Bringing a Network Perspective into Research on Technological Transfers and Other Interorganizational Relationships

Ellen R. Auster

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Professor Ellen R. Auster
Graduate School of Business
Columbia University

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Abstract

International interorganizational relationships have exploded in the last decade (U.S. News and World Report, June 20, 1988: 48) and not surprisingly researchers have become increasingly interested in this phenomenon. A strong foundation of research grounded in strategic and transaction cost approaches is emerging on dyads at the organizational and industry level. This article proposes that a network perspective which considers the constellation of relationships these dyads are embedded in could enhance this research stream by bringing issues of power, resource dependence and exchange to the forefront. Applications using data on U.S./Japan linkages are used to illustrate a network approach. Implications for future research on interorganizational relationships are considered.

International interorganizational relationships have skyrocketed in the last decade (U.S. News and World Report, June 20, 1988:48). In rapidly changing technological and market environments, they offer a means to diversify cost and risk and co-opt or block competition while gaining access to new technologies, customers, products, distribution channels and resources (Auster, 1987; Berlew, 1984; Contractor and Lorange, 1988:9; Killing, 1983; Harrigan, 1987). Not surprisingly, a growing body of literature is emerging as researchers attempt to understand this phenomenon and these trends. This chapter will concentrate on and contribute primarily to the macro literature on international interorganizational relationships.

Early macro research in this area focused primarily on one type of interfirm linkage, joint ventures, and was mostly based in strategy (Harrigan, 1985b; Killing, 1983, check). The competitive benefits of "alliances" in improving the firm's strategic posture in its industry and issues in managing the "parent-child-parent" relationship were the topics of greatest concern (Bivens and Lovell, 1966; Wright, 1979; Harrigan, 1985).

Recent macro research is more diverse. The structural and process issues examined in interorganizational relationships have broadened to include topics ranging from what types of human resource programs are most effective in international joint ventures to the relationship of industry conditions to joint venture performance (Pucik, 1988; Hladlik, 1988). Second, rather than an exclusive focus on joint ventures, multiple forms of linkages such as technological transfers, and joint R&D are being analyzed and compared to joint ventures (Hergert and Morris, 1987; Doz, 1988; Pisano, Russo and Teece, 1988; Pisano, Shan and Teece, 1988). Third, transaction cost approaches are often used as an alternative or complementary theoretical framework (Brahm and Astley, 1988; Pisano, Russo, and Teece, 1988; Pisano, Shan and Teece, 1988; Kogut, 1988). Arguing that interorganizational relationships are contractual arrangements that stand in between the typical make or buy, hierarchy or market distinctions, these studies have focused on issues at both the organization and industry levels of analysis.

Organizational level studies have explored issues such as choices of governance modes in joint ventures and their impact on performance (Brahm and Astley, 1988). Industry level studies have examined formation rates of different types of interorganizational linkages within biotechnology and telecommunications (Pisano, Russo, and Teece, 1988; Pisano, Shan and Teece, 1988) or choice of entry mode as it relates to variables such as industry R&D intensity, marketing intensity, growth, and concentration (Kogut and Singh, 1988).

This chapter proposes that the conceptual and analytical tools of network methodology combined with exchange and resource dependence theoretical perspectives offer a powerful, useful and insight provoking framework for enriching this research stream. It directs our attention to important but relatively neglected dimensions of these relationships such as power, reciprocity, influence, and interdependency. Strategic and transaction cost approaches tend to emphasize economic costs and benefits, often in the shorter run, and typically analyze dyads or triads (parent/child/parent) of relationships. Power dynamics can be inferred or extracted from some variables such as asset specificity or sunk costs but often power dynamics or the implications of webs of relationships are overlooked.

Network analysis, in contrast, brings the webs of relationships these dyads and triads are embedded in to the surface. The imagery changes from a focus on pairs of partners and isolated linkages to one where constellations, wheels and systems of relationships are examined. In doing so, new angles, questions, and insights emerge.

There are pragmatic as well as analytical reasons for expanding our frameworks to include networks. Consider these excerpts from interviews recently conducted with top managers in Japan at a number of companies including Hitachi, Toshiba, and Mitsubishi Electric (Personal interviews, March 1989).

> "When I evaluate a possible joint venture or technological cooperation, I talk to other Japanese companies and ask what their experiences have been with that U.S. company."

> "I am aware of most of the relationships our company and its sister companies have with U.S. companies. This enables me to see the larger picture."

> "Any particular venture can only be evaluated by considering the other ventures we have with that company and with others in the industry."

What is striking about these comments is the consideration of portfolios of interorganizational relationships and how they are connected to the interdependence within the industry. It is clear that an evaluation of any specific interorganizational linkage involves an assessment of how this connection meshes with other linkages already established in the industry. And networks are used to acquire information, for both now and in the future. The importance of a network orientation to the Japanese is further indicated by the resources devoted to tracking interdependencies. A branch of the Ministry of Trade and Industry called the Japanese External Trade Organization regularly tracks all forms of linkages publicly announced. In addition, many companies have their own in house tracking and monitoring of interorganizational hook-ups in their industry.

In the U.S. in contrast, some public information is available on joint ventures with foreign companies but systematically collected information on other forms of international hook-ups such as joint R&D, or technological transfers is not easily accessed and only beginning to be compiled, often by academics. More surprising perhaps, is the lack of in-house information tracking the interdependencies within their industry collected by companies. Many companies interviewed did not even have accurate reports of the interorganizational linkages with Japanese companies that their company is currently involved in because the decisions and information often remains at the business unit level, and is not centralized.

Thus, the field of international interorganizational studies has grown tremendously in the last decade. Multiple forms of relationships are being examined. Research questions, grounded in transaction cost and strategic views, address issues at both the organizational level of analysis and the industry level of analysis. Moreover, studies are exploring both the process side of managing these linkages, and structural features such as the distribution of forms within industries or industry conditions and their relationship to formation, mortality, and performance. However, its orientation, like that of many U.S. managers, has tended to be dyadic with an emphasis on costs and benefits in the short-run.[1] A network perspective beckons consideration of issues such as power and dependence in the long-run by bringing the webs of relationships that firms are embedded in into focus.

The chapter begins by establishing the theoretical underpinnings of network analysis -- power, exchange and resource dependence. The next section defines and describes the conceptual and analytical tools of network methodology using illustrative examples based on interorganizational linkages between U.S. and Japan in 1984 and 1985. The chapter concludes with a discussion and the implications of network analysis at multiple levels of analysis.

Theoretical Underpinnings of a Network Approach

A network can be defined as all the linkages between actors in a system. In its essence, network analysis is an analytical tool, not a theoretical framework. However, since the mid-1970's, network analysis has been grounded primarily in theories of exchange, power, and resource dependence (Cook, 1982; Aldrich, 1979; Aldrich and Whetten, 1981; Pfeffer and Salancik, 1978). Although initially somewhat distinctive approaches, these three perspectives have merged in recent years as their overlaps have become more apparent. Power can be viewed as asymmetric exchanges, and dependence the outcome of exerted power.

The key assumptions underlying this network approach can be summarized as follows:

1) Actors attempt to establish linkages in order to acquire resources or information about their environment, coordinate competitive interdependence, or reduce competitive uncertainty, and therby increase their power (Pffeffer and Salancik, 1979: 139-158).
2) Action is viewed as intentional, thus ties between actors are established, maintained, or broken because of their perceived value (Cook, 1982: 177-199).

3) Networks represent interconnected flows of resources and resource dependencies (power relationships) between actors. This flow and its causes and consequences are the focus of network analysis (Aldrich, 1979; Pfeffer and Salancik, 1978; Cook, 1982).

4) Networks are dynamic, their configuration shifts and changes as actors attempt to gain power or balance power by redistributing resources (Cook, 1982: 177-199).

Thus, from a network perspective, linkages are intentionally formed in order to manage uncertainty and acquire resources, information and power. Networks are systems of these resource dependencies that are dynamic as a result of the actions of the actors involved.

The Analytical Tools of Network Analysis

Different research questions require different tools. This section provides an overview and brief discussion of a variety of tools that may be useful for analyzing a range of questions pertinent to international interorganizational relationships.

Many different structural dimensions of networks have been developed by sociologists and social psychologists studying networks of individuals (Burt, 1983: 35-47). Some have been applied to the study of domestic interorganizational relations (see for example, Aldrich and Whetten, 1981; Cook, 1977). However, the literature on networks is not easily accessible. As Burt (1980:79) notes, "Anyone reading through what purports to be a 'network' literature will readily perceive. . . the analogy between that literature" and what Barnes (1972) labelled "a terminological jungle in which any newcomer may plant a tree." The purpose of this discussion is to thrash through that terminological jungle, simplifying it where possible and extracting components that are useful for understanding networks of organizations, rather than networks of people.

Network Boundaries

Establishing the boundaries of the network is the first issue confronted when conducting network analyses. How the boundaries of networks are drawn is a critical step, for it creates the sample of linkages that are further examined. The boundaries of a system may be defined by the researcher ("nominalist approach") or socially constructed by those involved ("realist approach") (Laumann, Marsden, & Prensky, 1983). In the nominalist approach, the selection criteria for organizations chosen for a network might be based on attributes of the organizations, activities the organizations are involved in, or characteristics of their relations. Defining a network by its home country, size or age of the organization, or whether it is a Fortune 500 company would be examples of selection based on attributes. Choosing companies based on the types of products or services they produce would be an activity-based method of selection. Characteristics of relations as a method of selection might mean a focus on companies currently engaged in overseas joint ventures. Often many different selection criteria will be combined to define the boundaries of the system.

The realist approach uses the social construction of those involved to define the boundaries of the system. However, this approach does have nominalist qualities. Those included in the sample reflect the researcher's selection criteria and expected boundaries of the system.

The Building Blocks of Networks: Interorganizational Linkages

Interorganization linkages are the building blocks of networks and can be defined as a relation between two or more organizations formed to transfer, exchange, develop or produce technology, raw materials, products, or information. The term linkage rather than alliance, collaborative agreement, and cooperation is used because the extent to which these relationships are mutually beneficial should not be overestimated. The firms may in fact be exploiting each other and be pursuing contradictory goals, and their purpose may change over time (Auster, 1987; Buckley and Casson, 1988). Linkage, unlike dyad, also allows for n-way linkages often called consortia.

Understanding the basic underlying structure connecting linkages is important in any network analysis. Relationships in a linkage may be one-way (also called asymmetric, unilateral) or two way (also called reciprocal, symmetric, or bilateral), horizontal or vertical. Horizontal linkages refer to exchanges between organizations producing similar products, processes or resources. This type of relation has also been called "commensalistic" (Aldrich, 1979: 266; Hawley, 1950: 39) or described as interdependence as the same stage of the value or transformation chain (Harrigan, 1985b; Porter, 1985). Vertical linkages refer to exchanges between organizations at different stages of the production and distribution chain (Contractor and Lorange, 1988: 15; Pennings, 1981; Porter, 1985). GM's joint venture with Akebono Brake would be an example. These organizations have complementary relations with each other "in production or the rendering of services to clients" (Pennings, 1981: 434). Backward vertical interdependence refers to a linkage with a firm in an earlier stage of the transformation process. Forward vertical interdependence refers to linking up with a firm at a later stage of the transformation process.

The content of a linkage refers to what is exchanged or transmitted (Blau, 1964; Homans, 1961). In the sociological and psychological network literature, studies have analyzed content relations such as friendship, acquaintance, work, kinship and intimacy (Burt, 1983: 35-47). In the interorganizational context, some common linkages include: OEM supply linkages, licensing, technological transfers or exchanges, joint research and development, and joint ventures. See Table 1 for a generic definition of these forms.

Insert Table 1 about here

The degree of dependence varies depending on the content of linkages as several researchers have recently noted. Contractor and Lorange (1988: 6-10), for example, develop a continuum of interorganizational dependence in linkages based on the type of compensation between partners. Technological training is the lowest on their scale because compensation is based on a lump-sum fee. Joint ventures anchor the high end of the scale with compensation based on a fraction of shares or dividends. In between these extremes, fall forms such as production agreements with compensation based on a markup on components sold or finished, or licensing with compensation based on royalties.

Auster (1989), offers an alternative scheme by using the degree of resource investment to rank the relative dependence of forms. Thus, LRIL's (low resource investment linkages) would include relationships such as technological transfers and joint R&D that are more autonomous and more easily severed. High resource investment linkages (HRIL's) would be forms such as joint ventures that require much longer-term commitment and trust, a greater financial investment, the construction or acquisition of a space to house the venture, equipment and technology to produce the output, and more management time and energy to oversee the venture. Given this high resource investment, switching cost and barriers to exit are formidable obstacles to termination.

Having established the boundaries of the system and delineated common structures and contents of the linkages within the system, it is appropriate to turn now to tools for analyzing networks. Table 2 operationally defines the terms discussed in subsequent sections. Figures 1 and 2 and Tables 3 and 4 illustrate some simple applications. Figures 1 and 2 display simple networks graphically. Tables 3 and 4 display simple networks in matrix form. Figure 1 and Table 3 show linkages between the major auto companies in U.S. and Japan. Figure 2 and Table 4 show linkages between the major electronics companies in U.S. and Japan. The data for these applications is based on cases of inter-organizational linkages and direct investment in the electronics industry and the auto industry that were formed in 1984 and 1985. Direct investment is also displayed because it represents a strategic alternative that many Japanese companies opt for instead of a linkage. This information was obtained through the Japanese External Trade Organization and is supplemented by qualitative interviews with top managers in the U.S. and Japan.

Insert Table 2 about here

Network approaches fall into two basic categories: 1) those analyzing characteristics of networks (networks are the focus of analysis) and 2) those analyzing the position of an organization within a network (an organization's position within the network is the focus of analysis).

Networks as the Focus of Analysis

Networks of organizations can be analyzed in terms of their size, density, diversity, reachability, and stability. These dimensions can be used as the basis for comparisons across networks. These concepts have been defined and used in many different ways but the definitions below seem simplest and most intuitive. The size of a network is the number of organizations in the network. In Figure 1, size equals 8. In Figure 2, size equals 10.

The density of a network is the number of linkages in the network (Aldrich & Whetten, 1981: 398). It can also be calculated as a percentage, the number of linkages divided by the size of the network. Or, density can measured as the number of holes in a matrix where cell a_{ij} represents the nature of the relationship between organization i and organization j as shown in Table 3 and Table 4. Figures 1 and 2 and Tables 3 and 4 indicate that the auto industry is higher density than the electronics network (63% versus 50%).

Diversity is the number of different types of linkages found in the network (Burt, 1983:193). In Figures 3 and 4, there are three major types of linkages shown: OEM supply relationships, technological transfers or exchanges, and joint ventures. Organizational diversity is the number of different types of organizations in the network. Diversity could be measured along a number of characteristics including industry or size. Reachability is the number of links separating two organizations in the network (Aldrich & Whetten, 1981:398; Tichy, 1981:229). For example, from General Electric to Westinghouse is two linkages.

Linkage stability refers to whether the linkages in the network remain the same type over time (Aldrich & Whetten, 1981:391). For example, the Westinghouse/Toshiba joint venture is now wholly owned by Toshiba. Organizational stability could refer to whether the organizations in the network change over time. Two dimensions of stability are: 1) the frequency of change or how often ties of organizations change, and 2) the magnitude of change -- how many ties change. In office equipment and computers, for example, the networks are more fluid than in a more mature industry such as autos.

The configuration of networks can also be analyzed both within and across networks. The numbers of stars, isolates, and linking pins can be counted. The number of stars would be the number of organizations with greater than x number of ties. If greater than three ties is the defining criterion used in Figure 2, then General Electric and Toshiba would be the stars. Isolates are those organizations with no linkages to other organizations. Honda Corporation would be an isolate in Figure 1. Isolates are also created when over time, organizations previously linked in the network become uncoupled, such as Toshiba and Westinghouse as noted above. Isolates are also created when over time, organizations previously linked in the network become uncoupled, Linking pins are those organizations with extensive and overlapping ties to different parts of a network (Aldrich & Whetten, 1981: 390).

More sophisticated network techniques such as structural equivalence should be noted although space constraints limit the discussion. Structural equivalence, strictly speaking, refers to elements in a network that have identical sets of relations (Burt, 1988). However, it is typically used as a continuous variable based on a calculation of Euclidean distance where 0 equals two perfectly equivalent elements in a network. As the Euclidean distance moves towards one, the extent to which the elements are involved in different patterns increases. Structural equivalence could be applied at the firm level for example, in an assessment of whether Mitsui and Mitsubishi engage in similar types of relations with U.S. companies.

Position of Organizations Within the Network as Focus of Analysis

Examining the relative the position or power of specific organizations is another use of network analysis. One strategy is to analyze whether the organization of interest is a star, isolate, or linking pin. Other measures of the position of an organization in a network include centrality, range, and multiplexity. Centrality as defined by Burt (1980: 92) is the proportion of the sum of relations within a network that involve actor (organization) x. The centrality ratio for Ford is 40% in Figure 1. The absolute number of contacts of actor (organization) x has been called range by Burt (1983: 184) although intensity of contacts may better convey the meaning of this relationship. Multiplexity for an organization is the extent that organization x is connected to a high proportion of organizations in the network by multiple types of relations (Burt, 1980; 90). GE and Toshiba have higher multiplexity than the other companies in their network and higher than any of the companies in the auto network. Overlap and redundancy (Tichy, 1981; Tichy, Tushman, & Fombrun, 1979) are used as synonyms for multiplexity, but are less useful because they do not capture whether the content of the linkage differs.

Applying Network Tools to Organization Sets

A network perspective can be applied to organization sets as well. An organization set as developed by Evan (1963) and Aldrich (1979) is the set of linkages of one focal organization. The linkages of Toshiba, General Electric, and General Motors shown in Figure 3 are examples of organization sets of new linkages formed for that time period. Except for notable exceptions such as Evan's (1972) study of federal regulatory commissions or Hirsch's (1972) study of organizational sets in the culture industry, few organizational set analyses have been done.

Insert Figure 3 about here

Many of the dimensions used for structural analyses of networks can be applied to organization sets. (See Table 2 and those terms marked "*".) Size, density, diversity, and stability all tap different features of an organization set that are useful for comparing organization sets of different organizations or of the same organization over time. A comparison of the organization sets in Figure 3, for example, reveals several interesting patterns.

Toshiba, a high technology company in Japan, formed 16 linkages with 14 companies during 1984 and 1985. Twenty-five percent were joint ventures, 19% were joint R&D, 19% were technological transfers or exchanges, and 38% were OEM supply relationships. General Electric, a large high technology company in the U.S., formed 12 linkages with 10 Japanese companies during the same time period. Twenty-five percent were joint ventures, 8% were joint R&D, 25% were technological transfers or exchanges, and 42% were OEM supply relationships. Thus, although General Electric was slightly less active than Toshiba during this time period, the proportions of different forms of linkages are roughly the same except in the joint R&D category where General Electric had half as many as Toshiba.

In contrast, the organization set of new linkages in 1984 and 1985 for General Motors is very different. GM formed 11 linkages with 7 Japanese companies. Fifty-five percent were joint ventures, 18% were joint R&D, 18% were technological transfers or exchanges, and 9% were OEM supply relationships. Honda on the other hand, a large Japanese auto company, has pursued a direct investment strategy as shown in Figure 1 rather than a joint venture or technological exchange strategy. Thus, the strategies for these two organizations in high technology are relatively similar. Both stand in marked contrast to the strategy of a large auto company in the U.S. and a large auto company in Japan. Reachability would not be relevant since the distance between organizations cannot be measured except through the focal organization. Analyses of the "input-organization-set" -- those who provide resources to the organization or the "output-organization-set" -- those who receive goods or services are other possible dimensions (Evan, 1972:183; Beard & Dess, 1988). This last measure is an aggregate measure of horizontal and vertical interdependence.

Conceptualization of the relation of members of the organization set to the focal organization can also be done using dimensions such as multiplexity, and vertical or horizontal interdependence. (See previous discussion.) For example, Figure 3 shows that Toshiba has a multiplex relation with Diasonics and General Electric. Its joint ventures are mostly horizontally interdependent, its technological exchanges and joint R&D are backward vertically interdependent, and the OEM supply relations are forward vertically interdependent.

Research Applications of a Network Perspective at Multiple Levels of Analysis

Four key levels of analysis can be synthesized from the major macro theoretical perspectives on interorganizational relationships: (1) the individual level, 2) the organizational level, 3) the population/grouping level, and 4) the community level. (See Table 6.) It is important to note that although the general distinctions between levels are clear, the specific boundaries between levels may be ambiguous. At each level of analysis, a network perspective prompts new research questions.

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Insert Table 6 about here

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Individual Level

The individual level can be defined as the study of how people affect interorganizational relations and the effects of interorganizational relations on individuals. Questions addressing the former topic might examine the role of boundary spanners in the creation, persistence, and evolution of linkages such as technological transfers. Aldrich (1979) conceptualizes the area but much more attention should be paid to the relationship of individual ties to interorganizational linkages. Mizruchi & Stearns (1988) and others have studied many aspects of interlocking directorates but less attention has been paid to the effects of these types of personel relationships on interorganizational linkages. Mapping networks of interlocking boards of directors with networks of interorganizational linkages might be a first step. How boundary spanner characteristics, demographics, their networks, their functional background and experience are related to the creation of new forms, to the life cycles of linkages, to the diffusion of innovation in interorganizational networks might be of interest as well. A related topic would be factors to consider in selecting boundary spanners and managers to oversee interorganizational relations such as technological transfers, and the kinds of characteristics of individuals associated with success in managing different forms. The impact of upper echelon attitudes on the creation and evolution of linkages and networks would be another avenue to develop.

The impact of interorganizational relations on individuals is another research area at this level of analysis in which little work has been done. How a firm's interorganizational set and networks affect upper echelon attitudes, decision-making, individual power, and career advancement would be the key questions of interest. The impact of interorganizational linkages such as joint ventures on lower level employees would be another dimension to consider. Research exploring when in a career path a boundary spanning role is most beneficial might prove fruitful.

Organizational Level

This level focuses on organizational characteristics and their relationship to the creation, management, maintenance, persistance, and failure of interorganizational relations. Rather than viewing the organization as an isolated atom, a firm is analyzed in within its context of relations. Research is beginning to emerge which reflects this perspective but more is needed to establish generalizeability and reliability.

Strategic questions include re-evaluating topics such as: organizational motives for creating linkages, how to choose a partner, how to negotiate a linkage, and competitive trade-offs of different forms of linkages, taking into consideration the webs of linkages the organization and its competitors are currently engaged in.

Research on what types of portfolios of linkages are most effective in what types of environments would be extremely useful. For example, U.S. companies in mature industries often have horizontally interdependent joint ventures and forward vertically interdependent OEM supply relationships from the Japanese company to the U.S. company. Could that portfolio mean that the manufacturing capability of the company is likely to be weakened in future years?

A broader descriptive and empirical base would be helpful in answering many of the questions mentioned above. Case studies of topics such as interorganizational negotiation processes (see Weiss, 1987), the transformation of different forms of interorganizational relations over time, longitudinal analyses of the changes an organization set undergoes over time and the impact of linkage characteristics, their nature and number on organizational evolution are critical. For example, a number of Japanese companies have formed joint ventures with U.S. companies that evolved to 100% Japanese owned within a few years. Longitudinal analyses can track such patterns. Case studies can help us to understand the dynamics underlying those patterns.

A third area would be the impact of organizational characteristics such as size, age, technology, and structure on the creation, and transformation of organization sets and linkages. The relationship of linkage formation to certain stages of organizational life cycles might be interesting. For example, do linkages provide a means of overcoming the liabilities of age and size (Aldrich & Auster, 1986)? Can a large, aging organization use joint technological transfers with small, innovative companies to revitalize? Can two large, aging organizations use a joint R&D linkage to foster creativity in inertia-laden systems?

The impact of organization sets and networks on firms would be a fourth major area. How does the nature and distribution of ties within a network or organization affect an organization's access to resources, organizational power and dependencies, and its ability to optimally position itself to change with environmental conditions. For example, in July, 1987 the U.S. Senate voted to ban imports of Toshiba products to punish the company for a subsidiary having sold superquiet submarine propellers to the Russians (Business Week, May 1987:65-66; July 1987:46-47). Had the government been aware of Toshiba's organization set and the extent of Toshiba's interdependencies with U.S. companies, it might have anticipated and better managed the backlash and lobbying that occurred from Toshiba's U.S. partners.

Similarly, it would be interesting to map the diffusion of technological innovation through globalized industries. Do technological hook-ups speed up the process? How does that impact the performance of the respective partners and their competitors?

Organizational Population/Groupings Level

Population is used here as a generic term that refers to various groupings of organizations used across strategic, transaction cost, resource dependence and ecological perspectives. Distinctive shared competencies within a specified time interval (Beard & Dess, 1988:363) would be the defining characteristic binding these groupings and distinguishing them from higher and lower levels of analysis. Competencies are defined as the set of technical, managerial and operational knowledge and skills needed to produce the primary product or service (Beard & Dess, 1988:363; McKelvey, 1982:24).

Within this category, strategic groups and market segments would be based on more narrowly defined shared competencies whereas species and industry may cut across strategic groups and market segments and would be based on broader definitions of shared competencies. Furthermore, strategic groups, species, population, and industry are based on aggregations of organizations, whereas market segment refers more to characteristics of customers.

Research areas at this level of analysis include basic and comprehensive information of the range of different forms of linkages, the composition of organization sets, and the structure of networks within a grouping/population. Beyond discriptive background, it would be useful to learn more about the dynamics of exchange relations resulting from linkages and networks and how they alter power and dependencies within a population. An extension might be explicit analyses of the extent of dependence of U.S. industries on key Japanese companies and competitors.

A third avenue might concentrate how environmental characteristics and industry characteristics are related to the creation, persistance, and decline of different forms of linkages, and the development of different types of organization sets and networks over time. For example, based on Figures 1, 2 and 3, one might question whether the environments of high technology industries tend to make low commitment linkages such as technological transfers and exchange, joint R&D, and OEM supply linkages more attractive, whereas the environments of more mature industries such as steel or auto make joint ventures more attractive. More fundamentally, a network orientation may challenge our view of the environment. Rather than a set of static attributes that organizations respond to, we may begin to see environments as flows of resources and transactions not clearly demarcated from the organizations immersed within (Pfeffer, 1987).

The interplay between government policy on linkage formation and evolution is another area with many research opportunities. For example, Jorde & Teece (1989) recently argued that U.S. anti-trust law currently facilitates overseas linkages rather than domestic linkages. They raise the question of whether laws that make easier for a U.S. auto maker to hook up with a Korean or Japanese auto maker than to hook up with a domestic competitor are healthy for the U.S. economy. As more network ties are established, anticipating the reaction of these collectivities to proposed legal changes and understanding the effects of legal changes on those webs will become increasingly critical.

Community

Beyond, the population is the community level of analysis. A community is a functionally integrated system of interacting populations. The community level of analysis differs from population studies, because the focus is on consortia and trade associations that cut across multiple populations and help the community to achieve common interests (Astley, 1985: 224). The Boeing, Mitsubishi Heavy Industries, Kawasaki Heavy Industries, Fuji Heavy Industries and Japanese government consortium, which is building and improving the Boeing 767, or the Texas Instruments, Motorola, Hitachi and Toshiba consortium formed to share the costs and risks of developing next generation chips would be examples of international consortia. The kinyu keiretsu (financial linkage) or kihyo shedan (enterprise group) in Japan, or PAC's or MCC (a joint R&D effort in microelectronics and computer technology formed in Austin, Texas) or

Sematech in the U.S. would be other examples (Sanger, 1989; Roehl & Truitt, 1987; Gerlach, 1987; Gibson & Rogers, 1988). Their implications for both national and global competition and economies are issues that must be addressed as these forms proliferate.

Conclusions

Previous research on interorganizational relationships has focused primarily on dyads or triads at the organizational level of analysis. A network perspective broadens this orientation offering new angles and raising new questions.

The empirical challenges of this type of research are great. Comprehensive, longitudinal data on large samples of linkages, organization sets, or networks are required. Yet, to the extent that different researchers can develop small bits and pieces of these questions, the larger puzzles may begin to take some coherence. These larger puzzles will help us acquire a more sophisticated approach to international interorganizational relationships so that U.S. companies can be better positioned for the global competition of today, tomorrow, and the decades to come.

Footnotes

[1] It is important to note that a few researchers have used network analysis to study international interorganizational relationships. See for example Jarillo, 1988; Thorelli, 1986; Walker, 1988.

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Table 1

The Generic Content and Structure of Common Linkages

OEM Supply -	a one way linkage formed to sell raw materials or products from organization X to organization Y
Licensing -	organization Y buys the right to use a process or product for a limited time period from organization X
Technological transfer -	a one way linkage formed to transfer technology from organization X to organization Y
Technological exchange -	a two way linkage formed to exchange technology or technological information between organization X and organization Y
Joint R&D -	a two way linkage formed to jointly develop and share research between organization X and organization Y
Joint venture -	organization X and organization Y create a separate organizational entity to produce goods or services

Table 2

Structural Dimensions of Networks

<u>Network as Focus of Analysis</u>

Size	- number of organizations in the network*
Density	- number of linkages in the network*
Diversity	- linkage: number of different types of linkages in the network*
	- organizational: the number of different types of organizations in the network*
Reachability	- the number of links separating two organizations
Stability	- linkage: whether the form of linkage in the network remains the same over time*
	- organizational: whether the organizations in the network remain the same over time*
frequency of change	- how often linkages or organizations change*
magnitude of change	- how many linkages or organizations change*
Stars	- the number of organizations with greater than X number of ties
Isolates	- the number of organizations with no linkages to other organizations
Linking pins	- organizations with extensive and overlapping ties to different parts of a network

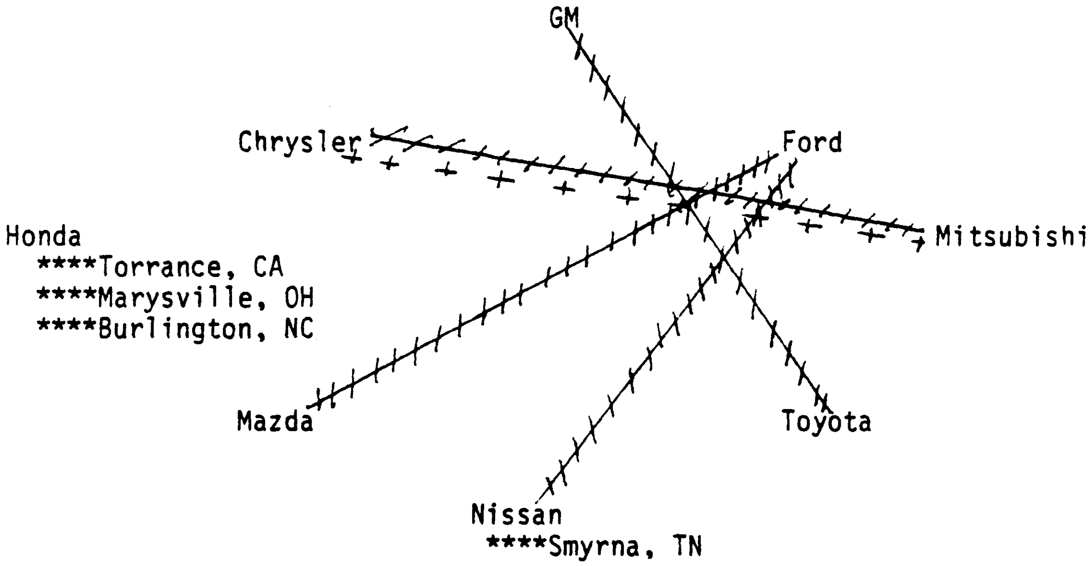
<u>Organizational Position within a Network as Focus of Analysis</u>

Centrality	- the proportion of the sum of relations that involve organization X
Range	- the number of contacts organization X has
Multiplexity	- the extent that organization X is connected to a high proportion of organizations in the network by multiple types of relations
Degree of Horizontal Interdependence	- the number of linkages with organization X at the same stage of the transformation process
Degree of Vertical Interdependence	- the number of linkages with organization X at different stages of the transformation process
backward	- the number of linkages with organization X at an earlier stage of the transformation process
forward	- the number of linkages with organization X at a later stage in the transformation process.

* This dimension is applicable to organization set analysis.

Figure 1

Interorganizational Relationships Created Between Top U.S. Auto Companies and Top Japanese Auto Companies



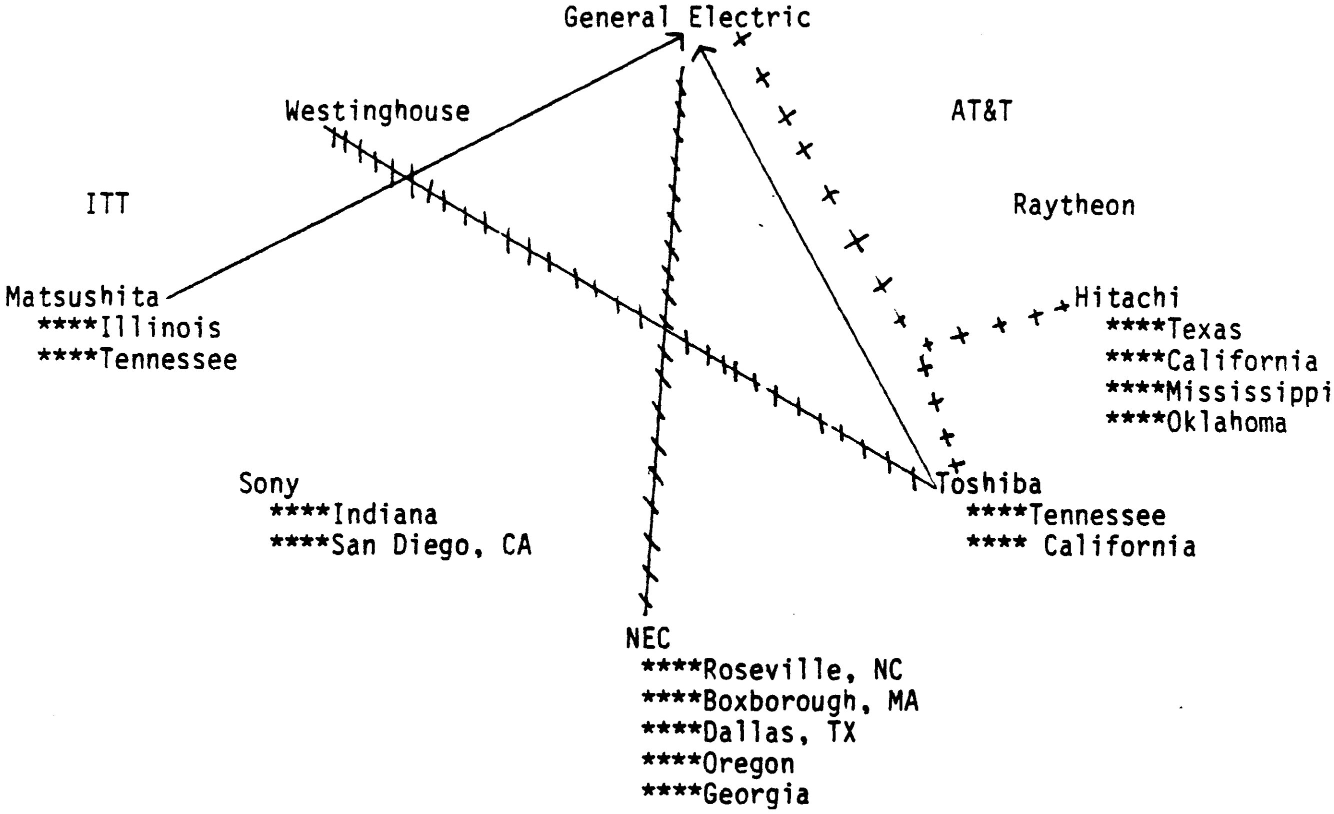
Key:

OEM Supply ————————————
Tech transfer, exchange + + + + + + + + +
Joint development, R&D - - - - - - - - - - -
Joint venture ++++++++++++++++++
Direct investment * * * * * * * * *

*All linkages were created in 1984 and 1985. Based on case data from Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1984 (Japanese External Trade Organization, N.Y., NY., pp. 1-154) and Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1985 (Japanese External Trade Organization, N.Y., N.Y., pp. 1-278), and JETRO Monitor. (1989) Newsletter on Japanese Economics and Trade Issues, January, Volume 3, 9: 1-4.

Figure 2

Interorganizational Linkages Created between Top U.S. Electronics Companies and Top Japanese Electronics Companies*



Key:

OEM Supply ———————————
Tech transfer, exchange + + + + + + + + +
Joint development, R&D - - - - - - - - - -
Joint venture ++++++++++++++++++
Direct investment * * * * * * * * *

*Based on case data from Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1984 (Japanese External Trade Organization, N.Y., NY., pp. 1-154) and Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1985 (Japanese External Trade Organization, N.Y., N.Y., pp. 1-278), and JETRO Monitor. (1989) Newsletter on Japanese Economics and Trade Issues, January, Volume 3, 9: 1-4.

Table 3

A Matrix Portrayal of Figure 1 with Applications of Network Methodology and Concepts*

	GM	Ford	Chrysler	Toyota	Nissan	Honda	Mitsubishi	Mazda
GM	0	0	0	1	0	0	0	0
Ford	0	0	0	0	1	0	0	1
Chrysler	0	0	0	0	0	0	2	0
Toyota	1	0	0	0	0	0	0	0
Nissan	0	1	0	0	0	0	0	0
Honda	0	0	0	0	0	0	0	0
Mitsubishi	0	0	1	0	0	0	0	0
Mazda	0	1	0	0	0	0	0	0

Network as Focus

Size = 8
Density = 5/8 = 63%
Diversity = 4
Reachability = e.g., from GE to Westinghouse = 2
Stars (2) = 2 (Ford, Chrysler, Mitsubishi)
Linking Pins = NA
Isolate = Honda

Organization Position within Network -- Ford's position

Centrality = 40%
Range = 2
Multiplexity = Very Low (Ford only has joint ventures).

*Based on case data from Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1984 (Japanese External Trade Organization, N.Y., NY., pp. 1-154) and Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1985 (Japanese External Trade Organization, N.Y., N.Y., pp. 1-278) and other data obtained through the Japanese External Trade Organization.

Table 4

A Matrix Portrayal of Figure 2 with Applications of Network Methodology and Concepts*

	GE	AT&T	Westing-house	ITT	Raytheon	Matsu-shita	Hitachi	Toshiba	NEC	Sony
GE	0	0	0	0	0	1	1	2	1	0
AT&T	0	0	0	0	0	0	0	0	0	0
Westing-house	0	0	0	0	0	0	0	1	0	0
ITT	0	0	0	0	0	0	0	0	0	0
Raytheon	0	0	0	0	0	0	0	0	0	0
Matsushita	1	0	0	0	0	0	0	0	0	0
Hitachi	1	0	0	0	0	0	0	1	0	0
Toshiba	2	0	1	0	0	0	0	0	0	0
NEC	1	0	0	0	0	0	0	0	0	0
Sony	0	0	0	0	0	0	0	0	0	0

Network as Focus

Size = 10
Density = 5/10 = 50%
Diversity = 4
Reachability = e.g., GE to Westinghouse = 2
Stars (3) = 2 (General Electric and Toshiba)
Isolates = AT&T, ITT, Raythoen, Sony

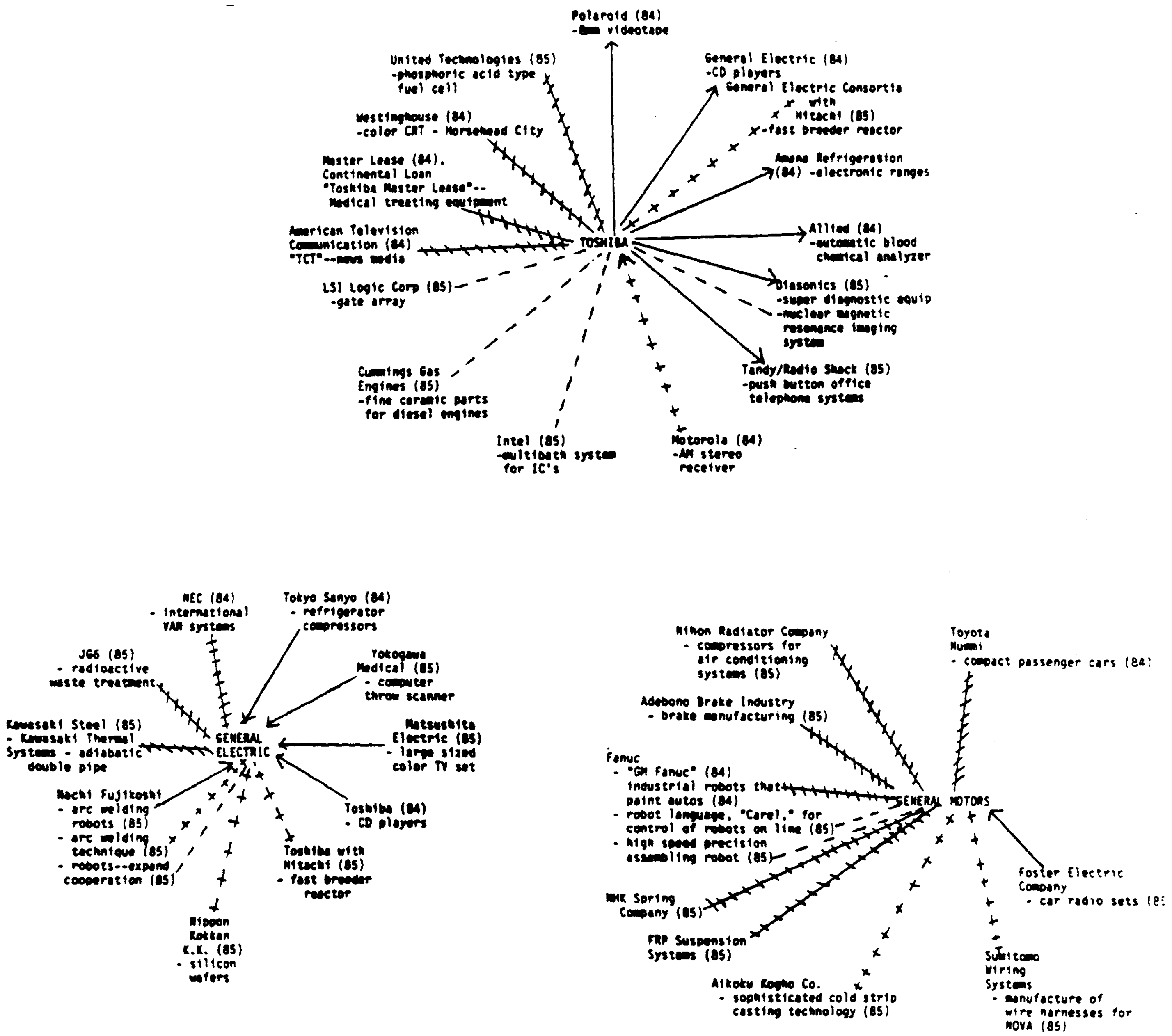
Organization Position within Network -- General Electric's position

Centrality = 4/10 = 40%
Range = 4
Multiplexity = GE and Toshiba have higher multiplexity than the other companies.

*Based on case data from Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1984 (Japanese External Trade Organization, N.Y., NY., pp. 1-154) and Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1985 (Japanese External Trade Organization, N.Y., N.Y., pp. 1-278).

Figure 3

Organization Sets of Toshiba, General Electric and General Motors



Key:

OEM Supply ————————————
Tech transfer, exchange + + + + + + + + +
Joint development, R&D - - - - - - - - - -
Joint venture ⧸⧸⧸⧸⧸⧸⧸⧸⧸⧸⧸⧸⧸⧸⧸

*All linkages were created in 1984 and 1985. Based on case data from Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1984 (Japanese External Trade Organization, N.Y., NY., pp. 1-154) and Cooperations between American and Japanese Firms: Cases of Industrial Cooperation in 1985 (Japanese External Trade Organization, N.Y., N.Y., pp. 1-278), and JETRO Monitor. (1989) Newsletter on Japanese Economics and Trade Issues, January, Volume 3, 9: 1-4.

Table 5
Levels of Analysis Across Four Perspectives

	Individual	Organizational	Population/Grouping	Communit
Strategy		<u>firm</u> business unit corporation	<u>market segment</u> "consists of buyers who seek the same offering" (O'Shaugnessy, 1988: 107) <u>strategic group</u> "firms that embrace the same <u>strategies</u> for serving customers, their competitive postures are similar" (Harrigan, 1985: 13) <u>industry</u> "a market in which similar or closely related products are sold to buyers" (Porter, 1985: 233)	
Transaction Cost		<u>organization</u> "governance structure" (Williamson, 1985: 13)	<u>industry</u> boundaries not clearly defined	
Resource Dependence	<u>individual level</u> "interlocking boards of directors	<u>organization</u> "a coalition of groups and interests, each attempting to obtain something from the collectivity by interacting with others and each with its own goals and preferences" (Pfeffer and Salancik, 1978: 36)	<u>industry</u> often defined as 2 digit SIC code level	
Ecology	<u>individual level</u> "boundary spanners"	<u>organization</u> "goal directed boundary maintaining activity systems" (Aldrich, 1979: 4)	<u>population</u> "a group of organizations that are similar in the competence needed to produce a product or service that is essential to their continued survival" (McKelvey, 1982: 24) <u>species</u> "polythetic groups of competence sharing populations isolated from each other because their dominant competencies are not easily shared or transmitted" (McKelvey, 1982: 192)	<u>community</u> "functionally integrated systems of interacting populations" (Astley, 1985: 234)