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A Blockmodel Study of a Computer Software Firm

Gordon Walker

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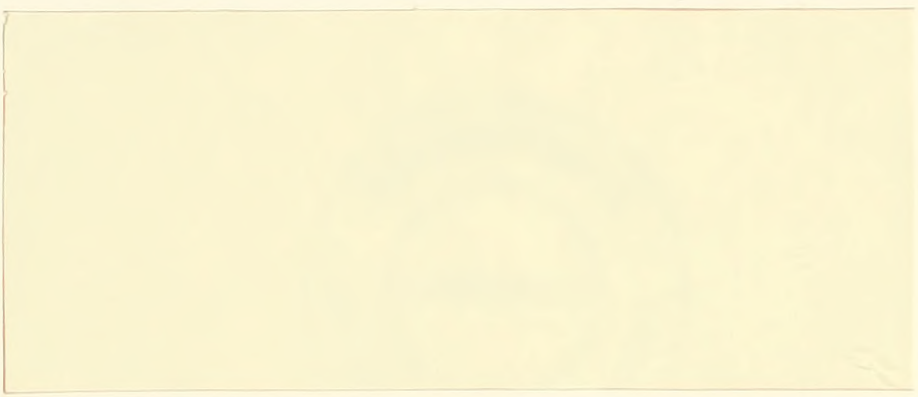

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Introduction

Research interest in intraorganizational networks has been steady but relatively weak and fragmented. In the tradition of research which the present study follows a network is conceived as an organization wide system of formal or informal relations between firm members.

In general, the network of relationships in an organization has been treated as a surrogate measure of certain constructs, such as the "informal system" or organizational structure, rather than as a theoretical entity in its own right. The present research is an attempt to make networks a distinct theoretical entity by analysing formal and informal relationships simultaneously. The approach taken in the present research is quite specific and relatively new primarily because of the advent of easy large-scale data analysis on computers (see Arabie, Boorman and Levitt, 1979). Burt (1980) characterizes the approach as "positional" and contrasts it to the "relational" perspective. Basically, the location of an actor in a network from the positional perspective is defined empirically through an analysis of ties among individuals in the population, where as from the relational point of view the actor's location is given a priori based on a predetermined category scheme.

When an organization is viewed as a network of different kinds of ties between individuals and the network is subjected to a form of positional analysis, the result is a partition of organizational members into subgroups (see Arabie, Boorman and Levitt, 1979; Burt, 1976a, 1976b). In the present study these subgroups are formed on the basis of the theoretical principle of

structural equivalence (Lorrain and White, 1972; White, Boorman and Breiger, 1976; Burt, 1978). In partitions created on this principle individuals are combined whose ties to the rest of the organization are the same or similar, regardless of whether they have ties with each other.

Individuals who are structurally equivalent thus have a similar experience of other organizational members. The theoretical implications of this commonality of experience depend on the types of relations that define the interpersonal ties composing the network.

In the present research networks of ties based on different kinds of functional relations are examined. The networks of functional relations in the firm should describe the distribution of goals and information which in turn should be related to the ability of the firm to solve various kinds of problems. Five types of functional relation are investigated in this paper: reporting, information dependence, problem referral, feedback on performance, and help with extra resources. These relations are discussed in some detail below.

Types of Network Relations

Reporting. The most commonly recognized type of interpersonal tie in organizations is reporting. Reporting relationships are used to construct organization charts, which are used to derive aspects of organizational structure, particularly span of control and the number of levels in the reporting hierarchy. The chart may indicate unusual characteristics of the organization's formal authority structure such as dual and lateral reporting relationships (see e.g., Galbraith, 1974).

The reporting structure can represent offices and departments as well as individuals, and often the meaning of the structure is a function of interdepartmental rather than interpersonal lines of authority. This expansion of meaning occurs because interpersonal reporting relationships entail the resources which the individuals command and can mobilize, in theory, to achieve a particular reporting result. Individuals report what their departments do both as a separate outcome and as a contributor to their own performance.

Information. Interpersonal relations based on the need for different kinds of task related information have been frequently studied by organizational researchers (Tushman and Scanlan, 1981; O'Reilly and Roberts, 1977; Fombrun, 1980). Information dependence can often transcend the boundaries of functional groups and flow down or across the hierarchy, especially in firms which have significant task discontinuities (see Offe, 1976).

Networks of information dependence by definition describe the distribution of information in an organization. In the present study three types of information are measured: technical, marketing and administrative. Relationships based on technical information are a very common type of tie in studies of intra-organizational networks, (see, e.g. Allen, 1977). Analyses of marketing and administrative information relationships have rarely been reported. However, both types of information flow are clearly important for task accomplishment. All three types of relations describe directly the distribution of information and involving the distribution of goals in the firm (see, March and Simon, 1958, p. 154).

Feedback on Performance. Another type of relation which should be associated with the distribution of information is feedback on task performance. In general, firm members receive knowledge about their work from two sources: other members and the job itself. Feedback from other members is similar to in-group communication as an influence on an individuals focus of information (Kim and Hamner, 1976; March and Simon, 1958, p. 154). The giving of feedback on performance entails an ability to judge some aspect of the performance's worth, and the judgment of a performance's worth cannot properly occur without relevant information. From the macro point of view, then, the network structure of feedback relationships describes to an extent the distribution of task-relevant information in an organization.

Moreover, feedback also entails access to a particular performance. The pattern of access in an organization is associated with the distribution of goals since a performance should be meaningful only to those whose goals are somehow linked to it. Networks of two other types of relation, resource dependence and problem referral, share this association with goal distribution.

Resource Dependence. There are many types of resources for which individuals may be dependent on others. In the present study four are identified: time, money, equipment, and people. The flow of resources from one person to another generally indicates a committment by the giver to a project or the expectation of a return favor, (see Pfeffer & Salancik, 1974). But resources may also be given because there is an administrative mandate for the transaction. By focusing in the present study on relationships where extra resources are given, resource dependence is to a great extent a discretionary relationship and indicates a measure of mutual commitment or, at worst, low overall goal conflict.

Problem Referral. Problem referral is perhaps the type of relation most clearly associated with goal linkage among individuals. The links here, though, are determined more by the pattern of work flow (see Comstock & Scott, 1976) in the organization than by goal agreement among individuals. Work problems may be referred between organizational members who need only to be adjacent to the sequence of subtasks required for achieving an overall solution. The goals of referer and referee thus are similar because they are closely connected to each other in a stream of work which is represented by the referral process.

Networks of the five types of functional relations each reflect aspects of the distribution of goals and information in the organization, and each type of relation implies the patterns of goals and information in different ways. The primary and secondary emphases of each of the five types of functional relationships are found in Figure 1.

Reporting and resource dependence relations are oriented primarily toward establishing and maintaining goal congruence and secondarily toward information flow. Problem referral is also goal oriented, but in contrast to reporting and resource dependence, which involve a continuing although not necessarily frequent interpersonal contact between the parties involved, problem referral may occur without the development of such a relationship. In the case of problem referral goal similarly is achieved through the pattern of the organization's workflow, not through interpersonal negotiation or obligation.

The structure of interpersonal ties based on dependence for specific kinds of information by definition describes the sources and sinks of information in an organization and only by implication represents the distribution of goals. Feedback relationships also imply a common information domain first and goal similarity second.

FIGURE 1

ORDER OF EMPHASIS OF GOALS AND INFORMATION IN EACH TYPE OF FUNCTIONAL RELATION

Type of Relation	Goals	Information
Reporting	primary	secondary
Dependence for Information	secondary	primary
Feedback on Performance	secondary	primary
Resource Dependence	primary	secondary
Problem Referral	primary	secondary

When the networks of the five types of functional relations are looked at simultaneously, subgroups can be identified composed of organizational members who are structurally equivalent and should share similar goals and information. These subgroups may or may not conform to the functional or hierarchical structure of the organization, depending on the degree to which that structure describes the relationships among organizational members accurately.

The remainder of this paper presents the methods and examines the results of empirical research conducted in a computer software products firm. The research is primarily descriptive; and in the best tradition of inductive studies, several propositions to be tested in other organizations are suggested by patterns in the data.

Research Design

The Organization. The firm in which the study was conducted was founded in the early 1960's. The company is publicly owned. Current revenues approximate twelve million dollars, and the number of employees is roughly 300. The organization has four main offices: New York, Washington, Far West, and Canada. The firm has held contracts with most of the large computer hardware manufacturers and continues to benefit from short-term contracts with a variety of companies both within and outside the computer business.

Data Collection. The construction and stability assessment of interpersonal networks of functional relations were based on data collected in two questionnaires. Several ways of collecting the data were considered with the constraints in mind that the data collection period should not exceed six

months and that a very large proportion of the organizational membership would be included in the study. It was felt that changes in the organizational over a period greater than six months would severely affect the reliability of the data. Furthermore, the large size of the population meant that it would have been extremely difficult to tailor questionnaires to individual perspectives.

The first alternative collection technique was a diary to be kept by organizational members (see Fombrun, 1980 for a discussion of this method). Respondents might have been instructed to record in a diary certain kinds of personal contacts made during the day for different days in the week several weeks in a row. This option was rejected by the organization as too demanding.

The remaining alternatives were different questionnaire formats. The first possible format consisted of a list of organizational members to whom respondents would be asked to refer when aswering questions about functional relations with others. In the second format, respondents would be asked to answer such questions without a list; and in the third format respondents would answer by checking names on the list. When presented with these options the officer of the organization in charge of the project agreed with the researcher that the third alternative was probably the most efficient, since respondents needed to do little writing and yet comprehensive data could be obtained. This method was also favored by other researchers concerned with the gathering of data suitable for large scale network analysis (Boorman, 1981).

In order to check the stability of the network data the same network questions were asked in the first and second questionnaires, with different orders of question presentation in the two instruments.

The list of members in both questionnaires was composed from several lists provided by the organization. The explicit criterion for inclusion in

the study and therefore inclusion on the list was that the member have some relationship with software products in the company, either in development, marketing, or critical inspection. One hundred and fifty members composed the list. Of these, one hundred responded to the questionnaire, and ninety-three questionnaires were usable.

Methods. Membership in a subgroup defined by the network of functional relations in the organization is a nominal scale variable. Subgroups were derived from an analysis of all relations simultaneously. That is, members of a subgroup were structurally equivalent in terms of their relationships with the other members of the organization on all five types of functional relation; such a generalized partition of the organization is consistent with other analyses of intra-organizational networks, e.g., in White, Breiger and Boorman, 1976.

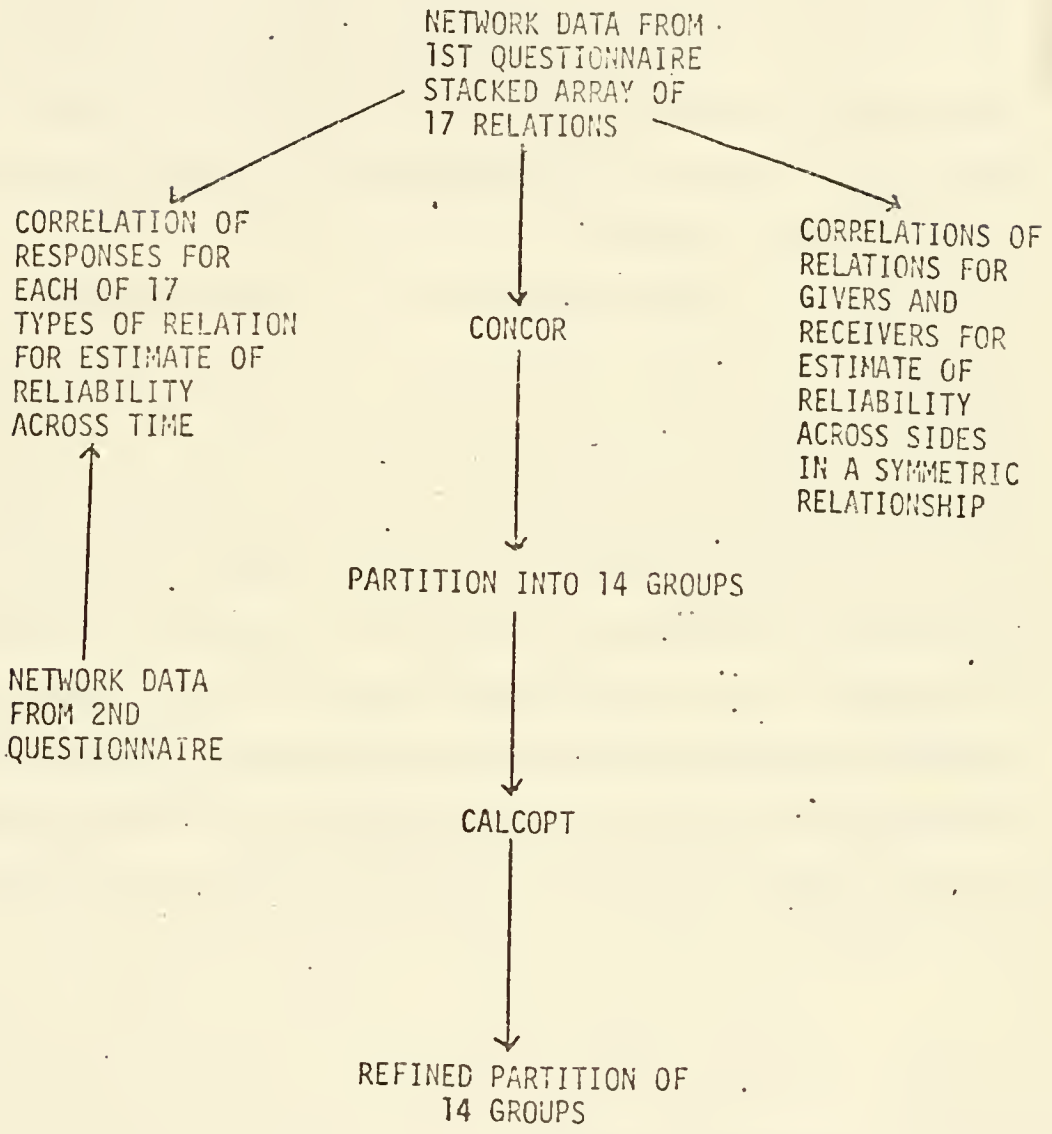
The method used to derive the subgroups is called blockmodelling (Arabie, Boorman and Levitt, 1979) and involves the use of two algorithms, in the present case, CONCOR (Breiger, Boorman and Arabie, 1975) and CALCOPT (Boorman, 1981). CONCOR is a clustering algorithm that splits the membership of the organization into two groups and hierarchically and successively into further groups until 1) a desired number of subgroups is obtained; 2) the subgroups have roughly a certain number of members; or 3) some other criterion is met. The members of each subgroup are defined as structurally equivalent to each other (see Lorrain and White, 1971; Breiger, 1975). The partition produced by CONCOR was used as an initial configuration for CALCOPT. CALCOPT alters the membership of the subgroups, iteratively, until no reassingment produces a better value of a target function. The target function used in this application was the sum of the squared differences between the

blockmodel's mean density and the densities of each block in the blockmodel. As members are relocated, the densities change. If the densities diverge, the target function increases and the partition is improved because the blockmodel has become "leaner" (see White, Breiger, and Boorman, 1976).

Two types of stability were assessed for the network data: 1) stability across time and 2) across respondents in the first time period. In each case stability was estimated for the raw data rather than the results of the network analysis. The first type of stability was measured by correlating the responses of organizational members to the network questions in the first and second questionnaires. A high correlation for a specific relation indicated that there was substantial stability in the perceptions of respondents of their ties to others over time. Such stability indicates that the instrument measured an aspect of a respondent's experience that could be identified consistently over time. Clearly, in a two month period (the span of time between the distribution of the first and second questionnaires) many organizational members may have changed their positions, perhaps in a systematic way (see, e.g., the analysis of Newcomb's longitudinal fraternity data in Boorman and White, 1976). However, such shifts in position should not have occurred on a large enough scale to destroy whatever aspect of experience the instrument was measuring for the population. A test of the second type of stability involved correlating the responses, in the first questionnaire, of members who said they "sent" a particular type of tie to others and the responses of those who purportedly "received" that tie. Here a high correlation meant that there was substantial symmetry in the perceptions of the partners in a relationship. The sequence of constructing the network and testing its stability is shown in Figure 2.

FIGURE 2

CONSTRUCTION AND RELIABILITY TESTS OF NETWORK SUBGROUPS



Results

The results of analysing the network data are presented in this section. The process of determining the relations is outlined and the method and results of the network anlysis described.

With the exception of reporting, the types of functional relations were measured for both senders and receivers. That is, for example, respondents were asked to indicate those from whom they received problems and those to whom they sent problems.

Reporting was measured as a binary variable. Responses for feedback and problem referral, which were measured on an ordinal scale, were dichotomized (see Arabie, Boorman and Levitt, 1979, p.43). The cutoff criterion for each of these relations was median split. Of the five types of extra resources given and received: time, money, people, equipment and more than one type of resource, only time and more than one type of resource had a sufficient number of responses to be included in the analysis. All three types of information measured: technical, marketing, and administrative, and a fourth category, dependence for information of more than one type were analysed. In all, then, seventeen separate relations were used to constitute the network:

1. reporting
2. feedback given
3. feedback received
4. problems given
5. problems received
6. extra time given
7. extra time received

8. more than one kind of resource given
9. more than one kind of resource received
10. technical information given
11. technical information received
12. marketing information given
13. marketing information received
14. administrative information given
15. administrative information received
16. more than one kind of information given
17. more than one kind of information receive

Frequencies for the categories of each relation are presented in Table 1.

Binary matrices for each of these relations were stacked and submitted to CONCOR. After successive splitting, 14 groups were identified. The splitting sequence is shown in Table 2A. The partition produced by CONCOR was used as an initial configuration for CALCOPT. In CALCOPT, a member was moved from one subgroup to another if the move increased the sum of squared differences between the interblock densities and the grand mean density. The initial value of the CALCOPT target function using the CONCOR partition was 215.94, and the terminal value was 452.54. The number of members in each group after CALCOPT was applied is shown in Table 2B.

The CALCOPT partition, like that of CONCOR, contains 14 groups. (CALCOPT would have eliminated a group had the relocation of its last member increased the target function.) In order to portray clearly the pattern of relationships in the blockmodel and density matrices, the order of the groups was changed. The ad hoc principle of reordering was simply to put groups which contained members from the same regional office next to each other. The density matrices based on this permutation are found in Table 3.

TABLE 1

FREQUENCY OF RESPONSE FOR NETWORK RELATIONS

A. Reporting

1. Average number of reporting ties per respondent: 1.13

Total Number of Responses per Category

B. Feedback

	Less than once a month	Roughly every month	Roughly every two weeks	Roughly every week	Roughly every day
1. Feedback received	90	51	41	61	26
2. Feedback sent	96	48	38	94	28

C. Problem Referral

1. Problems received	95	42	28	41	23
2. Problems sent	129	42	38	43	20

D. Help With Extra Resources

	Time	Money	People	Equipment	More than one kind
1. Help received	26	1	12	5	87
2. Help sent	98	1	8	2	130

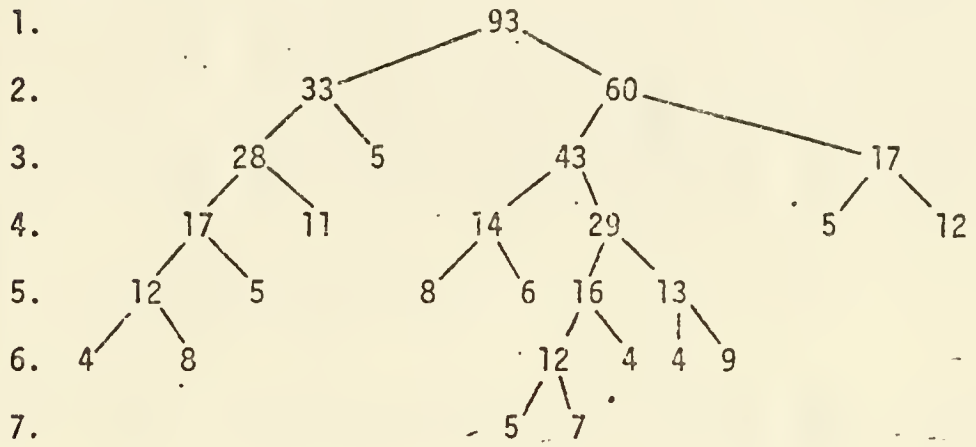
E. Dependence for Information

	Technical	Marketing	Administrative	More than one kind
1. Information received	270	73	57	62
2. Information sent	262	79	34	80

TABLE 2

CONCOR SPLITTING SEQUENCY AND CALCOPT PARTITION

A. CONCOR Splitting Sequence



B. CALCOPT Partition

Number of Members in Each Cell of the Partition:

Cells:	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
No.:	8	9	4	14	23	5	5	4	5	2	9	1	1	3

Target Function Values:

Initial Partition: 275.94 Final Partition: 452.54

TABLE 3

DENSITY MATRICES

A. Reporting

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.24	.00	.00	.00	.00	.00	.06	.00	.00	.20	.00	.10	.00	.00
II	.13	.02	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.25	.02	.19	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.11	.02	.08	.04	.00	.00	.01	.07	.00	.00	.00	.00	.00	.00
V	.01	.00	.00	.00	.00	.07	.05	.00	.00	.04	.00	.00	.00	.00
VI	.00	.00	.00	.00	.00	.22	.08	.00	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.00	.00	.02	.00	.00	.75	.00	.06	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.00	.08	.00	1.00	.06	.00	.00	.00
IX	.00	.00	.00	.00	.00	.00	.00	.04	.00	.89	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.03	.10	.00	.75	.25	.13	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.20	.00	.00	.08	1.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00	.00	.00

B. Feedback Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.10	.05	.02	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.05	.00	.13	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.07	.00	.03	.01	.01	.00	.01	.04	.00	.00	.00	.00	.00	.00
V	.01	.00	.00	.01	.01	.01	.02	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.04	.07	.44	.06	.07	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.01	.00	.05	.00	.00	.00	.00	.00	.00	.00
VIII	.00	.00	.00	.09	.00	.00	.03	.28	.07	.20	.05	.10	.00	.00
IX	.00	.00	.00	.00	.00	.00	.03	.00	.00	.11	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.88	.80	.11	.00	.80	1.00	.00	1.00
XI	.00	.00	.00	.00	.00	.00	.00	.15	.00	.25	.25	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.28	.80
XIV	.00	.00	.00	.00	.00	.00	.13	.00	.00	1.00	.00	.00	.20	.00

C. Feedback Sent

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.28	.03	.00	.04	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.04	.06	.02	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.00	.07	.06	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.02	.01	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.01	.02	.01	.02	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.04	.13	.44	.04	.07	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.01	.04	.05	.00	.00	.13	.00	.06	.00	.13
VIII	.00	.00	.00	.03	.01	.00	.03	.28	.03	.20	.05	.10	.00	.00
IX	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
X	.00	.00	.00	.11	.00	.00	1.00	.60	.83	.00	.75	1.00	.20	1.00
XI	.00	.00	.00	.00	.00	.00	.00	.15	.00	.00	.31	.00	.00	.00
XII	.00	.00	.00	.00	.02	.00	.00	.10	.00	.50	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.20	.40
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00

D. Help (Time) Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.04	.01	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.10	.02	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
V	.01	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.01	.11	.04	.00	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00
IX	.00	.00	.00	.00	.00	.00	.00	.00	.01	.11	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00

E. Help (More Than One Kind) Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.16	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.03	.02	.07	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.05	.11	.31	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.04	.02	.06	.01	.01	.00	.01	.02	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.01	.00	.01	.00	.00	.00	.00	.02	.00	.00
VI	.00	.00	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
VII	.03	.00	.00	.00	.00	.00	.03	.00	.00	.38	.00	.06	.00	.13
VIII	.00	.00	.00	.02	.00	.00	.08	.24	.02	.60	.05	.10	.00	.00
IX	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.13	.00	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.50	.30	.00	.00	.00
XII	.10	.00	.00	.00	.02	.00	.13	.10	.00	.50	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.08	.20
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

F. Help (Time) Sent

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.00	.07	.00	.02	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.03	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.10	.04	.06	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.09	.02	.06	.04	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.02	.00	.00
VI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.03	.04	.02	.00	.00	.00	.00	.00	.00	.00
VIII	.00	.00	.00	.02	.01	.07	.03	.08	.04	.20	.00	.00	.00	.00
IX	.00	.00	.00	.00	.00	.00	.01	.02	.02	.11	.00	.00	.00	.00
X	.00	.00	.00	.22	.30	.67	.25	.20	.67	.00	.75	1.00	.60	.00
XI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00	1.00	.00

G. Help (More Than One Kind) Sent

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.16	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.15	.16	.44	.14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.04	.02	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.02	.00	.00
VII	.03	.00	.00	.00	.01	.04	.04	.00	.00	.00	.00	.00	.00	.00
VIII	.00	.00	.00	.04	.00	.00	.03	.05	.00	.03	.25	.00	.06	.00
IX	.00	.00	.00	.00	.00	.00	.00	.03	.16	.02	.20	.05	.10	.00
X	.00	.00	.00	.00	.00	.33	.63	.80	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.25	.00	.40	1.00
XII	.20	.00	.00	.06	.11	.00	.63	.60	.44	1.00	.13	.00	.00	1.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

H. Information (Administrative) Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.36	.01	.05	.02	.00	.00	.03	.00	.00	.00	.00	.00	.00	.00
II	.07	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.05	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.01	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.04	.00	.00
VII	.03	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.33	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.25	.00	.06	.00	.00
IX	.00	.00	.00	.00	.00	.00	.03	.00	.00	.20	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.01	.00	.00	.11	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.13	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00	.00	.50
XIV	.00	.00	.00	.00	.00	.00	.13	.00	.00	1.00	.00	.00	.00	.00

I. Information (Administrative) Sent

	I	II	III	IV	V	VI	VII	VIII		X	XI	XII	XIII	XIV
I	.36	.01	.00	.00	.00	.00	.03	.00	.	.00	.00	.00	.00	.00
II	.06	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.10	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00
VII	.03	.00	.00	.00	.01	.04	.00	.00	.00	.00	.00	.00	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.00	.00	.01	.13	.00	.00	.03	.00
IX	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.33	.00	.00	.00	.00	.00	.00	.20	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.06	.50	.00	.25	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

J. Information (Marketing) Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.08	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.01	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.10	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.04	.04	.06	.04	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.01	.00	.01	.00	.00	.00	.00	.02	.00	.00
VI	.00	.00	.00	.00	.00	.00	.04	.07	.00	.33	.00	.17	.00	.00
VII	.00	.00	.00	.01	.02	.04	.16	.15	.01	.25	.00	.19	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.03	.00	.00	.25	.00	.10	.00	.00
IX	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.25	.00	.11	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.50	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

K. Information (Marketing) Sent

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.16	.05	.11	.09	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.01	.00	.01	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
VII	.03	.00	.00	.00	.01	.00	.17	.13	.01	.25	.00	.19	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.10	.00	.00	.20	.00	.00	.00	.00
IX	.00	.00	.00	.00	.00	.00	.04	.02	.00	.00	.00	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.00	.00	.33	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XII	.00	.00	.00	.00	.04	.00	.13	.10	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

L. Information (More Than One Kind) Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.20	.03	.00	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.02	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.00	.03	.01	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.04	.22	.04	.00	.00	.04	.00	.00	.00	.00
VII	.00	.00	.00	.00	.01	.04	.00	.00	.00	.00	.08	.00	.00	.00
VIII	.00	.00	.00	.00	.00	.00	.05	.12	.00	.25	.00	.06	.00	.00
IX	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.10	.00	.00	.00
X	.00	.00	.00	.00	.00	.00	.63	.60	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.05	.00	.25	.00	.00	.00	.00
XII	.10	.00	.00	.06	.02	.00	.06	.40	.06	.00	.13	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

M. Information (More Than One Kind) Sent

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.28	.01	.00	.04	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.01	.00	.01	.01	.00	.00	.04	.00	.00	.00	.00
VI	.00	.00	.00	.00	.04	.22	.13	.00	.00	.33	.00	.00	.00	.00
VII	.00	.00	.00	.01	.01	.00	.00	.08	.01	.25	.00	.06	.00	.13
VIII	.00	.00	.00	.00	.00	.00	.05	.12	.00	.20	.05	.00	.00	.00
IX	.00	.00	.00	.00	.00	.00	.01	.00	.00	.11	.00	.06	.00	.00
X	.00	.00	.00	.00	.00	.00	1.00	.80	.22	.00	.25	.00	.00	1.00
XI	.00	.00	.00	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00
XII	.10	.00	.00	.06	.04	.00	.13	.30	.06	.00	.13	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.00	.00	.00	.00	.00

N. Information (Technical) Received

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.00	.07	.10	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.06	.11	.14	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.10	.25	.38	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.09	.02	.11	.00	.01	.00	.00	.02	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.01	.05	.13	.02	.00	.01	.00	.00	.00	.00	.00
VI	.00	.00	.00	.07	.12	.22	.04	.67	.00	.00	.17	.00	.00	.00
VII	.00	.00	.00	.01	.04	.08	.09	.06	.03	.00	.09	.00	.00	.25
VIII	.00	.00	.00	.07	.00	.00	.00	.20	.07	.20	.10	.00	.00	.00
IX	.02	.01	.00	.01	.00	.00	.06	.18	.04	.22	.17	.00	.02	.00
X	.20	.00	.00	.11	.00	.67	.00	.40	.67	.00	.50	.00	.40	1.00
XI	.00	.00	.00	.06	.00	.17	.03	.30	.03	.25	.50	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.12	.40
XIV	.00	.00	.00	.00	.00	.00	.25	.00	.00	.00	.00	.00	.60	.00

O. Information (Technical) Sent

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.04	.07	.00	.04	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.04	.09	.11	.03	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.25	.39	.50	.25	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.02	.01	.00	.00	.00	.00	.00	.07	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.04	.13	.01	.02	.00	.00	.00	.02	.00	.00
VI	.00	.00	.00	.11	.16	.44	.13	.67	.00	.00	.50	.00	.00	.00
VII	.00	.00	.00	.01	.02	.00	.08	.00	.07	.00	.03	.00	.05	.25
VIII	.00	.00	.00	.09	.00	.07	10	.20	.20	.40	.05	.10	.00	.00
IX	.00	.00	.00	.02	.00	.00	.03	.09	.04	.11	.03	.00	.00	.00
X	.00	.00	.00	.22	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XI	.00	.00	.00	.03	.01	.08	.03	.25	.11	.00	.59	.13	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.12	.40
XIV	.00	.00	.00	.00	.00	.00	.25	.00	.00	.00	.00	.00	1.00	.00

P. Problems Referred (Received)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.01	.08	.13	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.05	.09	.38	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.00	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00
V	.00	.00	.00	.00	.02	.04	.02	.01	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.04	.12	.44	.08	.13	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.01	.00	.03	.00	.00	.25	.00	.06	.00	.13
VIII	.00	.00	.00	.04	.00	.00	.00	.20	.04	.00	.05	.00	.00	.00
IX	.00	.00	.00	.01	.00	.00	.00	.02	.00	.11	.00	.00	.00	.00
X	.00	.00	.00	.11	.00	.00	.38	.80	.22	.00	.25	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.03	.20	.06	.00	.50	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.30	.06	.00	.13	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.08	.40
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Q. Problems Referred (Sent)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	.12	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
II	.04	.08	.11	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
III	.05	.00	.31	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
IV	.07	.02	.03	.01	.01	.00	.00	.04	.00	.00	.00	.00	.00	.00
V	.01	.00	.00	.00	.02	.09	.01	.00	.00	.00	.00	.00	.00	.00
VI	.00	.00	.00	.00	.06	.22	.00	.00	.00	.00	.00	.00	.00	.00
VII	.00	.00	.00	.00	.01	.13	.03	.05	.01	.13	.00	.00	.00	.00
VIII	.00	.00	.00	.04	.00	.07	.03	.24	.02	.20	.05	.00	.00	.00
IX	.00	.00	.00	.00	.00	.00	.01	.07	.02	.11	.03	.00	.00	.00
X	.00	.00	.00	.11	.04	.67	.25	1.00	.44	.00	.50	.00	.00	.00
XI	.00	.00	.00	.00	.00	.00	.00	.30	.03	.00	.50	.00	.00	.00
XII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
XIII	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.08	.40
XIV	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

A blockmodel was constructed from the density matrices, using a zero block cutoff and is presented in two ways. First, Table 4 shows the blockmodel for all seventeen relations in one matrix. This form of presentation demonstrates the overall pattern of relationships between the structurally equivalent groups in the organization. Second, Table 5 presents the blockmodel for the seventeen relations in nine sets. In eight of these sets the blockmodel images for senders and receivers of a relation are shown together; each set shows how the structures of sending and receiving the same relation differ. The ninth set is the reporting relation.

Interpretation

The interpretation of the blockmodel is in four parts: 1) the effect of geography on the composition of the structurally equivalent subgroups; 2) an examination of the firm's reporting relationships; 3) the structural similarity of the subgroups; and 4) a comparison of the seventeen relations in terms of symmetry between subgroups.

Geography. The fit between geography and group membership is quite strong (see Table 6). The members of groups I to III belong only to Canadian office. Group IV contains mostly Canadian members. Group V is a large group composed predominately of the members of the Washington and Far West offices; most of the members of a small separate office in New York are also in this group. Group VI is a small cluster located in Washington, and the remaining groups are located, almost exclusively, in New York.

TABLE 4

COMPOSITE BLOCKMODEL

The blockmodel is found on the next page. The roman numerals on rows and columns indicate network subgroups. The groups from Table 6 have been reordered to reflect geographical clusters. The permutation order is: 6 4 3 2 5 14 1 9 11 12 8 10 7 13

The arabic numerals in the cells indicate types of relation. The code for these numerals is:

1. Reporting
2. Feedback Received
3. Feedback Given
4. Help (Time) Received
5. Help (More than One Kind) Received
6. Help (Time) Sent
7. Help (More than One Kind) Sent
8. Information (Administrative) Received
9. Information (Administrative) Sent
10. Information (Marketing) Received
11. Information (Marketing) Sent
12. Information (More than One Kind) Received
13. Information (More than One Kind) Sent
14. Information (Technical) Received
15. Information (Technical) Sent
16. Problems Received
17. Problems Sent

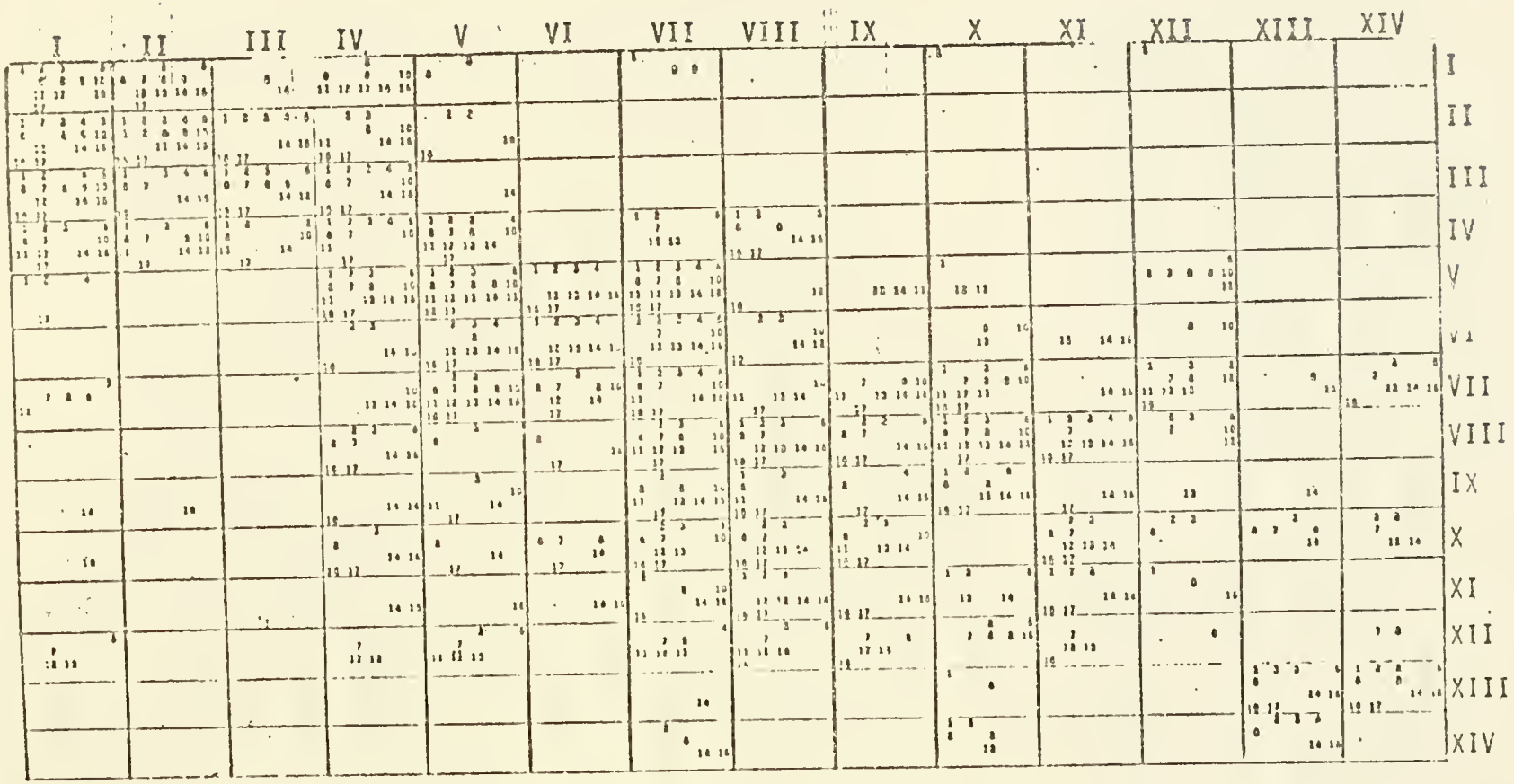

I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV

TABLE 5

BLOCKMODEL IMAGES FOR EACH TYPE OF RELATION

Cutoff for all types of relation: alpha = 0.

A. Reporting (from subordinates point of view):

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1						1			1		1		
II	1	1	1											
III	1	1	1	1										
IV	1	1	1	1	1		1	1						
V	1			1	1	1	1			1				
VI						1	1							
VII							1			1		1		
VIII								1		1	1			
IX								1		1				
X														
XI							1	1		1	1	1		
XII														
XIII										1			1	1
XIV										1				

B. Feedback - Code: 1. Receiv 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	2		2	2									
II	1 2	1 2	1 2	1 2	1 2									
III	1	2	1 2	1 2										
IV	1 2	2	1	1 2	1 2		1	1						
V	1			1 2	1 2	1 2	1 2							
VI				1 2	1 2	1 2	1 2	1 2						
VII					1 2	2	1 2			2		2		2
VIII				1 2	2		1 2	1 2	1 2	1 2	1 2	1 2		
IX					2		1	2		1				
X				2			1 2	1 2	1 2		1 2	1 2	2	1 2
XI								1 2		1	1 2			
XII					2			2		2				
XIII													1 2	1 2
X							1			1			1 2	

C. Help (Time) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I		2		2	2									
II	1 2	1 2	1											
III	1 2	1 2	2	1 2										
IV	2	2	2	1 2	2			2						
V	1			2	2	1	1 2					2		
VI					1	1	1							
VII					2	2	1 2							
VIII				2	2	2	2	2	2	2	1			
IX							2	2	1 2	1 2				
X				2	2	2	2	2	2		2	2	2	
XI														
XII														
XIII													2	2
XIV										2			1 2	

D. Help (More than One Kind) Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	1 2												
II	1	1 2	1											
III	1 2	1 2	1 2	1 2										
IV	1 2	1 2	1	1 2	1 2		1 2	1						
V				1 2	1 2		1 2					1 2		
VI							1 2							
VII	1 2				2	2	1 2		2	1 2		1 2		1 2
VIII				1 2			1 2	1 2	1 2	1 2	1 2	1 2		
IX														
X						2	1 2	2			2		2	2
XI										1				
XII	1 2			2	1 2		1 2	1 2	2	1 2	2			2
XIII													1	1
XIV														

E. Information (Administrative) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	1 2	1	1			1 2							
II	1 2	1 2		1										
III	1 2		1 2											
IV		2			1			1						
V				1	1 2		1					1 2		
VI					1					1		1		
VII	1 2				1 2	2			2	1 2		1	2	
VIII							1			1				
IX							1			1				
X						2							2	
XI							1					1		
XII							1		2	1 2		2		1
XIII										1				1
XIV							1			1				

F. Information (Marketing) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1			1 2										
II	1	1		1 2										
III	1			1										
IV	1 2	1 2	1 2	1 2	1 2									
V				1 2	1 2		1 2					1		
VI							1	1		1		1		
VII	2			1	1 2	1	1 2	1 2	1 2	1 2		1 2		
VIII							1 2			1 2		1		
IX					1 2		1 2	2						
X							1		1 2					
XI							1							
XII					2		2	2		1				
XIII														
XIV														

G. Information (More than One Kind) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1 2	1 2		1 2										
II	1	2												
III	1													
IV	1				1 2		1 2							
V				2	1 2	1 2	1 2		2	1 2				
VI					1 2	1 2	1 2			2	1			
VII				2	1 2	1		2	2	1 2		1 2		2
VIII							1 2	1 2		1 2	1 2			
IX							2			2		2		
X							1 2	1 2	2		1 2			2
XI								1 2		1				
XII	1 2			1 2	1 2		1 2	1 2	1 2		1 2			
XIII														
XIV										2				

H. Information (Technical) - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	2	1 2	1	1 2										
II	1 2	1 2	1 2	1 2	2									
III	1 2	1 2	1 2	1 2	2									
IV	1 2	1 2	1		1			1 2						
V				1 2	1 2	1 2	1 2	2	1 2			2		
VI				1 2	1 2	1 2	1 2	1 2			1 2			
VII				1 2	1 2	1	1 2	1	1 2		1 2		2	1 2
VIII				1 2		2	2	1 2	1 2	1 2	1 2	2		
IX	1	1		1 2	1		1 2	1 2	1 2	1 2	1 2		1	
X	1			1 2	1	1		1	1		1		1	1
XI				1 2	2	1 2	1 2	1 2	1 2	1	1 2	2		
XII														
XIII							1						1 2	1 2
XIV							1 2						1 2	

I. Problem Referral - Code: 1. Receive; 2. Send

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	2	2												
II	1 2	1 2	1 2	1 2	1									
III	1 2	1	1 2	1 2										
IV	2	2	2	2	2			1 2						
V	2			1 2	1 2	1 2	1 2	1						
VI				1	1 2	1 2	1	1						
VII					1 2	2	1 2	2	2	1 2		1		1
VIII				1 2		2	2	1 2	1 2	2	1 2			
IX				1	2		2	1 2	2	1 2	2			
X				1 2	2	2	1 2	1 2	1 2		1 2			
XI							1	1 2	1 2		1 2			
XII								1	1		1			
XIII													1 2	1 2
XIV														

TABLE 6

CROSS CLASSIFICATION OF CALCOPT PARITION AND REGIONAL OFFICE MEMBERSHIP

Groups from Table 6 are ordered: 6 4 3 2 5 14 1 9 11 12 8 10 7 13

CALCOPT Group	Office				
	Canada	Washington	Far West	NY I	NY II
I	5	0	0	0	0
II	14	0	0	0	0
III	4	0	0	0	0
IV	5	0	1	2	1
V	1	8	8	4	3
VI	0	3	0	0	0
VII	0	1	0	7	0
VIII	0	0	0	5	0
IX	0	0	0	9	0
X	0	0	0	1	0
XI	0	0	0	4	0
XII	0	0	0	2	0
XIII	0	0	0	5	0
XIV	0	0	0	1	0

However, relations between groups transcend geographical boundaries. Of the groups with only Canadian members, Group I has the most ties with groups outside Canada, whereas Group II has only one tie and Group III has none. Group IV includes four of the five offices and has a number of ties to all other groups except XIII and XIV. A small group in the Washington office, Group VI, has many relationships with the other groups, except those that contain only Canadian members; and many of the remaining groups, primarily located in New York, are related to groups outside the New York region. The pattern of relationships thus shows substantial, although clearly not complete, overlap, both within and between subgroups, among the geographically diversified offices.

Reporting. The Canadian office (groups I through IV) follows virtually the classic herarchical reporting pattern (virtually, because of reporting symmetry between groups II, III, and IV). But the New York office is fragmented into three hierarchies. Because of the idiosyncratic network positions of the single member groups, X and XV, and that of the double member group, XII, two of these hierarchies overlap. The first hierarchy in New York is composed of groups XIII, XIV and X; group X is the apex of this order. No other groups report to XIII or XIV nor do groups XIII or XIV report to other groups outside the hierarchy. The second hierarchy consists of Groups VII, VIII, IX, X, and XI. The apex of this hierarchy again is Group X. Groups VIII and XI exchange reporting ties, the only case of symmetric reporting outside Canada. The third hierarchy is Groups VII, VIII, IX, XI and XII. The apex is Group XII. Thus hierarchies two and three contain the same groups except for their apexes (see Friedell, 1967, for a discussion of such a structure as a semi-lattice).

Five subgroups stand out as highly placed in the reporting hierarchy of the firm as a whole: I, which heads the Canadian office, VII, X, XII, and XIV. All other subgroups report directly to at least one of these. Subgroups X and XIV consists of a single member, and subgroup XII of two members. The identity of these members is important for understanding the reporting structure.

The sole member of subgroup X is the firm's technical vice presdent; one member of group XII is the firm's marketing vice president; and the single member of group XIV is a project team leader whose team is located in group XIII. The project team leader reports to the technical vice president. The overlapping hierarchies in the New York office, therefore, are split between the technical and marketing vice presidents to both of which group I also reports. (The president of the firm is not in this network.) Knowing who belongs to the subgroups thus adds meaning to the structure of reporting relationships.

Structural Similarity of the Subgroups. The subgroup memberships also help to explain similarity among the subgroups when all relations are taken into account. A simple method was used to measure subgroup similarity of position: the density matrices for all relations were stacked and submitted to a principal components analysis; the components were rotated (VARIMAX) and factors with eigenvalues greater than one interpreted. Subgroups which load strongly on the same factor are seen as having similar positions in the network. The method was applied to both rows and columns of the density matrices; the results for each are shown in Table 7.

TABLE 7

RESULTS OF FACTOR ANALYSIS (PRINCIPAL COMPONENTS)

OF DENSITY MATRICES - ROWS AND COLUMNS

A. Analysis of Columns - VARIMAX Rotation

Subgroups	Factor 1	Factor 2	Factor 3	Factor 4
I	.01	.61	-.02	-.05
II	-.08	.91	-.05	-.04
III	-.08	.89	-.06	-.04
IV	.26	.65	.53	-.05
V	.15	.00	.88	.06
VI	.17	-.06	.87	-.02
VII	.89	-.04	-.04	.06
VIII	.79	-.05	.26	-.16
IX	.71	.07	.44	.11
X	.07	-.11	-.13	.59
XI	.69	-.03	.45	-.08
XII	.64	.01	.23	.16
XIII	.08	-.01	.21	.78
XIV	.75	-.01	-.12	.18
Eigenvalue:	4.38	2.49	1.52	1.03

B. Analysis of Rows - VARIMAX Rotation

Subgroups	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
I	.21	.54	-.13	-.15	-.03
II	-.10	.89	-.05	-.05	.02
III	-.11	.83	-.05	-.05	.02
IV	-.07	.59	.04	.00	-.13
V	.89	-.05	.82	-.02	.02
VI	.14	-.07	.81	.00	-.09
VII	.78	-.08	.02	.17	.13
VIII	.86	-.04	.05	.17	-.06
IX	.87	.03	.06	-.17	.12
X	-.01	-.12	.17	.71	.32
XI	.66	-.02	.25	.09	-.09
XII	.21	-.09	-.21	.71	-.21
XIII	.03	-.07	-.07	.09	.88
XIV	.46	-.10	-.04	-.31	.41
Eigenvalue:	3.2	2.17	1.46	1.17	1.03

The breakdown of subgroups into geographical regions is obvious for both row and column analyses. The Canadian groups: I through IV, load on the same factor; groups V and VI, with Far West and Washington members, load on a separate factor; and groups VII, VIII, IX, XI and XIV, all from a New York office, load on a third factor. The dimensions underlying the interrelations of groups X, XII, and XIII vary depending on whether their members are choosing the members of other groups as partners in relationships (the groups are analysed as rows of the density matrices) or they are chosen as partners (the analysis is by columns).

In the results of the row analysis, groups X and XII, the two New York vice presidents, determine a separate factor. Thus, their choices of other members are together unique. In addition, groups XIII and XIV load on a fifth factor, indicating that the pattern of relationships of both the boss and subordinates of this working unit are quite similar and distinct. However, group XIV also loads on the factor determined by the other New York groups, which shows that the boss and her subordinates differ in the similarity of their relationships with the rest of the New York office.

When the columns of the density matrices are analysed, however, the factor structure is different in several respects. Groups X and XII no longer determine a dimension, and group XII loads with the other groups from New York. Furthermore, groups IV, IX and XI, in addition to their associations with the other groups in their geographical regions, have patterns of relationships similar to groups V and VI.

Thus, the underlying symmetry of the network structure is reflected in the strong similarity between the factor structures of choosers and chosen. But differences between the factor structures also exist for seven of the

subgroups. These differences can be summarized by the following statements:

1. When choosing others, groups X and XII are similar only to each other; but when chosen, group X is similar to group XIII and group XII to the rest of the New York groups.

2. When choosing, group XIV is similar to both group XIII and the rest of the New York groups; when chosen, group XIV is similar only to the latter.

3. When choosing, groups IV, IX, and XI are similar to the other groups in their respective geographical areas; but when chosen, they are also similar to groups V and VI which together contain members from all regional offices.

The interpretations of the first two statements are reasonably clear. Groups X and XII contain vice presidents with different functions; their perspective on the rest of the network reflects their position in the hierarchy. However, the perspective of the rest of the network on them reflects both hierarchy and function. Group X is seen in the same way as group XIII, a technical boss; but group XII is seen as the other groups in New York. Thus the distinctiveness of the marketing vice-president's position, in the eyes of other firm members, is blurred much more than that of the technical chief.

The uniqueness of the technical boss in group XIII is also evident. When she chooses other members of the network, her choices are similar only to those of her team. But the rest of the network sees her in the same way as they see her boss. She is given greater position power (as defined by the functional relations analysed here) than she gives herself.

Comparison of Relations in Terms of Subgroup Symmetry. The seventeen relations differ substantially in the symmetry of their density matrices. A simple measure of subgroup symmetry for a relation, the correlation of the density matrix and its transpose (each strung into a vector by rows) is shown

for all relations in Table 8. A negative correlation means that subgroups have asymmetric ties, no correlation that the ties are on the whole neither symmetric nor asymmetric, and a positive correlation indicates symmetry.

Only the reporting relation, as might be expected, has a negative correlation, although quite close to zero. Resource dependence for time and for more than one kind of help, dependence for administrative information and for the reception of marketing information have small although positive correlations. The structures of these types of tie are thus neither symmetric nor asymmetric or, at best, are marginally symmetric. With the exception of receiving marketing information, these relations are associated with the administrative hierarchy of the organization. The flow of marketing information from outside to inside the firm may underlie the asymmetry in its structure. Of the remaining types of tie, sending marketing information has the lowest correlation. The relations with relatively high correlations: feedback, problem referral, dependence for technical and for more than one kind of information, can be thought of as potentially separate from, but not independent of, the administrative hierarchy. In essence, there is less intergroup symmetry for relations which are more strongly associated with administrative (or marketing) functions.

The blockmodel does not show the pattern of individual relationships but that of relationships between structurally equivalent individuals. Structural equivalence, in the present study, refers to all seventeen relations which were analysed simultaneously rather than to any relation singly. Furthermore, the blockmodel was constructed with a zero-block cutoff, meaning that, if <u>any</u> member of one group chose a member of his or her own or another group, the groups were considered related. Consequently, when interpreting for example, the structure of reporting relationships, care should be taken not to confuse it with other ways of representing reporting ties such as organization charts.

TABLE 8

SYMMETRY IN THE DENSITY MATRICES

A. Between Senders and Receivers (in descending order)

	Pearson r
1. Feedback.	.51
2. Information (Technical)	.46
3. Information (More than One Kind)	.39
4. Help (More than One Kind)	.38
5. Problem Referral	.34
6. Information (Marketing)	.28
7. Information (Administrative)	.22
8. Help (Time)	.095

B. Around Main Diagonal (in descending order)

1. Information (More than One Kind) Received	.71
2. Information (More than One Kind) Sent	.69
3. Information (Technical) Sent	.56
4. Feedback Received	.52
5. Problems Received	.40
6. Information (Technical) Received	.39
7. Feedback Sent	.36
8. Problems Sent	.35
9. Information (Marketing) Sent	.31
10. Information (Administrative) Sent	.28
11. Information (Marketing) Received	.19
12. Help (More than One Kind) Sent	.19
13. Help (More than One Kind) Received	.11
14. Help (Time) Sent	.07
15. Information (Administrative) Received	.01
16. Help (Time) Sent	.00
17. Reporting	-.026

Stability of the Network Data. The stability of the instrument for gathering data on the five types of functional relations was assessed in two ways. First, for four of the relations each respondent was asked to indicate those to whom s/he gave and those from whom s/he received whatever the relationship entailed, e.g., problems or feedback. The correlation between "from" and "to" responses shows how much organizational members agree about the existence and degree of their relationship. The second form of stability is measured by correlating the responses of members to the same question over time. The span of time here was roughly two months.

The correlations between senders and receivers of a relation, which are an index of corroboration, range from .154 to .395 across relations (see Table 9B). Dependence for technical information had the highest correlation and dependence for extra time the lowest. Feedback, problem referral and dependence for more than one type of information were above the mean; dependence for marketing information, for administrative information and for more than one type of help were below it. Although these correlations are significant, the asymmetry in perception between senders and receivers in a relationship is much greater than was expected.

The test-retest results are shown in Table 9A. Considering the length of time between administrations of the questionnaire and the number of individuals in the list each respondent chose from, the correlations appear quite reasonable. The range across relations runs from .410 to .729.

The highest correlations for each type of relation are found when the ties between members are defined in the simplest way, without regard for the strength or particular sub-content (e.g., technical information) of a relationship. Reporting relationships, as measured in this study, have neither intensity nor specific content, and have the highest cross-period

TABLE 9

RELIABILITY OF THE NETWORK DATA

A. Correlations of Responses Across First and Second Questionnaires

	Pearson r
1. Reporting	.73
2. Feedback Received	.50
3. Feedbcak Sent	.49
4. Help (Time) Received	.41
5. Help (Time) Sent	.51
6. Help (More than One Kind) Received	.49
7. Help (More than One Kind) Sent	.59
8. Information (Administrative) Received	.53
9. Information (Administrative) Sent	.45
10. Information (Marketing) Received	.59
11. Information (Marketing) Sent	.49
12. Information (More than One Kind) Received	.50
13. Information (More than One Kind) Sent	.49
14. Information (Technical) Received	.66
15. Information (Technical) Sent	.59
16. Problems Received	.51
17. Problems Sent	.59

B. Correlations of Responses of Senders and Receivers of the Same Type of Relation in the First Questionnaire

1. Feedback	.32
2. Help (Time)	.15
3. Help (More than One Kind)	.23
4. Information (Administrative)	.20
5. Information (Marketing)	.26
6. Information (More than One Kind)	.29
7. Information (Technical)	.39
8. Problem Referral	.31

correlation of all types of tie. Reporting was measured only from the subordinate's perspective.

The other types of relation have two perspectives, sender and receiver, and, in addition, variations in intensity or content. Information dependence, generally, has the highest correlations followed by problem referral, resource dependence and feedback. For information ties, receiving information is generally stronger than giving information. Among the types of information, technical relationships have the highest consistency across time; marketing and multiple types of information are less consistent, and administrative information ties are the least consistent. For resource dependence and problem referral, givers have higher correlations than receivers, whereas for feedback the correlations for givers and receivers are about the same. Dependence on others for more than one type of help is more consistent than dependence for extra time, the reception of which is the least consistent of all seventeen types of relation both within and across time periods. The types of relations were much more stable across time for each respondent than within the first time period across senders and receivers. A network composed of different matrices for both senders and receivers of a type of tie seems therefore to be a more stable and accurate representation than one in which senders and receivers are joined or averaged.

It is interesting to note how the rest-retest and sender-receiver stability scores for the relations fit the scores for intergroup symmetry. The sender-receiver stability scores (for the raw data) tend to match the symmtrey scores closely. Except that information of more than one kind has the highest degree of symmetry but is fourth in the sender-receiver correlations, the rank orders follow each other exactly, indicating that the participants tend to perceive a relationship more similarly when reciprocity between positions in the structure of the network is high.

The comparison of the symmetry scores with the test-retest correlations produces different results. Although the test-retest reliabilities of dependence for extra time and for administrative information are the lowest among all types of relations, reporting, the archetypal administrative tie has the highest test-retest correlation of all types of relation; and the score for dependence for more than one type of help is also strong. The average score for sending and receiving information of more than kind ranks sixth. Thus reciprocity among subgroups is more strongly related to cross-sectional consensus on the occurrence or content of an interpersonal tie than to the stability of the relationship over time.

The question arises whether reciprocity and reliability are not both functions of other factors, involving the administration of the firm and its technology. Thompson's (1967) argument for the erection of an administrative superstructure around a technical core seems to be an appropriate interpretive scheme. The function of administration is to maintain the stability of technological relationships in the face of contingencies in the firm's environment. Usually, administrative and technical relations are thought of as describing separate subpopulations of an organization, but in the firm studied here, these subpopulations are not distinguishable. Consequently, the protection of the technical core by administrative action occurs because of the way different types of relations interact and not because of the interaction between different types of individuals.

The technology of the firm studied here requires a generally high degree of reciprocity between subgroups, as is shown in the blockmodel. Overlaid on the technical relations are non-symmetric administrative ties which, with the important exception of the test-retest correlation of reporting, are generally less stable. Interindividual variation in the perception of administrative

relations can be attributed to fluctuations in their meaning caused by changing pressures in the firm's markets. These fluctuations in the administrative component are necessary, according to Thompson, to maintain the meaning of technical relations and thereby the frames of reference in which technical rationality can be achieved.

Conclusion

A blockmodel analysis of the functional relations among firm members describes in detail significant aspects of the organization structure. Seventeen relations were identified and analysed using CONCOR and CALCOPT. The analysis produced fourteen subgroups which were interpretable both in terms of their office location, their reporting relationships, and their structural similarity. Relations characterised as administrative tended to have less symmetric structures than technical relations. The raw network data appeared to be more generalizable across time than across senders and receivers. Finally, a comparison of correlations showed that measurements of technical relations generally tended to be more consistent across time and across senders and receivers than (informal) administrative relations, a result that was interpreted in terms of Thompson's theory of technical and organizational rationality.

Structures built from network data represent the relational system of an organization more accurately than an organization chart. The relational system is important as a primary problem-solving mechanism. The results of present study provide insights into differences between offices of the firm and between types of relations. Also, it is clear that the ex cathedra character of an organization chart can no longer remain unquestioned. Firm members do not perceive their relations with each other symmetrically.

Further research into the pattern of asymmetries should illuminate how the system of functional relationships reflects personal definitions of what each type of relationship means. An understanding of these differences in meaning should improve the chances for successfully implementing changes in the relational structure directed at improving the problem-solving ability of the firm, since perceptions of relationships may be more important to change than lines drawn on paper.

Important additional research with similar implications for organization design involves examining how the seventeen types of tie vary in their effect on the distributions of goals and information, in their degree of formality, and in technical and administrative characteristics. Further empirical study of these differences is warranted, with an additional focus on control. Since some functional relations are more controllable than others, e.g., reporting compared to information dependence, knowing how the relations are linked to each other structurally (through, for example, a role table analysis (Boorman and White, 1976)) should indicate the best strategies for changing the total structure.

The purpose of the present study was to demonstrate the strengths of a particular kind of network analysis for understanding a broad spectrum of functional behavior in a single firm. Currently, the main use to which network analysis can be put is diagnostic. No system of diagnosis, however, can long remain divorced from the implications of what it shows. These implications of the technique for purposeful organizational change are myriad and are just beginning to be explored.

REFERENCES

1. Allen, T. J., Managing The Flow of Technology, Cambridge, Mass., MIT Press, 1977.

2. Arabie, P., S. J. Boorman, and P. R. Levitt, "Constructing Blockmodels: Howand Why," Journal of Mathematical Psychology, 1978, 17:21-63.

3. Boorman, S. A. and H. C. White, "Social Structure from Multiple Networks. II. Role Structures," American Journal of Sociology, 1976, 81:;384:1446.

4. Breiger, R. L., S. A. Boorman, & P. Arabie, "An Algorithm for Clustering Relational Data, With Applications to Social Network Analysis and Comparison With Multidimentional Scaling," Journal of Mathematical Psychology, 1975, 12:328-383.

5. Burt, R. S., "Positions in Networks," Social Forces, 1976, 55:93-122.

6. Burt, R. S., "Cohesion Versus Structural Equivalence as a Basis for Network Subgroups," Sociological Methods and Research, 1978, 7:189-212.

7. Burt, R. S., "Models of Network Structure," Annual Review of Sociology, 1980, 6.

8. Constock, D. E. and R. S. Scott, "Technology and the Structure of Submits: Distinguishing Individual and Work Group Effects," Administrative Science Quarterly, 1977, 22:177-202.

9. Fombrun, C., Networks and Organization: Perspectives and Pragmatics for Assessing the Political Structure of Organizations, PhD. Dissertation, Columbia University, 1980.

10. Friedell, M. F., "Organizations as Semilattices," American Sociological Review, 1967, 32:46-54.

11. Galbraith, J., "Organization Design: An Information Processing View," Interfaces, 1974, 4:28-36.

12. Kim, J. S., and W. C. Hamner, "Affect of Performance Feedback and Goal Setting On Productivity and Satisfaction in An Organization Setting," Journal of Applied Psychology, 1976, 61:48-57.

13. Lorrain, F. P. and H. C. White, "Structural Equivalence of Individuals in Social Networks," Journal of Mathematical Sociology, 1971, 1:49-80.

14. O'Reilly, C. A. and K. H. Roberts, "Task Group Structure, Communication and Effectiveness in Three Organizations," Journal of Applied Psychology, 1977, 62:674-681.

15. Offe, C., Industry and Inequity: The Achievement Principle in Work and Social Status, St. Martin's Press, 1977.

16. Thompson, J. D., Organizations in Action, McGraw-Hill, 1967.

17. Tushman, M. L. and T. J. Scanlan, "Boundary Spanning Individuals: Their Role in Information Transfer and Their Antecedents," Academy of Management Journal, 1981, 24:289-305.

18. White, H. C., S. A. Boorman and R. L. Breiger, "Social Structure from Multiple Networks. I. Blockmodels of Roles and Positions," American Journal of Sociology, 1976, 81:730-780.

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