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CONFIGURATIONS OF INTER-ORGANIZATIONAL RELATIONSHIPS: A COMPARISON BETWEEN US AND JAPANESE AUTOMAKERS

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Configurations of Inter-Organizational Relationships:
A Comparison Between US and Japanese Automakers

Abstract

This paper seeks to uncover dominant configurations of inter-organizational relationships across the USA and Japan in the automotive industry. We integrate relevant theoretical concepts from transaction cost economics, organization theory and political economy to develop a conceptual model that serves as the anchor to collect data on 447 buyer-supplier relationships across the two countries. We employ this model to empirically uncover a set of naturally occurring patterns of inter-organizational relationships. We discuss implications for further research pertaining to both configurations as well as interorganizational relationships.

Key Words: Interorganizational Relationships; US & Japan; Configurations; Cluster Analysis.

Configurations of Interorganizational Relationships:

Introduction

There seems to be a renewed interest in organizational configurations that echo the calls by McKelvey (1975) and Pinder and Moore's (1979) to search for the small number of rich configurations that can account for and relate to a large percentage of organizations. In this stream commonly referred to as the configurational approach "a large number of attributes are studied simultaneously in order to yield a detailed, holistic, integrated image of reality" and "where data analysis and theory building are geared to finding common natural clusters among the attributes studied" (Miller and Friesen, 1984 p. 62). Although criticized as atheoretical in some quarters, the configurational approach has been widely applied at different levels of analysis, ranging from the individual level to uncover commonly occurring psychological patterns to the business unit level to uncover strategic groups (Harrigan, 1985; Thomas and Venkatraman, 1988), strategic taxonomies (Hambrick, 1984; Galbraith and Schendel, 1983; Miller, 1988) as well as to the level of the organization (Ulrich and McKelvey, 1990; Miller and Friesen, 1984).

While such configurations have been insightful in terms of providing more holistic interpretations, no study has yet reported configurations at the level of inter-organizational business relationships nor compared such configuration systematically across different countries. We believe that such extensions are timely and important for several reasons: one, the inter-organizational level of analysis has become attractive to organizational scholars since the traditional, pure forms -- market versus hierarchy -- appear to have limited explanatory power (Jarillo, 1988; Thorelli, 1986) and are too stylistic to be useful for descriptive and expository purposes. Where research efforts at this level of analysis exist, they have been narrowly-directed with a predominant emphasis on empirically-verifying a set of theoretical relationships under *ceteris paribus* conditions (see for instance, Walker and Weber, 1984; Heide and John, 1990). Such research efforts, while useful, are reductionistic in nature and should be complemented with the richness and synthetic power of the results typically obtained through a configurational approach (McKelvey, 1982; Miller and Mintzberg, 1983; Miller and Friesen, 1984). More importantly, such an approach would uncover a small set of naturally occurring patterns of inter-organizational relationships that could shed light on "powerful concepts of equifinality or the feasible sets of internally consistent and equally effective configurations" (Venkatraman, 1989; p 432).

Two, the international dimension of organization research has gained momentum over the last decade with increased attempts to understand strategies (Bartlett and Ghoshal, 1989), structural patterns as well as cultural dimensions (Hofstede, 1980). We believe that a systematic comparison of configurations at the inter-organizational level of analysis across different countries within the same industry would offer significant insights. Thus, this paper seeks to contribute to the literature through: (a) the development of a set of configurations of inter-organizational relationships at an important and under-researched level of analysis; (b) the formalization of an analytical framework that focuses on important issues of descriptive and predictive validity; and (c) operationalizing and testing the framework through field-data obtained on inter-organizational relationships in the auto industry covering US and Japanese manufacturers.

Extant Research: Empirical Tests of Typologies versus Uncovering Taxonomies

Prior research adopting a configurational approach falls into two major streams: one that focuses on empirical verifications of conceptual typologies and another that seeks to uncover empirically a set of configurations within a dataset. For instance, Haas, et al. (1966) appraised Etzioni's (1961) typology of compliance relationships in organizations, and Blau and Scott's (1962) typology of organizations. Woodward (1965) showed how her distinction in technology accounted for many differences in organization structure. Burns and Stalker's (1961) also showed that organic and mechanistic firms differed in their structure, process and environment (see Carper and Snizek (1980) for a review). Hambrick (1983a) tested and extended Miles and Snow (1978) strategic typology of defenders, analyzers and prospectors. More recently Miller (1988) tested a typology of organizations based upon their method of production, rates of innovation, and product sophistication. Some of the studies in the strategic groups follow the same deductive (i.e., theory or concept driven) approach such as Cool, 1985; Dess and Davis, 1984; Harrigan, 1980; Hatten and Schendel, 1977; Porter, 1981 1979. These studies have in common that the classificatory criteria preceded the use of empirical data to test the validity of the typology.

In the second stream of research, the classification was generated by a systematic and empirical analysis. For instance, Hambrick (1983b) derived from cluster analysis conducted on the PIMS database a taxonomy of eight industrial environments. In the strategic groups research many studies also follow this inductive (i.e., data driven) approach to uncovering configurations. These include Ryans and Wittink (1985), Hatten and Hatten (1985), Hayes et al. (1983), and Baird and Kumar (1983). Galbraith and Schendel (1983) empirically derived six strategy types for consumer products and four strategy types for industrial products.

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Table 1: Extant Research: Tests of Typologies versus Uncovering Taxonomies

Distinctive Characteristics	Testing Typologies	Uncovering Taxonomies
Major Advantages	Theory-driven and hence results can be assessed against *a priori* specifications	- Naturally occurring patterns may be uncovered that might shed on the limits of extant theories
Disadvantages	Empirical results that refute the theoretical specification may not be powerful to highlight any inherent weaknesses in the integrity of the typology	- No underlying theory or conceptual model to guide the selection of variables
Theoretical Assumptions	Positivist; Typology is mutually exclusive and collectively exhaustive	Interpretive; Taxonomies are casually interpreted in light of a conveniently available set of theories
Methodological Assumptions	Methodology is assumed to be in line with the theoretical typology (for instance, discriminant analysis would discriminate across the different types)	- Stability of the configurations; configurations are not an artifact of the chosen analytical method
Illustrative References	Hambrick (1983a); Haas, Hall and Johnson (1966); Woodward (1965); Burns and Stalker (1961); Miller (1988)	Hambrick (1983; 1984); Miller and Friesen (1982); Ryans and Wittink (1985), Hatten and Hatten (1985); Hayes, Spence and Marks (1983); Baird and Kumar (1983); Galbraith and Schendel (1983)

Our objective in this paper is to integrate the above two approaches whereby we minimize the disadvantages and maximize the advantages of the typologies and the taxonomies. For this purpose, we proceed as follows: first, we bring together three theoretical perspectives, namely: transaction cost economics, organization theory and political economy to develop a conceptual model for inter-organizational relations. Second, we derive a set of empirical indicators that directly relate to the theoretical dimensions and third, we employ these indicators as the basis to empirically derive a set of naturally occurring taxonomies or patterns of inter-firm relationships in the auto industry. Finally, we compare these configurations across two countries: the USA and Japan to exploratorily examine the

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pattern of similarities and differences.

A Conceptual Model of Inter-Organizational Relationships

The Information Processing Model

We propose a conceptual model of inter-organizational relationships that is rooted in the information-processing view (Galbraith, 1973, 1977; Tushman and Nadler, 1978; March and Simon, 1958; Weick, 1979). More specifically, we build from Galbraith's thesis on organizational design at an intra- organizational level to the inter-organizational level of analysis, namely that the information-processing needs of the structure should be matched (or fit with) to the information-processing capabilities. This rather simple, but elegant formulation (Daft and Lengel, 1986) served as the foundation for conceptual and empirical work in organization sciences. Studies by Tushman (1981, 1978), Van de Ven and Ferry (1980) and Daft and Mcintosh (1981), for instance, show that information processing increases or decreases depending on the complexity or variety of the organization's task. Van de Ven et al. (1976) found that when task nonroutineness or interdependence were high, information processing shifted from impersonal rules to personal exchanges including face-to-face and group meetings.

Information Processing Needs

We begin with a basic premise that the information processing needs arise from uncertainty. Hence, we draw upon three theoretical perspectives that recognize uncertainty as a key design contingency. These are: (a) *transaction cost economics* (Coase, 1937; Williamson, 1975, 1985) where one of the underlying determinants of high transaction costs is uncertainty as noted by Williamson: "When transactions are conducted under conditions of uncertainty/complexity, in which event it is very costly, perhaps impossible, to describe the complete decision tree, the bounded rationality constraint is binding and an assessment of alternative organizational modes, in efficiency respects, becomes necessary" (1975, p.23); (b) *organization theory* where uncertainty has long been viewed as a dominant contingency as noted by Thompson that: "Uncertainty appears as the fundamental problem for complex organizations and coping with uncertainty, as the essence of administrative process" (Thompson, 1967, p.159) and (c) *political economy* where "a promising framework for addressing these issues is provided by the political economy approach for the study of social systems" (Benson, 1975; see also Wamsley and Zald, 1973; Zald, 1970); Basically, the political economy approach views a social system as comprising interacting sets of major economic and sociopolitical forces which affect collective behavior and performance (Stern and Reve, 1980 p.53) . It is essential to highlight that all three theoretical perspectives are consistent in the sense that they recognize uncertainty (and its underlying determinants) as a key explanator of organizational characteristics.

Rooted in these three theoretical perspectives, we recognize three major types of uncertainty, whereby the greater is each source of uncertainty, the greater are the information processing needs of the inter-organizational relationship:

(i) *environmental uncertainty* -- arising due to the general environmental conditions underlying the inter-organizational business relationship,

(ii) *partnership uncertainty* -- arising due to one firm's perceived uncertainty about its specific partner's behavior in the future; and

(iii) *task uncertainty* -- arising due to the specific set of tasks carried out by the organizational agent responsible for the inter-organizational relationship.

Environmental Uncertainty. Although environmental uncertainty is a rather broad concept, it appears that it could be parsimoniously viewed in terms of three important dimensions of the environment, namely: *capacity, complexity*, and *dynamism*. We view *capacity* as the extent to which the environment can or does support growth and is akin to Starbuck's (1976) environmental munificence and Aldrich's (1979) environmental capacity definitions. Similarly, we follow Child's conceptualization of *complexity* as "the heterogeneity and range of an organization's activities" (1972), which is consistent with other predominant views such as Thompson (1967); Duncan (1972); and Pennings (1975). This is an important dimension because as Dess and Beard (1984) noted, "from the resource-dependence perspective, organizations competing in industries that require many different inputs or that produce many different outputs should find resource acquisition and disposal of output more complex than...[those] competing in industries with fewer different inputs and outputs." In relation to the third dimension of dynamism, there seems to be more agreement. Organization theorists have widely discussed the need for the design of organization to respond to the general characteristic of environmental dynamism (March and Simon, 1958; Jurkovich, 1974; Pfeffer and Salancik, 1978; Williamson, 1985).

Partnership Uncertainty. This is a new type that requires more discussion than the previous type. We define partnership uncertainty as the *'uncertainty a focal firm perceives about its relationship with a business partner.'* This type has been traditionally subsumed under the two other types, namely: general environmental uncertainty or the specific task uncertainty. For instance, when there is a predominance of market-like transactions, environmental uncertainty is the critical thrust; for predominantly hierarchical transactions, task uncertainty is the relevant thrust. Under conditions where transactions occur through these pure modes (markets versus hierarchy), partnership uncertainty is of secondary importance.

However, in view of the emergence of hybrids (Williamson, 1990) , networks (Jarillo, 1988) or partnership-like arrangements with a wide array of firms differing in their capabilities and goals (Johnston and Lawrence, 1988), we believe that partnership uncertainty should be distinguished from the broader environmental uncertainty and the narrower task uncertainty. More specifically, given our focus on inter-organizational relationships, it is important to recognize this type and delineate a corresponding set of determinants.

We argue that there are three primary sources of partnership uncertainty: (i) the focal firm's asset specificity, (ii) its partner's asset specificity and (iii) mutual trust within the relationship. These sources are consistent with the theoretical arguments in the resource-dependency stream of organization theory (Pfeffer, 1972a, 1972b; Jacobs, 1974; Pfeffer and Salancik, 1974) and the transaction cost economics perspective (Williamson, 1985). In particular, the *focal firm's asset specificity* as well as the *partner's asset specificity*, represent investments highly specific to the relationship through which one member may hold the other hostage (Anderson, 1985; Heide and John, 1990). Similarly, *Mutual trust* is another factor which has been argued to contribute to the reduction of uncertainty about the opportunistic behavior by the other partner (Axelrod, 1984; Dore, 1983; Ouchi, 1980). Reve and Stern (1976), for instance, introduce the concept of transaction climate as "the sentiments that exit between the parties to the transaction" (p. 76). These sentiments arise due to "the extent to which inter-firm transactions are based on mutual trust, whereby the parties share a unit bonding or belongingness (cf. Bonoma 1976)" (Reve and Stern, p.78).

Task Uncertainty. Recent research suggests that task uncertainty is a function of three constructs: (1) analyzability, (2) variety, and (3) interdependence. *Task analyzability* refers to the extent to which there is a known procedure that specifies the sequence of steps to be followed in performing the task. It is similar to Thompson's knowledge of cause-effect relationships (1967) as well as to Cyert and March's search procedures (1963). *Task variety* refers to the number of exceptions or the frequency of unanticipated and novel events which require different methods or procedures for doing the job. This definition is consistent with the various notions of task variability (Pugh et al., 1969; Van de Ven and Delbecq, 1974); uniformity (Mohr, 1971); predictability (Galbraith, 1973; March and Simon, 1958); complexity (Duncan, 1972), and sameness (Hall, 1962). Finally, *task interdependence* is consistent with Thompson's (1967) and Van de Ven et al.'s (1976) conceptions as "the extent to which unit [firm] personnel are dependent upon one another to perform their individual jobs".

Information Processing Capabilities

The information processing capabilities are derived from a number of coordination mechanisms, that can be classified in terms of: structural mechanisms, process mechanisms, and information technology mechanisms.

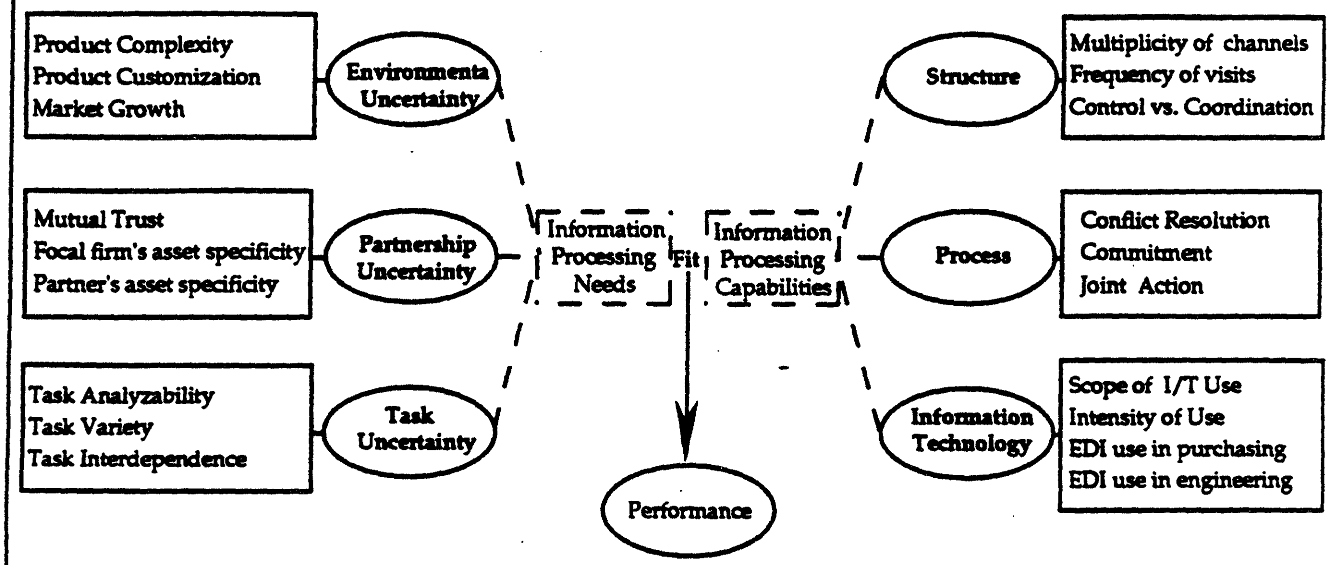
Structural Mechanisms. Daft and Lengel (1986) propose a hierarchy of "structural mechanisms that fit along a continuum with respect to their relative capacity for reducing uncertainty...rules and procedures, direct contacts, liaison roles, integrator roles, task forces and teams." (p.560) (see also Galbraith, 1977; Tushman and Nadler, 1978; Van de Ven et al., 1976). While we recognize that these mechanisms have been proposed at an *intra*-organizational level of analysis, we argue that they can be logically extended to our level of analysis, namely: the inter-organizational level.

Relationships will differ in their combination of use of these mechanisms. In particular, they will differ along three dimensions: the *multiplicity* of information channels between the two firms, the *frequency* of information exchange, and the *formalization* of the information exchange (or the extent to which the information exchange is for coordination vs. control purposes). The greater the multiplicity of channels and the frequency of information exchange the greater the information processing capabilities of the dyad. However, the greater the formalization of the exchange the lower the information processing capabilities.

Process Mechanisms. These represent the socio-political processes (Arndt, 1983; Benson, 1975) underlying the relationship, and they range along a cooperative-conflictual continuum, and directly affect the extent to which information is freely exchanged between the dyad members because or in spite of the nature of the structural mechanisms (Reve and Stern, 1984). For instance, under the same dyad structure coordination capabilities will tend to decrease in a negative, conflictual, and non-cooperative context. We operationalize and measure these process mechanisms along three distinct dimensions: (a) *conflict resolution* (Gaski, 1984; Lusch, 1976), (b) *joint action* ((Robicheaux and El-Ansary, 1976; Harry and McGrath, 1988), and (c) *commitment* (Gardner and Cooper, 1988). The information processing capabilities of the dyad will then tend to increase with higher joint action, higher commitment , and more collaborative (vs. adversarial) conflict resolution.

Information Technology Mechanisms. These represent the use of information technology (IT) functionality for facilitating inter-organizational coordination. The one that is of particular interest here is the nature and scope of the electronic linkages between the two dyad members. The information processing capabilities of a relationship will increase with greater intensity and scope of the use of the technology between the two firms.

Figure 1: Our Conceptual Model of Interorganizational Relationships



Methods

Our Analytical Approach

Our analytical approach integrates the two approaches (see Tables 1 and 2) by developing a conceptual model as the necessary first step to specify the indicators for the derivation of empirical configurations. Table 2 specifies the analytical approach in terms of six steps. In Steps 1 and 2, we use the information-processing model (Figure 1) to derive 19 variables as inputs for the constructs identified in the previous section.

In terms of the delineation of the configurations (steps 3 through 5), we follow Hambrick's (1984) suggestion regarding a multi-tiered approach and Punj and Stewart (1983) set of recommendations for cluster analysis: (a) use of standardized values for each variable; (b) use of the squared Euclidean

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distance as the similarity measure; and (c) the selection of Ward's minimum variance method as the method for cluster formation. Another potentially significant issue in cluster analysis is the selection of the *number of clusters* (Everitt, 1974 1979; Sneath and Sokal, 1973). For this purpose, we use a systematic technique to objectively determine the number of clusters in the data sets (i.e., the Variance Ratio Criterion (VRC) index proposed by Calinski and Harabasz 1974). This is important because in a hierarchical procedure, the researcher is required to specify this parameter before running the clustering program, and in nonhierarchical procedures the programs offer the full range of solutions from the one-cluster solution to the n-cluster solution. The determination of the final solution is thus left to the subjective judgement of the researcher (such as: N/30, where N=number of observations as suggested by Hambrick, 1984).

Recently, in the psychometric and multivariate behavioral research streams, there have been systematic attempts at developing reliable and valid procedures for the determination of the number of clusters in a dataset (Dubes and Jain, 1979; Milligan, 1981; Perruchet, 1983). Milligan and Cooper (1985) conducted a Monte Carlo evaluation of 30 different stopping rules across four hierarchical clustering methods (including the Ward's method) and concluded that there exists high variability in the ability of the procedures to determine the correct number of clusters in the data. More importantly, they demonstrated that the Calinski and Harabasz (1974) index procedure scored high on their recovery criteria across a varying number of clusters and procedures. Hence, we adopt this criterion and computed the Calinski and Harabasz variance ratio criteria (VRC) index to systematically determine the number of clusters in the data set (in the Appendix, we elaborate on this issue).

Thus, in step 3, we conduct a set of cluster analyses to uncover the configurations of information processing needs while in step 4, we seek to uncover configurations of information processing capabilities within each configuration obtained in step 3. The resulting clusters at the end of step 4, therefore, represent the final solution, i.e., the dominant patterns of fit between information processing needs and information processing capabilities in the two countries. Step 5 seeks to understand the descriptive validity of the configurations. For this purpose, we conduct a series of oneway analysis of variance across the 19 variables used to determine the configurations. While this is a necessary-but-not sufficient condition for establishing the validity of these clusters, they provide useful insights for the definition and interpretation of the configurations of inter-firm relationships. Finally, in step 6 we test the predictive validity of the taxonomical scheme. A series of oneway analyses of variance across a set of '*dependent*' variables (namely, those not used to define the clusters) illustrates the meaningfulness of the configurations, and in particular their ability to capture and explain differences in performance as well as similarities and differences across the two countries.

Table 2: Our Analytical Approach

Step Number	Description
1	Conceptual Model of Inter-Organizational Relationships based on an Information Processing Perspective – reflecting the fit between information processing needs and information processing capabilities.
2	Derivation of 19 variables reflecting the six dimensions of the conceptual model
3	Identification of the configurations reflecting the information processing needs; the 'best' solution is selected based on the *Calinski and Harabasz VRC criterion*
4	Identification of the configurations reflecting the information processing capabilities; the 'best' solution is selected based on the *Calinski and Harabasz VRC criterion*
5	Assessment of descriptive validity of the configurations
6	Assessment of predictive validity of the configurations

Research Design

The required data for this study was collected from managers responsible for critical inter-organizational relationships in the auto industry in the USA and Japan. The selection of the auto industry was based on the following factors. Recent research studies (see especially, Cusumano and Takeishi, 1991; Nishiguchi, 1989; Helper, 1987; Lamming, 1989) have documented that supplier relationships have been undergoing major changes, "indicating far reaching transformations in the way automobile production and automobile companies themselves are organized" (Sabel et al., 1989). Traditionally, US automakers were characterized by a high degree of vertical integration having designed the car, manufactured nearly all the necessary core components and coordinated final production. The trend, however, is towards a car company becoming the coordinator of an increasingly intricate production network, typically purchasing more core components from outside, thus reducing its level of vertical integration and increasing the number and relative importance of relations with suppliers. This supply system, widely associated with Japanese companies (Asanuma, 1989) and accepted as the major explanation to the global competitiveness of Japanese assemblers (Clark, 1989; Dertouzos et al., 1989), has become the "best practice" to emulate (Womack et al., 1990). Thus, the necessity to include both US and Japanese manufacturers data into the study.

Our field work proceeded as follows. First, we conducted a set of 17 interviews primarily in the Detroit and Tokyo areas with senior managers responsible for inter-organizational business relationships in the USA and Japan. These were complemented by visits to assembly plants, design and engineering facilities at both assemblers and suppliers. Both countries were included for these field studies to ensure that we were not reflecting a US-bias on the Japanese firms and vice versa. These interviews were focused at two boundary-spanning functions that were considered to be most critical for the auto industry: purchasing and design. The interviews were exploratory in nature but focused on clarifying the following issues: (a) a preliminary corroboration of the applicability and appropriateness of the information-processing model as capturing the nuances of the inter-organizational relationships; (b) assessing the role and importance of information technology mechanisms, and the partnership uncertainty within the model as these were the two distinguishing dimensions of our conceptual model; and (c) ensuring that we have an adequate basis to sample the relationships covering the vast array of suppliers and components.

Subsequently, we developed a structured questionnaire to measure the 19 variables – both in English and Japanese for the two samples (an initial English version was first translated into a Japanese version itself independently translated back into English to check for and correct inconsistencies). Pre-tests of the instruments were conducted in 4 companies and 8 focus groups were conducted with potential respondents (i.e., those purchasing agents and design engineers responsible for a given component account) to ensure that the target informants in both settings understood the wording consistent with the researchers and that the Japanese version was a valid translation of the US version.

Sampling followed the same process in all three US and all eleven Japanese car companies. A purchasing and engineering senior manager at the central division or platform level were first asked to select a set of car components under their responsibility from the stratified list of 50 components prepared by the researchers (i.e., to prevent from selection bias). Then for each of the selected components these senior managers helped identify the purchasing agent and/or engineer to whom we could send the questionnaire. The final decision about which specific supplier (the respondent's name as well as the name of the supplier were not asked) and which part number to choose was at the respondent's discretion. In summary, each questionnaire represents a data point, that is a unique component-dyad-task triplet, where the controlled range of components included in the sampling contributes to variance in environmental uncertainty, the variety of manufacturer-supplier dyads in both countries contributes to variance in partnership uncertainty, and finally where the presence of two different boundary spanning functions dealing with different products and suppliers contributes to variance in task characteristics. In sum, the proposed conceptual model is tested on the basis of a sample of n= 447 independent buyer-supplier relationships. These questionnaires were administered to a set of managers belonging to two boundary spanning function: purchasing and engineering in 14 automakers. The sample of companies include the big three firms in the US and the 11 firms in Japan. The total data set constitutes a representative sample of n = 447 buyer-supplier relationships (43% response rate; n= 140 in the US and n=307 in Japan) across different assemblers, different supplier firms, and different vehicle components.

Operationalization of the Variables

Following Venkatraman and Grant (1986), we paid particular attention to issues of

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operationalization and measurement in this study. Operationalization of the variables was achieved through two ways: (1) for those variables that have been previously employed in research settings, we adopted the measures as long as they satisfied acceptable measurement quality; and (2) for those variables that were unique to the conceptual model developed here, we developed operational measures; these were assessed for content validity through interviews and discussions with managers in Detroit and Tokyo. In addition, the six constructs of the model are operationalized along multiple dimensions most of which were measured using multi-item scales. The detailed operationalization scheme for each construct is described in table 3 with examples of the specific indicators and the anchors used to calibrate them. The reliability statistics (Cronbach α ranging from 0.71 to 0.92) provide strong support that the measures used are reliable and can be used for deriving the configurations.

Table 3: Operationalization of the 19 Variables

Construct	Variables	items (α)	Illustrative Questions and Scaling
Environmental Uncertainty	Environmental dynamism (changes in product)	3 (.79)	- product technical complexity, - maturity of the underlying technology, and - the engineering content were measured using 7-point interval scales ranging respectively from a product: technically simple to technically complex, based on mature technology to based on new technology, and needs low to significant engineering effort and expertise.
	Environmental complexity	1 (na)	- product level of customization measured using a 7-point interval scale ranging from a standard product with a low level of customization to a specialized product with high level of customization to one model
	Environmental Capacity	1 (na)	- market growth level measured using a 7-point interval scale ranging from a declining to a growing market for the component
Partnership Uncertainty	Mutual trust	2 (.77)	- degree of mutual trust between the two firms measured using a 7-point interval scale ranging from extremely weak to extremely strong; - degree of comfort about sharing sensitive information with the supplier measured using a 7-point interval scale ranging from very uncomfortable to very conformable
	Manufacturer's asset specificity	4 (.72)	extent to which the manufacturer has made major investments specifically for its relationship with this supplier: - in tooling; -on tailoring its products to using this supplier's component; - in time and effort to learn this supplier's business practices; - in time and effort to develop the relationship with this supplier. The 4 indicators were measured using 7-point internval scales ranging from strongly disagree to strongly agree.

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	Supplier's asset specificity	4 (.92)	extent to which the production of this component requires capabilities an skills (i.e., - layout, facilities and tooling; - technical knowledge,; - design skills and capabilities; - manufacturing skills and capabilities; - managerial skills and experience)unique to this supplier, or can it be produced with standard capabilities and labor skills by any supplier. The 4 indicators were measured using 7-point internval scales ranging from very standard to very unique to this supplier.
Task Uncertainty	Task Analyzability	4 (.71)	extent to which there is: - a clearly known way to do your job when it relates to this supplier (e.g., a manual); - established practices and procedures you follow in doing your job with this supplier; - extent to which your job description is detailed or broadly defined; - extent to which the boundaries around your job are vague or clear. The 4 indicators measured using 7-point internval scales ranging from strongly disagree to strongly agree for the first two indicators, from very detailed to very broadly defined, and from very vague to very clear for the other 2 indicators.
	Task Variety	2 (.79)	extent to which you basically perform repetitive tasks, and extent to which you do the same tasks in the same way most of the time. The 2 indicators measured using 7-point internval scales ranging from strongly disagree to strongly agree.
	Task Interdependence	2 (.75)	how much of your total job has to do with this supplier and this component; how much of it is spent directly with this supplier. The 2 indicators are measured using a 5-point interval scale ranging from less than 5%, 6 to 10%, 11 to 25 %, 26 to 50%, to 51 to 100%

Structural Mechanisms	Multiplicity (number of communication channels)	1 (na)	degree to which the following business functions from both firms work together. This indicator is the sum of the "High" scores in a 4 x 4 matrix where each cell contains the degree to which function A at the supplier works together with function B at the manufcaturer (3-point scale, High, Medium, Low). Four functions make up the rows and the columns: sales/purchasing, products engineers, manufacturing and quality.
	Frequency (of mutual visits)	1 (na)	frequency of mutual visits. This indicator is the sum of six separate 6-point interval scales: three scales measure the frequency of visits done last year by engineers from the supplier to the manufacturer's engineering department, purchasing offices and assembly plants (ranging from: not once, once, 2 to 5 times, 6 to 10 times, more than 10 times, a guest engineer; the other 3 indicators measure the frequency of visits to the supplier made by the assembler's personnel from the purchasing, engineering and manufacturing departments (ranging from no regular visits, only when there is a problem, weekly, quarterly, annually, and guest)
	Formalization (Control/Coordination)	1 (na)	Importance of control vs. coordination tasks. This indicator is measured as the total ratio of time spent on control tasks. From a total of 100 points representing the time spent working with this supplier each of six keys tasks representative of the boundary spanning job receives a score between 0 to 100. Three tasks are control oriented: negociating price with the supplier, monitoring the supplier's performance, resolving very urgent problems; while three are coordination oriented: coordinating with supplier for continuous improvements, exchanging ideas and future plans and keeping in touch with supplier.

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Process Mechanisms	Conflict Resolution	1 (na)	Extent to which major past disagreements between the two firms have been resolved in an adversarial or collaborative way. This indicator is measured using a 7-point interval scale ranging adversarial, based on confrontation to coolaborative, based on problem-solving and negotiation.
	Commitment	3 (.71)	Extent to which their exists an equal sharing between the two firms of - risks, - burden, and - benefits. This indicator is measured using a 7-point interval scale ranging from your firm has more of the share, to this supplier has more of the share.
	Joint Action	7 (.85)	Extent to which exists joint effort and cooperation between the two companies in the following areas; long range planning, product planning, product engineering (component design) process engineering (for the manufacturer), tooling development (for the supplier), technical assistance, training/education. These 7 indicators were measured using 7-point interval scales ranging from: no or minimal joint effort, to extensive joint effort.
Technological Mechanisms	Scope of the use of IT	1 (na)	This indicator is the sum of 6 dichotomous items measuring each whether data is exchanged in electronic form with this supplier in this function. The six functions are: purchasing, engineering, quality, production control, transportation and payment.
	Intensity of EDI use	1 (na)	This indicator is the sum of 1 dichotomous items measuring whether a specific document was exchanged in electronic form between the two firms (e.g., requests for quote, purchase order, material release, shipment schedule, two dimensional CAD, three-dimensional wireframes, etc.).
	EDI use for engineering	1 (na)	dichotomous item (yes/no) indicating whether data is exchanged in electronic form in the engineering function.
	EDI use for purchasing	1 (na)	dichotomous item (yes/no) indicating whether data is exchanged in electronic form in the purchasing function.

Results and Discussions of Configurations

We first conducted a cluster analysis of the total data set across the 9 variables for information processing needs. The VRC index procedure supports a 2-cluster solution: cluster C_1 where $n_1 = 174$, and cluster C_2 with $n_2 = 273$. The next step was to run the same cluster algorithm and procedure with each of these two clusters across the 10 variables for information processing capabilities. The Calinski and Harabasz algorithm supports a 3-cluster solution for cluster C_1 (C_{11} with $n_{11} = 90$, C_{12} with $n_{12} = 39$, and C_{13} with $n_{13} = 45$), and a 2-cluster solution for cluster C_2 (C_{21} with $n_{21} = 213$, and C_{22} with $n_{22} = 60$). In summary, the data analytic procedure uncovers 5 configurations of fit between information processing needs and capabilities in the context of buyer-supplier relationships in the US and Japanese automobile industries. In the Appendix, we provide the supporting analyses.

Configurations of Interorganizational Relationships:

Descriptive Validity

Our analysis uncovered five distinct and dominant configurations of fit between information processing needs and information processing capabilities in inter-organizational relationships in the automobile industry across the US and Japan. A key question then becomes whether the configurational approach and the analytical procedure employed in this paper have any statistical power to meaningfully distinguish among the five configurations. Table 4 distinguishes the 19 variables across the five clusters. It can be seen from Table 4 that all but one variable (i.e., task analyzability) exhibit highly significant p-values and seem to strongly discriminate between the configurations as demonstrated by the multiple comparisons significant at the 0.05 Scheffe range. It appears, however, that among the characteristics of the boundary spanning task, it is task interdependence, highly specific to the relationship, rather than characteristics intrinsic to the task that discriminate between the configurations. The following paragraphs offer a discussion of the results used to define and interpret the five configurations. Specifically, we first define each configuration on the basis of *only those variables that exhibit Scheffe differences at the 0.05 level.* Table 4 summarizes the five configurations.

Table 4: Summary of the Five Configurations

Variables	F (p)	Scheffe ** differences
Environmental dynamism	28.75 (.000)	(4; 2,1,3); (5; 2,1,3);
Environmental complexity	10.45 (.000)	(4; 3,2); (1; 3)
Environmental Capacity	13.35 (.000)	(5; 2,1,3); (4; 2,1,3)
Mutual trust	26 (.000)	(4; 2,1,3); (5; 2,1)
Manufacturer's asset specificity	15.69 (.000)	(4; 2,3,1); (5; 2)
Supplier's asset specificity	22.46 (.000)	(5; 1,2,3); (4; 1,2,3)
Task Analyzability	NS*	NS*
Task Variety	3.49 (.01)	NS*
Task Interdependence	27.75 (.000)	(4; 3,1,2); (5; 3,1,2)

Variables	F (p)	Scheffe differences
Multiplicity	13 (.000)	(4; 2,5); (1; 2)
Frequency	13.33 (.000)	(4; 2,3); (1; 2,3); (5; 2)
Formalization	4.71 (.001)	(5; 4)
Conflict Resolution	7.42 (.000)	(3; 1); (4; 1); (5; 1)
Commitment	10.04 (.000)	(2; 1,5,4); (3; 1); (4; 1)
Joint Action	18.76 (.000)	(4; 2,3,5); (1; 2); (5; 2)
Scope of the use of IT	80.08 (.000)	(3; 2,5,1,4); (4; 2,5,1); (1; 2,5)
Intensity of EDI use	33.03 (.000)	(3; 2,5); (4; 2,5); (1; 2,5)
EDI for engineering	36.51 (.000)	(4; 2,5); (1; 2,5)
EDI for purchasing	74.38 (.000)	(3; 5,2,1,4); (4; 5,2,1)

*: not significant at 0.05 level
**: (x; a,b,c) means that the following pairs were significant different (x,a); (x,b) and (x,c)

Configurations of Interorganizational Relationships:

Remote Relationship. This type of relationships typically involves highly standardized components, based on a simple and mature technology for which the supplier needs little engineering effort and expertise. The supply market is primarily made of a large number of small-size independent mom and pop shops that compete against each other for short-term contracts with any of the assemblers. None of the partners has made any significant investments specific to the relationship, thus switching costs remain extremely low. Mutual trust is also absent from these relationships. The negotiation of the contract, the operational coordination of delivery and inventory as well as the monitoring of quality are all typically executed following the same well understood and proven practices or pre-established procedures. As a result, well structured and routine boundary spanning tasks create little interdependence between the two firms.

The exchange of information between the assembler and the supplier is limited to what is operationally necessary. Not only the frequency of the exchanges, but also the multiplicity of the channels activated between the two firms are extremely limited. The primary information channel consists of the contract and the link between the supplier's sales department and the customer's purchasing department; hence the name "remote relationship". The use of information technology is literally non-existent. The common practice is still to exchange the documents that certify the multiple transactions between the two firms (e.g. negotiation documents, requests for quote, purchase order, ship schedules, etc...) in paper form via regular mail.

In essence, remote relationships emerge in a low uncertainty context that gives rise to lesser information processing requirements. The market for the products involved is low in capacity and complexity. The buyer typically perceives little uncertainty about the future behaviour of the supplier and the implication it could have on its own production processes. The operational tasks of managing the interface also contribute little to the uncertainty surrounding the relationship. Remote relationships display in response low information processing capabilities. Structural mechanisms are highly formalized, low in the frequency and multiplicity of their use. In addition, no information technology applications are implemented to compensate for the poorness of the information exchange. Little effort to engage in joint action and cooperation activities which normally increase the richness of the information exchange further demonstrates a poor utilization of process mechanisms. Remote relationships therefore represents a configuration of fit between low information processing requirements and low information processing capabilities.

Automakers in both the US and Japanese sample (6.4 to 9.8%, see table 5) rely on this configuration to manage a significant portion of their supply base. They can choose from of a large pool of small captive firms and do not feel the need to further develop or nurture these relationship with after all highly inter-changeable suppliers. For instance, a standard contract and procedures suffice to manage the supply for standardized products such as piston rings, standard fasteners or ornamentation.

Electronic Control Relationships. This pattern of inter-firm relationships seem similar to the previous configuration as far as information processing needs are concerned. The environment is also characterized by low capacity (i.e., low growth market segment), low complexity (i.e., market for highly standardized products), and low dynamism (i.e., market for products based on mature and simple technology, very unlikely to undergo major innovations in functionality or product improvements). For instance, we found in this configuration components such as oil filters, gaskets or standard bearings. The task of boundary agents is characterized by high task analyzability (i.e., typically executed following a set of pre-established rules and standard procedures) and low task variety (i.e., new and unexpected problems in areas of design or specification changes or production control are reportedly rare, thus contributing to a perception of routineness). Both firms' low level of asset specificity testifies to a limited sense of mutual interdependence. The manufacturer did not tailor its products, facilities or tooling to accommodate the supplier's components. Nor did the supplier invest into developing and nurturing a close relationship with the assembler.

The information processing capabilities of such relationships remarkably reveal an emphasis on control activities combined with a low frequency of information exchange (as reflected by low frequency of visits, and weak joint action) between the two firms. Boundary agents predominantly spend their time on control tasks, such as monitoring the supplier's performance, resolving very urgent problems, negotiating contracts. However, a key feature of this configuration is the heavy use of information technology application to mediate these control activities, in particular in the purchasing function. The use of technology manifests along the multiple dimensions of the construct: intensity of use in purchasing, high intensity of use and wide use across multiple functions. This result is consistent with the fact that the areas where the technology is more reliable and offers stable standards are those applications related to automatic order entry, inventory control, delivery scheduling and payment rather than in the highly coordinative applications such as CAD/CAM exchanges or other applications applied to support computer supported cooperative work across organizational boundaries. Finally, the socio-political context characteristic of electronic control or I.T.-mediated control relationships consists of a highly supportive set of processes and actions. Tension between the two firms is typically dealt with by in a collaborative, and constructive problem-solving mode. Joint action, especially in planning or design, remains limited. The assembler's commitment to the relationship is, however, strong as demonstrate the results about the extent to which the assembler side believes it is sharing burdens, benefits and risks with its supplier.

Electronic Integration Relationships. This type of relationships involves those products closer to the auto manufacturer's core competencies. Highly customized components or integrated subsystems they require high levels of technology and engineering the major players in the global auto market traditionally keep close to themselves. Competition is increasingly wagered in the technology and design of these core systems. The technical complexity affects and runs across multiple stages along the value chain, from the concept design, through the development of tooling and manufacturing processes at the assembler and the supplier, to the coordination of production and delivery between the two firms. The manufacturer has generally made important investments into the relationship tying critical assets to the supplier, hence increasing the potential risk and damage to itself were the supplier to behave opportunistically and start leveraging threats, by suddenly exiting the relationship, or worst moving to a competitor. However, it appears that the supplier as well has developed skills and capabilities highly specialized and unique to the production of components customized to the specific platform and car make. As a result, the two partners to electronic integration perceive their mutual economic fate as closely linked. Their high interdependence also shows up at the level of boundary spanning tasks. Given the fast pace of change in the technology and product design it is not only difficult to forecast and pre-plan (i.e., low task analyzability), but also any decision can quickly become obsolete and irrelevant (i.e., very high task variety).

Information exchange between the two partners is rich and intense. Engineers from the supplier pay frequent visits to the assembler's engineering offices, purchasing headquarters and assembly plants. The practice of guest engineers residing on the manufacturer's premises or being an integral member of the team involved in the design of a major system is also a frequent practice in this configuration. Boundary agents also reported allocating a greater part of their time to coordinative tasks (as opposed to control tasks), such as exchanging ideas about future plans, coordination for continuous improvements and keeping in touch with the supplier. Uses of information technology between the two firms also represents some of the best practice in E.D.I. (electronic data interchange) – hence the name "*electronic* integration". The customer exchanges data with the supplier in a form directly readable by a computer either by exchanging magnetic tapes or discs (primarily in Japan), or by sending data from one computer to another via modem or telecommunication links (we exclude the use of fax machines). E.D.I. is typically implemented across multiple functional areas: from purchasing, engineering, quality and production control to transportation or payment through electronic fund transfer. In addition, purchasing managers as well as engineers reported a high intensity of use of E.D.I. to exchange a wide range of documents from request for quotes, purchase orders, paper drawings or three-dimensional wireframes.

Critical also is the fact that this high level of information exchange between the two firms occurs in a context where conflict is resolved in a collaborative fashion, the customer displays a high commitment to the relationship and is willing to engage into joint action with the supplier. For instance, the manufacturer frequently gets the supplier involved in early stages of the component design and cooperates in long range planning, advanced research, product, process and tooling development as well as in technical assistance and training/education. This is not to suggest that there exist little disagreement between the manufacturer and its supplier. In fact, data indicates the opposite, i.e., that component pricing (or transfer pricing for internal divisions), cost structure (and contribution to lowering cost over time), product design, quality levels, as well as inventory and delivery policies all constitute causes for frequent disagreements and tensions between the two firms. But the important finding is that these frequent disagreements are usually resolved through collaborative processes based upon problem-solving and negotiation rather than upon confrontation.

Electronic integration is clearly a configuration for the high uncertainty contingencies that require important and rich information processing capabilities. The environment consists of a highly dynamic, complex and growing market for high tech products. Those who manage the boundaries are also subject to greater amount of uncertainty and ambiguity. Partnership uncertainty, however, is lower, since both parties have major assets tied up to the relationship and are unlikely to behave opportunistically. The investment in all three coordination mechanisms gives the relationship high information processing capabilities. The frequent usage of rich and impersonal structural mechanisms such as visits, teams and groups meetings is combined with information technology applications across multiple functions. Moreover, the cooperative climate within which these structural and technological media are implemented indicates no trade-off or substitution between structure, process and information technology.

Interestingly, this complex configuration includes about half of the sample population for both the US and Japan. This indicates that for critical and complex products such as power steering, wheels or shock absorbers auto manufacturers establish close relationships with a few suppliers with whom they share a common fate, and hence are willing to collectively leverage all coordination mechanisms, including information technology.

Configurations of Interorganizational Relationships:

Structural relationships. This is the dominant configuration for relationships facing a "hybrid" environmental contingency. While on the one hand electronic control and remote relationships appear in low environmental uncertainty (i.e., low capacity, complexity and dynamism), on the other hand electronic integration emerges under high environmental uncertainty (i.e., high capacity, complexity and dynamism). In contrast, arms length relationships face an environment characterized by low capacity (i.e., limited growth) and low dynamism (stable technology with few changes in products), but high complexity (i.e., market for products with a high level of customization). The products involved are complex to manufacture, need customization, but are based on a well understood and stable technology. The supply market is saturated with a predictable set of competitors. As a result, boundary spanning tasks are structured and predictable. Hence, in spite of the need to customize the component to a specific vehicle model, operational coordination across firm boundaries can be analyzed and broken down into manageable and well-understood steps and procedures. Finally, the lack of mutual trust and a strong sense of inter-dependence (i.e., high mutual investments and switching costs) further contribute to greater partnership uncertainty.

Communication between the two firms reflects a predominance of structural mechanisms. Frequent visits are exchanged between personnel of the two firms. In addition , multiple functions such as design, manufacturing, quality and of course purchasing/sales work together across firm boundaries, thus establishing a wide array of distinct communication channels within the relationship. The use of information technology, on the other hand, is restricted in its scope and intensity of use, even for the purchasing function. The climate within which structural relationships are embedded is particularly confrontational. Not only disagreements are frequent, but also their resolution is adversarial. In addition, the assembler does not display a strong commitment to the relationship. This, of course, is not conducive to constructive and rich information exchange between the customer and its supplier, in spite of the multiplicity and frequency of the interactions.

While information processing requirements remain important, the information processing capabilites of structural relationships primarily come from the heavy investment in structural mechanisms. However, the lack of IT implementation and more importantly the confrontational nature of the relational climate indicate poor information exchange. Indeed, interviews reveal that much of the time spent in visits and meetings is spent resolving disagreements and putting off fires.

Primarily, a US response, structural relationships also appear in the Japanese sample for parts such as carpeting, glass or bumper facia and beams. In the eyes of these customers, the nature of the products does not justify developing and nurturing special relationships with a few suppliers when a large pool of capable and vulnerable suppliers is readily available.

Mutual Adjustment. This configuration is restricted to high tech, new and complex products quickly changing in their design and performance, and for which the car company is heavily dependent on the supplier and its proprietary technology. The high level of its asset specificity indicates that the supplier has typically developed unique skills and capabilities highly specific to the production of this model of component for the assembler. The relationship is nevertheless based on a strong sense of mutual trust, where both partners would feel comfortable sharing sensitive information with the other.

However, actual information exchange may be limited. Indeed, this configuration exhibits the lowest frequency of visits exchanged one way or the other. When it happens information exchange is nevertheless oriented towards coordination activities, such as exchanging ideas and future plans with the supplier or coordinating for continuous improvement, as opposed to the control tasks such as negotiating the contract, monitoring the supplier which we discussed keep boundary spanners busy in electronic control and remote relationships. Data indicates no significant use of information technology across firm boundaries. Finally, mutual trust does not operationalize into joint planning, joint design or cooperation in development and manufacturing.

Mutual adjustment thus constitutes a poor response to a high uncertainty contingency. The environment is dynamic, complex and munificent, but the mix of coordination mechanisms provides limited information processing capabilities. Assemblers in both countries tend to rely on this type of arrangements for products for which suppliers have a monopoly and are driving the innovations in product and technology.

Predictive Validity

Predictive validity in its most general sense is the ability to identify future differences and thus constitutes an evaluation of a test's practical worth in foreseeing the future. In this study, we specifically seek to evaluate whether the five configurations empirically uncovered by our analytical approach as described in Table 2 behave in accordance with the theory underlying the measurement exercise. We therefore assess predictive validity by examining whether the distinction between the five configurations is useful in predicting differences along other "dependent" variables (i.e., not among the 19 variables used to define the configurations), in particular measures of performance. Table 5 reports a set of the variables which exhibit significant differences across configurations (i.e.. oneway differences highly significant $p < 0.01$ with Scheffe ranges of 0.05).

In this section we choose to discuss three performance variables that were measured with the instrument administered to key informants at the assemblers' sites. The first multi-item performance variable consists of the independent (i.e., from the respondent) rating of the supplier performed by an assessment team of engineers during visits to the supplier sites. The resulting 10-item scale (Cronbach $\alpha = 0.90$) assesses the attribute of the relationship rather than the supplier itself: e.g., development time, delivery performance, quality performance, price competitiveness, contribution to lowering costs. The second variable is a subjective assessment provided by the key informant of his or her satisfaction with the relationship and with the quality, amount or accuracy of the information exchanged with the supplier (7-item scale; $\alpha = 0.94$). Finally, we measured the level of buffers that exist between the two firms (average levels of inventory kept by the assembler, by the supplier, shipment increments for the component, and average quality levels for the component delivered).

The first important result is that we found highly significant differences in performance measures across the five configurations (the F-values for the three scales respectively are $F_{perf} = 9.66$; $F_{satisfy} = 6.37$; $F_{buffer} = 6.51$ that is a p-value < 0.001). Two configurations stand out as low performers: remote relationships and structural relationships. Typically scoring high on all three performance variables are mutual adjustments, electronic integration and electronic control. It appears that the information processing needs contingency within which the relationship operates does not predict performance. Indeed, on the one hand we find highly performing (i.e., electronic control) as well as low performing (i.e., remote relationships) configurations under low information processing needs, and on the other hand low performing (i.e., arms length relationships) as well as highly performing (i.e., electronic integration) configurations operating under high information processing needs contingencies. This result strongly agrees with the logic of fit underlying the conceptual model described in this paper. For instance, structural relationships operate in a high uncertainty context (i.e., customized products, high uncertainty about the supplier) not sufficiently contained with simply strong structural coordination mechanisms. Not only information technology is not leveraged sufficiently, but more importantly the lack of commitment and the highly conflictual climate of the relationship does not encourage a rich information exchange between the two partners. On the other hand, electronic control reveals an appropriate use of technology to support routine and straightforward data (as opposed to information or knowledge) exchange activities necessary in a low information processing needs contingency.

Configurations of Interorganizational Relationships:

Table 5: Predictive Validity

	Structural Relationship	Remote Relationship	Electronic Control Relationship	Electronic Integration
Remote Relationship				
Electronic Control Relationship	buffers (1,3)	performance (3,2), history (3,2)		
Electronic Integration	satisfaction (4,1), buffers (1,4), interdependence (4,1), supplier proprietary technology (4,1)	performance (4,2), fax (2,4), supplier size (4,2), ownership (4,2), continuity (4,2), history (4,2), interdependence (4,1), proprietary technology (4,2)	interdependence (4,3)	
Mutual Adjustment	performance (5,1), satisfaction (5,1), proprietary technology (5,1)	performance (5,2), satisfaction (5,2), supplier size (5,2), continuity (5,2), interdependence (5,2)	buffers (5,3)	buffers (5,4), use of fax (5,4)

**: (x,y) signifies that the mean for cluster x is significantly greater than the mean for cluster y at Scheffe ranges of 0.05

Results for other variables further demonstrate the ability of the five configurations as defined along 19 variables for the six constructs of the model to predict other differences consistent with theory or other empirical findings as reported by Womack et al., Helper and Nishiguchi. Table 5, for instance, reports the key significant differences for variables such as the history of the relationship (number of years, $F = 4.14$; $p < 0.005$) , ownership structure of the relationship (i.e., equity ratio, $F = 4.91$; $p < 0.001$), use of the fax ($F = 5.80$; $p < 0.001$), continuity of the relationship (i.e., likelihood the relationship will continue on a long term basis beyond the current contract; $F = 5.54$; $p < 0.001$), the level of interdependence between the component at hand and the rest of the vehicle ($F = 8.68$; $p = 0.000$).

Table 6 depicts the relative ratio of each configuration as found in the two country samples. First, the results indicate the multiplicity and richness of supplier relationships in both countries. In particular, we should note the significant presence of structural and control type of relationship in Japan. Similarly, the US sample displays 11% of mutual adjustment relationships usually associated with Japanese auto firms. In fact, the results provide important insights not only in the differences between the two countries but also in the similarities. For instance, in both national settings tight and strong relationships are established around those critical components close to the assembler's core competencies. In the US these include internal division (e.g., equity ratio superior to 50%) and in Japan internal division and first tier suppliers. It is with these special suppliers that auto firms have aggressively invested in electronic exchange of information. The significant differences lie in the not surprisingly higher US ratio of structural relationships and the greater importance of electronic control relationships in Japan, indicating a preference to using IT for highly structured and low uncertainty relationships.

Table 6: Differences Across the US & Japanese Samples (% of the Relationships in Each Category)

	Structural Relationships	Remote Relationships	Electronic Control Relationships	Electronic Integration Relationships	Mutual Adjustment Relationships
US sample	26.4	6.4	5.7	50.0	11.4
Japanese sample	17.3	9.8	12.1	46.6	14.3

Conclusions

This paper sought to uncover a set of naturally occurring configurations of interorganizational relationships in the auto industry – with a particular focus on US and Japanese auto makers. Our contributions relate to: (a) deriving the configurations at the interorganizational level of analysis that is increasingly becoming important and relevant for theorizing where prior research has adopted narrower, bivariate specifications under *ceteris paribus* conditions; (b) adopting a conceptual model based on an information processing view to guide the selection of variables as critical inputs into the derivation of configurations; (c) increased methodological considerations to the analytics underlying the development of configurations; as well as (d) adopting a multi-country design for the collection of data consistent with the recent trend towards globalization of industries and markets. We hope that this research will stimulate others to adopt a more holistic approach to the understanding of interorganizational relationships.

Configurations of Interorganizational Relationships:

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Appendix

Determining the "best number" of clusters in a data set

The Calinski and Harabasz index procedure is based on a shortest dendrite method (or minimum spanning tree) for identifying the clusters of points in a multi-dimensional Euclidean space. Their working intuitive definition of a cluster is "that points within a cluster are close together, while clusters themselves are far apart" (Rao, 1964, p.351). The objective is then to find some minimum variance clusters. The formal index proposed by Calinski and Harabasz is based on two familiar objective functions: the within-group sum of squares (WGSS) and the between-groups sum of squares (BGSS). The index, referred to as the VRC index, variance ratio criterion, is defined by:

$$VRC = \frac{BGSS}{k-1} / \frac{WGSS}{n-k}$$

n = total sample size
k = number of clusters

VRC is first computed for a k = 2 cluster solution, then k = 3, and so on. For each clustering solution we calculate WGSS, BGSS and VRC. Calinski and Harabasz's conclusion, validated by the Milligan and Cooper Monte Carlo simulation, is to choose that number k for which the VRC, variance ratio criterion, has an *absolute or a first local maximum.*

WGSS is the within-group sum of squares (here squared Euclidean distances). The distance d_{ij} between two data points P_i and P_j is defined by the function:

$$d^2_{ij} = (x_i - x_j)'(x_i - x_j),\ i,j = 1,2, ..., n$$

If d^2_g denotes the general mean of all $n_g (n_g - 1) / 2$ squared distances between data points within the g-th group (g=1, 2, ..., k). Then WGSS is given by:

$$WGSS = S_i\ WGSS_i, \quad i = 1, 2, g, ..., k$$

or $$WGSS = 1/2\,((n_1 - 1)\,d^2_1 + (n_2 - 1)\,d^2_2 + ... + (n_k - 1)\,d^2_k)$$

BGSS can be derived from the value of TSS the total sum of squares. We know that TSS = WGSS + BGSS , but also TSS is the general mean of all n (n - 1) / 2 squared distances d^2_{ij}.

Step 3: Two configurations of information processing needs: : C_1 and C_2

The total sum of all pairwise squared distances between the 447 data points in the total sample is TSS = 4014. There are 447 x (447 - 1) / 2 such distances. A k=2 solution gives two clusters of information processing needs C_1 and C_2 with n_1 = 174 and n_2 = 273. The sum of squared distances between the cases in cluster C_1 is 1350, and the sum of squared distances between those in cluster C_2 is 2223. Consequently, WGSS is given by:

WGSS = 1350+ 2223= 3573 and BGSS = 4014 - 3573 = 441.

and VRC is then derived by (#); $VRC = \frac{441}{(2-1)} / \frac{3573}{(447-2)} = 54.88$

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A k=3 solution derived for the same total data set (i.e., n=447) across the same 9 variables for information processing needs gives three clusters with the following characteristics: $n_1 = 174$, $n_2 = 167$ and $n_3 = 106$ with respective within-cluster sum of squared distances $WGSS_1 = 1/2\,(174 - 1)\, d^2{}_1 = 1350$, $WGSS_2 = 1/2\,(167 - 1)\, d^2{}_2 = 1061$; and

$$WGSS_3 = 1/2\,(106 - 1)\, d^2{}_3 = 921.$$

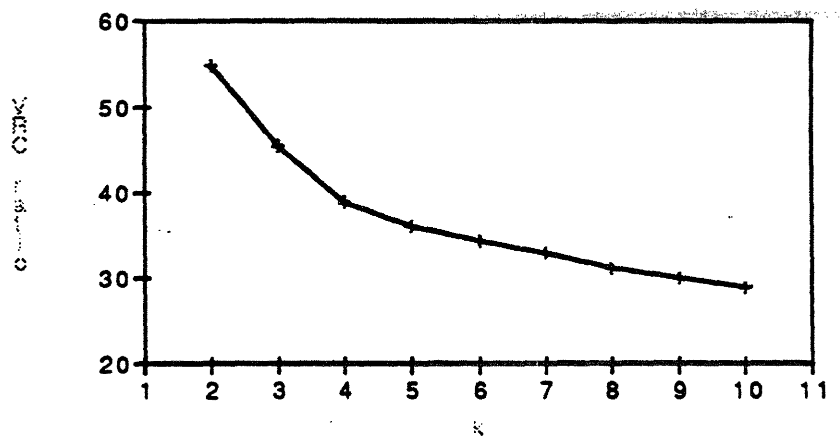
Therefore WGSS = 1350+ 1061+ 921= 3332 and BGSS = 4014 - 3332 = 682, and finally VRC has a value of:

$$VRC = \frac{682}{(3-1)} \Big/ \frac{3332}{(447-3)} = 45.42$$

Following Calinski and Harabasz rule which consists in selecting k for which VRC has a general or local maximum as the "best number" of clusters, we can select the 2 cluster solution (i.e., k = 2) as the best clustering solution for information processing needs in the total sample. The following table and figure depict the results for the same VRC procedure conducted up to k = 10.

Results of the VRC procedure up to k = 10

number of clusters k	2	3	4	5	6	7	8	9	10
BGSS	441	682	836	988	1124	1245	1333	1419	1498
WGSS	3573	3332	3178	3026	2890	2769	2681	2595	2516
VRC	54.88	45.42	38.87	36.06	34.29	32.97	31.19	29.94	28.90



<u>*Step 4: Five configurations of fit: C_{12}, C_{12}, C_{13}, C_{21}, and C_{22}*</u>

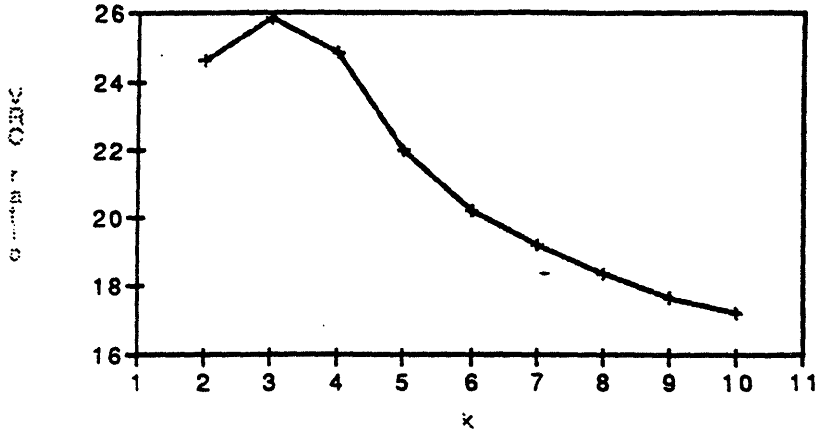
For each of the two configurations of information processing needs identified in step 3 we repeat the same clustering procedure across the 10 information processing capabilities variables. The VRC index support a 3 cluster solution for C_1 and a 2 cluster solution for C_2. The following tables give the summary results from the Calinski and Harabasz procedures for C1 and C2., for illustration, the

Configurations of Interorganizational Relationships:

intermediate results up to k = 4 for C_1.

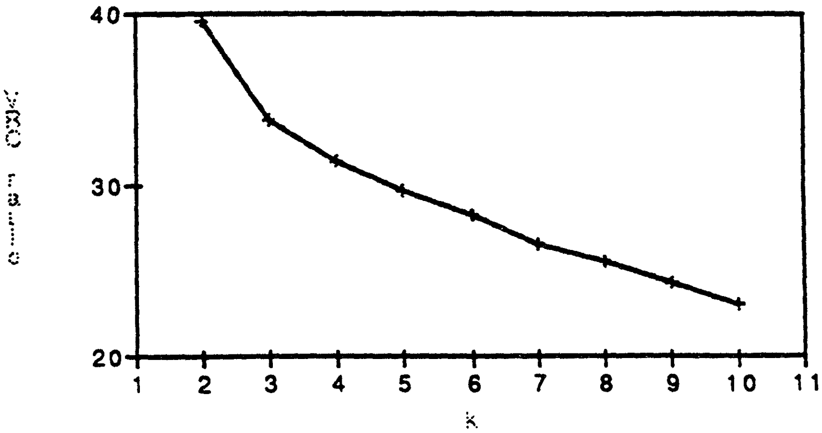
Summary results for cluster C1 and k= 2 to 10

number of clusters k	2	3	4	5	6	7	8	9	10
BGSS	224	415	545	612	672	731	780	825	869
WGSS	1565	1374	1244	1177	1117	1058	1009	964	920
VRC	24.66	25.85	24.83	21.99	20.22	19.22	18.33	17.65	17.20



Summary results for cluster C2 and k= 2 to 10

number of clusters k	2	3	4	5	6	7	8	9	10
BGSS	331	519	673	797	898	973	1047	1099	1141
WGSS	2263	2075	1921	1797	1696	1621	1547	1495	1453
VRC	39.61	33.79	31.42	29.74	28.30	26.60	25.63	24.27	22.96



Configurations of Interorganizational Relationships: