of the values of the components of their (L_M, L_T, L_D). Thus, as of 1989, one of the two companies achieved such a short lead time as $L_D = 3$ days. This means that, if a vehicle has been scheduled to roll off the final assembly line on the day D (in other words, building of this vehicle has been scheduled to begin on the day D – 1), the order to change its secondary specification is acceptable from the dealer by the end of the day D – 4. For the other of the two companies, $L_D = 4$.

It should be noted here that, with such a short notice, the companies cannot admit all of the changes in the specification of the vehicle that the dealer may come to want. First, as already remarked, the companies normally admits only changes in the secondary specification. Second, depending on the lead time required for preparation or procurement of each individual part, different constraints are imposed on changeability of individual parts. For instance, the situation during a particular period might be as follows: while changes are admissible for some particular option item up to 10 percent of the scheduled volume, 8 perrcent is the admissible maximum for another item. Third, these admissible ceiling may vary depending on the environmental changes and life–cycle of the models. When supply of some item is especially tight, the ceiling must be set quite low; when the end of production of a given model of vehicle is coming close, the daily change–order system has to be suspended concerning this model. All of these constraints are set in the computerized system of order files held by the automobile manufacturers; as a dealer accesses this file and tries to put in a change–order, the dealer instantaneously can know on the display of the terminal whether this order has been accepted, or rejected due to such constraints.

But, with all of these constraints, admissibility of changes with such a short notice gives the production system a remarkable degree of flexibility, and, at the same time, reduces the risk assumed by the dealers to a considerable degree. As of 1989, managers of these two companies said to me that 35 percent of the cars it sold in the domestic market was being produced on daily change–orders.[6)] According to the remark made in the last part of 3.1, this means that, on the average, 35 percent of the orders placed by each dealer at the cycle of making the ten–day schedule actually gets the backing of orders from final consumers by the deadline for daily change–orders. The consumer who placed such an order at the dealer's store can receive the car within 12 days including the time for building and delivery of that car. The other side of the same coin is that the dealer can concentrate his or her effort to sell cars during the coming period on the remaining 65 percent, which has been ordered to the core firm at his or her own risk.

The foregoing observation will certainly evoke the following question. What kind of state is prospected to emerge as development along such a line proceeds ? Is it very likely in near future that 100 percent of the vehicles produced by a manufacturer comes to be built based on an order entered by a consumer at some electronic terminal, diminishing thereby the risk borne by dealers to a null level ? Before tackling this question, however, let us have a glance at how automobile manufacturers in other countries have been responding to the same challenge met by these Japanese core firms.

3.4 *Some Observations in the UK and US*

In October in 1989, I visited in the United Kingdom a production subsidiary of a Japanese company, and an European corporation of a US-based global enterprise. While the former was operating on a very small scale, the latter was operating on a large scale comparable to the two Japanese core firms we have seen above. The former was operating according to the Method 1. The latter was using the Method 2. In addition, this company was trying actively to introduce the Method 3 citing Toyota as the competitor running ahead of them in this regard, but had not yet been able to overtake it then.

In January 1991, I visited in the United States sales and production subsidiaries of three Japanese automobile manufacturers, and a US automobile manufacturer the European subsidiary of which I visited in 1989. The Japan-based firms were using the Method 1 in their interface with vehicle plants in Japan, and the Method 1 with allowance of some flexibility at the weekly planning level in their interface with vehicle plants in North America. The US-based firm was basically relying on the Method 2, though seemed to have begun using the daily change-order system on a small experimental scale.

The coverage of these interview studies was admittedly limited, but the following picture emerges from them as a result. In achieving production flexibility in the automobile industry, one or two of the Japanese core firms may be constituting the top group in the race, regarding their domestic operations. But, in their overseas operations, these Japanese firms have not been exerting particularly high degrees of flexibility.

This observation leads to the following question. What are the factors that have enabled these Japanese automobile manufacturers to achieve a rather high degree of flexibility in their domestic operations ? Are these factors transferable to their overseas operation ? What are the factors that have made them less flexible in their operations for the overseas markets ? The question raised at the end of 3.3 will be answered in Section 4 and the answer to the question raised here will be sought throughout the whole discussion to follow.

4. Coordination between Distribution and Production of Vehicles

In Subsection 3.1, I introduced the concepts of three different methods for making monthly production plan, using Figure 1 and Figure 2 for explanation. The discussion there started on the assumption that either the full monthly production plan (in the case of the Method 1) or the plan on the number of the units to be built for each of the car–lines (in the cases of the Method 2 and Method 3) has been determined *by some mechanism* with the lead time L_M prior to the production month M. For brevity, let us call the plan determined at this time point as the *Plan 1* hereafter.

In this section, I examine two mechanisms that I treated as a black box in the last section. One is the mechanism just referred to in the last paragraph, the mechanism through which the Plan 1 is formed and determined, starting from informational inputs by individual dealers. This mechanism is the subject of Subsection 4.1. The other is the mechanism through which the planned units of vehicles in this Plan 1 is allocated to individual dealers. This will be discussed in Subsection 4.3. Subsection 4.2 gives an intermediate link, discussing the role of dealers expected by the core firm. Throughout this section I mainly outline the procedure followed by one of the two representative Japanese automobile manufacturers, which I name as J_A hereafter. But, whenever it is felt necessary, I compare the practice with that of other automobile manufacturers.

4.1 *The Process through Which the Plan 1 Is Made*

The Plan 1 is a plan for the entire corporation in which matching is achieved between the monthly demand from all over the world for the vehicles with J_A's brands and the production capacities in Japan and other countries available for producing these kinds of vehicles. The plan is determined as an outcome of a complex process of information processing and bargaining.

Let us start from the domestic market side. The organizational unit inside J_A responsible for planning and coordination of domestic sales and marketing activities is the Domestic Sales Planning Division (DSP, hereafter). Five Vehicle Distribution Divisions, each of which handles one channel, are engaged in distribution and keep direct contact with dealers through their District Staff. Each of the dealers monthly submits a document named the "monthly order of vehicles" to J_A , in which the number of units that he or she wants to lay in to sell during a coming month is listed for all of the car-lines for which he or she has franchised dealership. But, these numbers are not automatically transmitted to the production side. DSP and Vehicle Distribution Divisions have the company's own forecasting of sales by car-line for the national and regional markets, assessment of each dealer's attitude and capabilities, and forecasting on the availability of production capacities within the network for the time period concerned. Based on these sets of information, and based on the opinion of the Field Staff, J_A modifies the numbers submitted by each dealer. In this sense, "monthly order" may not be a proper word; in reality, it is a request, which is a necessary informational input to initiate the process, but is not expected to be met exactly. Based on the modified figures, DSP compiles the list of demand for the vehicles to be sold in the domestic market, which this organizational unit tries to secure on behalf of the dealers it represents in the corporation.

The organizational unit inside J_A responsible for the planning and coordination of overseas sales and marketing activities is the Overseas Sales Planning Division (OSP, hereafter). In each of the national or regional markets where vehicles with J_A brands are sold, a subsidiary, a branch office, or an agent of J_A takes a role analogous to that of DSP in the domestic market. It submits to OSP the list of demand compiled in the same way as DSP does in Japan. Collecting these, OSP makes its list of demand.

The Plan 1 is determined at a monthly meeting held at the corporate headquarters named the *Vehicle Production Meeting*. One interesting thing to note is that there is no single executive in the corporation who represents total sales and marketing activities of J_A and can coordinate DSP and OSP from a higher hierarchical position before the demand for the vehicles to the production side is presented. DSP and OSP present their respective lists. This means that they are in a position to compete with each other at the corporate level, especially when demands tend to exceed the production capacities, in their endeavor to secure the number of vehicles they want. It is the responsibility of the Corporate Production Control Division (CPC, hereafter) to draft the original Plan 1 to be submitted to the Vehicle Production Meeting. Not only the demands from DSP and OSP have to be coordinated comparing them with production capacities, coordination between different car-lines also has to be made, since often the same type of engine is used for different car-lines and they compete for the capacity of the same engine plant. CPC strives in drafting the plan to solve these conflicts, playing the role of coordinator on the same horizontal level as the divisions and plants to be coordinated. Still, the Vehicle Production Meeting is bound to become a long and heated meeting to reach a bargaining equilibrium for the entire corporation. In any event, however, the corporation has to determine the Plan 1 as the solution by the end of the scheduled target date.

4.2 *A Role of Dealers Expected by the Core Firm*

It should be now clear why the initial informational inputs from the dealers cannot be accepted automatically as "orders." An adjustment to reach an equilibrium has to be made monthly between the total of the demand that distribution side of the network transmits to the planning center and the total of the production capacities that the production side informs the same center as available. For this purpose, some rationing mechanism has to be used. When the demand tends to exceed the production capacities, the requests submitted by dealers have to be curtailed. On the other hand, when the demand becomes under, organizational units such as DSP and OSP have to strive for making their dealers to take more units than they must have wanted were it not for such efforts. Since production capacities cannot be very quickly increased or decreased, the distribution side are expected to absorb the burden for this adjustment to a nonnegligible degree. This observation applies commonly to all of the core firms I visited, including the American corporation and European subsidiary of the US–based global firm.

The same logic applies as to the percentage ratio that vehicles built on firm orders from consumers can occupy in the total vehicles produced. The Japanese automobile manufacturers I visited were not expecting emergence of such a system in which that percentage ratio reaches 100. According to them, the current figure of 35 percent reached by the two core firms seems to be a reasonable ceiling; the proper way of selling cars is that dealers lay in substantial portion based on their expectation and active plans for sales, not just playing the role of passive electronic terminal. Underlying this view seems to be a fear that, under such a system, fluctuation of production would become so sharp that the production side cannot endure.

In sum, core firms commonly desire that their dealers bear some burden in the form of the effort to smooth out the demand, to make the adjustment of the network's production capacities to the demand side easier.

4.3 *How the Planned Units Are Allocated to Dealers*

Still, the total volume of the vehicles contained in the Plan 1 has to fluctuate reflecting the general condition of the market. How are the planned units in this list broken down to be distributed to various regional markets and finally allocated to individual dealers that constitute the retail end of the network ? The vehicles are allocated to dealers according to the "weight" given by the core firm to each dealer. The exact method or formula to calculate this weight can differ between core firms, but the most critical factor is common regardless of the country-origin of the core firm. That is the share of that dealer in the total sales of the core firm. Thus, roughly speaking, if a dealer's share has been 1 percent over a certain number of consecutive months up to the most recent month, the dealer gets allocated 1 percent of whatever volume the core firm plans to produce in the coming month.[7)] The dealer cannot get suddenly a big volume by suddenly sending a proposal to lay in a big volume. In this way, each dealer's continual performance and assessment of this performane by the core firm plays a central role in the manufacturer-dealer relationship; the relationship is something different from the relations that emerge across the spot market.[8)]

5. Coordination between Vehicle Production and Parts Supply

In this section, I turn to the upstream side of the network. In Subsection 5.1 I examine how the core firm has its in-house parts manufacturing plants and outside suppliers start manufacturing of necessary parts upon completion of the Plan 1, and how it secures timely delivery. In Subsection 5.2 I spotlight the means developed by a Japanese core firm that seem to be especially contributing in achieving a flexible production system.

5.1 *How the Core Firm Secures Coordinated Supply of Proper Parts*

For any automobile manufacturer, it is necessary to send out monthly orders to parts suppliers and in-house parts plants with sufficient lead time, to let them prepare for production and shipment. But, unless the core firm is operating the production system according to the Method 1, the specification of each vehicle in the Plan 1 has yet to be determined, except the name of the car-line, even at the moment when the Plan 1 has been determined. How do the core firms determine the content of their orders to the upstream units ?

Let us name the US–based global firm referred to before as A_Y. It is a common practice shared by A_Y and J_A to base the content of their monthly order on forecasting. Based on trend data available from the sales record of the company, say, over the most recent three months, you can estimate the probability distribution of different final specifications for each car–line. Once you have the targeted number of units for each car–line as your sales plan for a coming month, then you can forecast the number of units to be produced for each different final specification applying this distribution, and calculate the necessary volume to be procured for each different part accordingly. The monthly order is issued based on this calculation. Therefore, there always is a possibility that discrepancy will arise between the volume of each part requested at this stage and the volume which the core firm really comes to demand as it receives the detailed order from the downstream side at later stages. How to cope with this discrepancy is a major problem faced by all core firms.

Let us look at the practice taken by J_A in its domestic operation. Upon completion of the forecasing which ensues the finalizing of the Plan 1, CPC of the company calenderize the production plan of the vehicles with forecasted final specifications. Based on this, the company issues the monthly order to each upstream unit in a calenderized form. At the same time, CPC sets a guideline for each of the three ten–day production plan to accomodate possible changes in trend from what was assumed at the timepoint of aforementioned forecasting. Usually, body types are fixed as has been forecasted; for other items in basic specification, such as transmissions and grades of luxury, changes are allowed up to 10 percent increase or decrease.

Comparing this guideline with the ten–day orders sent from the dealers, DSP writes up the request of vehicles for the given ten–day period and send it to CPC. Based on this request, CPC makes the ten–day production plan and sends back calenderized production schedule of each vehicle to the dealer via DSP.

But, to most of the organizational units in the upstream side, the ten–day production plan has no repercussions. They begin necessary preparations with the receipt of the monthly order, and actual production and delivery is triggered by the receipt or *kanban* or other means of signal transmission, which in turn is issued by the core firm only after the deadline for the daily change–order has passed.

Thus, the *kanban* and other means of signal transmission used in this stage bear the meaning of fine–tunings of the monthly order. Not only the detailed timing of delivery is determined by these signals, changes in the volume per detailed kind of a part may occur at this point. For instance, while 30 pieces of the standard version of that part and 20 pieces of the deluxe version of that part were listed in the monthly order as the requirement for that date, actual movement of the *kanban* may dictate that 28 standard parts and 22 deluxe parts be delivered that day.

This kind of fine–tunings in kind of parts with a very short notice was, among others, felt particularly difficult to implement by managers of the European corporation of A_Y. What are the factors that have enabled it in the domestic operation of J_A ?

5.2 *Production Smoothing*

The name of the *Just–In–Time* Method or the *Kanban* System has become well–known. But a prerequisite for smooth functioning of this kind of system has not been very well–known. The prerequisite is a buffering function exercised by CPC when it transmits the signals from the downstream side to the units responsible for production.

Choices by final consumers are extremely diversified and orders are entered at the dealers' terminal in various locations in a irregular manner. But, to keep stable operation of the production side, the sequence of the incoming signals has to be transformed into a sequence that follows a regular pattern.

The CPC of J_A has contrived one way of such transformation which seems to be especially contributing in the company's effort to achieve a flexible production system. This way is called as *Production Smoothing.* It consists of *Smoothing in Volume* and *Smoothing in Kind*. The former means equalization of the volume to be processed per day during a given period. The purpose is to avoid day–to–day fluctuation of the work–load of a worker, a line, a shop, or an entire plant. If the company is producing a single standardized good, production smoothing would end here.

But, how is smoothing in kind achieved when there are a number of variations ? Suppose that a plant is to assemble 10,000 units of a car–line, say, C, during a coming month. Suppose furthur that, within this car–line, there are three variations, say, C_P, C_Q, and C_R, and the plant is to assemble 5,000 units of C_P, 2,500 units of C_Q, and 2,500 units of C_R. If we assume that there are 20 working days in this month, the philosophy of production smoothing dictates that 250 units of C_P, 125 units of C_R, and 125 units of C_R be assembled on every working day of this month. Further, it dictates that the sequence on the assembly be composed as in the following pattern: (C_P, C_Q, C_P, C_R). This is the atom, or smallest possible collection that cannot be further divided. By repeating this pattern, most stable operation under the condition of diversity of products can be secured.

The basic reason is as follows. Suppose that a part or material is necessary only for C_P, while a second part or material is used only for C_Q, and a third is only for C_R. Then, if assembly is done in such a way that C_P is assembled continuously in the former half of the month and then C_Q (C_R) is assembled continuously in the third (fourth) quarter of the month, the production line for the material for C_P has to have capacities that can meet the demand in the first half of the demand; further, it has to be operated at its peak load during the first half of the month, and then, suddenly, it has to be kept idle during the latter half of the month. The same logic applies to other two production lines for materials. But, if the production smoothing at the vehicle assembly plant is made in the way as described above, production capacities required at each of the three upstream lines can become much smaller, and can be operated much more constantly.[9)]

The CPC of J_A has assiduously striven to apply this philosophy not only to the vehicle assembly plants but also to the upstream plants including those of suppliers. For such purpose, this division has a department the duty of which is to provide assistance in prognosis and improvement of the production processes of the company and its suppliers. Further, the CPC has applied the philosophy at the level of final specification of each car–line, where tens of thousands of variations frequently appears as we have seen, searching for suitable methods for the purpose.

It can be seen that, if all of the production units in a network have accustomed to produce things in small lots without incurring much change–over costs, it facilitates the core firm in responding to the daily–change orders with a relatively short lead time. The abilities accumulated in the organization of suppliers in this respect constitutes a components of the *relation–specific skill* that Asanuma (1989) has introduced as a concept that concerns suppliers. It should be emphasized here that a corresponding skill is required on the part of the core firm to help the suppliers develop their relation–specific skill and to operate the production system efficiently. The philosophy and technique of production smoothing and the organizational practices to help implementation thereof throughout the network constitute an important component of this skill. Coupling of these skills developed in both sides of the transaction seem to have been a decisive factor that enabled relatively high flexibility achieved in their domestic operation.

6. Export and Offshore Production

The basic reason why Japanese automobile manufacturers are using the Method 1 in their operations in the United States and United Kingdom is that their operations in these countries started from importing business. The vehicles imported from Japan have to be shipped by sea discontinuously in a very large lot, which makes the notion of flexible production largely inapplicable. Though production in these countries started recently, it is still in an early phase as of today. Therefore, marketing activities are handled by the sales compamies which have been engaged in import business for a long time. Viewed from these sales companies and their dealers, the plants in these countries are just one of the sources of the vehicles. As far as the Method 1 has worked well in the import business, there is no reason to rush the plants to implement the Method 2 or 3.

Further, at the presented stage, a substantial portion of the parts used in these plants are sent from Japan. To secure a necessary lead time for manufacturing and shipment of these parts, these plants have to receive the monthly order for their vehicles with approximately 2 to 3 month lead time prior to their production. This order is a derivative of the Plan 1 determined in Japan. Since the lead time from the Plan 1 to vehicle production in Japan is smaller than one month, the vehicles to export can be built with much less lead time. In other words, if we focus on this lead time, offshore production at the current moment can be expressed as even less flexible than production to export.

But, emergence of a production system in one geographical area has its own dynamism. It can gradually come to have a system within it to accomodate later amendment of orders receiving signals sent directly from the sales company or even dealers in the same geographical area. The plants in the United States have already made some steps in that direction. In this sense, the planning system used there is no more the Method 1 in its genuine sense; though the monthly order is received with the detailed specification for each vehicle in the list, part of the specification can be changed at the weekly plan stage.

Theoretically speaking, such accomodation of later changes in orders can be made in two different methods. One is through piling up inventory of the parts at the vehicle plant. The other is through gradual increase of sources of parts in the same geographical area and developing skills necessary for close coordination. The philosophy formed in Japan over a long time is expected to exert its influence in such a way that the latter method weighs more with the management of these overseas production subsidiaries, even if it means a more roundabout and slower course.

7. Concluding Remarks

In this paper, limiting the object of analysis to the automobile industry, I tried to analyze the network of firms that a typical core manufacturer in today's economy creates for the production and distribution of its products by developing relations with other firms. I focused on how a fundamental tendency noticeable in contemporary manufacturing affects the interfirm relations spanned by the core firm. The tendency is a transition from mass production of a single standardized good to flexible production of diversified goods.

I first illuminated the nature of the challenge faced by major automobile manufacturers in today's economy. This led us to a natural measure of flexibility which focuses on the method of making the monthly production plan. This measure suggests that one or two Japanese automobile manufacturers have achieved relatively high degree of flexibility in the operation of their domestic network. Noting this, I proceeded to examine interactions in the network.

In the first part of this examination, I investigated how the fundamental frame plan for the monthly production plan is made using informational inputs from dealers as one of the important materials. This investigation led us to a conclusion that the core firm expects their dealers to play a more active role to facilitate adjustment of the network to the demand for the final product; though achieving evolution in flexibility serves to diminish the dealer's risk of making misjudgment of demand regarding the specification of the goods demanded, dealers are still expected to share some burden of volume adjustment in proportion to their share.

In the second part of the examination, I turned to the upstream side to find the factors that enabled the Japanese core firms to achieve relatively high flexibility in their domestic operations. I spotlighted here a kind of skill required of and developed by the core firm. That is the philosophy and techniques of production smoothing, which represents a buffering function exercised by the core firm in transmitting the signal from the market to the upstream side of the networrk.

Finally, I gave a glance to the overseas operations of the Japanese manufacturers. Though logistics problems have hindered application of the same method cultivated in their domestic operations, it can be expected that production outside Japan will gradually come to have more flexibility than export, as supply bases in respective areas gradually grow.

Two notes are in order before concluding the paper. First, the notion of flexibility contains another aspect removed from the object of this paper. That is relatively speedy development of a new model or product. To facilitate understanding interactions between dealers, the core firm, and suppliers, I limited the analysis in this paper to ongoing production and distribution of already developed products. Second, this paper focused on practices of some large firms which seem to most conspicuously represent the tendency toward increasing product diversity and the challenge cast thereby to achieve flexibility. It should be noted that core firms of smaller scale usually offer far less number of variations, and yet some of them have been able to enjoy strong attachment by customers, due to high reputation of their cars. Product diversity and speedy responses to consumers seem to be just one factor among many that constitute attractiveness of a firm and its products.

Product diversification and speeding-up of the firms' responses will not proceed monotonically. Firms face bounds and constraints. Not only social critiques but also the manufacturers themselves have at intervals put the question whether some part of the variations of products or quick responses might not be dispensed with. For instance, the company in our sample, J_A , started recently to review the existent variations to curtail unnecessary portion. Similarly, the cycle for development of Japanese cars will probably be somewhat prolonged in near future to remove excessive strain in the organization and to give more time for fruitful ideas to ripen. Yet, with all of these caveats in mind, we can still foresee that the course of industrial development henceforth will not revert to mass production of a single standardized good. As far as flexible production of diversified products is necessitated to some degree, this paper serves to illuminate some aspects of contemporary business organization that seem to bear importance for economists and policy makers.

Footnotes

** This article is based on a research project supported by a grant from the Telecommunications Advancement Foundation for the academic years of April 1989–1990 and April 1990–March 1991. The field research conducted from October to November 1989 in the United Kingdom was partly financed by the British Council in Japan and benefited from the assistance provided by faculty members of the UMIST, especially by Dr. Nigel J. Holden. I also used in this paper part of the materials on dealer relations collected through a research project that I am currently engaged in under a grant from the Kikawada Foundation.

1. See, for instance, Womack, Jones, and Roos (1990). Chapters 4 and 5 of Abegglen and Stalk (1985) also has referred to this point.

2. This information has been taken from the "1991 Car Prices Buyer's Guide" of *Consumer Review*.

3. This information has been taken from *Jidosha Sangyo no Gaikyo 1990*, April 1990, The Public Relations Division, Toyota Motor Company.

4. For instance, the European corporation of a US–based firm that I visited in October 1989 was offering five car–lines as passenger cars, two of which used a common platform. Let us represent these car–lines by code names as: A, B/C, D, and E. The number of orderable variations for these car–lines as of May 1989 was as follows, *excluding* variations in color and trim. A: 1,596. B/C: 11,000. D: 22,000. E: 14,310.

5. Some information on the order processing method adopted by Toyota is available from Ohno and Monden (1983), Monden (1983), and Monden (1991). Monden (1989) and Monden (1991) includes information on Nissan's order processing method. Okamoto (1985a) provides information on development of the computerized order–entry system in the Japanese steel and automobile industries. Okamoto (1985b) reports the results of his field research on the order–entry system, in which comparisons are made between a number of Japanese automobile manufacturers. Asanuma (1986) reports the results of his field research on the cause and effects of computerized telecommunication network in the Japanese automobile industry. All of these reports focus on the Stage 3 in my terminology. They tend to lack the examination of the coordination between the core firm and its dealers, which is discussed in Subsection 4.1 of this article.

6. This figure coincides with the number reported by Aoki (1990) in p.5 based on his research on one of the firms.

7. Obviously, both adjustment of the initial monthly requests submitted by dealers and later allocation of planned number of vehicles cannot be made in a bureaucratic or hierarchical fashion by command. Consent and cooperation from dealers have to be educed through face–to–face communication. Securing these, as well as developing longer–term interface, belongs to the job of the Field Staff, who spend each month about a half of the month in visiting dealers. There is no difference between Japan–based firms and US–based manufacturers in this respect.

8. Williamson (1981) has given an explanation of forward integration based on asset specificity, represented by the quality and repuation of the product. Here I am indicating existence of some factor accumulated on the part of dealers and favor continuity of the relationship, under the condition of separate ownership.

9. To understand the basic logic of production smoothing, Ohno (1978) is very illuminating. Monden (1983) also provides a useful explanation.

References

Abegglen, J.C. and Stalk, G., Jr.(1985). "Kaisha: The Japanese Corporation," Basic Books,Inc., New York.

Aoki, M.(1988). "Information, Incentives, and Bargaining in the Japanese Economy," Cambridge University Press, Cambridge.

Aoki, M.(1990). Toward an economic model of the Japanese firm, *Journal of Economic Literature* **28**, 1–27.

Asanuma, B.(1984a). Nihon ni okeru buhin torihiki no kozo: Jidosha sangyo no jirei, *Keizai Ronso* **131**, 137–158. [English translation: The contractual practice for parts supply in the Japanese automotive industry, *Japanese Economic Studies*, Summer 1985, 54–78.]

Asanuma, B.(1984b). Jidosha sangyo ni okeru buhin torihiki no kozo: Chosei to kakusinteki tekio no mechanism, *Kikan Gendai Keizai* No.58, 38–48. [English translation: The organization of parts purchases in the Japanese automotive industry, *Japanese Economic Studies*, Summer 1985, 32–53.]

Asanuma, B.(1986). Joho Network to Kigyokan Kankei [Information Network and Interfirm Relationship], *Keizai Ronso* **137**,1–21.

Asanuma, B.(1988). Japanese manufacturer–supplier relationships in international perspective: The automobile case, Working Paper, No.8, Faculty of Economics, Kyoto University. forthcoming *in* "International Adjustment and the Japanese Firm" (P. Sheard, Ed.), Allen and Unwin, London.

Asanuma, B.(1989). Manufacturer–supplier relationships in Japan and the concept of relation–specific slill, *J.Japanese Int.Economies* **3**, 1–30.

Asanuma, B. and Kikutani, T.(1991). Risk absorption in Japanese subcontracting: A micro–econmetric studies on the automobile industry. (revised). forthcoming *in J.Japanese Int. Economies*.

Chandler, A.,Jr.(1962). "Strategy and Structure," The MIT Press, Cambridge, Massachusetts.

Clark, K.B. and Fujimoto, T.(1991). "Product Development Performance: Strategy, Organization and Management in the World Auto Industry," Harvard Business School Press, Boston.

Fukuoka, Y. and Iwatsuki, N.(1989). Toyota no network system kochiku ni yoru kigyo joho senryaku no tenkai [Development of corporate strategy by Toyota through construction of a computerized telecommunicaton network system] *in* "Senryaku Joho System Kochiku no Nerai to Katsuyo [The Aim and Applications of Strategic Information Systems]," Nippon Office Automation Kyokai [Japan Institute of Office Automation], Tokyo.

Jidosha Kogaku Zensho Henshu Iinkai (ed.)(1980). "Jidosha no Hanbai Ryutsu System [The Sales and Distribution System of Automobiles]," Sankaido, Tokyo.

Kawasaki, S. and McMillan, J.(1987). The design of contracts: Evidence from Japanese subcontracting, *J.Japanese Int. Economies* **1**,327–349.

Milgrom, P. and Roberts, J.(1990). The economics of modern manufacturing: Technology, strategy, and organization, *Amer.Econ.Rev.* **80**, 511–528.

Monden, Y.(1983). "Toyota Production System," Industrial Engineering and Management Press, Institute of Industrial Engineers, Atlanta.

Monden, Y.(1989). "Jitsurei: Jidosha Sangyo no Just–In–Time Seisan Hoshiki [Cases of the JIT Method in the Automobile Industry]," Nippon Noritsu Kyokai, Tokyo.

Monden, Y.(1991). "Shin Toyota System [New Toyota System]," Kodansha, Tokyo.

Ohno, T. and Monden, Y. (eds.)(1983). "Toyota Seisan Hoshiki no Shin Tenkai [New Development of the Toyota Production Method]," Nippon Noritsu Kyokai, Tokyo.

Ohno, T.(1978). "Toyota Seisan Hoshiki: Datsu Kibo no Keiei wo Mezashite [The Toyota Production Method: How Can We Overcome The Management Philosophy of Scale Economies]," Diamond Sha, Tokyo.

Okamoto, H.(1985a). Gendai no seisan hanbai togo system: Tekkogyo to jidosha sangyo no case [The contemporary system to integrate production and distribution: cases of the steel and automobile industries] *in* "Gijutsu Kakushin to Kigyo Kozo [Innovation and the Structue of the Firm]" (K. Sakamoto, Ed.), pp.114–148.

Okamoto, H.(1985b). Seisan to hanbai no interface [The productiono–distribution interface](1)(2), *Doshisha Shogaku* **37**, xx–xx.

Williamson, O.E.(1979). Transaction–cost ecnomics: The governance of contractual relations, *J.Law Econ.* **22**, 233–261.

Williamson, O.E.(1981). The modern corporation: Origins, evolution, attributes, *Journal of Economic Literature* **19**, 1537–1568.

Williamson, O.E.(1985). "The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting," The Free Press, New York.

Womack, J.P., Jones, D.T., and Roos, D.(1990). "The Machine That Changed The World," Rawson Associates, New York.

TABLE 1 Increase in the Number of Orderable Variations of Toyota Crown

Name of Item	The number of different kinds available as of April 1966	The number of different kinds available as of April 1978
Body type	2	4
Engine	2	4
Carburetor	2	2
Fuel to use	2	3
Transmission	3	7
Grade of luxury	4	8
Seat shape	2	5
Option	1	20
Color	14	13
Final specification of the vehicle	322	101,088

Note: The number of orderable different final specifications of the vehicle is not equal to the number of all possible combinations of selectable items calculated by simple multiplication. This is because some combinations are not offered by the company as orderable.

Source: Jidosha Kogaku Zensho Henshu Iinkai (1980), p.186.

TABLE 2 The Numbers of Different Final Specifications and of Units of Vehicles by Car–Line Produced by Toyota in a Three–Month Period

Code name of Car–line	The number of different final specifications of the vehicles produced	The number of units of the vehicles produced	The number of units per final specification of the vehicle
A	3,700	63,000	17
B	16,400	204,000	12
C	4,500	53,000	12
D	7,700	44,000	6
Total of the Sample	32,100	364,000	11

Source: Ohno and Monden (1983), p. 15.

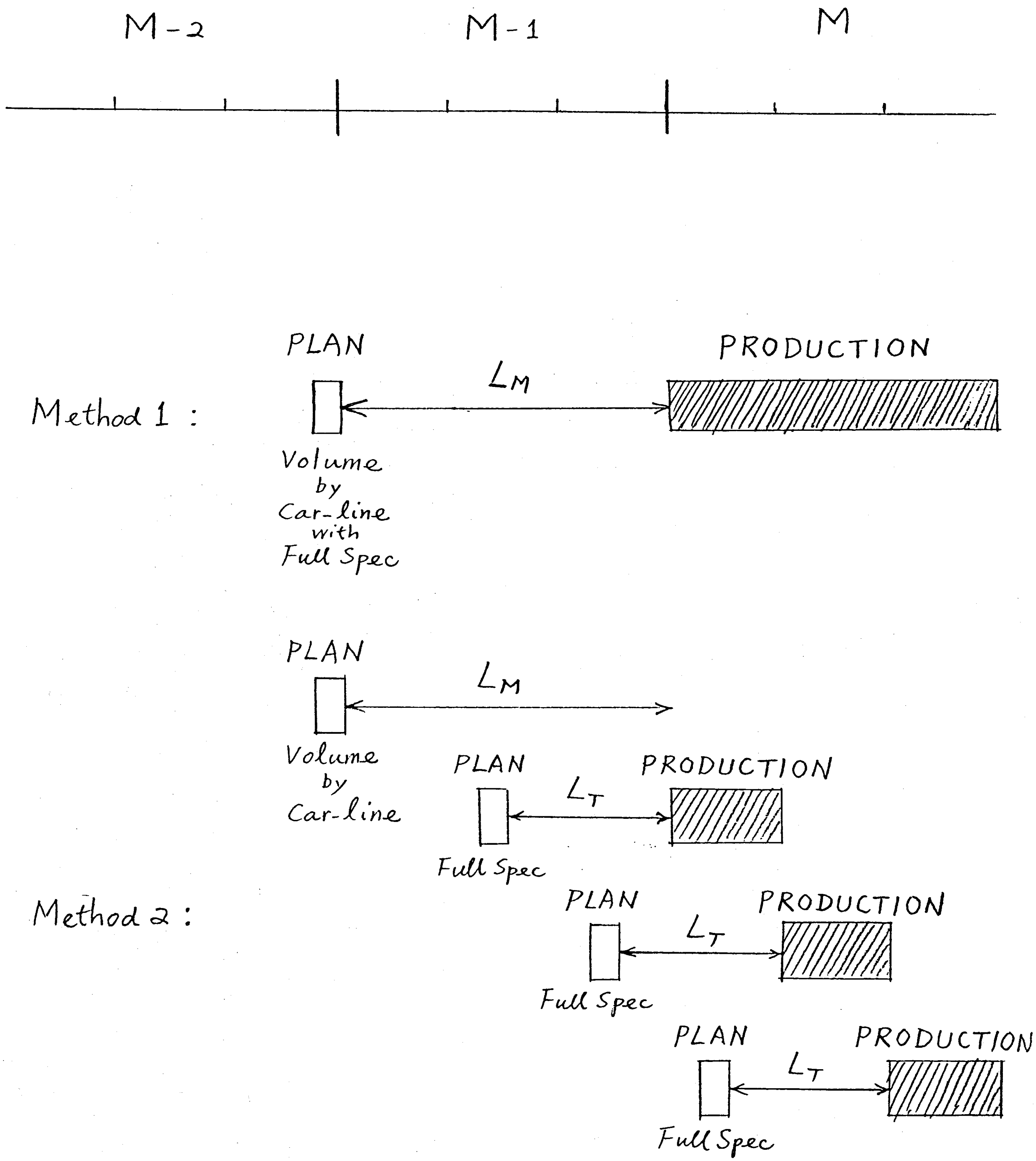

Figure 1 Two Methods for Monthly Production Planning

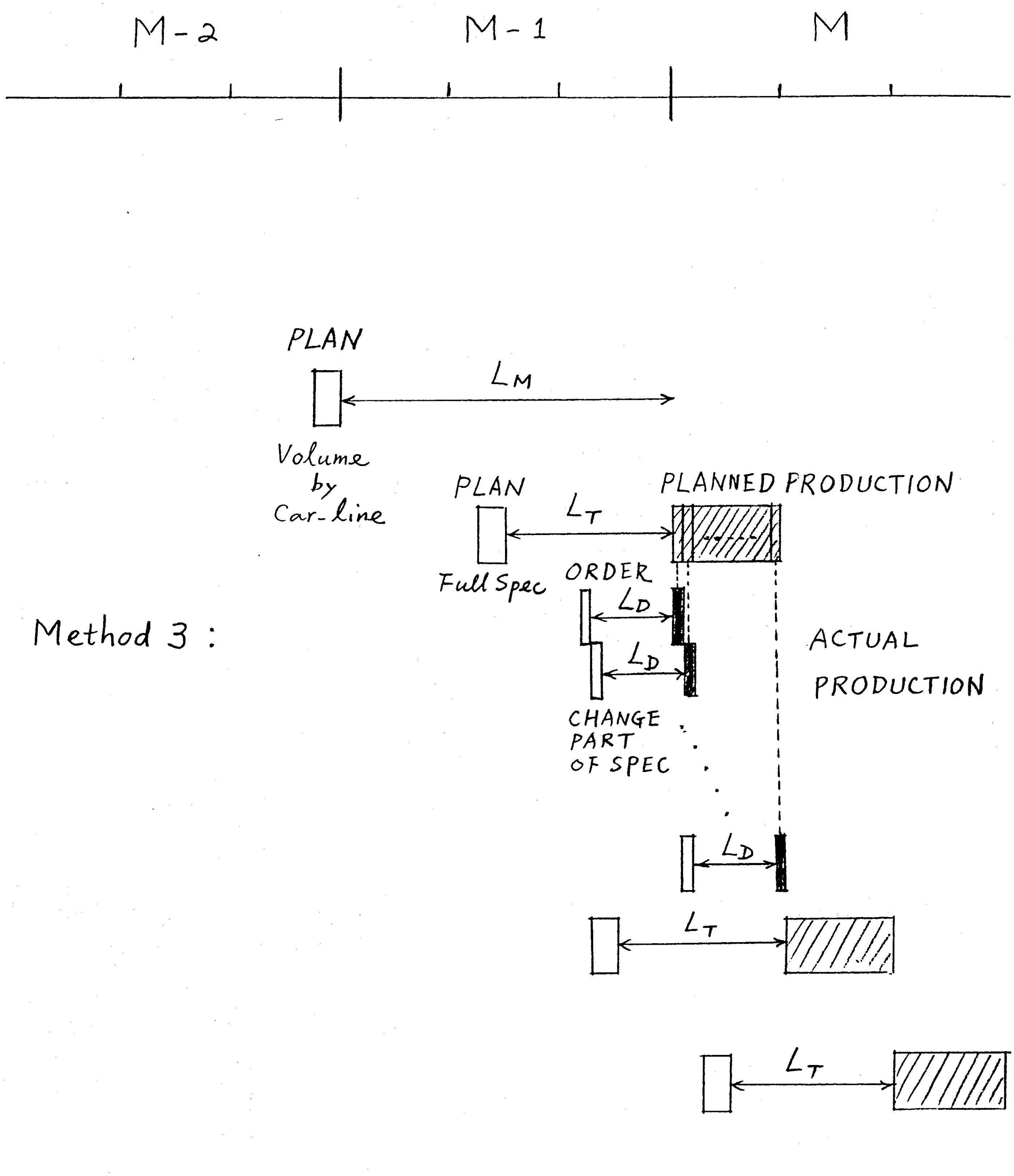

Figure 2 Method 3 of Monthly Production Planning