

**CREATING AND MANAGING A HIGH PERFORMANCE
KNOWLEDGE-SHARING NETWORK: THE TOYOTA CASE**

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Abstract

This study offers a detailed case study of how Toyota facilitates interorganizational knowledge transfers among within its production network. In particular, we identify and examine six key institutionalized knowledge sharing routines developed by Toyota and its suppliers. By examining *how* Toyota facilitates knowledge-sharing with, and among, suppliers we are able to identify the key variables which influence interorganizational and network learning. Moreover, since Toyota is early in the process of creating a learning network with U.S. suppliers, we explore the creation and evolution of Toyota's new learning "network" in the United States. We attempt to extrapolate from Toyota's experience by developing a series of propositions regarding creating and designing a high performance knowledge-sharing network. We believe our analysis provides at least a partial explanation for why Toyota has been able to maintain its productivity and quality advantages long after the principles of the Toyota Production System have diffused throughout the industry (Knowledge Sharing, Interorganizational Learning, Competitive Advantage).

The ideas behind the Toyota Production System have basically diffused and are understood by our competitors. But the know-how regarding how to implement it in specific factories and contexts has not. I believe that Toyota Group companies are better at implementing the ongoing *kaizen* activities associated with the Toyota Production system.

Michio Tanaka, Director of International Purchasing, Toyota Corp., June 10, 1996

Recently both executives and academics have identified organizational learning as perhaps *the* key factor in achieving sustainable competitive advantage. As De Geus (1988) argues, "The ability to learn faster than your competitors may be the only sustainable competitive advantage." The academic literature on organizational learning as a source of competitive advantage is also expanding in unprecedented fashion (Cohen & Levinthal, 1990; Teece et al, 1997; Kogut & Zander, 1992; Spender, 1996; Grant, 1996). For example, Teece et al (1997) have proposed a "dynamic capabilities" approach to firm-level advantage suggesting that a firm's ability to continually learn, adapt, and upgrade its capabilities is key to competitive success. Other scholars have recently argued for a "knowledge-based view of the firm" suggesting that the key role of the firm is in creating, storing, and applying knowledge (Kogut & Zander, 1992; Conner & Prahalad, 1996; Grant, 1996) rather than simply reducing transaction costs (Coase, 1937; Williamson, 1985).

Although the focus of much of the organizational learning literature is on the individual firm as the unit of analysis, there is increasing evidence which suggests that a "network" of firms may be a critical, but less understood, unit of analysis for understanding firm-level learning (Powell et al, 1996; Dyer & Singh, 1996). Various scholars have recognized that *interorganizational* learning is critical to competitive success, noting that organizations learn by collaborating with other organizations as well as by observing and importing the practices of other organizations (March & Simon, 1958:188; Powell et al, 1996; Levinson & Asahi, 1996). This observation is supported by research on the sources of organizational innovation and knowledge (Mueller, 1962; Von Hippel, 1988; Nishiguchi, 1994). For example, Von Hippel (1988) found that a firm's customers and suppliers were its primary sources of innovative ideas. Von Hippel argues that a production network with superior knowledge-transfer

mechanisms among users, suppliers, and manufacturers, will be able to 'out innovate' production networks with less effective knowledge sharing routines.

In a similar vein, Powell et al (1996) found that in the biotechnology industry the locus of innovation was the network, not the individual firm. Patents were typically filed by a large number of individuals working for a number of different organizations, including biotech firms, pharmaceutical companies, and universities. Powell et al (1996) argue that biotech firms who are unable to create (or position themselves in) "learning networks" are at a competitive disadvantage. Although Powell et al (1996) make the case for the "network" as the appropriate unit of analysis for learning and innovation in biotechnology, they do not address the specific routines involved in the interorganizational learning process.

In fact, although there has been considerable theoretical discussion on the topic of organizational and network learning (Spender, 1996; Levinson & Asahi, 1996; Grant, 1996), there is little empirical research to date. As Grant (1996:384) recently observed, "detailed study of the operation of organizational [learning] routines is limited. Further progress is critically dependent upon closer observation of the processes through which tacit knowledge is transferred." How exactly are learning networks created? What are the structures and processes that allow for effective interorganizational learning within a network? How do firms in a knowledge-sharing network solve problems inherent in knowledge sharing, such as free rider problems and preventing undesirable spillovers? To answer these questions, it is important to empirically examine those networks which have demonstrated a particular ability at inter-firm knowledge transfers.

The automotive industry offers an interesting opportunity to empirically examine interorganizational learning. Automobiles are developed and manufactured by OEM's and their network of suppliers who often produce as much as 70 percent of the value of a vehicle. Consequently, the cost and quality of a vehicle is a function of the productivity of a network of firms working in collaboration. Research to date suggests that Japanese automotive networks, and Toyota's in particular, have been

superior at transferring productivity-enhancing knowledge throughout the network (Nishiguchi, 1994; Lieberman, 1994). For example, a study by Lieberman (1994) examined the diffusion of lean production practices as measured by labor productivity improvements and inventory reductions by automakers and their suppliers from 1965-1990. Lieberman found that in Japan, labor productivity (as measured by value added per employee) increased steadily and consistently for both automakers and suppliers throughout the time period (See Figure 1). In contrast, the productivity of U.S. automakers and suppliers was stagnant until the mid 1980s when U.S. automaker productivity began to increase. These productivity increases began during a time period when Japanese automakers began establishing transplants in the U.S. (U.S. figures include transplants) and when U.S. automakers were seriously attempting to imitate "lean" production practices by benchmarking "transplant" operations. However, these productivity improvements did not spillover to U.S. suppliers whose productivity remained stagnant until roughly 1990.¹ Why is this the case?

We submit that part of the answer has to do with the fact that Japanese automakers (especially Toyota) have developed bilateral and multi-lateral knowledge sharing routines with suppliers that result in superior interorganizational or network learning. Toyota, in particular, is widely recognized by both Japanese and U.S. firms as a leader in continuous learning and improvement. There are a number of reasons to examine Toyota's practices in greater detail. First, Toyota is the largest Japanese company and is regularly voted by Japanese executives as the best managed and the most respected Japanese company. Second, the most rapid diffusion of lean production techniques (e.g., kanban, inventory reduction) has occurred within Toyota and its suppliers (Lieberman, 1994). Moreover, Lieberman et al (1997) found a significant positive correlation between membership in Toyota's supplier association and supplier productivity. In summary, Toyota's "network" appears to be highly effective at facilitating

¹ Sako (1997) replicated Lieberman's study in the United Kingdom with virtually identical results.

inter-firm knowledge transfers and may be a model for the future.

This paper has two primary objectives. The first objective is to examine in detail the institutionalized knowledge sharing routines developed by Toyota and its suppliers. By examining *how* Toyota facilitates knowledge-sharing with, and among, suppliers we are able to identify the key variables which influence interorganizational and network learning. Moreover, since Toyota is early in the process of creating a learning network with U.S. suppliers, we have the opportunity to examine how a firm undertakes the task of creating a new learning "network." The second objective is to examine how Toyota has attempted to solve the dilemmas associated with knowledge transfers (e.g., free rider problems). We attempt to extrapolate from Toyota's experience to develop a series of propositions regarding creating and designing a high performance knowledge-sharing network.

THEORETICAL BACKGROUND

Research on organizational learning suggests that organizations that are effective at "learning" have developed routines that allow the firm to effectively develop, store, assimilate, and apply new knowledge on a systematic basis (Nelson & Winter, 1982; Levitt & March, 1988; Cohen & Levinthal, 1990; Nonaka, 1994). Nelson and Winter (1982) were among the first to argue that organizational "routines" are the essence of the firm and that organizational learning would be expected to occur when firms develop "adaptation routines" which allow the organization to continually modify existing routines based upon new knowledge. Other scholars have also viewed organizational learning as "routine based and history dependent" (Levitt & March, 1988: 319). Following Grant (1996) we define a learning routine as regular pattern of interactions among individuals which permits the transfer, recombination, or creation of specialized knowledge. Of course, organizational learning may also be haphazard in the sense that knowledge is not generated by routines but rather is based on "luck" or haphazard events. In this study we are interested in studying "routine-based" learning rather than "haphazard" learning. In

other words, our objective is to examine learning that is facilitated through interorganizational routines that are *purposefully designed to facilitate knowledge transfers* throughout the network.

We are primarily interested in the network as the unit of analysis rather than the individual firm (although these two levels of analysis are clearly related). Consequently, the routines of interest are those collectively developed within Toyota's production network which facilitate knowledge transfers among members. Since our focal interest is knowledge sharing within a network of firms, it is useful to define what we mean by knowledge. Most scholars divide knowledge into two types: (1) *explicit knowledge or information*, and (2) *tacit knowledge or know-how* (Kogut and Zander, 1992; Grant, 1996; Ryle, 1984). Information is defined as easily codifiable knowledge that can be transmitted "without loss of integrity once the syntactical rules required for deciphering it are known. Information includes facts, axiomatic propositions, and symbols" (Kogut & Zander, 1992:386). By comparison, know-how involves knowledge that is tacit, "sticky," complex, and difficult to codify (Nelson & Winter, 1982; Kogut & Zander, 1992; Szulanski, 1996).²

Information sharing within a network can be accomplished through "weak ties." Thus, the breadth or size of the network is likely to influence the amount of diverse information available to members and thus will be important for generating value to individual members. However, know-how is sticky, tacit, and difficult-to-codify and thus is difficult to transfer. Thus, it requires "thick" or dense ties with other members of the network. Consequently, a smaller network may have some advantages relative to a larger network. The properties of know-how suggest that, compared to information, know-how is more likely to result in advantages that are sustainable. As a result, production networks that are particularly effective at transferring know-how are likely to outperform competing networks.

² Spender (1996) separates tacit knowledge into three types: (1) conscious knowledge, or knowledge that can be codified to some extent and is potentially available to others, (2) automatic knowledge, which is taken-for-granted implicit knowledge that happens by itself, and (3) collective knowledge, or knowledge of a social or communal nature.

Previous research suggests that the effective transfer of know-how requires: (1) absorptive capacity (ability to assimilate the transfer) on the part of the receiving firm (Cohen & Levinthal, 1990; Von Hippel, 1988; Szulanski, 1996), (2) the appropriate processes to make the transfer happen; for know-how sharing the processes involve long term, dense (thick) network ties developed through repeated social (socio-technical) interactions (Von Hippel, 1988; Marsden, 1990; Kogut & Zander, 1992) and (3) incentives for knowledge sharing (transferring firm) and knowledge acquisition (receiving firm)[Szulanski, 1996]. These challenges are significant in a network setting because the creation of knowledge sharing routines among members poses two key dilemmas: (1) preventing “free riders,”³ and (2) preventing undesirable knowledge spillovers. Firms that have developed proprietary knowledge that they believe provides their firm a competitive advantage in the marketplace will be especially reluctant to participate in knowledge-sharing activities. Thus, a key challenge for a knowledge sharing network is providing assurances to members that proprietary knowledge will be protected while at the same time encouraging members to contribute valuable knowledge to the collective good. There is an important tradeoff here: network members may be so concerned about protecting proprietary knowledge that they devise rules or engage in behavior such that little or no valuable knowledge is contributed to the network. However, the knowledge that is likely to be *most* valuable to other firms in the production network is often exactly the kind of knowledge that individual firms want to keep proprietary because it is valuable.

RESEARCH METHODOLOGY

In our exploratory study the "production network" consisted of the group of firms which

³ The free rider problem is often discussed in collective action theories which examine the challenges associated with achieving collaboration toward common goals among self interested individuals, groups, or organizations (Rolphs, 1974; Sandler, 1992; Marwell & Oliver, 1993). Successful collaboration may produce “collective” or “public” goods (e.g., knowledge) that are accessible to all members of the network (impossibility of exclusion). However, the creation of routines for knowledge sharing within a network has the potential for “free riders,” members who enjoy the benefits of the collective good without contributing to its establishment and/or maintenance.

collaborate to develop and manufacture a motor vehicle. The automaker, Toyota, is the "central" or core firm in the network because: (1) Toyota is the only firm with direct ties to every other firm in the network, and (2) Toyota coordinates the activities of all firms in the network. As the central firm, Toyota also has the most to gain from developing learning routines that increase the efficiency of the entire value chain or production network.

The primary objective of this exploratory study was to identify and examine the *institutionalized routines* developed by Toyota designed to facilitate knowledge sharing among Toyota and its network of first tier suppliers. Consequently, it was necessary to identify the organizational units (divisions) within Toyota which interact with suppliers and are involved in "supplier development" activities. This was done by interviewing Toyota's purchasing general managers in both Japan and the United States. These senior purchasing executives identified the various Toyota divisions which had significant interactions with suppliers. These divisions included: (1) Purchasing Division, (2) Operations Management Consulting Division (OMCD), (3) Quality Assurance Division (QAD), (4) Logistics Administration Division (LAD), (5) Manufacturing Operations Division (MOD), and (6) Design Engineering Division (DED). Executives from each of these divisions were interviewed to identify the formalized routines designed to facilitate knowledge sharing with, and among, suppliers. Using a snowball sampling technique, our research team interviewed a total of 30 Toyota executives totaling more than 100 hours in interviews. To verify the knowledge sharing activities identified by Toyota, as well as explore the supplier-to-supplier routines not identified by Toyota, we also interviewed senior executives at 10 of Toyota's first tier suppliers in Japan and 11 Toyota suppliers in the U.S. (See Table 1 for a list of Toyota executives and suppliers interviewed).

As we conducted interviews with both Toyota and supplier executives, we focused our attention on identifying and understanding the bilateral and multi-lateral knowledge transfer "routines" among Toyota and its suppliers. We also explored the challenges associated with the creation and maintenance

of those routines.

INSTITUTIONALIZED KNOWLEDGE-SHARING ROUTINES

Toyota has developed a wide range of organizational routines to enhance “supplier development” and inter-firm learning. Purchasing takes the lead role in coordinating supplier development activities (followed by OMCD), but all of the previously mentioned divisions have specific “supplier development” responsibilities. When necessary, these different functions work together to solve problems with suppliers. Through our interviews we identified six key institutionalized processes/routines which facilitate inter-firm knowledge sharing within the production network (See Table 2).

1. Supplier Association

Toyota's supplier association (*kyohokai*) in Japan was established in 1943 to promote "mutual friendship" and the "exchange of technical information" between Toyota and its parts suppliers. In 1996 Toyota's *kyohokai* had three stated "purposes": (1) information exchange between member companies and Toyota, (2) mutual development and training among member companies, and (3) socializing events (Internal Toyota Document, 1996). To achieve these purposes, Toyota's *kyohokai* is divided into three regions, Tokai *kyohokai* (150 members) for the Tokai region (aichi prefecture where Toyota City resides), Kanto *kyohokai* (65 members) for the Tokyo region, and Kansai *kyohokai* (29 members). Toyota has created three separate regional associations because it recognizes that for the supplier associations to achieve their objectives, the suppliers must be in close geographic proximity (e.g., within 3-4 hours by car or train). Toyota also established an equipment supplier association (*eihoukai*) in 1983 which currently has 77 members and is designed to achieve the same purposes as the *kyohokai*.

Toyota started its U.S. supplier association (Bluegrass Automotive Manufacturers Association, or BAMA) in 1989 with only 13 suppliers. Involvement was voluntary and most of the initial members were U.S. suppliers and Japanese transplants located in close proximity to the Georgetown, Kentucky plant.

The initial objective was to provide a monthly forum for sharing information with suppliers and for eliciting supplier feedback. Even though few suppliers joined, Toyota proceeded and attempted to make BAMA meetings as valuable as possible for suppliers. Gradually, the word spread through the supply base that these meetings were useful. By 1997 the association had grown to 97 suppliers. States Toyota's Chris Nielsen, assistant general manager for purchasing planning,

We really didn't know if this would work in the U.S. Getting suppliers to talk to each other was a key element of the program. Before BAMA, it was not very natural for supplier executives to talk and share information. It was uncomfortable. Over the years that has changed significantly as suppliers have built relationships at senior levels (Interview, November 17, 1997).

This message is echoed by the plant manager of a Toyota supplier.

Before BAMA, we really didn't know or share information with executives at other suppliers. And we just didn't think about calling them up or visiting. It just didn't happen. BAMA has helped us to get to know each other and now it feels a lot more comfortable calling up another supplier for information or even visiting their plants (Interview, November 18, 1997).

The organization of Toyota's *kyohokai* is outlined in Figure 2. The general assembly, top management meetings, and executive meetings are designed to allow for high-level communication within the network with regard to production plans, policies, market trends, etc. Thus, these meetings primarily facilitate information sharing among members. More frequent interaction occurs within the divisional committees and topic committees (cost, quality, safety, etc.) where members engage in both information and know-how sharing. Divisional committees are comprised of suppliers who join the meetings because of the nature of the parts they produce or the production processes they employ. For example, division committee 2 is comprised of suppliers who primarily supply parts to the powertrain (engine, transmission, etc.) of Toyota vehicles. This allows Toyota and its members to share knowledge with others that are making parts which interface with each other. It also facilitates knowledge sharing among members using similar production processes. This method of grouping suppliers ensures that the information and know-how shared is relevant to the supplier member.

The topic committees on cost, quality, safety, and general affairs are designed to facilitate

knowledge sharing on topics that are critical to all members in the network.⁴ The PR-Sports committee (which primarily sets up golf events and baseball activities) is designed to facilitate social interaction among members. To illustrate the role that the topic committees play in facilitating network learning, we examine the quality committee activities in greater detail.

The quality committee, established in 1961, engages in a number of activities designed to improve the quality capabilities of members of the network. The "regular committee" picks a theme for the year (e.g., the 1994 theme was "Eliminating supplier design defects") and meets six times each year to share knowledge with regard to that particular theme. These themes are selected by suppliers (with Toyota's input) in areas believed to be important and relevant to a large number of members in the network. In addition to the "regular committee" meetings, the quality committee also sponsors "basic quality training," "excellent plant tours," and an annual "quality management conference." The basic training course offers quality training to approximately 100 engineers each year. The 5 session, 12 day course takes 96 hours to complete. This training provides a basic, common knowledge base (builds absorptive capacity) among network members which allows them to more efficiently transfer more complex quality knowledge through plant tours, conferences, etc.

The excellent plant tours allow network members to visit "best practice" plants both inside and outside the automotive industry so that members can see the processes used by firms which achieve high quality. The quality management conference is held once each year and offers Toyota suppliers the opportunity to learn from lectures delivered by experienced Toyota directors and senior managers, as well as six successful supplier cases of quality improvement: 2 managers' cases, 2 foremens' cases, and 2 quality circles' cases. The six supplier cases are selected from case write-ups submitted to a committee panel by

⁴ The general affairs committee focuses on activities of current interest to a broad set of members. For example, during 1994 (a recession year) the committee's "theme" was improving the productivity of white collar workers. This is of particular importance during a recession because Japanese firms cannot easily lay off white collar workers.

member companies. In 1994, 146 out of 150 Tokai Kyohokai members (98%) submitted cases to the conference.

In summary, the supplier association's primary objective is to develop ties among members and transfer explicit knowledge through multi-lateral knowledge transfers. The subcommittees are designed to facilitate the transfer of both explicit and tacit knowledge.

2. Operations Management Consulting Division

The Operations Management Consulting Division (OMCD) was established in the mid 1960s by Taiichi Ohno. The purpose of OMCD is to maintain a group of internal consultants with high levels of expertise in operations to assist in solving operational problems both at Toyota and at Toyota's suppliers. These individuals are assigned the task of assisting plants achieve productivity improvements, inventory reductions, and quality improvements. OMCD currently consists of six senior and highly experienced executives (each with responsibility for two Toyota plants and approximately 10 suppliers) and about fifty consultants. Approximately 15-20 consultants are permanent members of OMCD while the rest are younger individuals who are expected to deepen their knowledge of the Toyota Production System (TPS) and enhance their experience through a rotation (usually 3 years) at OMCD. In many respects, these senior executives and consultants are the experts of TPS. OMCD facilitates knowledge sharing by providing direct assistance to suppliers, who must request OMCD's assistance (usually through the purchasing division). This typically involves sending a team of consultants to the supplier for a period of time ranging from 1 day to many months, depending on the nature of the problem. This assistance is "free" to suppliers who are not charged for the consultants time. Our 1992 survey of 38 first tier Toyota suppliers revealed that all suppliers in our sample had, at one time or another, been visited by Toyota personnel who assisted in improving the suppliers' operations. On average, suppliers reported receiving 4.2 visits per year (during the past three years) and these visits lasted an average of 3.1 days.

The U.S. version of OMCD is called the Toyota Supplier Support Center (TSSC). TSSC was established in 1992 with the objective of "assisting North American suppliers to implement their own version of TPS" (Internal Toyota document, 1995). TSSC's general manager, Hajime Ohba, was formerly a member of OMCD in Japan. TSSC began in 1992 with only one consultant, Mr. Ohba, but the consulting staff grew to 14 by 1994, and 20 by 1996. The real know-how sharing occurs in the consultation projects with suppliers on the plant floor. Since 1992 TSSC has received approximately 100 requests for assistance and has entered into 53 consultation projects. Toyota does not charge fees for its assistance but does demand that participating suppliers be willing to let Toyota bring other companies to see their operations when the project is completed. States TSSC consultant Lesa Nichols, "That's one of our requirements because if we take the time and effort to transfer the know-how, we need to be able to use the suppliers' operations as a vehicle to help other suppliers." This allows Toyota to: (1) develop some "showcase suppliers" that have successfully implemented the TPS; this provides a valuable learning laboratory for other suppliers attempting to improve their operations, and (2) start the process of getting suppliers to open their operations to one another.⁵ Suppliers are selected based upon several factors, including: their enthusiasm for improvement, the involvement of top management, and the potential for successful completion within six months. To date, Toyota has found that know-how transfers with regard to TPS are extremely difficult and time consuming. Although the goal is to achieve success in 6 months, no project has been completed in less than 8 months and most last at least 18 months. States Mr. Ohba, "It takes a very long time and tremendous commitment to implement the Toyota Production System. In many cases it takes a total cultural and organizational change. Many U.S. firms have management systems that contradict where you need to go." Consequently, some of TSSC's consulting projects can be quite time and resource intensive. One of the first U.S. suppliers to use TSSC was Summit Polymers, a manufacturer

⁵ Suppliers can designate certain other areas of their plants (where Toyota has not provided assistance) as off-limits to visits in order to protect proprietary knowledge.

of plastic interior parts. According to Tom Luyster, Summit's Vice President of Planning, TSSC sent approximately 4-6 consultants *every day* for a period of 3-4 months as Summit Polymers attempted to implement TPS concepts in a new plant. In their case, ongoing support has continued for over 3 years.

By November of 1996, TSSC had "completed" 31 projects with suppliers with impressive results. On average, TSSC had assisted suppliers in achieving an average inventory reduction of 75 percent and an average increase in productivity or output per worker of 124 percent (See Figure 3). These data provide evidence that TSSC's process of knowledge transfer and assistance substantially improves performance. It is worth noting that Toyota does not ask for immediate price decreases or a portion of the savings from the improvements. However, suppliers claim that they often pass on some of the savings due to a feeling of obligation.

3. Voluntary Learning Teams (Jishuken)

OMCD facilitates knowledge sharing across suppliers in a way that is quite unique within the automotive industry (and perhaps within any industry). In 1977 OMCD organized a group of roughly 55-60 of its key suppliers (providing over 80 percent of its parts in value) into "voluntary study groups" (*Jishukenkyu-kai* or *jishuken*) for the purpose of assisting each other with productivity and quality improvements. Each supplier group consists of roughly 5-7 suppliers, many of whom use similar production processes (e.g., stamping, welding, painting, etc.). Body suppliers are placed in one of two groups (Group I, II) and parts suppliers are placed in one of seven groups, (Groups A-G; See Figure 4). Toyota groups suppliers together based upon: (1) geographic proximity, (2) competition (direct competitors are not in the same group), and (3) experience with Toyota (each group has at least one affiliated Toyota supplier such as Denso or Aisin Seiki; these suppliers may be expected to take a leadership role). Groups are usually reorganized every three years by Toyota in order to put some stimulus

into the activity and maintain diversity of ideas.⁶ Each year the suppliers meet together with the responsible OMCD manager and consultants to determine a "theme" (project) for the year. The basic idea is to help each other increase productivity in areas of common interest, such as reducing lead times or inventories. Supplier executives that participate in *jishuken* activities are typically plant managers, assistant plant managers, and/or section managers (each member company usually has 5-8 people taking part in the activity).

After a theme is decided, the group then sets a schedule to rotate from one supplier plant to the next to examine the processes in question and to jointly develop suggestions for improvement. The group will go through four "phases" with regard to each project and will focus on one supplier plant for a period of four months. The phases are as follows: (1) preliminary inspection, (2) diagnosis and experimentation, (3) presentation, (4) follow-up/evaluation. During the first two months the processes being examined are videotaped and executives from the other suppliers visit as needed in order to examine the process and offer suggestions for improvement, much like consultants. A member of OMCD also visits frequently (i.e. every week or two) to give advice and monitor progress. This allows Toyota to bring its expertise to bear in helping solve supplier problems. It also allows Toyota to "learn" what is being learned by suppliers. This adds to Toyota's stock of knowledge and allows OMCD to keep abreast of new ideas and applications of the Toyota Production System. This is valuable to both Toyota and the network because OMCD can transfer this knowledge to Toyota's internal operations or to other suppliers. At the end of the year Toyota organizes a meeting (conference) where all of the *jishuken* groups meet together to share the key knowledge acquired from the year's activities. This allows suppliers to learn what issues are being addressed in other groups. This is useful for two primary reasons. First, suppliers often acquire valuable information from the presentations, including ideas for the next year's *jishuken* project. Second, and more

⁶ However, Toyota last reorganized its *jishuken* groups in 1992 so the current groups have been together for 5 years.

importantly, suppliers obtain information on which other suppliers are working on projects that may offer valuable knowledge. This information is useful because supplier executives can follow-up informally in making contacts to learn from those suppliers with relevant expertise.

In 1994 Toyota established its Plant Development Activity (PDA) Core Groups which was an attempt to replicate the *jishuken* concept in the United States. Three groups were formed with 11 suppliers placed in each group.⁷ As with the supplier association, involvement was voluntary and suppliers that were chosen for involvement were members of BAMA. The theme for the first year was "quality improvement" because, as Nielsen noted, "everyone agrees that they can improve quality." Each TPS core group member was asked to select a "demonstration line" within a plant as a place to experiment when implementing the concepts. A schedule was developed to meet each month at a supplier plant at which Toyota personnel from the technical support group would attempt to demonstrate some key concepts at the demonstration line, and the group members would discuss ways to improve the line. The group would visit the same supplier for three months and then rotate to a new supplier.

The first year was successful enough that other suppliers requested the opportunity to join a PDA core group. So Toyota added 15 suppliers and another PDA core group in 1995 (roughly 12 suppliers per group). However, some of the groups were experiencing difficulties because of markedly different skills and knowledge of TPS methods among suppliers. Stated Toyota technical support specialist Tom Fitzgibbons, "We tried high skill and low skill suppliers together but sometimes it didn't work well because we had to keep stopping to explain basic concepts to the new suppliers." Consequently, Toyota reorganized the groups in 1996 into four groups where "skill level" was also considered. The "orange" group included suppliers with strong TPS skills, the "blue" and "green" groups with mid-level skills, and

⁷ Toyota indicated that they considered two factors in placing suppliers into groups: (1) no direct competitors in the same group, (2) geographic proximity (they try to keep members within a 3-4 hour drive).

the "purple" group consisted of less experienced or new members who were participating for the first time.

In order to be considered for participation in a PDA core group the supplier must be a member of BAMA for at least one year. Toyota claims that this requirement is necessary to assure assimilation into BAMA, top management commitment, and familiarity with the basic concepts of TPS (e.g., develop the requisite absorptive capacity within the supplier). US. plant managers report that they believe the PDA core group activities have been extremely valuable. Stated one plant manager,

We get blinded just like everyone else. When you bring a whole new set of eyes into your plant you learn a lot. You feel like you are getting beat up for the first few hours. We've made quite a few improvements. In fact, after the (PDA) core group visits to our plant, we made more than 70 changes to the manufacturing cell.

In fact, all 10 U.S. suppliers we interviewed claimed that the PDA core group activities are *more valuable* to suppliers than BAMA. As one plant manager stated,

I think BAMA is extremely valuable. But the TPS core group activities are even more valuable to us than BAMA. If I had to choose, I would definitely choose to be involved in the core groups rather than BAMA. We learn more that is useful in our daily operations.

A key reason that the PDA core group activities are particularly effective at knowledge transfers is that they involve learning that is "hands on" and "on site." Furthermore, as one plant manager noted, "We find more things that are useful visiting other suppliers' plants versus Toyota's plants; even simple things like how to best start our equipment. Suppliers' operations are more similar to ours."

4. Problem Solving Teams

Jishuken teams are processes designed to systematically transfer knowledge that resides within network members to other members. However, in addition to *jishuken*, Toyota has a process of forming problem solving teams designed to bring knowledge to bear in solving emergent problems within the network. For example, in some cases a supplier may be experiencing a quality problem where the root cause is not easily determined. In this case, Toyota's Quality Assurance Division (QAD) will set up a problem solving team (which includes various Toyota divisions and may even involve other Toyota

suppliers) to collectively bring their knowledge to bear to “fix” the quality problems. When established, the team defines the cause(s) of the supplier’s quality problems and hands over the problem solving process to an appropriate division(s) within Toyota. For example, once the problem-solving team has defined the root of the supplier’s quality problem as being in the product design, Toyota’s Design Engineering Division, which has already been involved in the problem-solving team, will be asked to take the lead in working more closely with the supplier to implement solutions to improve quality. In some cases, Toyota may determine that the relevant knowledge resides within a competitor of the supplier. In this case, Toyota will attempt to orchestrate a supplier-to-supplier knowledge transfer. Toyota has long maintained a two vendor policy and typically procures the same types of parts from two suppliers. When the quality of one supplier is significantly inferior to the other’s, QAD may transfer information regarding quality processes from the better supplier to the inferior supplier based upon a negotiated agreement with both suppliers. In some rare cases, QAD will coordinate a visit by the inferior supplier to the superior supplier’s plant.⁸ According to Toyota executives, upgrading the skills of the inferior supplier not only improves the quality of the weaker supplier but also stimulates long term competition (see Dyer & Ouchi, 1993).

5. Interfirm Employee Transfers

The practice of interfirm employee transfers (*shukko*) in Japan is by now well known (Cusumano, 1985; Lincoln et al, 1992; Gerlach, 1992; Dyer & Ouchi, 1993), though less is known about how many individuals are transferred or the exact reasons for employee transfers. Some previous studies suggest that important reasons for *shukko* include helping large assemblers maintain control of suppliers and the opportunity to shed unwanted employees (Lincoln et al, 1992; Gerlach, 1992). However, our interviews

⁸ We did not find this type of supplier-to-supplier knowledge sharing in the U.S. However, 8 of 10 U.S. suppliers we interviewed reported that Toyota orchestrated a trip to Japan during which they visited supplier plants, in some cases Japanese suppliers in the same business.

suggest that, at least in Toyota's case, *shukko* is also an important mechanism for transferring knowledge to suppliers. In a survey of 48 of Toyota's largest suppliers, we found that 11 percent of the suppliers' directors (*yakuin*) were former employees (the figure was 23 percent for Toyota's "affiliated" suppliers or suppliers in which Toyota owned some stock). Overall, Toyota transfers approximately 120-130 individuals per year to other firms in the value chain, most of whom go to suppliers (Interview, June 10, 1997). Some of these transfers are permanent in nature (usually at the director level) but others are temporary. For example, when we visited Kojima Press, a supplier of spoilers and other body parts, we found that the assistant plant manager was a Toyota engineer on leave from Toyota for a 2-3 year assignment. The purpose of the assignment was to bring his Toyota training and knowledge to bear in helping the supplier while learning about the problems that suppliers experience. At another supplier, we interviewed a "transferee" who had been sent to the supplier to help it set up operations and accounting systems in the U.S. and Mexico. This particular individual had worked in the automaker's U.S. operations and therefore had a knowledge of U.S. and Mexican accounting systems which he was able to transfer to the supplier. In many cases the supplier may have a need for particular skills or knowledge which members of its workforce do not possess. Consequently, it will make a request to the automaker (usually through purchasing to the personnel department) for someone with particular skills. The automaker will search within its organization and then offer someone to the supplier organization. Suppliers claimed that they had the right to refuse the person offered. However, given Toyota's importance as a customer, it is questionable as to whether this "right" is ever exercised. Regardless, these transfers are an important routine which fulfills a knowledge-transfer function. To date, these transfers only occur with Japanese suppliers in Japan.

6. Performance Feedback and Monitoring Processes

Finally, by providing frequent performance feedback to suppliers and by monitoring whether or

not suppliers implement new knowledge/technology, Toyota pushes suppliers to learn and implement new knowledge. In particular, Toyota has developed numerous means for giving feedback to suppliers on their performance and encouraging them to implement new practices to improve their productivity and quality. For example, Toyota systematically offers feedback to suppliers on their performance in a number of areas, including management, production, quality, research, etc. Wada (1991) claims that by providing feedback to suppliers on their performance, suppliers feel motivated to search for new technologies and methods to improve.

“Without naming names the [performance] Summary...enabled each supplier to see quite easily where the company stood in relation to other companies in the same line of business and in relation to all the other companies. This ranking of suppliers and its publication at an open meeting in a form that made it easy for suppliers to compare themselves with others had the effect of stimulating a more competitive spirit among suppliers.” (Wada, 1991:31).

In addition to the regular feedback (e.g., monthly) on performance, Toyota also provides more detailed feedback on an adhoc basis and occasionally conducts audits to monitor whether or not suppliers are implementing new processes. For example, QAD is in charge of quality audits for supplier plants. QAD visits suppliers on a rotating basis to check to evaluate quality systems and processes and to ensure that these processes maintain the company's quality standard. The purchasing division typically identifies which suppliers it wants QAD to visit based upon the purchasing division's evaluation of the supplier's quality performance. Naturally, suppliers with a history of quality problems are more likely to be audited. During these audits, QAD writes a “quality problem report” which analyzes whether there might be chronic and fundamental problems in a supplier's production system. These audits also give QAD an opportunity to provide direct, on site instruction to suppliers in quality assurance processes. In a similar fashion, Toyota's “cost planning departments” within both purchasing and engineering monitor suppliers' components costs. OMCD would be asked to assist suppliers that needed to reduce costs and improve productivity.

After Toyota offers instruction to suppliers, Toyota documents the changes that suppliers are asked

to make. They use this documentation later when monitoring the suppliers' processes to ensure that suppliers have implemented the necessary changes. To illustrate, a U.S. supplier executive described how Toyota used this information to push his company to learn and improve.

Toyota sent in a team of consultants to offer suggestions on how we could reduce our costs to meet the target cost. Their help was extremely valuable and we made some significant improvements. But after considerable effort we felt we would be unable to hit the target cost. So we visited the purchasing manager to ask for a price increase. After we made the request, the purchasing manager pulled out a file which had a list of the actions we were to take based upon the suggestions of their consultants. While pointing to the first item on the list, he asked, "Have you done this yet?" Fortunately we had and we responded positively. But then he proceeded to go through each item the list. We could only answer "yes" to about two-thirds of the items. Then he said politely, "When you have taken action on every item on this list you won't need a price increase; but if you still think you do, come back and we will discuss it (Interview, September 1993).

This supplier executive explained that while Toyota is generous in offering assistance, they also expect results. Perhaps that is why the supplier community in Japan often uses the term "Toyota Jigoku" (Toyota Hell) to refer to working with Toyota. Working with Toyota as a supplier is not easy because Toyota is extremely demanding and expects continuous improvement (learning). But Toyota's efforts to assist suppliers and to encourage them to improve have resulted in a supplier base that is the most productive in the industry (Lieberman et al, 1997).

In summary, Toyota has created a number of complex routines designed to store and diffuse knowledge within the network and facilitate both bilateral and multi-lateral transfers of both explicit and tacit knowledge. As a final example of the importance Toyota places on communication with, and among suppliers, Toyota is currently building a "Supplier Center" next to its headquarters and technical center in Toyota City, Japan. The new five-floor building, which will be completed in 1998 to commemorate the 50th anniversary of the *Kyohokai*, will have display rooms for suppliers' products as well as meeting rooms to be used for suppliers. The building represents not only Toyota's commitment to working closely with its suppliers, but also demonstrates Toyota's appreciation of its suppliers' contribution to Toyota's success.

FEATURES OF AN EFFECTIVE KNOWLEDGE-SHARING NETWORK

Our exploratory study of Toyota's knowledge sharing network suggests that there are a number of important features that play an important role in creating and managing an effective knowledge-sharing network.

1. Creating Organizational Units (Locations) for Accumulating Knowledge in the Network.

In order to increase the ability of the organization/network to accumulate and build on its stock of valuable knowledge, Toyota has created a number of organizational units which are given the responsibility for knowledge acquisition, storage, and diffusion. The most important of these is OMCD/TSSC which has the primary responsibility for acquiring, storing, and diffusing production know-how. However, the supplier association subcommittees (e.g., cost, quality, safety) and *jishuken* also perform important knowledge management functions. By creating organizational units that are tasked with accumulating knowledge that resides within the network, Toyota has been able to systematically build and add to the existing stock of knowledge within the network. Furthermore, network members know where to find different types of knowledge so it reduces their search costs. As one supplier executive noted, "With Toyota as a customer, I always know where to go to get help when I have a problem." Thus, we offer the following proposition:

Proposition 1: The amount of interorganizational learning which takes place within a production network increases when the network creates organizational units (locations) for accumulating the stock of knowledge that resides within the network. (Increases the number of individuals/units responsible for knowledge acquisition, storage, and diffusion).

2. Eliminating "Proprietary Knowledge" Within Particular Knowledge Domains

We previously suggested that a fundamental dilemma for a knowledge sharing network is providing assurances to members that proprietary knowledge will be protected while at the same time encouraging members to contribute *valuable* knowledge to the collective good. Toyota solves this

problem by simply eliminating the notion that there is “proprietary knowledge” within certain knowledge domains (e.g., production, quality, etc.). By openly sharing *all* of the valuable production know-how at its disposal, Toyota creates a norm within the network that very little of the knowledge that a firm possesses is proprietary (with the exception of certain product designs/technology). Production processes are simply not viewed as proprietary and Toyota accepts that some valuable knowledge will spillover to benefit competitors. Thus, any knowledge that is production related (cost, quality, inventory management, etc.) is viewed as accessible to virtually any member of the network (with *perhaps* the exception of a direct competitor). Toyota creates a norm of reciprocal knowledge sharing within the production network by providing free assistance to suppliers and allowing suppliers full access to Toyota’s operations and stock of knowledge (the *only* exception is the new model design area which is available only to certain key suppliers). Suppliers *must* be willing to open their plants to other network members if they choose to receive Toyota consulting assistance and/or participate in *jishuken*/PDA core groups. This requirement essentially eliminates the free rider problem because the price of entry is a willingness to open up your operations for inspection. As one supplier executive stated, “They gave us a gift [TPS]; how can we not open our plant and share what we’ve learned with other Toyota suppliers.” Thus, Toyota’s initiatives to freely share its proprietary knowledge with other network members act as a “starting mechanism” (see Gouldner, 1963) for reciprocal knowledge sharing of proprietary knowledge. In turn, these norms have the effect of minimizing the amount of firm-specific knowledge within particular knowledge domains that is considered proprietary.

Proposition 2: The amount of interorganizational learning which takes place within a production network increases when the network creates norms for knowledge sharing which minimize the amount of firm-specific knowledge that is considered proprietary by network members.

3. Creating Multiple Knowledge-Sharing Processes and Nested Networks in the Larger Network

Toyota has developed a variety of bilateral and multi-lateral processes to facilitate the sharing of

different types of knowledge (both explicit and tacit) within the network. This allows for a “matching” of the type of knowledge with the process such that the knowledge flows in the most efficient manner possible. For example, the supplier association is a vehicle for quickly disseminating explicit knowledge to all members of the network. By creating “nested networks” (e.g., the jishuken groups) within the full network, individual members are able to develop embedded ties with those other members that have particularly relevant knowledge. Further, the processes allow for multi-lateral transfers of tacit knowledge on a particular topic/knowledge domain. OMCD and the problem solving teams engage in bilateral tacit knowledge transfers of a particular type. Thus, there are a variety of complex processes through which members can choose to receive, or transfer, different types of knowledge. Generally speaking, the more tacit the knowledge, the smaller the knowledge sharing group and the longer the transfer takes.

Proposition 3: The amount of interorganizational learning which takes place within a production network increases when the full network creates nested networks to facilitate the sharing of different types of knowledge.

Incentives for Knowledge Acquisition and Application

In addition to creating a norm for reciprocal knowledge-sharing among network members, as previously described Toyota “pushes” suppliers to learn through frequent performance feedback and monitoring processes. Ultimately, suppliers pursue the acquisition of knowledge in a self-interested effort to increase firm-level productivity and profitability. However, the fact that Toyota constantly keeps “score” with regard to a supplier’s success at implementing new knowledge provides constant motivation to acquire and implement new knowledge. Furthermore, Toyota rewards those suppliers that make exceptional knowledge-sharing contributions to the network by giving them additional business or even paying a bonus for their contributions (See Nishiguchi, 1997).

Proposition 4: The amount of interorganizational learning which takes place within a production network increases as measures of learning are developed and feedback on performance

is frequently shared within the network.

In summary, Toyota is effective at creating an effective knowledge sharing network because it: (1) creates organizational units with the explicit responsibility to accumulate, store, and diffuse relevant knowledge within the network, (2) creates “rules” or norms for participation in the network which essentially eliminates the free rider problem, (3) creates a range of processes and nested networks within the full network to facilitate the effective transfer of both explicit and tacit knowledge, and (4) creates incentives for knowledge acquisition and application.

The Creation and Evolution of Toyota’s Knowledge-Sharing Network

By examining the creation and evolution of Toyota’s network over time, we gain insights into how firms may attempt to successfully create and manage a knowledge sharing network. In particular, our ability to study the creation and evolution of Toyota’s relatively new U.S. supplier network offers the opportunity to examine how the network was created as well as how it has evolved. Our exploratory study of Toyota suggests a number of factors have contributed to its ability to create high-performance knowledge-sharing networks in the U.S. and Japan. First, Toyota introduced three institutional innovations which have played an important role in the creation of the network and in facilitating interorganizational learning. These innovations were: (1) the supplier association, (2) the in-house knowledge transfer consultants (OMCD, TSSC), and (3) *jishuken* or small group learning teams. In both Japan and the United States, these institutions were introduced to suppliers in the same order (See Figure 5). Toyota first established the supplier association which facilitated the sharing of explicit knowledge and the creation of social network ties among suppliers. This was a critical first step in getting members of the network to talk to each other in a non-threatening setting. The supplier association was followed by the availability of Toyota consultants who were accessible, free of charge, to transfer valuable tacit know-how regarding TPS at the suppliers’ facilities. The Toyota consultants were the catalysts for

creating a norm of reciprocal knowledge sharing (of seemingly proprietary knowledge) and a feeling of indebtedness and openness within the supplier network. Indeed, to receive assistance from Toyota consultants the supplier had to agree to open up its plant to other Toyota suppliers. Finally, after network members had developed social ties and norms of reciprocal knowledge sharing with Toyota (and a feeling of obligation to Toyota) and other Toyota suppliers, Toyota organized suppliers into small learning teams, carefully organizing teams to maximize the willingness and ability of suppliers to learn from each other (e.g., keeping direct competitors apart; rotating group membership to maximize diversity of ideas, requiring a minimum level of absorptive capacity with regard to TPS, etc.). By doing so, Toyota created a set of “nested networks” within the full network. These nested networks were designed to facilitate the sharing of tacit knowledge among members and reduced the importance of Toyota’s role in the network. Over time, the network became more effective at facilitating both explicit and tacit knowledge transfers due to the creation of a variety of processes for knowledge sharing.

Thus, the network structure, motivation for member participation, and types of knowledge shared have evolved and changed substantially over time. In the initiation phase the network structure was one large network with the core firm (Toyota) as a hub subsidizing network activities (See Figure 6).⁹ There were weak ties among network members and few members even had strong ties with the core firm. Suppliers were motivated to participate in the supplier association primarily to demonstrate their commitment to Toyota in hopes that Toyota would reward them with more business. The type of knowledge exchanged was primarily explicit knowledge/information. Over time, Toyota built strong bilateral relationships with suppliers through the one-to-one knowledge transfers and the supplier association activities. Suppliers now participated in the network not only to demonstrate their

⁹ Toyota’s subsidies came in two forms: 1) financial (money for meeting rooms, social activities, organizing and planning meetings); and 2) valuable knowledge (Toyota sends in its consultants free of charge to participating members). It was important for Toyota to subsidize network knowledge-sharing activities early on to ensure that members realized sufficient benefits from participation.

commitment to Toyota, but also to receive the knowledge transfers from Toyota. The knowledge exchanged was primarily explicit knowledge in the large network (supplier association) setting but also tacit knowledge in the bilateral-transfer (consulting) setting.

The next phase in the evolutionary process was to strengthen multi-lateral ties among members and develop multiple “nested networks” for knowledge sharing within the larger network. This was accomplished largely through the *jishuken*/PDA core group processes which strengthened multi-lateral ties, thereby facilitating knowledge sharing among suppliers. At this stage of network evolution, the individual supplier’s motivation for participation in network activities is knowledge acquisition and reciprocity. Thus, network knowledge sharing processes have become self-sustaining in the sense that suppliers willingly and actively participate without doing it simply to show loyalty to Toyota. Further, there are multiple mechanisms for transferring both explicit and tacit knowledge, with mostly tacit knowledge being exchanged in the nested networks and one-to-one transfers. In this mature phase of the network, the degree of tacit knowledge being transferred is *substantial* whereas it was almost non-existent in the initiation phase (See Figure 6).

CONCLUSION

Our study suggests that Toyota’s ability to effectively create and manage knowledge sharing processes within its production network at least partially explains the relative productivity advantages enjoyed by Toyota and its suppliers (Lieberman et al, 1997; Dyer, 1996). Toyota has created a set of “meso” routines which facilitate the bilateral and multi-lateral transfer of knowledge among production network members. This explains why Toyota continues to maintain its productivity and quality advantages long after the practices and principles of TPS have diffused throughout the auto industry. As Toyota’s international purchasing chief, Michio Tanaka, observed, Toyota is simply better at “knowing how to implement TPS in specific factories and contexts.” Many of these knowledge-transfer processes

are unique to Toyota. Competitors have not yet been able to imitate the institutionalized knowledge sharing processes that reside within the Toyota production network. Our research indicates that network-level knowledge sharing routines are a critical factor in explaining why Toyota is a moving target and why it continues to maintain productivity and quality advantages over its competitors. Our study also suggests that the notion of a “dynamic learning capability” (Teece et al, 1997) that creates competitive advantage may well need to be extended beyond firm boundaries.

TABLE 1.**LIST OF TOYOTA EXECUTIVES AND SUPPLIERS INTERVIEWED****Toyota Executives Interviewed**

| <u>Name</u> | <u>Position</u> | <u>Name</u> | <u>Position</u> |
|------------------------|---|-------------------------|--|
| 1. Koichiro Noguchi | Gen. Mgr.-Int. Purchasing | 12. Suguya Fukusato | Proj. Mgr. - Int. Affairs Technical Admin. Div. |
| 2. Michio Tanaka | Gen. Mgr.-Int. Purchasing | 13. Takaaki Matsumoto | Gen. Mgr. Public Affairs |
| 3. Junzo Matsumoto | Mgr. - Planning & Admin. Int. Purchasing Div. | 14. Noriyuki Yokouchi | V.P. - Purchasing |
| 4. Kenji Sato | Corp. Mgr.-Purchasing | 15. Chris Nielson | Asst. Gen. Mgr. - Purchasing Planning |
| 5. Nobuhiko Suzuki | Mgr. - Cost Reduction Int. Purchasing Div. | 16. Motoo Usui | Coord. - Purchasing |
| 6. Keiichi Tamura | Asst. Mgr. - Engine, Power Train, & Electronics Parts & Body Purchasing | 17. Lance Lewis | Mgr. - Tech Support Purchasing Planning |
| 7. Tsuyoshi Kuriyamoto | Mgr. - Metal, Interior & Chemicals, Parts & Body Purchasing | 18. F.E. (Gene) Tabor | Gen. Mgr. - Parts and Components Purchasing |
| 8. Bart D. Heller | N. Amer. Project Group Int. Purchasing Div. | 19. Masami (Max) Suzuki | Coordinator - Purchasing |
| 9. Hiroshi Kawaguchi | Mgr. - Administration Purchasing Planning | 20. Tom Fitzgibbons | Asst. Project Mgr - Tech Support - Purchasing |
| 10. Ichiro Yamada | Asst. Mgr. - Planning & Administration Group Int. Purchasing Div. | 21. Hajime Ohba | General Mgr., TSSC |
| 11. Yukihiro Takemura | Asst. Mgr. - Equipment Design Dept. Body | 22. Lesa Nichols | Asst. Mgr. - Research & Training, TSSC |
| | | 23. Cindy Kuhlman-Voss | Specialist - Research & Training, TSSC |
| | | 24. Koji Kondo | Proj. Mgr. - Bus. Planning Proj. Planning/Mgmt |
| | | 25. James R. Olson | V.P. - External Affairs |
| | | 26. Kenji Miura | Manager, OMCD |
| | | 27. Kazunori, Hayashi, | Project GM, Int. Purchasing |
| | | 28. Toshihiro Sugai | Gen. Mgr., Quality Control |
| | | 29. Ryoichi Hibio | Manager, Purchasing |
| | | 30. Akihiko Morikawa, | Manager, Purchasing |

Toyota Suppliers Interviewed**Japan**

1. Nippondenso Co.
2. Kojima Press Co.
3. NSK Ltd.
4. Asahi Glass Co.
5. Aishin Seiki Co.
6. Araco Corporation
7. Tokai Rika Co.
8. Toyota Automatic Loom Works
9. Toyota Auto Body Co.
10. Central Motor Wheel Co.

United States

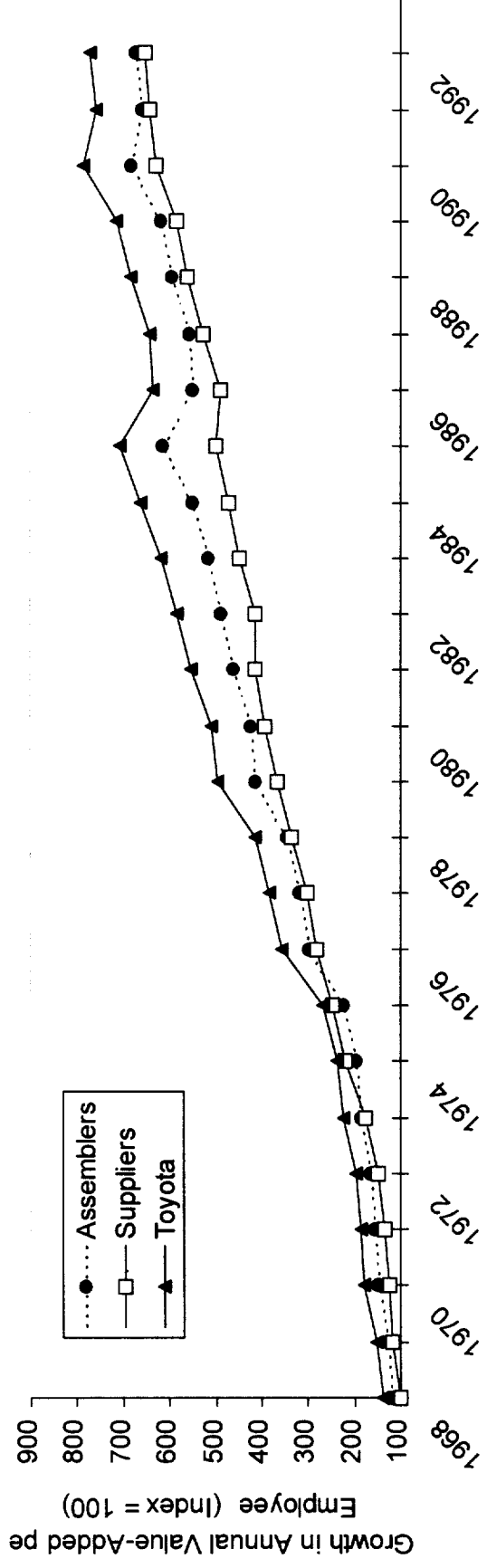
1. Johnson Controls, Inc.
2. Continental Metal Specialty, Inc.
3. Summit Polymers, Inc.
4. Amtex
5. Aisin U.S.A. Mfg., Inc.
6. Quality Safety Systems Co.
7. Lucas Body Systems NA - Ettrick
8. Tokai Rika U.S.A., Inc.
9. Takata Inc.
10. McKechnie Vehicle Components
11. Grand Haven

TABLE 2**KEY KNOWLEDGE-SHARING PROCESSES IN THE TOYOTA NETWORK**

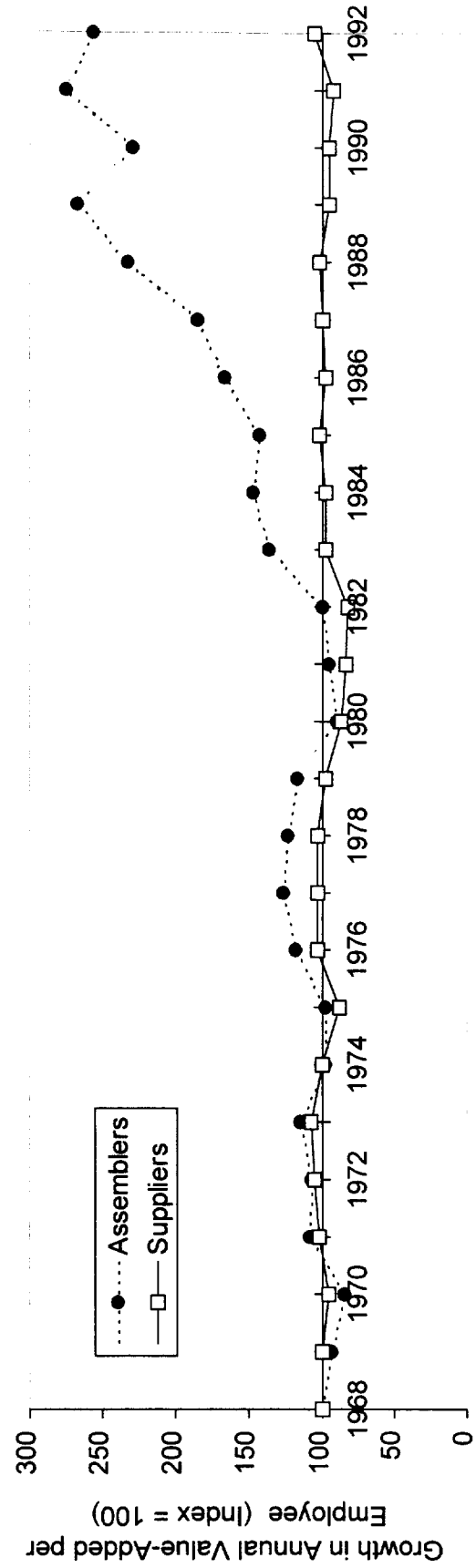
| Process | Nature of the Transfer Process | Type of Knowledge | Toyota Functions Involved |
|--|---------------------------------------|---|----------------------------------|
| 1. Supplier-Association | Multi-lateral | Explicit Knowledge (some tacit knowledge) | Purchasing |
| 2. On-site Consulting (OMCD) | Bilateral | Tacit Knowledge | OMCD |
| 3. Supplier Learning Teams (Jishuken) | Multi-lateral | Tacit Knowledge | OMCD LAD |
| 4. Problem Solving Teams | Bilateral | Tacit Knowledge | QAD OMCD MOD LAD |
| 5. Employee Transfers | Bilateral | Tacit Knowledge | Purchasing Personnel |
| 6. Performance feedback; Process Monitoring | Bilateral | Explicit Knowledge | Purchasing |

Note: OMCD=Operations Management Consulting Division; MOD=Manufacturing Operations Division; QAD=Quality Assurance Division; LAD=Logistics Administration Division. "Tacit knowledge" as referred to here refers primarily to (1) conscious tacit knowledge, and (2) collective tacit knowledge (see Spender, 1996).

Figure 1: Japanese Automotive Labor Productivity



US Automotive Labor Productivity



Source: Adapted from Lieberman, 1994

Figure 2 Organization of Toyota's Supplier Association

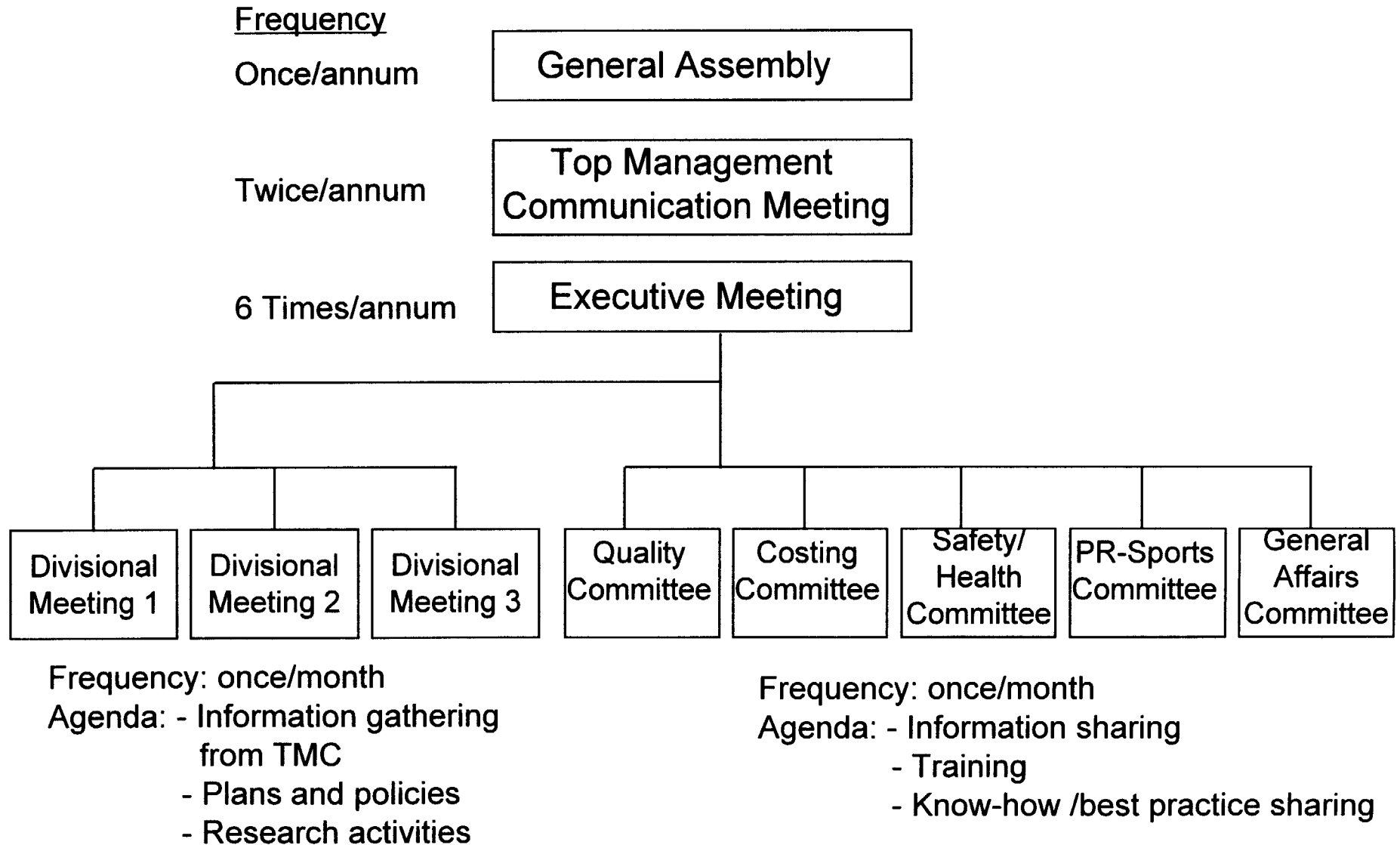


Figure 3
TSSC Project Results
(31 Suppliers)

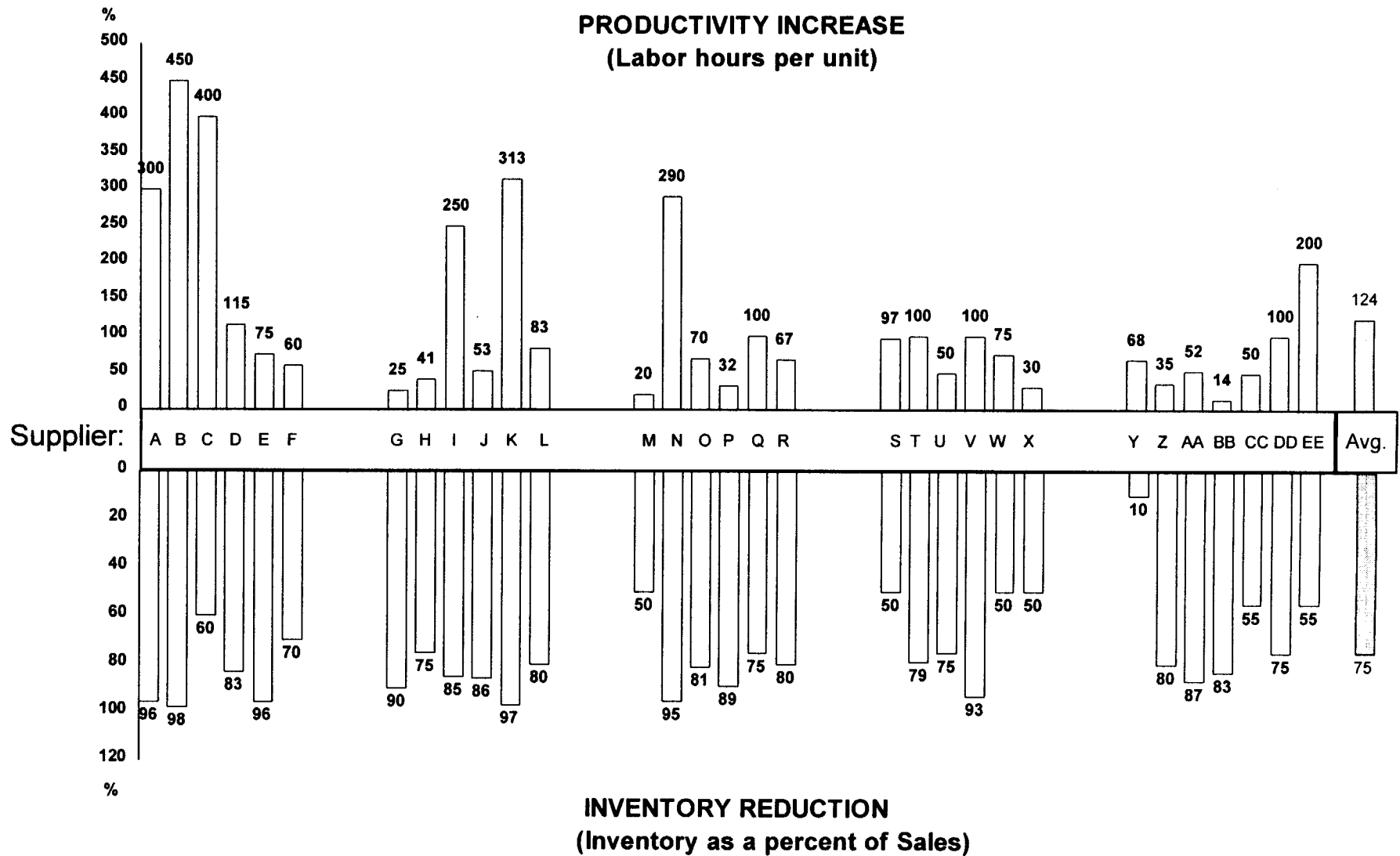
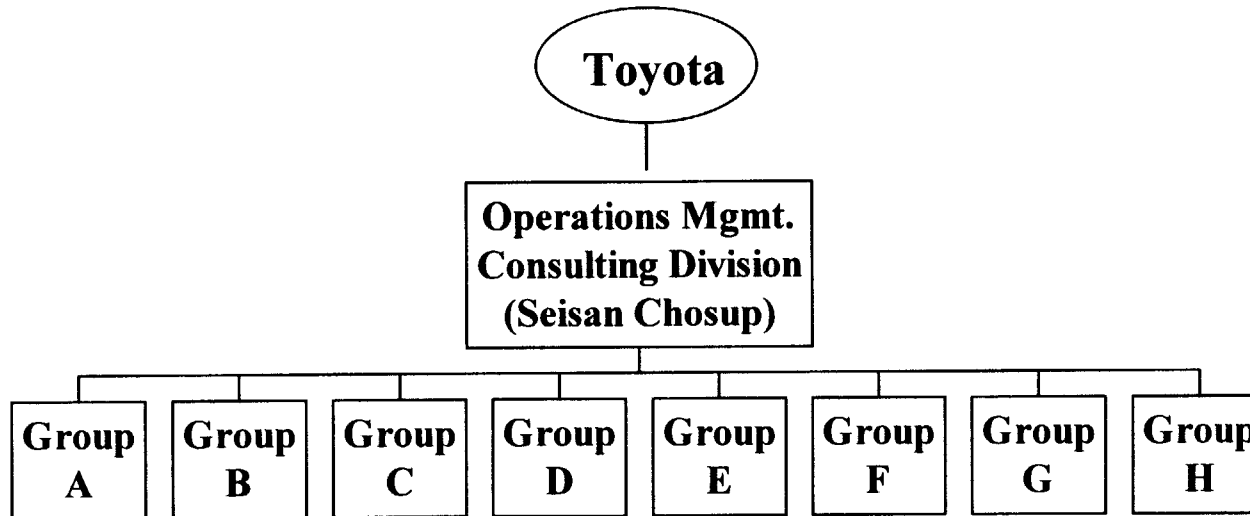


Figure 4
Toyota's Voluntary Study Group (*Jishuken*) Organization



- Each group consists of 6-8 suppliers. Direct competitors are not in the same group. Group composition changes every 3 years to keep groups “fresh.”
- Each group meets with Toyota to decide the theme (area of focus) for the year.
- The group visits each supplier's plant over a 4-month period examining the processes and offering suggestions for improvement.
- Toyota's operations management consulting division visits weekly to give advice and monitor progress.
- Toyota organizes an annual meeting where each group presents the key learnings from the year's activities.

Figure 5. Evolution of Toyota's U.S. Supplier Network

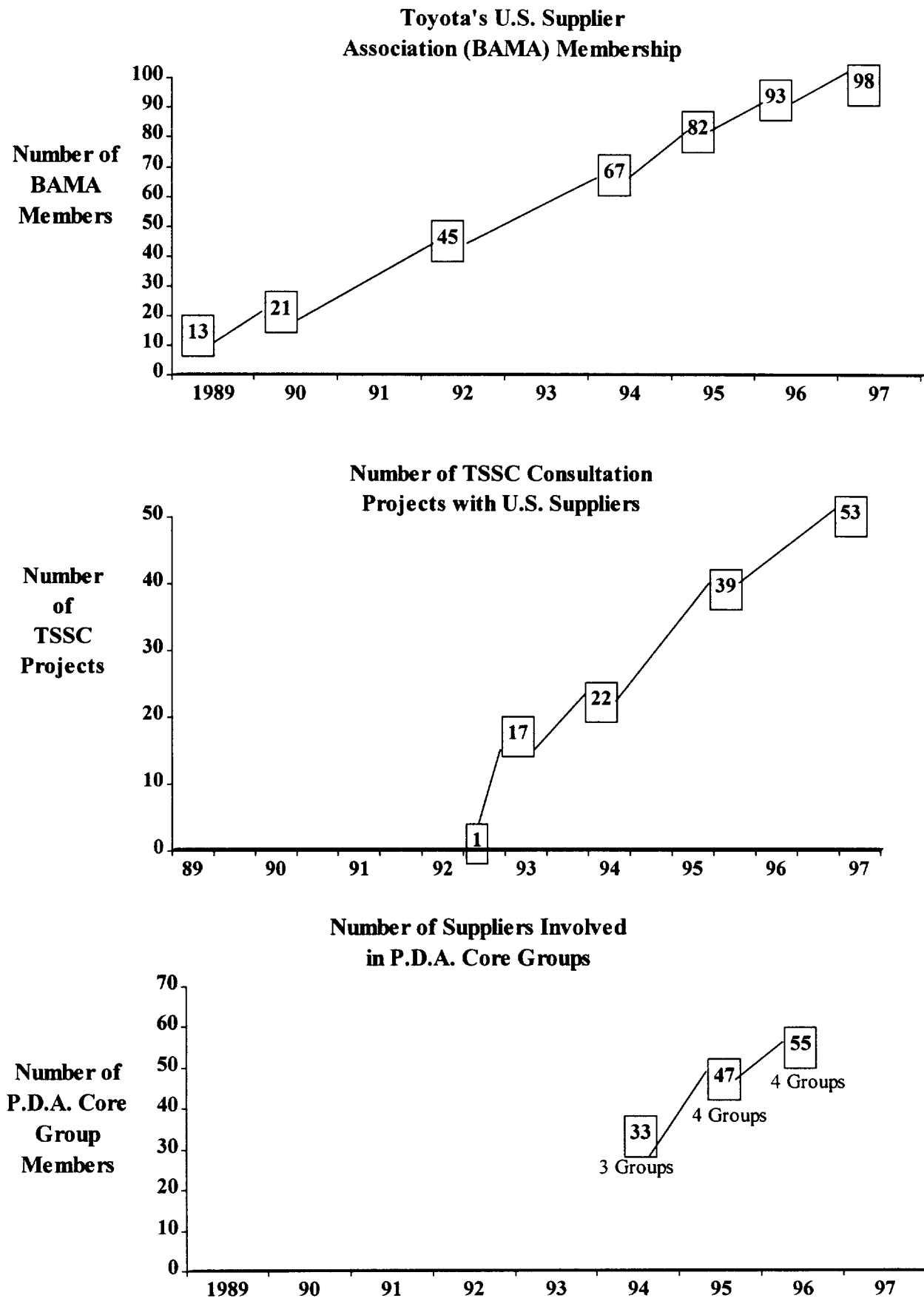
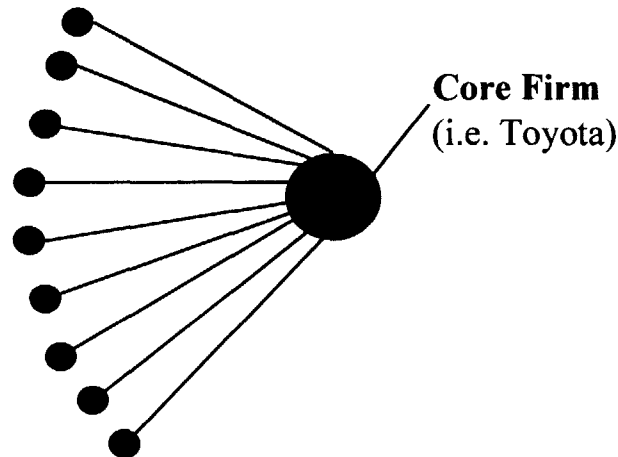
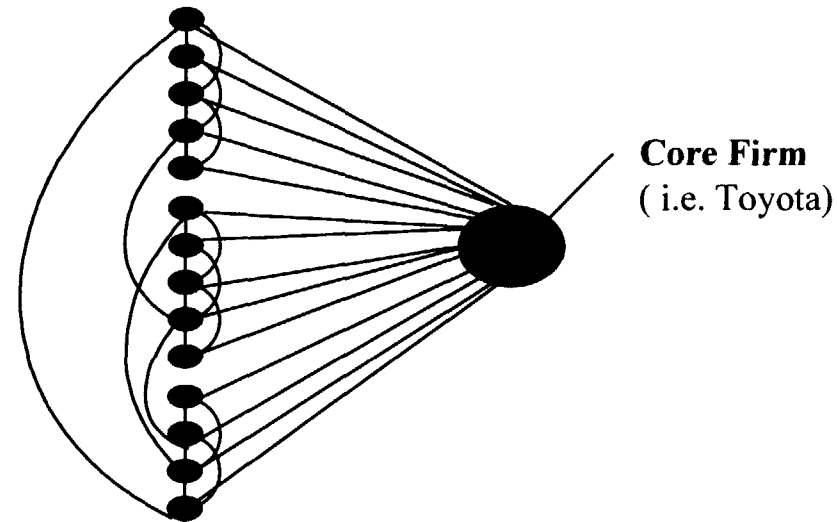


Figure 6. Evolution of a Knowledge-Sharing Network

Initiation Phase; Immature & Ineffective Knowledge-Sharing Network



Mature Phase; Effective Knowledge-Sharing Network



| <u>Dimensions</u> | <u>Key Characteristics</u> | | <u>Key Characteristics</u> |
|--------------------|--|---|--|
| Network Structure: | <ul style="list-style-type: none"> • One large network with core firm as hub • Bilateral relationships with core firm • Weak ties among most members • Numerous structural holes | <div></div> <div></div> <div></div> <div></div> | <ul style="list-style-type: none"> • Large network plus multiple “nested networks” • Multi-lateral relationships • Strong/embedded ties in nested networks and with core firm • Few structural holes |
| Type of Knowledge: | <ul style="list-style-type: none"> • Explicit knowledge | <div></div> | <ul style="list-style-type: none"> • Both explicit and tacit knowledge |
| Member Motivation: | <ul style="list-style-type: none"> • Demonstrate commitment to core firm | <div></div> | <ul style="list-style-type: none"> • Acquire valuable knowledge; self sustaining system |

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