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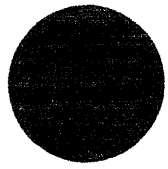

SUPPLIER RELATIONS AND MANAGEMENT: A SURVEY OF JAPANESE, JAPANESE-TRANSPLANT, AND U.S. AUTO PLANTS

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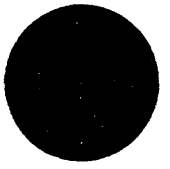

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ABSTRACT

This article presents the results of a questionnaire survey sent to a sample of automobile manufacturers in the United States and Japan (including Japanese-managed plants in the United States) during the spring of 1990. The data support observations that Japanese and U.S. practices tend to differ in key areas and Japanese suppliers perform better in dimensions such as quality (defects) and prices (meeting targets, reducing prices over time); and that Japanese-managed auto plants established in the United States have, in general, adopted Japanese practices and receive extremely high levels of quality from Japanese as well as U.S. suppliers. These findings provide evidence that Japanese practices and performance levels are transferable outside Japan and suggest that considerable improvements are possible for U.S. suppliers supplying U.S. auto plants. In addition, the survey indicates that U.S. firms have adopted at least some practices traditionally associated with Japanese firms, apparently reflecting some convergence toward Japanese practices and higher performance levels in supplier management.

1. Introduction

Supplier relations and management are crucial areas for any firm that subcontracts portions of components design and production because of the dependence this creates on the skills of outside organizations. An automobile, for example, contains approximately 15,000 components, only a few of which companies choose to produce in-house. As a result, to obtain the best quality parts at a given price, managers must decide whether to promote long-term relationships and mutual cooperation with suppliers, extending from product development to manufacturing, rely on shorter-term contracts and competitive bidding, or pursue more in-house development and manufacturing (Abernathy 1979; Monteverde and Teece 1982). It follows that effective supplier relations are equally important and potentially more difficult for firms that attempt to locate abroad in order to increase access to foreign markets, take advantage of different cost factors, or exploit other elements of flexibility stemming from multi-domestic or integrated global operations (Kogut 1985, Bartlett and Ghoshal 1987, Ghoshal 1987, Porter 1987).

This article presents the results of a questionnaire survey sent to a sample of Japanese as well as U.S. automobile manufacturers (including Japanese-managed plants in the United States known as the "transplants") during the spring of 1990, covering models introduced primarily during 1987-1988. The study pursued three general questions: (1) Did reported differences in supplier relations and management, as well as performance, appear in a comparison of Japanese auto plants with U.S. auto plants for an identical set of components and, if so, why? (2) For the same set of components, did significant differences appear between the Japanese and the transplants in the United States, or between the transplants and U.S. firms, and, if so, why? And (3) what do the analyses indicate regarding effective supplier management in

general and as part of a globalization process for production, procurement, and design operations?

In brief, the research supports observations that Japanese and U.S. practices, while increasingly similar in several respects, still differ in key areas, with Japanese suppliers performing better in quality (defects) and prices (meeting targets and reducing prices over time). On the other hand, Japanese firms have managed to persuade or help Japanese and American suppliers in the United States to meet Japanese standards or practices for quality and pricing. These findings suggest that Japanese efforts to transfer their management practices to overseas suppliers are succeeding, although the transplants are relying as much or more on the movement of Japanese suppliers to the United States as on their managerial skills. In addition, the survey provides evidence that U.S. automakers and suppliers have adopted at least some practices traditionally associated with the Japanese, thus indicating a possible convergence toward a "Japanese model" of supplier management, including higher levels of performance. At the same time, however, U.S. firms supplying U.S. auto plants still have room to improve, especially in raising quality and restricting price increases.

2. Reported Differences in Practice and Performance

A review of recent studies comparing Japanese and U.S. approaches to supplier management suggested several differences among the three groups of plants. This section summarizes major observations from the literature.

Number and Type of Suppliers

A common point made by various researchers has been that the degree of

vertical integration, or the percentage of components manufacturing, assembly, and even product development done in house, differed between automakers in the two countries. American automakers, with the exception of Chrysler, appeared to be more vertically integrated than the Japanese, although the Japanese appeared to buy a variety of components, rely on fewer parts suppliers than their U.S. counterparts, and have closer relations[1] with these suppliers (including integration of suppliers with factory production systems through "just-in-time" deliveries, extensive information exchanges, and cooperation in product development). The Japanese also appeared to be organized more in a pyramid structure, with many more affiliated suppliers that each had their own suppliers, creating a high level of "group" integration. In contrast, U.S. automakers seemed to buy more lower-level components and have several independent suppliers for each component, with supplier selection mainly by competitive bidding (Altshuler et al. 1984; Cusumano 1985, 1988; Temple, Barker, and Sloane 1987; Mitsubishi Research Institute 1987; Asanuma 1988b; Helper 1989a, 1989b; Nishiguchi 1989; Lamming 1989).

Length and Stability of Relationships

Numerous studies indicated that the relationships between buyers and suppliers in the Japanese auto industry tended to be longer term and more stable than in the U.S. industry. Not only did many relationships date back to before World War II (Cusumano 1985), but Japanese automakers seemed to continue purchasing new components from the same suppliers after model changes, although without formal guarantees of extending their contracts beyond an initial two or four years. In addition, Japanese automakers appeared to select their suppliers through competitive bids in the product-development stage (at which point the buyers had alternative sources) and then rate suppliers

periodically by the value of their products (for example, quality and price), continuing business contacts with those who scored high (Asanuma 1988a, 1988b; Nishiguchi 1989). In the United States, automakers reportedly set contracts for one year at a time and tried to locate the least expensive suppliers through annual competitive bidding (Asanuma 1988b, Lamming 1989). In a few exceptional cases, large parts manufacturers supplying system components received implicit long-term commitments, but U.S. automakers at times reneged on these implicit contracts (Helper 1989a; also, see White 1971).

Role in Product Development

Researchers have categorized the role of suppliers in product development into three modes: (1) suppliers that develop parts on their own as standard products (supplier-proprietary parts); (2) suppliers that do the detailed engineering for parts based on functional specifications provided by automakers (black-box parts); and (3) suppliers that produce parts developed by automakers according to the buyer's detailed specifications (detail-controlled parts). According to a research project at the Harvard Business School, there was a sharp contrast between Japanese and U.S. practices according to these categories. Black-box parts accounted for 62% of a sample of Japanese components (measured as a percentage of total procurement costs), with approximately 50% of the product engineering carried out by suppliers, whereas U.S. automakers undertook 86% of the engineering, using detail-controlled parts for 81% of their components (Clark 1989; Fujimoto 1989; Clark and Fujimoto 1991).

Another study found that Japanese suppliers became involved in product development earlier than their U.S. counterparts (Asanuma 1988b). Japanese firms also appeared to push suppliers to make a greater commitment to

technological improvement, giving Japanese automakers more effective product development than the U.S. counterparts. Clark (1989) even estimated that supplier involvement accounted for one-third of a significant Japanese advantage in total engineering hours required to develop a new automobile (1.2 million in Japan, compared to about 3.5 million in the United States and Europe), and four to five months of the Japanese advantage in lead time, the number of months required to complete and deliver a new product (43 months in Japan, compared to 58 months in Europe and 62 months in the United States).

Pricing Practices

Pricing practices drew attention as an area that constituted perhaps the most striking operational differences in purchasing behavior between U.S. and Japanese auto producers. Traditionally, American automakers seemed to rely more on direct market forces among suppliers (competitive bidding) and the Japanese more on subtle and indirect forms of competition, utilizing what they have called "target pricing." Japanese automakers reportedly set a target price for each part based upon the sales price for the new car model, and then urged and helped suppliers reach their targets (Cole and Yakushiji 1984; Nishiguchi 1989). Researchers also reported that Japanese automakers negotiated semi-annual reductions in part prices throughout the model life-cycle, based on the notion that suppliers should be able to reduce their costs through experience and continual efforts to improve their product designs, materials, and manufacturing methods. In the United States, though automakers used price bidding to pressure suppliers to lower prices, they also seemed to allow suppliers to pass wage and other cost increases back to the buyers for as long as the contract continued (Asanuma 1988b; Lamming 1989).

Quality Management

A study by the Japan Automobile Manufacturers Association of parts imported from American suppliers and parts made in Japan showed that the defect rates for U.S. imports was 0.35% to 2.6%, compared to 0% to 0.01% for parts from Japanese suppliers in Japan (Mitsubishi Research Institute 1987). Because their level of defects was close to zero, Japanese automakers generally did not inspect incoming parts and thus saved on inspection labor and well as losses from the cost of defects. Various authors have attributed this level of quality to management practices that required suppliers and the automakers themselves to examine, on a continual basis, defects found in designs, materials, and manufacturing methods, customer responses to products, employee training and involvement in problem solving, and other areas of operations (Cole 1979; Cusumano 1985; Sei 1989; Nishiguchi 1989). In contrast, not only were U.S. defect levels higher, but U.S. firms seemed to rely more on the detection of errors after-the-fact rather than prevention of problems, with less systematic efforts to learn from their experiences with defective parts or diffuse quality responsibility among all employees (Temple, Barker, and Sloane 1987; Helper 1989a).

Information Exchanges and Suggestions

Mutual information exchanges and problem solving through suggestions from the Japanese automakers to suppliers appeared to stem from the stability and closeness of relationships, active participation of suppliers in product development, as well as effective cost and quality management practices in general. The Harvard researchers documented information exchanges in various phases of product development, finding that Japanese auto projects overlapped more activities and exchanged information more frequently through formal and

informal mechanisms (Clark, Chew, and Fujimoto 1987; Clark 1989; Fujimoto 1989; Clark and Fujimoto 1991). Helper (1989a) identified different responses to problems arising in buyer-supplier relationships and measured the degree of administrative coordination and commitment, arguing that the practices of higher vertical integration and ending relations with poorly performing suppliers gave American automakers strong bargaining power but did not encourage technological progress. Nishiguchi (1989) also described the Japanese "problem-solving" orientation as opposed to the "bargaining" orientation of American firms, noting that Japanese suppliers pursued continuous cost reductions and quality improvement.

Summary

Table 1 summarizes key differences between supplier management and performance among Japanese and U.S. automakers discussed in recent literature. It should be emphasized, however, that many observers noted the dynamic rather than static nature of the industry, with U.S. producers possibly moving closer to Japanese practices, while Japanese producers established U.S. plants that required them to manage U.S. suppliers. Existing research based on quantitative data and statistical comparisons also had limitations. For example, Cusumano (1985, 1988) measured vertical integration but only provided historical descriptions of supplier-management practices. The Harvard study (Clark, Chew, and Fujimoto 1987; Clark 1989; Fujimoto 1989; Clark and Fujimoto 1991) focused on product development and supplier involvement, rather than exploring the details of supplier-management practices. Mitsubishi Research Institute (1987) provided quantitative data on various dimensions but relied on small samples of interviews and secondary sources, with no statistical analyses, as did Altshuler et al. (1984), Cole and Yakushiji (1984), Temple, Barker, and Sloane (1987),

Asanuma (1988a, 1988b), Lamming (1989), and Sei (1989). Nishiguchi (1989) collected some primary data but mainly on the flexibility of suppliers' manufacturing systems, again with no statistical analysis. Helper (1989b), while analyzing a broad set of quantitative data on supplier relationships, only covered facilities in the United States.

Table 1: Reported Differences in U.S.-Japanese Supplier Management

Dimension	U.S.	Japanese
Number of Suppliers	Many	Fewer
Integration/Supplier Types	Many in-house	Many affiliated
Length of Relationships	Shorter	Longer
Length of Contracts	Shorter	Longer
Length of Part Transactions	1 year	2 or 4 years
Selection Criteria	Price	Quality, price, etc.
Role in Development	Smaller	Larger
Pricing Practices	Competitive bids	Target prices
Price Changes	Upward	Downward
Defect Rates	Higher	Lower
Quality Improvement	Lower	Higher
Information Exchanges	Lower	Higher
Suggestions to Suppliers	Few	Many

Sources: References in Section 2 of this article.

3. Survey Methodology and Sample Characteristics

To collect quantitative data on the areas listed in Table 1 and then compare supplier management practices and performance between Japanese and U.S. plants as well as with Japanese factories in the United States, from January to March 1990 we carried out a questionnaire survey of auto manufacturers in the United States and Japan. In addition, to aid in understanding key issues faced by Japanese firms moving into the United States, this research project included interviews with 49 managers, engineers, and other personnel at four Japanese transplants and 23 Japanese suppliers in the United States (see Section 6 and Appendix 3).[1]

Units of Analysis

Before selecting components to compare, interviews and analysis of other research suggested that we adopt several criteria to ensure comparability of the data. First, we believed the survey should examine a variety of parts, to reduce the possibility of idiosyncratic answers dependent on the type of part. We thus considered black-box parts (detailed designs done by suppliers) and detail-controlled parts (detailed designs done by the automakers), as well as components for the exterior and interior of a vehicle, and parts made of metal, electrical, and plastic materials. Second, we decided to exclude highly complex and critical parts or subassemblies, such as engines and transmissions, that Japanese transplants were mainly importing from Japan. Third, we decided to exclude parts that American automakers usually produced internally.

After these considerations, we chose four kinds of parts: shock absorbers, front seat assemblies, gauge (meter) assemblies, and instrument panels. These

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[1] We also discussed the survey with approximately one dozen managers at U.S. automakers to convince them to cooperate in the questionnaire or to clarify specific questions.

represented components of moderate technical complexity in that they were not so complicated that automakers were unlikely to subcontract design or manufacturing, while, at the same time, they were not so simple that automakers could completely ignore the details of the designs. The number of parts in an automobile and the limited scope of the survey make it difficult to determine whether responses for these four components represent common or standard practices for the surveyed automakers and suppliers. However, the components chosen avoid unique or critical parts that might not represent standard practices. In addition, statistical tests, discussed in the text and in Appendix 2, indicate that most responses were not sensitive to the part type.

Analyzing suppliers in this manner presented other difficulties that have placed limitations on this study. For example, relationships may differ for each car model even within the same companies and over time. Areas with no significant differences between Japanese and U.S. practices or performance levels could provide evidence either for convergence or the inaccuracy of reported differences. These and other issues are treated where appropriate, although the questions asked and the data gathered appear adequate at least to explore whether differences existed in several key dimensions among the three groups of auto plants surveyed. Table 2 lists the data collected.

Table 2: Data Collected in the Questionnaires

Question[#]	Dimension
1.1	Model market segment (subcompact, compact, mid-size, full-size)
1.2	Model production volume
1.3	Model year (time of market introduction)
2	Number of suppliers
	Types of suppliers (internal division, affiliated, independent)
3	Length of contract and business relations
4	Frequency of changing suppliers
5	Supplier selection criteria
6.1	Role of suppliers in product development
6.2	Stage of supplier involvement in development
7.1	Target price ratio
7.2	Price change rate
7.3	Rationale behind price increase/decrease
8.1	Defect rate
8.2	Defect rate change over time
9.1	Information possessed by the buyers about suppliers
9.2	Suggestions made by the buyers to suppliers

Note: [#]See Takeishi 1990: 71-78 for the actual survey questions.

The Sample

To fill out the survey, we approached the three U.S.-based automakers (General Motors, Ford, and Chrysler), the five largest Japanese automakers (Toyota, Nissan, Honda, Mitsubishi, and Mazda), and six Japanese transplants in the United States managed by the same Japanese firms. We identified one manager responsible for purchasing and product planning in each firm and asked them to fill out a questionnaire for one or more models, with a promise of confidentiality such that no data would be associated with particular firms. Each respondent decided the number of models and which models to include. The survey, therefore, reflects not a random sample but data on four components we selected for models chosen by managers at the largest automakers in the United States and Japan. These data may also represent either "best practices" or models for which the managers had sufficient information to answer the questionnaire.

Table 3 summarizes the response rate and other characteristics of the sample. One U.S. firm and two Japanese firms chose not to respond. Upon reviewing the survey results, several questionnaires also contained incomplete or unclear answers, or data that seemed unusual based on information we had obtained in interviews or from other reports; these we returned to the respondents, who then sent clarifications or corrected surveys back. Another difficulty was that some managers, especially from U.S. firms, did not collect data for all four parts. For example, there are only two responses for gauge assemblies in the U.S. sample, although the other three parts are more evenly balanced across the three groups.

Table 3: Sample Description

Key: SA = shock absorber; GG = gauge assembly; ST = front seat assembly; IP = instrument panel

Group	Automakers		Models## (Average Model Year)	Parts Analyzed				
	Contacted	Responses		SA	GG	ST	IP	Total
U.S.	3	2 (66%)	11 (1987)	7	2	7	6	22
Japan/U.S.#	6	5 (83%)	6 (1988)	6	6	6	6	24
Japanese	5	3 (60%)	7 (1987)	7	7	7	6	27
Total	13	10 (71%)	24 (1987)	20	15	20	18	73

Notes: #Japanese-managed transplants, which include two joint ventures with American automakers.

##The number of models reported on in the survey and the average calendar year of model introduction. The range of models for the U.S. firms was 1982-90, for Japan/U.S., 1988-89, and for the Japanese, 1982-89. Profiles of models are shown in Appendix 1.

As seen in Table 2, the questionnaire also collected information on each model's market segment, production volume, and year of introduction as control variables to determine if the size, customer focus, or newness of the product had any impact on the responses. Once again, these factors were insignificant except in a few cases, as noted. In addition, for each question, we asked respondents to list a degree of confidence in their answers; as discussed in Appendix 2, only on one of 17 questions did the responses from a group appear less than confident.

4. Survey Results

The data thus consist of responses to 17 questions regarding the four components. This section compares the three groups of automakers in the following order: U.S.-based auto plants, Japanese-managed transplants in the United States (abbreviated as "Japan/U.S."), and Japanese auto plants in Japan.

Number of Suppliers

Table 4 indicates the number of suppliers (including internal parts divisions) per part for each model. In all but one case, auto plants procured the four parts as subassemblies. Excluding the exception, the average number of suppliers per part is 1.8 for the U.S. automakers, 1.2 for the Japanese transplants, and 1.3 for the Japanese automakers. Though the number for the U.S. producers still exceeds those for the other two groups, cases of procuring from only one supplier account for 59% of the U.S. sample; this suggests that U.S. automakers did limit the number of suppliers per part, in contrast to reports that they always had many suppliers for each component. In addition, Japanese firms did not always have sole sources for single components.

Table 4: Number of Suppliers Per Part[2]

Units: Frequency distributions and means for number of suppliers per part. Percentages indicated in parentheses.

No. of Suppliers	U.S.	Japan /U.S.	Japan	Total
1	13 (59.1)	20 (83.3)	19 (70.2)	52 (71.2)
2	3 (13.6)	4 (16.7)	8 (29.6)	15 (20.6)
3	3 (13.6)	0 (0)	0 (0)	3 (4.1)
4	1 (13.6)	0 (0)	0 (0)	1 (1.4)
5	1 (4.6)	0 (0)	0 (0)	1 (1.4)
> 5	1# (4.6)	0 (0)	0 (0)	1 (1.4)
Total	22 (100)	24 (100)	27 (100)	73 (100)
Mean ab	2.8	1.2	1.3	1.7
Mean## a**b*	1.8	1.2	1.3	1.4

Notes:
#Refers to one automaker using 25 suppliers for the seat assembly.
##The means calculated excluding the one exceptional case of 25 suppliers for the seat assembly.
a = U.S. and Japan/U.S. difference significant at .10
a** = U.S. and Japan/U.S. difference significant at .01
b = U.S. and Japan difference significant at .10
b* = U.S. and Japan difference significant at .05

[2] The statistical test used to determine the differences among the two or three means in this and other tables, except as noted, was the Fisher's PLSD (Protected Least Significant Difference) test (Snedecor and Cochran 1986: 232-236). For additional details of the statistical tests for this and other tables, as well as the appendixes, see Takeishi 1990.

Type and Origin of Suppliers

Table 5 compares supplier type by financial affiliation and country of origin. Companies were asked to identify the key supplier for each part, defined as the supplier that provided the largest percentage of the cost or value of the part. The large number of categories and the relatively small sample resulted in inconclusive statistical tests and thus it is not possible to generalize about this variable. For this sample, nonetheless, the data indicate that 50% of the major suppliers for the U.S. automakers were internal parts divisions while 45% were independent U.S. suppliers; 5% (1 supplier) was from West Germany.

For the Japanese automakers responding to the survey, merely 7% of their suppliers were in-house divisions; 33% were affiliated firms (defined as minimum 20% equity ownership) and nearly 60% were independent. These numbers appear consistent with previous reports of higher levels of vertical integration for U.S. automakers in contrast to more outside suppliers for the Japanese. The responses from the transplants resembled the Japanese in the low level of vertical integration, but with far more reliance on U.S. suppliers. Fully 87.5% of their suppliers for the four components were based in the United States. Half of these were Japanese and only 37.5% U.S.-owned, although the Japanese automakers in Japan used no U.S. suppliers for this set of components.

Table 5: Type and Origin of Major Suppliers

Units: Frequency distribution of number of major suppliers[#]; percentages in parentheses.

	U.S.	Japan /U.S.	Japan	Total
Supplier Type/Location				
Internal	10 (50)	3 (12.5)	2 (7.4)	15 (21.1)
Affiliated[##] /Japan	0 (0)	1 (4.7)	9 (33.3)	14 (19.7)
Affiliated /U.S.A.	0 (0)	5 (20.8)	0 (0)	1 (1.4)
Independent Japanese/Japan	0 (0)	2 (8.3)	16 (59.3)	18 (25.4)
Independent Japanese/U.S.A.	0 (0)	4 (16.7)	0 (0)	4 (5.6)
Independent U.S./U.S.A.	9 (45)	9 (37.5)	0 (0)	18 (25.4)
Other	1 (5)	0 (0)	0 (0)	1 (1.4)
Supplier Origin/Location				
U.S./U.S.A.	20 (100)	9 (37.5)	0 (0)	29 (40.8)
Japanese/U.S.A.	0 (0)	12 (50)	0 (0)	12 (16.9)
Japanese/Japan	0 (0)	3 (12.5)	27 100)	30 (42.3)
Total	20 (100)	24 (100)	27 (100)	71 (100)

Notes: [#]A major supplier is defined here as the supplier that accounts for the largest portion of a part number by value procured by the automaker.

[##]An affiliated supplier is defined as one in which the automaker owns at least 20% of the supplier's outstanding shares.

Length of Contracts and Business Relationships

Table 6 indicates the length and stability of supplier relationships. First, in terms of the average contract length, the U.S. sample is the shortest (1.7 years), followed by the Japanese transplants (2.5 years) and the Japanese (3.2 years). The frequency distribution, shown in Table 7, reveals that most U.S. contracts (nearly 82%) in this sample are short-term (1 year). Japanese contracts covered a broad range, although the most common contract (62% of the sample) is 4 years, corresponding to the average model life-cycle. The Japanese transplants had 50% 1-year and 50% 4-year contracts, indicating a mixture of Japanese and U.S. practices.

Although contract length differs among the three groups, the actual duration of part purchases appears more uniform. As seen in Table 6, for each group, the average duration of the part transaction (the length of time for purchasing a particular part for a specific model from the same major supplier) is almost equivalent to the model life-cycle (the model life-cycles were shorter for the Japanese than the U.S. automakers but shortest for the transplants, which had slightly newer models on average). Responses to a question on how often the automakers changed suppliers are also consistent with this finding. No automaker changed a supplier for the parts surveyed after the model's market introduction.[3]

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[3] It is still possible U.S. automakers conduct competitive bidding every year when their 1-year contracts end, although interviews of the U.S. respondents who use 1-year contracts indicated that, in 16 of 17 cases, they did not carry out any competitive bidding after market introduction. These results strongly suggest that, although the average contract length for U.S. automakers is shorter than for Japanese automakers, the actual duration of purchasing parts for specific models is as long and as stable as in Japan.

Table 6: Length of Contracts, Transactions, and Model Life-cycles

Units: years, number of times suppliers changed, number of observations in parentheses

	U.S.	Japan /U.S.	Japan	Total
Length of Contract [b**]	1.7 (22)	2.5 (16)	3.2 (26)	3.0 (64)
Length of Part Transaction [a*c**]	3.2 (21)	1.6 (24)	3.5 (27)	2.8 (72)
Length of Model Life-cycle [a**c*]	3.6 (20)	1.7 (24)	3.1 (27)	2.7 (71)
No. of Times Suppliers Changed	0 (21)	0 (24)	0 (27)	0 (72)

Notes:
a* = U.S. and Japan/U.S. difference significant at .05
a** = U.S. and Japan/U.S. difference significant at .01
b** = U.S. and Japan difference significant at .01
c* = Japan/U.S. and Japan difference significant at .05
c** = Japan/U.S. and Japan difference significant at .01

Table 7: Length of Contracts

Unit: years, number of observations, percentages in parentheses

Contract Length (years)	U.S.	Japan /U.S.	Japan	Total
0.5	0 (0)	0 (0)	3 (11.5)	3 (4.7)
1	18 (81.8)	8 (50.0)	2 (7.7)	28 (43.8)
2	0 (0)	0 (0)	4 (15.4)	4 (6.2)
4	1 (4.6)	8 (50)	16 (61.5)	25 (39.1)
5	3 (13.6)	0 (0)	0 (0)	3 (4.7)
8	0 (0)	0 (0)	1 (3.9)	1 (1.6)
Total Observations	22 (100)	16[#] (100)	26 (100)	64 (100)
Average Length (years)	1.7	2.5	3.2	3.0

Notes: [#]Two Japanese transplants (8 cases) do not define the length of transaction period in the contract.
b** = U.S. and Japan difference significant at .01

A related issue is the total duration of the business relationships between the automakers and their suppliers, including any part transactions for any model (that is, for parts and models in addition to those described in the questionnaire). As seen in Table 8 as well as Table 7, most of the relationships tended to be long-term, and neither U.S. nor Japanese automakers changed suppliers for these parts.[4] Only the transplants tended to have short-term relationships, although this reflected their short history of operations, with all plants established during the early or mid-1980s.

Table 8: Length of Business Relationships

Unit: years, number of observations, percentages in parentheses

Relationship (years)	U.S.	Japan /U.S.	Japan	Total
< 2	0 (0)	6 (26.1)	0 (0)	6 (8.3)
3 to 5	0 (0)	6 (26.1)	0 (0)	6 (8.3)
5 to 10	4 (18.2)	6 (26.1)	0 (0)	10 (13.9)
> 10	18 (81.8)	5 (21.7)	27 (100)	50 (69.4)
Total Observations	22 (100)	23 (100)	27 (100)	72 (100)

[4] Even excluding the 12 cases where suppliers were internal divisions (for U.S. automakers only), 80% of the cases (8) were for more than 10 years and 20% (2) were for 5 to 10 years.

Supplier Selection Criteria

To examine potential criteria used to select suppliers for each of the four parts, the questionnaire asked respondents to rate nine factors we selected in the order listed in Table 9 on a five-point scale (5 = very important, 1 = not important) or specify and rate other factors of their own choosing. The results, rather surprisingly, indicate that, whereas common impressions of U.S. automakers might have them place more emphasis on prices and costs rather than quality and delivery capabilities, the Japanese respondents placed a higher emphasis on initial prices offered and target-pricing capabilities in the development process.

The largest gaps between the U.S. and Japanese responses were in the importance of "past business experience with your company" and "financial affiliation," factors that the U.S. firms valued more highly, although the larger role of internal parts divisions for the U.S. producers in this sample (see Table 5) may explain why financial affiliations were more important for them than for the Japanese. Other significant differences were that Japanese transplants consider "quality" and "manufacturing capability" more important than do the Japanese automakers in this sample. All the transplant respondents also rated quality as very important.

Table 9: Supplier Selection Criteria

Units: Mean score (5-point scale, with 5 = very important and 1 = not important), number of observations, standard deviations in parentheses

Criteria	U.S.	Japan /U.S.	Japan
Observations:	**21**	**23**	**27**
Initial Price Offered b**c*	4.1 (1.0)	4.4 (0.8)	4.9 (0.3)
Target Price Capability a**b**	4.1 (0.8)	4.7 (0.5)	4.7 (0.5)
Cost Reduction Capability c	4.1 (1.0)	4.4 (0.7)	4.0 (0.9)
Quality (Conformance) c*	4.8 (0.4)	5.0 (0)	4.7 (0.5)
Delivery Capability	4.6 (1.0)	4.7 (0.4)	4.7 (0.6)
Design/Engineering Capability	4.6 (0.5)	4.7 (0.7)	4.6 (0.7)
Technological Capability	4.1 (0.8)	4.2 (1.0)	4.4 (0.8)
Manufacturing Capability c	4.4 (0.6)	4.7 (0.5)	4.4 (0.8)
Past Business Relations a**b**	4.4 (0.8)	3.1 (1.3)	3.1 (1.1)
Financial Affiliation a**b**	3.8 (1.2)	1.9 (1.2)	2.1 (1.0)

Notes:
a** = U.S. and Japan/U.S. difference significant at .01
b** = U.S. and Japan difference significant at .01
c = Japan/U.S. and Japan difference significant at .10
c* = Japan/U.S. and Japan difference significant at .05

Timing and Role of Suppliers in Development

Most responses to questions regarding the role of suppliers in product development, summarized in Table 10, were not statistically significant, reflecting the limited sample sizes and mix of observations for specific categories (including many categories with zero observations, as reported in the frequency distributions). Nonetheless, with regard to timing, for a question asking automakers how many months prior to the market introduction of a model they sent out inquiries to suppliers and then selected suppliers, one group of responses was statistically different at a 10% significance level: the transplants, which sent out inquiries 33 months before model introduction, compared to 27 months for the Japanese sample.

Overall, these results suggest that suppliers to U.S. firms play a large role from an apparently early stage in development, although Japanese suppliers still play a greater role in design. The ability of the Japanese to send out inquiries relatively late appears to reflect the extent of their relationships with suppliers and their dependence on suppliers for detailed design, since nearly all the Japanese parts were black-box. This interpretation is reinforced by Japanese responses in Table 8 on the length of business relationships and other research (Clark, Chew, and Fujimoto 1987; Clark 1989; Fujimoto 1989; Clark and Fujimoto 1991), as well as by more detailed data in the survey.

Table 10: Supplier Involvement in Product Development

Units: months prior to market introduction, percentages of responses, average sample size in parentheses

	U.S. (19)	Japan /U.S. (16)	Japan (26)
Timing of Involvement			
Sending Inquiries*	30.2	32.5	26.9
Selecting Suppliers	25.5	23.8	22.5
Type of Part#			
% Black-box	70	64	96
% Detail-Controlled	30	23	0
% Supplier-Proprietary	0	13	4
Stage for Inquiries#			
% Before Concept Generation	27	0	0
% Before First Clay Model	18	0	32
% Before Detailed Drawings	55	100	68
Stage for Selection#			
% Before Concept Generation	6	0	0
% Before First Clay Model	19	0	12
% Before Detailed Drawings	56	30	28
% Before First Prototype	19	45	60
% Before Pilot Run	0	25	0

Notes: * = Japan/U.S. and Japan difference significant at .05

#Frequency distribution of the sample (There were not enough observations in each cell to conduct reliable statistical tests for estimating the probability of differences among the three groups.)

The second part of the same question asked respondents to specify when suppliers became involved in product development: before completion of concept generation, the first clay model, the first detailed drawings, the first prototype, or the pilot run. These results, also reported in Table 10, again show U.S. suppliers involved earlier than the Japanese, at least on a formal level. In fact, the Japanese in this sample chose most of their suppliers (60%) after completion of detailed drawings, that is, before the first prototype. Yet the Japanese, as

well as the U.S. sample and the transplants, all sent inquiries before this stage. In addition, since 96% of the Japanese parts were black-box and 4% supplier-proprietary, there had to exist extensive contacts between the engineering departments of the suppliers and the Japanese automakers prior to formal supplier selection, at least to discuss specifications for functions and interfaces (how parts fit with other components).

Pricing Practices

Two measures that literature and interviews suggested were important to automakers were the target-price ratio, which reflects how well a supplier meets a price contracted for (although not necessarily the ability to deliver components at lower prices or costs), and the price-change rate, which refers to the average annual price increases or decreases for a part after market introduction. These figures, reported in Table 11 and Figure 1, indicate striking contrasts. Japanese automakers in the sample started purchasing new parts at prices approximately 2% cheaper than initially targeted and these dropped approximately 2% annually thereafter. The U.S. sample started purchasing new parts at a price approximately 9% higher than targeted and prices rose approximately 1% per year thereafter. This contrasts to observations in previous studies that U.S. automakers have recently started asking suppliers to reduce prices.

Table 11: Pricing Practices

Units: Percentages, number of observations in parentheses

Practice	U.S.	Japan /U.S.	Japan	Total
Target-Price Ratio# b**c**	109.4 (13)	110.7 (19)	97.6 (25)	104.7 (57)
Price-Change Rate## a*b**c**	0.9 (11)	-0.4 (16)	-2.1 (26)	-0.9 (53)

Notes: #Target-price ratio = (actual part price at market introduction)/ (target price the automaker set when it selected the major supplier for the part) * 100.

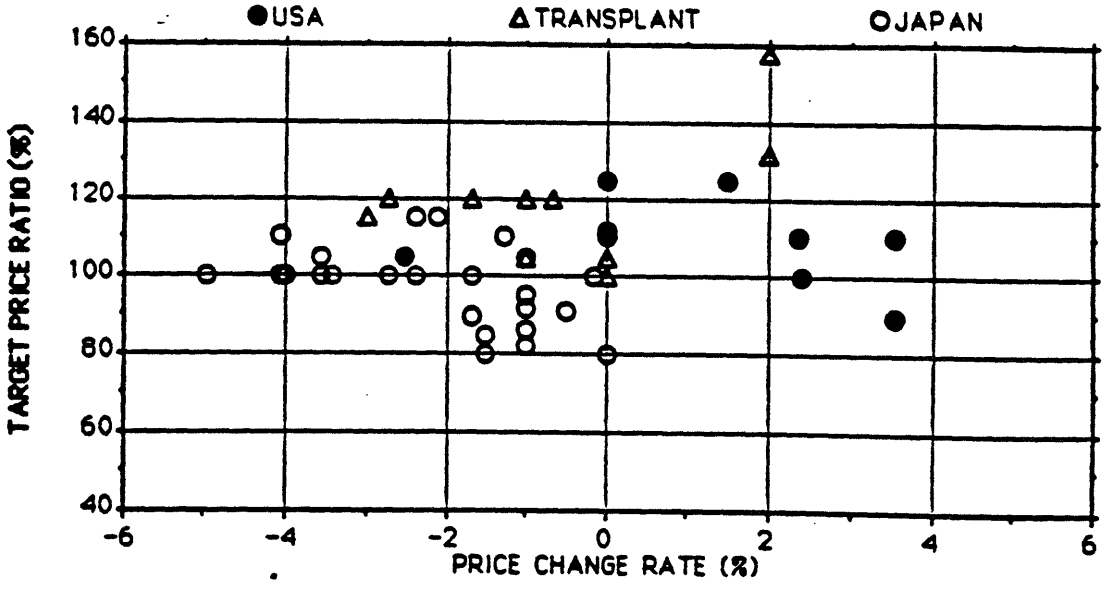
##Price-change rate = the average annual rate of price change after the market introduction (excluding the price change when the part's design was changed due to the minor change of the model).

a* = U.S. and Japan/U.S. difference significant at .05

b** = U.S. and Japan difference significant at .01

c** = Japan/U.S. and Japan difference significant at .01

Figure 1: Target Price Ratio vs. Price Change Rate



Note: Sample size: USA= 9, TRANSPLANT = 16, JAPAN= 25.

The target price ratio for the Japanese transplants, however, is as high as for the U.S. sample, and their price-change rate fell in between the other two groups.[5] Half of the suppliers to the transplants were also U.S. firms, which in general did not meet target prices as well as the Japanese suppliers. Nonetheless, the transplants performed somewhat better (significant at the 10% level) than the U.S. sample, obtaining price decreases from U.S. suppliers averaging -0.6%, compared to an increase of 0.9% for the U.S. sample.[6]

The questionnaire also requested reasons why prices of the four parts increased or decreased after the model introduction by asking respondents to check one or more of eight potential factors behind increases and one or more of eleven factors for decreases. (The respondents could specify other reasons, but generally did not). The large number of possible reasons and the relatively small number of observations, as well as the fact that no Japanese firm reported price increases while 25 reported price decreases, compared to only 2 U.S. firms, made it difficult to compare the results statistically, although several trends stand out for description. The transplants that reported price increases (2 observations) attributed these to rising materials costs; this factor

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[5] A minor factor that contributed to the higher target-price ratios of the transplants was that their detail-controlled parts averaged a ratio of 128%, compared to approximately 107% for black-box and supplier-proprietary components. However, because of the small percentage of detail-controlled parts for both the transplants (23%) and the U.S. sample (30%), black-box parts (96% of the Japanese components, compared to 64% for the transplants and 70% for the U.S. sample), for which the suppliers did the detailed design, had a much larger impact on target-price ratios. For black-box parts, the Japanese averaged a target-price ratio of 98%, compared to 107% for the transplants and 110% for the U.S. sample. The difference between the target-price ratios of the black-box parts for the U.S and Japanese samples are significant at the 1% level, while the difference between the transplants and the Japanese are significant at the 5% level.

[6] We analyzed both target-price ratios and price-change rates breaking down suppliers by their origin and location (U.S. suppliers in the United States, Japanese suppliers in the United States, or Japanese suppliers in Japan). These results were not different at the 10% level of significance except for this one instance.

was also cited by 83% of the U.S. respondents (6 observations) to explain their increases, followed by process changes (33% of respondents) and labor costs (17%). The major source of price reductions was productivity improvements, cited by 97% of all respondents (32 observations). Other major factors cited behind price reductions were design changes (76% of respondents), defect-rate improvements (52%), and process changes (42%).

Quality

Table 12 compares the current defect rate and the annual average defect-rate change after market introduction. Again, a marked contrast among the three groups emerges. The Japanese automakers in this sample enjoyed a decrease in the defect rate of approximately 10% per year as well as received parts with the lowest defect rate (0.01%), significantly better than the U.S. respondents. Defect rates for the U.S. automakers also decreased, but the pace was relatively slow (2% annually) and the mean defect rate was still high (1.8%). Though the average rate of decrease for the Japanese transplants (0.05%) was not yet as low as the Japanese, it was also significantly better than the U.S. rate.

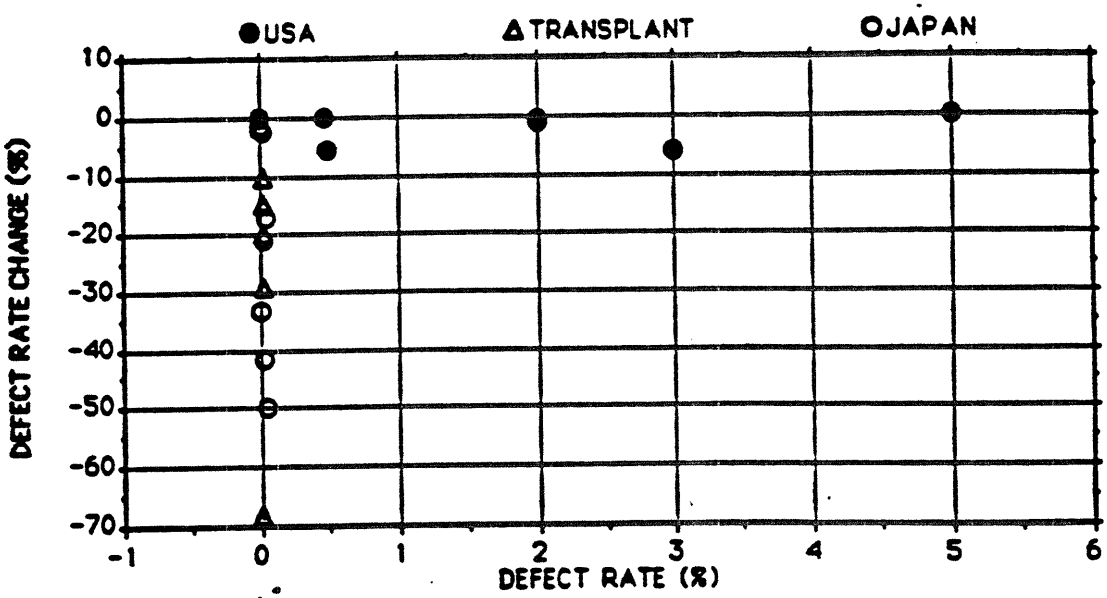
Table 12: Defect Rates and Defect-Rate Changes

Units: percentages, number of observations in parentheses

	U.S.	Japan /U.S.	Japan	Total
Defect Rate[#] a**b**	1.81 (12)	0.05 (15)	0.01 (25)	0.44 (52)
Defect-Rate Change[##] a**c**	-1.7 (9)	-30.1 (7)	-9.5 (25)	-11.5 (40)

Notes: [#]Defect rate = (the number of defective parts / the number of parts received) * 100.
[##]Defect-rate change = the average annual rate of defect rate change after market introduction.
a** = U.S. and Japan/U.S. difference significant at .01
b** = U.S. and Japan difference significant at .01
c** = Japan/U.S. and Japan difference significant at .01

Figure 2: Defect Rates vs. Defect-Rate Changes



Note: Sample size: USA= 7, JP/US = 7, JAPAN= 25.

In addition, the data indicate the transplants were improving much faster than either the U.S. or Japanese respondents, with defect rates dropping more than 30% since model introductions. The U.S. plants managed by the Japanese automakers, therefore, were quickly approaching the Japanese defect levels, even with their much greater use of U.S. suppliers. Figure 2 presents a graph of these results. This shows that, while in no U.S. case did the defect rate improve by more than 10%, in spite of a relatively higher average defect rate, most of the Japanese transplants and Japanese automakers have improved their defect rates by more than 10%, even starting with lower defect rates than the U.S. sample. It thus appears that U.S. automakers, at least in this survey, still have difficulties matching the Japanese or their transplants in quality as reflected in component defects.

Table 13 analyzes these rates by the origin and location of suppliers. A major difference (statistically significant at the 1% level) appeared in the performance of U.S. suppliers when delivering to the transplants, as opposed to the U.S. plants. U.S. suppliers provided approximately 0.1% defects to the transplants compared to 1.8% to U.S. plants. The U.S. suppliers also showed nearly a 49% decrease in defects, compared to merely 1.7% when delivering to U.S. firms. Internal parts divisions appeared to have the worst quality in the sample, although, due to the small number of observations (4 defect rates and 5 for defect-rate changes), the results were not significant statistically.

Table 13: Defect Rates and Changes by Supplier Origin

Units: percentages, number of observations in parentheses

	U.S.	Japan /U.S.	Japan	Total
Defect Rate[#]				
American Suppliers in U.S.A. [a**]	1.81 (12)	0.11 (6)	-	1.25 (18)
Japanese Suppliers in U.S.A.	-	0.01 (6)	-	0.02 (6)
Japanese Suppliers in Japan	-	0.01 (3)	0.01 (25)	0.01 (28)
Defect-Rate Change[#]				
American Suppliers in U.S.A. [a**]	-1.7 (8)	-48.8 (2)	-	-11.2 (10)
Japanese Suppliers in U.S.A.	-	-31.1 (3)	-	-31.1 (3)
Japanese Suppliers in Japan	-	-10.0 (2)	-9.5 (25)	-9.5 (27)

Notes: [#] See Table 12 for definition.
[a**] = U.S. and Japan/U.S. difference significant at .01

Information and Suggestions

A final set of questions asked respondents to indicate either what type of information on suppliers they possessed or what types of suggestions they have given to suppliers. Earlier studies (Mitsubishi Research Institute 1987 and Fujimoto 1989) served as a guide to select categories.

With regard to information exchange (Table 14), 37% of the Japanese respondents had more information on the cost of process steps, compared to both the U.S. and Japanese/U.S. samples, although no group reported high levels of information in this area and the differences among the three were significant only at the 10% level. The U.S. auto plants, on the other hand, had more information on statistical process control (90.5% of respondents) than the Japanese and Japanese/U.S. respondents, which may indicate a greater emphasis on this technique at the American firms. The U.S. (85.7%) and Japanese (88.9%) auto plants also had more information on equipment than the transplants (52.2%), which the interviews suggested reflected difficulties the transplants had in obtaining detailed information on their suppliers, in part because of their shorter histories of relationships. With regard to suggestions made by the automakers to suppliers, the differences were more dramatic among the three groups, with the Japanese and the transplants reporting higher numbers for every category (Table 15). These data indicate a much greater involvement with suppliers for nearly all aspects of the production process, and nearly identical practices between the Japanese and the transplants, at least as indicated by this survey.

Table 14: Information Possessed on Suppliers by Automakers

Unit: percentage indicating possession of information on each category, number of observations in parentheses

	U.S. (21)	Japan /U.S. (23)	Japan (27)
Production Capacity	95.2	87.0	89.0
General Cost Breakdown	66.7	65.2	51.9
Process Steps Breakdown	57.1	100.0	95.6
Cost of Each Process Step*	14.3	13.0	37.0
Quality Control Program	95.2	91.3	100.0
Stat. Process Control Data**	90.5	47.8	66.7
Equipment Used**	85.7	56.5	88.9
Inventory Level	57.1	52.2	44.4

Notes: *Differences between the 3 groups are significant at .10 (chi-square test).
**Differences between the 3 groups are significant at .05

Table 15: Suggestions Made by Automakers to Suppliers

Unit: percentage making suggestions in each category, number of observations in parentheses

	U.S. (21)	Japan /U.S. (23)	Japan (27)
Quality Control*	47.6	69.6	77.8
Production Process Changes***	33.3	56.5	92.6
Cost Reduction	85.7	100.0	100.0
Design Changes	57.1	65.2	59.3
Material Changes*	33.3	69.6	48.2
Equipment Changes***	0	52.2	18.5
Inventory Control Changes*	19.1	47.8	48.2

Notes: *Differences between the 3 groups are significant at .10 (chi-square test)
***Differences between the 3 groups are significant at .01

5. Data Summary and Analysis

Table 16 presents an overview of the major findings of the survey as they relate to issues raised in the literature cited earlier in Table 1. In general, the results support several of the reported differences between Japanese and U.S. supplier management and performance. In addition, they indicate that, in key dimensions, Japanese transplants are managing suppliers more effectively than U.S. automakers and much the same as Japanese companies in Japan, as well as receiving similarly high levels of performance in defects and especially defect reductions, even though approximately 87% of their suppliers were in the United States (37% were independent U.S. firms and 50% Japanese affiliates). There were, nonetheless, several differences between the transplants and the Japanese sample, reflecting the special circumstances and short histories of the transplants but also difficulties the Japanese encountered in adapting to the United States. Equally surprising, in several areas, the U.S. sample exhibited practices that differed from the general views reported in the literature.

With regard to U.S.-Japan differences, as indicated in the literature, the Japanese had lower levels of internal vertical integration (but more affiliates), fewer suppliers per part, longer contracts, decreasing prices, extremely low and improving defect rates, and high levels of information exchange with suppliers, including frequent offering of suggestions for improvement. For supplier selection, the Japanese, somewhat surprisingly, placed the highest emphasis on price; since relationships were clearly long-term in Japan, respondents may not have felt a need to single out business contacts as a selection factor, although this result clearly illustrates the importance Japanese firms placed on low prices from their suppliers, in addition to high and improving quality.

Table 16: Summary of Main Survey Results

Dimension	U.S.	Japan/U.S.	Japan
Number of Suppliers Per Part	Most (1.8)	Fewest (1.2)	Fewer (1.3)
Integration/Type of Supplier	More in-house & U.S. independents	Affiliated U.S./Japan., U.S. independents	Independent & affiliated Japanese
Length of Relations	Long (> 10 yrs.)	Short (1-4 yrs.)	Long (> 10 yrs.)
Length of Contracts	Short (1.7 yrs.)	Longer (2.5 yrs.)	Longest (3.2 yrs.)
Length of Part Transactions	Long (3.2 yrs.)	Short (1.6 yrs.)	Longest (3.5 yrs.)
Selection Criteria (Emphasis)	Past contact, affiliation	Price & quality	Price
Selection Timing	Early	Earliest	Latest
Involvement in Development	70% black-box 30% detail-controlled	64% black-box 23% detail-controlled	96% black-box 4% supplier-proprietary
Pricing Practices	Above target (109%)	Above target (110%)	Below target (98%)
Price Changes	Increasing (+0.9%)	Decreasing (-0.4%)	Decreasing (-2.1%)
Defect Rates	High (1.81%)	Low (0.05%)	Lowest (0.01%)
Defect Rate Change	Decreasing (-1.7%)	Decreasing (-30.1%)	Decreasing (-9.5%)
Information Exchanges	Low, mainly statistical process control	Higher, more on process steps	Higher, more on process steps, and costs
Supplier Suggestions	Few	Many	Many

The transplants closely resembled the Japanese in these dimensions but departed significantly in other areas. The transplants utilized many more suppliers based in the United States, reflecting their locations; they had shorter part transactions, a result of their briefer histories. They were very early in sending inquiries to suppliers, reflecting again the newness of their operations. They had much higher levels of detail-controlled parts, following the U.S. rather than the Japanese practice, apparently because they had not established sufficient relationships with suppliers to delegate much detailed design. In addition, the transplants closely resembled the U.S. sample with part prices approximately 10% over target, compared to 2% below target in Japan. On the other hand, the transplants led the entire sample in the rate of quality improvement, with defects dropping 30% since the model introductions, compared to decreases of 9.5% in Japan and merely 1.7% for the U.S. sample. While it is somewhat surprising that suppliers were so far above the target prices for the transplants, the data (as well as interviews and other research discussed in Section 6) indicate that the transplants also emphasized a combination of price and quality, and tolerated higher prices, at least temporarily, to receive higher quality (higher, in fact, than U.S. automakers received from U.S. suppliers).

Additional data analysis supports another contention: that U.S. automakers have moved closer to what may be considered a more Japanese approach to supplier management. Because of the small size of the sample for individual groups and the small number of models in individual years, especially prior to the mid-1980s, the individual model year was not significant as a control variable. However, dividing the Japanese and the U.S. responses in half--models introduced before 1987, which did not include any transplant models, and models introduced after 1986 -- make it possible to explore changes during this period (Table 17).

Table 17: Early Versus Later 1980s' Comparisons

Units: See Tables 4,6,9,11,12,15

	U.S. Sample		Japanese Sample	
	Pre-87	Post-86	Pre-87	Post-86
Average Sample Size	8	10	7	20
Performance Variables				
Target price index	105.0*	116.4*	100.7	97.6
Price change %	2.38**	.148**	-2.08	-2.07
Defect rates	2.60	1.37	.014	.008
Defect rate change %	-.590	-1.73	-14.3	-7.58
Descriptive Variables				
Suppliers per part	4.75	1.42	1.00	1.40
Contract length	1.00	1.58	3.08	3.25
Suggestion index	2.75	2.46	4.00	4.80
Supplier Selection Criteria				
Initial price offered	3.63	4.36	5.00	4.90
Target price ability	3.88	4.27	4.43	4.75
Quality	4.75	4.82	4.58	4.75
Past relations	4.63	4.27	3.29	3.05
Financial affiliation	4.13	3.91	1.86	2.25

Notes: All variables above showed significant differences at .10 between the pre-1987 and post-1986 responses for the combined sample. Pre-87 = responses on models introduced before 1987; Post-86 = responses on models introduced after 1986
* = difference significant at .10
** = difference significant at .05

While no significant departures appeared for the Japanese, two for the U.S. sample indicated that: (1) U.S. suppliers missed target prices by a wider margin for models after 1986; and (2) U.S. suppliers substantially decreased their rates of price changes following market introduction for models after 1986. Other differences were not large enough to be statistically significant at usual levels, and some were difficult to interpret (such as declines in U.S. suggestions). Overall, however, responses sorted for the early versus the later 1980s suggested that U.S. automakers were moving closer to the Japanese not only in controlling price increases but also in other directions: decreasing

defects and improving quality; lowering the number of suppliers per part while lengthening contracts; placing more emphasis in supplier selection on initial prices offered and capabilities for meeting target prices and quality; and paying less attention to past business relationships or financial affiliations.

Several simple correlations also existed among specific practices and performance measures. First, as seen in Table 18, companies that sent out early inquiries and made early selections of suppliers -- primarily the transplants and the U.S. automakers (see Table 10) -- had more difficulty keeping to target prices after the start of mass production, apparently because of problems in foreseeing rises in materials costs, as noted earlier. Since the Japanese had relationships of 10 or more years with each supplier (see Table 8), some level of informal relationships clearly preceded the formal parts contracts and this makes it difficult to interpret the relevance of formal inquiries and selection. However, later inquiries and selection of suppliers may have given Japanese automakers and suppliers a better sense of factors such as materials costs that affect their ability to meet price targets.

Second, more frequent price increases, which occurred more with suppliers to U.S. automakers (see Table 11), were strongly associated with high defect rates as well as with fewer suggestions to suppliers and shorter contracts. These findings are consistent with notions such as that U.S. suppliers to U.S. automakers may be revising prices upward as a reflection of their shorter commitments to specific prices; they may be charging more for intensive inspection or quality-assurance activities; or they may still not be receiving as much guidance on quality improvement and cost reduction as Japanese suppliers receive from Japanese firms.

Third, early inquiries to suppliers were associated with reductions in defect rates. This may reflect efforts on the part of the transplants and U.S.

automakers to work with suppliers early to improve quality, even if prices rise. Other correlations in Table 18 tend to reinforce the notion that firms closely coordinated inquiries and selection of suppliers with suggestions and information on suppliers.

Table 18: Simple Correlation Matrix: Performance Criteria and Selected Descriptive Variables

Unit: Correlation coefficients
N = 30 (43 out of 73 cases deleted with missing values)

	TPR	PCR	DR	DRC	SUP	CL	INQ	SEL	INF	SUG
TPR	1.000									
PCR	-.155	1.000								
DR	-.022	.712*	1.000							
DRC	-.391	-.051	.180	1.000						
SUP	-.237	.339	.040	.146	1.000					
CL	-.030	-.420**	-.366*	.222	-.007	1.000				
INQ	.529*	-.160	-.183	-.538*	-.088	-.158	1.000			
SEL	.476*	-.274	-.062	-.215	-.222	-.193	.858*	1.000		
INF	.020	-.175	-.072	.318	-.030	-.212	.165	.293	1.000	
SUG	.335	-.456*	-.354	.151	.066	.244	.470*	.471*	.539*	1.000

Notes: TPR = target price ratio; PCR = price change rate; DR = defect rate; DRC = defect rate change; SUP = number of suppliers; CL = contract length; INQ = stage of sending inquiries to suppliers in the months prior to market introduction; SEL = stage of selecting suppliers in the months prior to market introduction; INF = the number of categories of information possessed on a supplier; SUG = the number of categories of suggestions made to a supplier
* significance level of .01 or higher
** significance level of .05

There were also significant correlations among the performance variables and selection criteria, although some results are difficult to interpret. In particular, as seen in Table 19, responses where suppliers had difficulty meeting their target prices were correlated with emphasis on initial prices, as well as with cost reduction capabilities, quality, and past business relations; this suggests (and the interviews tend to support this interpretation) that too much emphasis on initial prices led to situations where suppliers, recognized for their

capabilities or past history, submitted low bids and then raised prices after market introduction. On the other hand, suppliers valued for their initial prices had fewer price changes. Low defect rates or defect-rate improvements were also associated with suppliers valued for their initial prices, ability to meet target prices and reduce costs, and, to a lesser extent, general manufacturing capability and past business relations.

Table 19: Simple Correlation Matrix: Performance Variables and Supplier Selection Criteria

Unit: Correlation coefficients
N = 36 (37 out of 73 cases deleted with missing values)

	IPO	TPC	CRC	Q	DC	DEC	TC	MC	PBR	FA
IPO	1.000									
TPC	.117	1.000								
CRC	-.177	.463*	1.000							
Q	-.160	.541*	.397*	1.000						
DC	-.207	.350**	.183	.740*	1.000					
DEC	-.218	.612*	.182	.208	.299	1.000				
TC	-.258	.601*	.212	.469*	.286	.671*	1.000			
MC	-.098	.631*	.200	.534*	.271	.696*	.767*	1.000		
PBR	-.278	.000	.559*	.165	.135	.027	-.056	.080	1.000	
FA	-.181	.017	.205	.462*	.454*	.100	.056	.307	.706*	1.000
TPR	.550*	.075	.525*	.337**	.317	-.016	-.073	.023	.383**	.166
PCR	-.597*	-.244	-.194	-.014	-.040	.234	.229	.214	.000	.072
DR	-.454*	-.592*	-.383**	-.110	.133	.109	-.051	.015	.135	.318
DRC	-.188	-.346**	-.493*	-.185	.093	-.267	-.044	-.386**	-.347**	-.154

	TPR	PCR	DR	DRC
TPR	1.000			
PCR	.208	1.000		
DR	.042	.641*	1.000	
DRC	-.213	-.062	.175	1.000

Notes: IPO = initial price offered; TPC = target price capability; CRC = cost reduction capability; Q = quality; DC = delivery capability; DEC = design/engineering capability; TC = technological capability; MC = manufacturing capability; PBR = past business relations; FA = financial affiliation; TPR = target price ratio; PCR = price change rate; DR = defect rate; DRC = defect rate change
* significance level of .01 or higher
** significance level of .05

6. Interview Findings and Discussion

In addition to the broader U.S.-Japanese comparisons, the data survey and accompanying interviews present a unique opportunity to assess the practices and performance of Japanese transplants in the United States compared to their Japanese parents and U.S. competitors. In particular, interviews conducted prior to the actual survey at four of the Japanese transplants (including one joint venture with a U.S. firm) and 23 Japanese suppliers in the United States (including several joint ventures with U.S. firms) highlighted four sets of obstacles the transplants and their U.S.-based Japanese suppliers encountered in meeting their pricing and quality objectives (Table 20).

First were limitations of the transplants themselves. Interviewees pointed out that Japanese automakers in Japan set low target prices and high quality objectives for the transplants. In turn, they felt the transplants and their U.S.-based suppliers had more limited product and process engineering capabilities than the Japanese, making it difficult to work closely with suppliers to reduce costs or raise quality. The transplants also had smaller manufacturing volumes per model as well as shorter histories of operations, compared to the U.S. or Japanese plants; interviewees felt these circumstances reduced their ability to negotiate price reductions and left them susceptible to suppliers claiming they could not meet low target prices.

Table 20: Obstacles to Transplants' Pricing and Quality Objectives

Categories and Issues	Company/Interview Codes
(1) Limitations of Transplants	
Limited engineering capability of Japanese transplants	A2,S1,S9,11,13,15,17
Limited database for cost analysis	A1,S2
U.S. suppliers' refusal to provide cost data	S2,9
Low production volume and short history of operations	A4,S4,6,13,18,23
(2) Limitations of U.S. Base	
Limited engineering capability of U.S. suppliers	A1,S3,16,18,19
Limited capability of second-tier U.S. suppliers	A4,S1,2,5,6,8,10,11,13,14,16, 20,22,23
Limited capability of manufacturing infrastructure (dies, fasteners, steel, materials, tools, gilding)	S1,7,8,9,10,11,13,14,17,19,23
Lack of continuous improvement efforts or programs in U.S. firms	A1,S2,3,7,12,13,14,15,21
Shortage of U.S. maintenance workers	A2,S7,9,17,18
(3) Quality/Pricing Policies	
Higher quality requirements from Japanese automakers	A1,2,S2,5,11,13,16,18,19
Higher costs expected for higher quality at U.S. firms	A1,4,S14,16,20
(4) Profit/Pricing Policies	
Higher profit margins charged by U.S. suppliers	A2,A4,S1,6,7,8,9,10,11,12,13,15, 16,17,19,21
More short-term profit pressures at U.S. suppliers	A4,S6,9,15,16,17,21
No U.S. tradition of price reductions	A1,A2, A4, S2, S5,6,7,8,10,14

Note: Company/interview codes are explained in Appendix 3.

In addition, transplant managers and other personnel complained of limited cost data about their suppliers, reflecting their much shorter histories of operations compared to Japanese firms in Japan or U.S. firms but also a reluctance of some U.S. suppliers to provide proprietary cost data, which made it difficult for them to estimate whether U.S. suppliers could meet target prices. This lack of information appears as well in the responses summarized in Table 14; the transplants had no more information on costs than U.S. automakers and significantly less than the Japanese automakers. The transplants also had relatively little information on equipment their suppliers used, although their emphasis on making suggestions to suppliers about equipment (significantly more so than the U.S. or Japanese automakers) appeared to reflect efforts to influence or learn more about this aspect of their suppliers' operations.

A second area of concern were limitations related to operating in the United States. Interviewees believed that U.S. suppliers, owned by Americans or Japanese, had less engineering capabilities and responsibilities for product and process development, which Japanese suppliers in Japan seemed to use so effectively to lower costs. Nor did they feel that U.S. suppliers had programs for productivity and quality improvement comparable to those in Japan. While most felt productivity levels were equivalent in the United States and Japan, at least under Japanese management methods, several cited a shortage of maintenance workers in the United States, needed to keep equipment operating efficiently.

Perhaps more seriously, while personnel interviewed at the transplants and Japanese suppliers in the United States indicated a desire to produce or procure even more components locally, in response to political pressures as well as exchange-rate fluctuations, they referred to two specific problems: the difficulty of finding additional U.S. subcontractors that could meet their quality

and cost standards (a complaint supported by the quality and target-pricing data supplied by the transplants); and the inadequacy of the manufacturing infrastructure in the United States, especially for dies, tools, steel, compound materials for plastics, paints, fasteners, and gilding.

Third, many interviewees claimed that Japanese automakers, and the transplants, had higher quality standards than U.S. firms, such as for design quality (a component's durability) and manufacturing defects. To meet these higher standards, they claimed that suppliers in the United States, whether managed by Japanese or Americans, charged higher prices and often increased prices over initial targets during a model's life cycle. A Japanese researcher who assisted in these interviews encountered this same finding in an earlier study of the transplants and their suppliers (Sei 1989). In addition, a case study of procurement practices at the Toyota-General Motors joint venture (New United Motor Manufacturing, Inc. or NUMMI), written by a former American quality-control engineer at the plant, claimed that U.S. suppliers set up special shops with higher quality standards, achieved mainly through more intensive inspection prior to shipping components, for which they tried to charge higher prices (Krafcik 1986). This latter report is also consistent with the survey data and the interviews of transplant managers and other personnel, and suggested that the operations of U.S. suppliers were not necessarily improving as a result of the higher quality standards of the transplants.

Fourth, companies appeared to have different philosophies regarding prices and profits. Interviewees described how Japanese suppliers accepted low prices and low margins, and then increased their potential margins by reducing prices; this is suggested as well in Table 11. They claimed, however, that U.S. suppliers required higher margins, calculated carefully for individual components, and therefore requested higher initial prices; U.S. suppliers also expected their

costs to rise rather than fall over time and, accordingly, raised prices above the targets in the initial contracts. Nor did U.S. suppliers have a tradition of "burden sharing," explained as special efforts to lower prices that Japanese suppliers are expected to make if automakers request reductions because of competitive pressures or other factors. These differences between Japanese and U.S. pricing practices are important for explaining the survey findings with regard to target prices as well as price increases, and are consistent with reports by other researchers (Hiromoto 1988, Kaplan and Atkinson 1989).

7. Implications

The survey data and interviews suggest several implications with respect to the three questions posed earlier in the Introduction to this article. First, there clearly exist differences in supplier relations and management practices between U.S. and Japanese automakers for the sample of firms and components examined in the survey; at least some differences appear related to performance and thus should help Japanese firms maintain an advantage over competitors.

For example, U.S. automakers and their suppliers trailed the Japanese in quality levels, quality improvement rates, pricing or cost accuracy of components before market introduction, price decreases after market introduction, use of suppliers as opposed to internal production, subcontracting of detailed design to suppliers, information on suppliers, and suggestions to suppliers that affected quality and costs. Pricing differences may reflect that U.S. suppliers simply require higher profit margins and submit low initial bids to obtain contracts, before raising component prices after a model enters the market. Nonetheless, this practice, compared to the Japanese refusal to accept price increases while working with suppliers to reduce prices over time,

appeared to place U.S. firms at a disadvantage. Low Japanese target-price ratios may also reflect initial numbers where suppliers have already taken into account that Japanese automakers will expect them to reduce prices over time, although the unusually strong emphasis of the Japanese automakers on price as the major factor in determining supplier selection would seem to limit the effectiveness of this strategy on the part of suppliers.

Overall, the Japanese advantages stemming from their operations in Japan have created an historic, strategic challenge: to replicate this style and level of supplier management and performance outside Japan and even with non-Japanese suppliers. The data also reinforce various impressions of the world automobile industry as dynamic. Despite indications in the literature of very large differences between Japanese and U.S. firms in supplier management, some generalizations may have been wrong or inapplicable to this sample. In addition, U.S. firms appeared to move closer to the Japanese model during the 1980s in several areas. For example, U.S. automakers had long, stable histories of relations with their suppliers; the average contract lengths they gave out for components were increasing, as were the average number of suppliers per component; price increases for components after market introduction were dropping while quality was improving; past relations and financial affiliations, such as use of internal parts departments, were becoming less important as factors in choosing suppliers, while pricing accuracy and quality seemed to be gaining. These changes indicated that U.S. automakers and suppliers were becoming more effective competitors, although the Japanese appeared to meet the new challenges aggressively: Their quality continued to improve much faster than U.S. quality while prices fell not rose, for example; and the transplants appeared to manage suppliers almost as well as the Japanese plants in Japan, which meant they were more effective or received better results, in

some though not all areas, than U.S. firms.

This latter observation provides a summary response to the second question regarding comparisons of the Japanese and the transplants or the transplants and U.S. firms. The major differences between the Japanese plants and the transplants were an inability of transplant suppliers to meet target prices, good but still lower components quality than in Japan, less use of suppliers for detailed design, less information on suppliers, and other differences related to their short history of operations. The target pricing discrepancy appeared to reflect the low prices Japanese automakers set in Japan for the transplants versus what their actual costs or prices turned out to be in the United States, both as a result of their lapses (such as the cost of controlling design details) and those of suppliers; in particular, U.S. practices historically permitted price increases over time. Nonetheless, in using few suppliers per part and long contracts, working closely with suppliers, and obtaining fewer defects than U.S. automakers received as well as quality improvements and price cuts after a model's introduction, the transplants resembled their Japanese parents in most areas of management style and performance. In fact, suppliers to the transplants were improving quality at a truly astounding rate, far exceeding Japanese suppliers though still trailing in absolute levels of defects reported.

The third question posed is more difficult to address: What does the survey say about effective supplier management in general and in the context of globalizing operations? Of course, the survey questions dealt with complex interrelationships that are not always easy to interpret. Nevertheless, several practices usually associated with Japanese supplier management appear to have a positive affect on performance, at least as measured in this study. In particular, longer contracts, suggestions to suppliers, and an emphasis on accurate target-pricing and cost-reduction capabilities, all seemed to encourage

high quality, low-cost components.

At the same time, however, Japanese relationships with their suppliers clearly went beyond formal contracts, which may make it difficult for the Japanese to use American or other foreign suppliers to the same extent as they use Japanese suppliers, such as in subcontracting detailed design or managing against price increases. For example, the Japanese automakers sent out inquiries and made supplier selections relatively late; this appears to require a level of confidence in suppliers that supercedes formal agreements or transactions as indicated by selection dates, especially since other data indicated the Japanese had long-term relations with a small number of suppliers.

In addition, the Japanese had more specific information on their suppliers' costs, such as for each process step, compared to the U.S. automakers or the transplants. While the level of detailed cost information was far from complete and did not correlate with the target price index, it suggests a relationship that would make it difficult for Japanese suppliers to bargain with the Japanese automakers, such as to increase prices over initial targets. The Japanese also set prices closer to market introduction, which may provide a better sense of costs, and assisted suppliers in lowering costs. Yet the Japanese automakers apparently would not accept price increases, which went against common practices in the United States even though the Japanese exhibited a stronger adherence to formal price commitments than U.S. suppliers did.

A more detailed examination of suppliers to the transplants raises another concern: that their performance reflects more a transfer of Japanese suppliers to the United States rather than a transfer of managerial skills through which the transplants encourage improvements, such as in cost reductions or quality, from U.S.-based suppliers. The data in the survey provide some insights into this issue. On the one hand, half the transplant suppliers for the sample of

components studied were Japanese firms operating in the United States; just over one-third (37.5%) were U.S. firms. For this reason, it appears true that a key and effective strategy for extending Japanese automobile manufacturing operations abroad has been the large-scale movement of suppliers to the United States. The higher quality and lower prices that come from Japanese suppliers in Japan, as well as relationships that allow Japanese automakers to subcontract large amounts of design, may well be a sufficient justification to continue this approach.

On the other hand, buying components and assembly services from local firms has strategic value as well as political benefits when dealing with local communities and governments, and perhaps customers as well. For this and other reasons, the Japanese may want to increase the level of involvement of U.S. suppliers. Information from the survey and interviews as well as in the literature, such as that the transplants received much higher quality from U.S. suppliers than U.S. automakers received from U.S. suppliers, even if this mainly reflected more stringent inspection, indicates that Japanese firms in the United States can work effectively with U.S. suppliers and that U.S. suppliers are willing and capable of improvements. Any improvements in cost and quality, moreover, bode well for U.S. consumers and for the competitiveness of the American automobile industry in general.

Appendix 1: Sample by Model Segment and Annual Volume

Units: Number of models, percentages in parentheses

	U.S.	Japan /U.S.	Japan	Total
Segment:				
Subcompact	3 (14.3)	8 (33.3)	8 (29.6)	19 (26.4)
Compact	4 (19.1)	16 (66.7)	15 (55.6)	35 (48.6)
Mid-Size	10 (47.6)	0 (0)	0 (0)	4 (5.6)
Full-Size	4 (19.1)	0 (0)	0 (0)	4 (5.6)
Annual Production:				
< 100,000	4 (19.1)	4 (16.7)	4 (14.8)	12 (16.7)
100,000-200,000	3 (14.3)	16 (66.7)	11 (40.7)	30 (41.7)
200,000-300,000	12 (57.1)	4 (16.7)	4 (14.8)	20 (27.8)
300,000-400,000	2 (9.5)	0 (0)	8 (29.6)	10 (1.4)
Total	21 (100)	24 (100)	27 (100)	72 (100)

Appendix 2: Data Sensitivity and Reliability

As in any survey of this type, there exist concerns about both the sensitivity of the data to foreseen as well as unforeseen biases or interactions among variables, and the reliability of the respondents. We included several measures to explore these possibilities and conclude that, with few exceptions, the data for the three groups appear statistically robust as well as comparable.

First, we were concerned that our selection of four components might have biased the results. If automakers in the three groups systematically managed these parts differently, the survey results might reflect management policies generally consistent for all components or merely differences related to the type of components. In a few cases, the type of part proved a significant variable in the analyses; however, as noted in Section 4, these were not common and did not affect the general results or conclusions of the survey.

Another concern was that, while we chose the components, respondents would choose models from different segments that would complicate an interpretation of the answers. For this reason, we asked for information on the model segments as well as production volumes (Appendix 1). As we suspected, the model mix differed; U.S. automakers reported on more full-size and mid-size vehicles, and the Japanese and transplants on more subcompact and compact vehicles. The U.S. models also had higher average annual production volumes, which might indicate a general bias toward mass production and low costs. However, analysis of variance (ANOVA) and chi-square tests for cross tabulation indicated that, while some minor differences existed, they did not affect the results reported in Section 4.

For example, information on inventory levels differed by model segments, where the Japanese and transplants reported on more subcompacts than other types of models. Differences among the three groups were not significant,

however, including or excluding subcompacts. Suggestions regarding quality control also differed by model segment, although excluding the mid-size and full-size vehicles, which were mainly in the U.S. sample and had lower rates of suggestions, the U.S. ratio remained significantly lower than for the other two groups. Other variables (suggestions about design changes, quality control, and inventory control) proved to be sensitive to model segment but did not affect the general results of the analysis. Eliminating full-size models from the analysis also reduced the difference between the average price-change rates for the U.S. group and the transplants to a level slightly below the 10% confidence interval, although the difference between the U.S. and Japan responses remained significant at the 1% level.

With regard to production volume, only a few variables proved to be sensitive to this attribute, and thus most results of the survey were unaffected. For example, while the importance attached to the initial price as a selection criterion for suppliers differed by production volume, the Japanese still placed more importance on this variable than the U.S. or transplant samples except for the 300,000 to 400,000 units-per-year segment, where both the Japanese and U.S. respondents strongly emphasized this variable. In the 200,000 to 300,000-unit segment, the emphasis of the transplants on this criterion was not statistically higher than the Japanese respondents. Possession of statistical process-control data, as well as suggestions regarding changes in materials, equipment, and inventory control, also showed some sensitivity to production volume, with a few significant differences becoming insignificant for particular volume segments. The reason for these results seems to be that U.S. automakers managed and performed more comparably to the Japanese and the transplants in their model lines with production levels below 200,000. However, including the volume segments above 200,000, the majority (nearly 67%) of the

U.S. models, the differences presented in Section 4 remain significant.

To gain a sense of the reliability of the data, we compared information in the survey with data from other researchers and our own interviews, and several times asked respondents to clarify or amend their answers (we found several mistakes that were obvious because the data did not make sense or were radically different from other respondents). In addition, for each question in the survey, we asked respondents to indicate their confidence in their answers on a three-point scale (1 = very confident, 2 = somewhat confident, 3 = not very confident). Of the 17 separate questions in the survey, in four instances each, the U.S. and transplant respondents had significantly less confidence than the Japanese respondents. This suggests that the data they reported for these questions may not be entirely accurate, although only in one instance did the average response from one of the groups appear to be "not very confident."

The U.S. group proved slightly less confident (1.3 score, different at the 10% significance level) than the Japanese and the transplants on one question asking when they started purchasing from a particular supplier and on another question asking at what stage in development they selected suppliers (1.67 score, significant at 5%). Both the U.S. and the transplant respondents were less confident than the Japanese regarding defect rates (1.9 score for the U.S., significant at 5%; 1.8 for the transplants, significant at 10%) and defect rate changes over time (2.6 score for the U.S., significant at 1%; 2.3 for the transplants, significant at 5%). The transplant respondents were also significantly less confident (at the 5% or 1% levels) in their answers, compared to both the U.S. and Japanese respondents, on two other questions: the type of information possessed on suppliers (1.7 score), and the type of suggestions made to suppliers (1.6 score).

The interviews provided an additional check on possible inconsistencies or

misunderstandings with the survey questions; as indicated in Section 6, the interviews with suppliers tended to reinforce and elaborate upon the survey findings. In addition, while the survey focused on the automakers' management of suppliers, the interviews also offered no indication that information provided by the automakers' procurement departments did not reflect actual operations at the suppliers. As discussed, however, the survey findings did, in some areas, contradict reports in the literature.

Appendix 3: List of Interviewees

Company Code (Product)	Interviews	Interviewee Positions
Automakers		
A1 (passenger car)	2	Executive Vice President
A2 (passenger car)	4	Purchasing Senior Advisor
		Vice President, Administration
		Administrator, Corp. Communications
		Administrator, Administration Dept.
A3 (passenger car)	1	Purchasing Advisor
A4 (passenger car)*	4	President
		General Manager, Purchasing
		Coordinator, Purchasing
		Coordinator, General Affairs
Suppliers		
S1 (seats)	3	Executive Vice President
		Representative, Sales and Marketing
		Executive Advisor
S2 (glass)*	2	Manufacturing Manager
		Administration Manager
S3 (electrical)	3	President
		Assistant Director
		Assistant GM, Marketing and Planning
S4 (brakes)*	1	Account Representative
S5 (electrical)	1	Senior Manager, Applications
S6 (electrical)	1	Vice President
S7 (plastic)*	1	Chairman
S8 (suspension)	2	President
		Officer Secretary
S9 (seats)	2	President
		Staff Coordinator, Purchasing
S10 (fasteners)*	1	General Manager, Sales
S11 (electrical)	2	President
		Executive Vice President
S12 (plastic)*	1	Vice President
S13 (electrical)	1	Vice President
S14 (seats)*	1	President
S15 (rubber)*	3	President
		Vice President, Production & Sales
		Administration & Purchasing Manager
S16 (brakes)	1	President
S17 (electrical)	2	President
		Director of Planning & Purchasing
S18 (suspension)*	2	President
		Assist. to President, Sales & Marketing
S19 (fasteners)	1	Vice President
S20 (rubber)	2	Vice President, Secretary/Treasurer
		Management Staff, General Affairs
S21 (brakes)*	2	President
		Executive Vice President
S22 (plastic)	1	Executive Vice President
S23 (radiators)	2	Vice President, Purchasing
		Sr. Advisor/Operations & Materials

Note: Due to requests for confidentiality the name of companies and persons interviewed are not identified. * indicates joint ventures of Japanese and American companies. The interviews were conducted by Akira Takeishi and Shoichiro Sei (of Chuo University) from January 22 through February 9, 1990.

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