Social Interaction and R&D Project Performance

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The purpose of this working paper is to present some initial findings from research currently being conducted on the effect of informal structures of communication and interaction on the product development process. The general hypothesis of the study is that higher levels of communication are associated with more effective working relationships among the different functional groups working on product innovation. The first part of this paper will review previous work in the area. Part II develops the questions of the current study. Part III outlines the methods used to address the research questions. Part IV presents the results from an initial pilot study performed within one organization. The final section discusses these results in terms of their implications for the management of innovation.

PART I: Introduction and Literature Review

Innovation plays an important role in the performance of many firms, and this importance is likely to increase as the battle for competitive advantage continues to escalate. Although large scale research and development activities became prevalent in industry after the second world war, systematic research on the management of innovation and its implications for organizations did not emerge until the 1960's (Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Bennis, 1966).

The highly competitive 1980's saw a veritable fever of interest in the area. Not only have management books on the topic become best-sellers (e.g., Kidder, 1981; Peters and Waterman, 1982; Kanter, 1983; Drucker, 1985), but through the recent emergence of new journals, courses, and even business school curriculum, the management of innovation has gained achieved the status of a professional subspecialty.

Philosophies and assumptions regarding the management of research and development have, of course, evolved over the last thirty years (see Klimstra and Potts, 1988, for an interesting discussion of this evolution). Since Utterback's milestone work (Utterback, 1974; Abernathy and Utterback, 1975), however, the attempt to integrate research efforts with overall company strategies and objectives has been the focus of attention. The philosophy that creativity can not be controlled has waned as higher levels of management have become progressively more concerned and involved with the efficient use of research dollars.

Indeed, classical analyses of the innovation process have shown that the major impediments to innovative success are not technical but managerial and organizational.

These problems include a management emphasis on short-term profitability, delays in decision making, motivational restraints induced by counter-productive management incentives and structures, poor coordination, unclear responsibility and authority, and a lack of meaningful interaction between the various functional groups involved in the innovation process (Booz, Allen, and Hamilton, 1982, 1968; Gerstenfeld et al., 1969; Quinn and Mueller, 1963).

Therefore, while basic and applied science is the basis for technological innovation within the firm, effective innovation involves the integration of effort across the entire organization. As Moore (1970, p. 367) has stated, "...within [the bounds of the innovation process] occurs the inevitable confrontation of human resistance to change, urgency to meet product schedules, new technology infusion into products, interdisciplinary language problems, continuing design alterations, and corporate cash commitments, to name but a few." Managers must be concerned with more than the technical performance of either individual engineers or project groups if successful commercial innovation is the ultimate goal.

Research and informed discussion continues to supports this organization-wide perspective on innovation. Utterback (1974) highlighted the importance of the marketing function when his review showed that 60 to 80% of successful innovations were in response to a recognized market demand or need. It should be noted, however, that this does not imply that market-pull innovations have a higher rate of success, only that they are a more common. Integration with the marketing function may be even more important for technology-push innovations since a viable market application will need to be developed.

Utterback's results have been supported and elaborated by a host of more recent studies examining the factors associated with innovative success. Probably the most robust finding to emerge from this work is the importance of a strong marketing orientation throughout the innovation process. Having a market-derived idea or understanding of user needs, the development of clearly defined goals or targets for the innovation, a matching of technology to user needs, accurate estimation of the size, price sensitivities, and competitor strength in the potential market, and a real product/process advantage in the eyes of the user each have been identified as crucial factors associated with success (Baker, Green, & Bean, 1984; Maidique & Zirger, 1984; Cooper, 1980; Souder, 1977, 1987; Rubenstein et al., 1976; Rothwell et.al., 1974).

For example, Cooper and Kleinschmidt (1986) found that several pre-development marketing activities contributed to new product success but were frequently neglected or inadequately performed. Souder (1987) collected longitudinal data on the relationship between R&D and Marketing personnel for 289 projects in 53 consumer and industrial product firms. Relationship patterns were empirically clustered in terms of seven "states" of harmony/disharmony. He found that mild to severe disharmony between the two functional groups was experienced by nearly 60% of the projects. Further, the degree of disharmony was significantly related to the project's eventual commercial success. Eighty-three percent of the projects with harmonious relations were considered to be at least a partial success while only 32% of the projects characterized by disharmony at the R&D/Marketing interface were so rated.

The importance of integration with manufacturing has recently been discussed by

Abita (1985), Wolf (1985) and Gray (1985). Survey research by Prakke (1974) in America and Faas (1985) in Holland has also demonstrated the importance of the interface with manufacturing and finance groups. Both studies found that the quality of integration reported by senior executives between R&D and production, marketing, and finance was a critical determinant of overall innovative performance.

The cause of difficulties at the R&D/Production interface were recently addressed by Ginn and Rubenstein (1986) and Souder and Padmanabhan (1987). Factors named by these studies included goal incompatibility between functions, perceptions of new technology as too fragile or complex, inadequate staffing by the manufacturing department, manufacturing preoccupation with day-to-day problems, fears of disruption to plant production schedules, and uncertainty regarding eventual outcomes.

At the marketing interface work by Gupta and Wilemon has explored some of the specific causes of poor intergroup relations. Gupta and Wilemon (1988) found that marketing information was perceived as less credible by R&D personnel in organizations experiencing low functional integration. Marketing managers who were cooperative, open, fair, and had demonstrated competence were perceived as most credible.

Gupta, Raj, and Wilemon (1985) examined the perceptions of R&D and Marketing managers regarding ideal and actual levels of cooperation in thirteen specific domains. Both sets of managers were in agreement as to the importance of Marketing's role in providing R&D with customer product requirements, feedback on product performance, and information on competitor strategies. However, the Marketing managers tended to want greater involvement than R&D managers saw as ideal in setting new product goals,

establishing development schedules, and generating and screening new product ideas.

The greatest dissatisfaction felt by Marketing managers with actual practice was their lack of involvement in setting new product goals and priorities and in establishing new product development schedules. Further, these managers reported relatively low responsiveness from the R&D function in modifying products according to marketing's recommendations and in developing new products according to the markets needs. R&D managers tended to be dissatisfied with the Marketing function's willingness to find commercial applications for their product ideas or technical capabilities and the lack of information sharing regarding customer new product requirements, test-market results, and competitor strategies.

Recommendations for improving the process follow closely upon the analyses of interface difficulties. What is perhaps most remarkable about these recommendations is their consistency over time. For example, in an early paper on the topic Johnson and Jones (1957) recommend the establishment of a separate "new products" department with primary responsibility for new product outcomes and with authority equal to that of the other functional departments. Quinn and Mueller (1963) took a more strategic approach to the management of new technology. They suggested a number of possible organizational forms, ranging from cross-functional task-forces to corporate level entrepreneurial groups, to be chosen on the basis of the particular firm's objectives, organization, and relative strengths.

Recent work also typically recommends alterations in organizational structures and practices to encourage greater communication and cooperation. Ginn and Rubenstein (1986) advised earlier manufacturing involvement, joint decision making and goal setting, and the

development of a reward system which provides shared incentives to R&D and Manufacturing personnel. Souder and Padmanabhan (1987) found that involvement of manufacturing in the design phase, joint selection of vendors, in-plant demonstration by an R&D/Manufacturing team, and the temporary dedication of a development engineer to the plant facilitated the transfer of technology. Managers on both sides of the R&D/Marketing interface expressed the opinion that a lack of communication and consensus on critical issues such as customer requirements, development schedules and market needs were impediments to more effective integration.

Unfortunately, the behavioral science literature devoted to the study of R&D work has failed to reflect the demonstrated importance of functional integration for successful product innovation. The majority of the research conducted below the level of the total organization has been primarily concerned with the productivity of the individual engineer (e.g., Pelz and Andrews, 1966; Whitley and Frost, 1971) or the capacity of the project group to meet technical goals within time and cost constraints (e.g., Marquis and Straight, 1965).

A major contribution to this literature has been made by the MIT researcher Tom Allen and his associates. They have examined the role of informal communications in the performance of basic and applied research. While this work does not address the issue of functional integration, a number of important concepts have been developed within this tradition. A review of this work and its limitations will provide the basis for the hypotheses to be tested in the current research.

The most fundamental concept to emerge from studies of communication in industrial research and development laboratories is the notion of the technological gatekeeper (Allen,

1977; Allen and Cohen, 1969). Earlier research had demonstrated a consistent positive relationship between individual performance and the use of personal contacts within the R&D laboratory (e.g., Allen, 1970; Pelz and Andrews, 1966). A study by Gerstenfeld (1967; reported in Allen, 1977), for example, found that more frequent technical communication and communication with a larger number of individuals outside of the project group each related positively to the engineer's performance.

Equally consistent evidence demonstrated an inverse relationship between performance and the use of personal contacts external to the organization (Baker et al., 1967; Shilling and Bernard, 1964; Allen 1966). Only for scientists involved in basic research was there a strong positive relationship between performance and external communication (Farris, 1972; Parker, Linwood, & Paisley, 1968; Hagstrom, 1965).

This pattern of effects is explained by Allen as the result of important differences between basic research and the work of development engineers in industry. While research work is conducted according to universalistic criteria within an "invisible college" extending beyond any one organization, development projects are necessarily strongly local in their orientation.

> "Development groups in different organizations may face similar problems, yet they define their solutions approaches and parameters very differently. The coupling of bureaucratic interests and demands with such localized tasks and language schemes produces a communication boundary which makes it difficult for most development engineers to communicate effectively with outside professionals and consultants about their project-related activities" (Katz, 1982).

The communication barrier does not effect research scientists because their orientation is presumed to be toward the wider research community and not the local organization.

This situation presents a problem because no organization can perform very

effectively by relying solely on locally generated knowledge. In order to better understand the process of technology transfer, Allen and Cohen (1969) examined the communication patterns of two industrial research laboratories. They found a small number of key individuals to whom others in the laboratory frequently turned for technical communication. These internal communication "stars" also read more formal literature and maintained a greater degree of informal contact with members of the scientific and technical community outside of their own laboratory. Allen's conclusion is that technology is most efficiently transferred into the laboratory through a two step communication process. Information is first acquired by the "technological gatekeepers" and then disseminated through personal contacts within the laboratory.

Since gatekeepers are involved in applied research, why isn't their performance adversely effected by the high levels of external communication in which they engage? The crucial element is the development of effective working relationships between the gatekeepers and their external sources. According to Allen (1977), the difficulties with external communication is due to the short-term, problem-oriented nature of the contact. Continuing informal contact, or a strong tie in network analytic terms, allows the gatekeeper to develop a relationship which can overcome communication barriers caused by a local orientation.

The effect of gatekeeper activity on project performance was addressed by Allen, Tushman, and Lee (1979). Again they examined the relationship between performance and the level of technical communication outside of the organization. As expected, the relationship was positive for groups involved in basic research but negative for those groups involved in development work. In addition however, a measure of the degree to which

extra-organizational communication was monopolized by one or a few individuals was taken as a proxy for the existence of a gatekeeper role. For the development groups, the degree of centralization in external communication was positively related to project performance.

Roberts and Fusefeld (1981) have noted the importance of communication roles internal to the organization for research performance. They have called for the extension of the gatekeeper concept to intra-organizational boundaries, such as those between R&D and the marketing and production functions. Research by Katz (1982) and Tushman (1977, 1979) has examined the role of intra-organizational communication in project performance.

Tushman (1977) found that, as with the diffusion of new technology, communication between the R&D laboratory and other departments within the organization occurs in a two-step fashion. Organizational "boundary spanners" were identified as internal communication stars who maintained high rates of communication with other departments of the laboratory or other functions in the organization.

A curvilinear relationship was found for groups facing substantial information processing requirements. Performance first increased and then decreased as the number of boundary spanners per project increased. Boundary spanners were considered as those internal "stars" communicating frequency with any source outside of the project group. On the average, projects with high information processing needs required a greater number of boundary spanners to achieved peak performance than did groups with lower information processing requirements.

Results from Tushman (1979) also suggest that effective interdepartmental information exchange is a two-step process. In that study Tushman examined the structure of

communication within the project group. He found that amongst the successful groups a more vertical (superior-subordinate) communication structure was associated with higher levels of interdependence with other functional groups within the organization. This relationship was not found for the lower performing groups.

Conclusions from the research on intraorganizational communication are not as persuasive as those presented earlier concerning the technological gatekeeper. Tushman's work shows that a two-step process does occur for the transfer of information across functional boundaries within the organization, but the direct relationship between extra-project communication centralization and performance has not been assessed. According to Allen's (1977) logic, the negative impact of extra-organizational communication on performance necessitates the use of a technological gatekeeper, but this negative relationship has not been demonstrated for extra-departmental communication.

In fact, Katz (1982) found evidence (actually using the same research sample as Tushman) suggesting a positive relationship between the amount of organizational communication maintained by long-tenured development projects and their performance. Unfortunately, the degree to which boundary spanner activity was responsible for the total amount of communication was not examined.

PART II: Hypotheses

Thus, the effect of interdepartmental communication structure on the technical performance of the project group has not been conclusively demonstrated. Its effects on intergroup integration have not even been addressed. The previous work on R&D project

performance has examined only one phase of the innovation process, the development phase, and have therefore used technical performance as the primary criterion of success. Yet our earlier review indicated that the most significant barriers to successful innovation were not technical but organizational. As we have seen, the integration of functional activities and the successful transfer of technology across organizational interfaces have been found to have a significant impact on overall innovative outcomes. While the centralization of external communication may improve the utility of information flowing into the project, it is not necessarily an ideal way to promote integration and the successful continuation of the project beyond the development phase. The specific relationship between communication structure and integration is therefore an important area for study.

In fact, other theoretical perspectives and empirical work contradict the idea that the boundary spanner role will be the most effective mechanism for dealing with the problem of functional integration during product development. Within the organizational literature, the role of social interaction in developing positive sentiment (Homans, 1950) and shared goals (March and Simon, 1958; Likert, 1961) has been emphasized repeatedly. Within the field of social psychology F.H. Allport et al. (1953) and others formulated the "contact hypothesis" as a mechanism for reducing intergroup stereotyping and prejudice. According to this hypothesis intergroup tension can be reduced if interaction between group members can be initiated within situations typified by equal status among participants, interpersonal cooperation, institutional support for the contact, and relatively high levels of intimacy. While the contact hypothesis has been qualified by individual, interpersonal, situational, and even societal factors, the central contention that interaction can lead to better intergroup

relations remains (Stephan, 1987).

In a recent study Nelson (1989) used a network analytic procedure based on a positional analysis to examine the role of intergroup ties in organizational conflict. Results showed that strong communication ties between groups were more prevalent in low conflict organizations than in high conflict organizations.

Taken together this work supports the idea that, in order to improve integration, efforts should be made to increase the number of contacts between groups rather than centralizing communication to one or a few individuals. Since functional integration, unlike basic or applied research, is basically a problem in developing shared understandings between organizational subcultures, we expect direct communication links between functional groups to be the most effective means of achieving functional integration. Using an approach known as network analysis, there are three major ways to measure the amount of contact between groups. Thus the following three hypotheses:

Hypothesis 1:

> The number of work-related communication ties between two functional groups will be positively related to the degree of integration between those groups.

Hypothesis 2:

> The amount of communication between groups, measured as the number of ties multiplied by frequency of communication for each tie, will be positively related to intergroup integration.

Hypothesis 3:

> The communication distance between members of each group, measured as the average number of ties required to link all members of the R&D group with all members of the other functional group, will be negatively related to intergroup

integration.

A second mode of contact previously unexamined in the context of research on innovation, but given a much more prominent place in the more expansive organizational literature, is the role of personal friendships. These are relationships which are not mandated by work-related requirements and which are based on some degree of interpersonal trust and mutual interest. They also provide channels through which potentially sensitive organizational, occupational, or personal information may flow.

Social-psychological research on bargaining and negotiation has shown that acquaintance and trust promote the attainment of higher mutual outcomes in bargaining and exchange situations. We therefore expect that friendship relationships will provide the basis for the development greater cross-functional integration. Therefore:

Hypothesis 4:

> The number of friendship ties between functional members of corresponding functional groups will be positively related to intergroup integration.

Hypothesis 5:

> The social distance between members of each group, measured as the average number of friendship ties required to link all members of the R&D group with all members of the other functional group, will be negatively related to intergroup integration.

PART III: Method

Data was collected for two projects from one division of a Fortune 500 company involved in the manufacture of computers, electronics, and scientific instruments. The company is know for being successful at providing high quality, technically advanced products. Both projects were developing electronic instruments for a the engineering market

and were nearing product launch.

Questionnaires were administered to all members of the development (engineering), marketing (marketing & sales), and manufacturing (process engineering, production, quality control), departments involved in the two projects as well as the division managers. A total of 120 responses were collected.

Dependent Variables

Cross-functional integration was measured by two sets of questions for the purpose of this study. The first set defined integration in terms of several behavioral processes. Items were designed to assess the degree to which relevant information is exchanged in a timely and useful manner, the degree of cooperation across functional specialties, the level of responsiveness to requests for action from other groups, the extent and nature of inter-group conflicts, and the manner in which conflicts are typically resolved.

The first three variables are single item questions. The conflict resolution style question is based on a fourfold typology developed by Blake and Mouton (1964). According to Blake and Mouton an approach to conflict resolution which requires the parties to work through their differences is optimal because it allows for creative, maximizing problem solutions. The other approaches, while requiring less time and energy, are unlikely to result in such an outcome.

Integration was also assessed in terms of two outcomes. The first of these outcomes was the degree of satisfaction with the resolution of conflicts. This item was meant to assess the quality of solutions to problems as they arose. The second set of outcome items were concerned with the evaluation of the project itself from the point of view of the members of

each functional department involved. In order to assess this variable personnel in the various functions will be asked to evaluate, based on what they know from the project's current status, the degree to which the project meets the performance criteria relevant to each functional department.

Marketing criteria reflect the degree to which the new technology or product is targeted toward a clearly identified market segment, sales volume of the market is potentially great, the technology provides a significant advantage in the market, is timed according to marketing plans, produces little adverse impact on current product lines, and can be produced at a competitive price. Production criteria are expected to reflect the degree to which implementing the new technology or product will require the development of new manufacturing capabilities, will be disruptive to current production, will require additional training or personnel for manufacture, and can be produced at an acceptable level of profit. Finally, Division Management criteria are expected to reflect the extent to which the innovation matches or complements the organizations market and production strategy, involves financial or technical risk, and places strains upon the company's cash flow.

Independent Variables

The first set of independent variables is based on the work-related communication pattern among functional groups. Respondents were asked to indicate the frequency with which they engage in work-related face-to-face communicate with each individual listed on the questionnaire provided them. The names of all respondents from the specific project were listed.

The second set of variables is based on the pattern of friendships among the groups.

Respondents were asked to indicate from amongst the individuals listed those with whom they have acquaintance or friendships.

PART IV: Results

The current results are tentative and are presented only as suggestive. They are based on a sample of twelve interfaces between functional groups (the unit of analysis for this study) from two projects within a single company. With the current small sample statistically significant effects would be very difficult to detect. Therefore, throughout this discussion we will regard correlations of .30 and higher as of interest and as suggestive of results to be verified through further data collection.

Table 1 shows the results for the work-related communication patterns. The three network measures in Table 1 are based on symmetrized and dichotomized data. Data is symmetrized by averaging the two frequencies reported by the members of each dyad to represent the level of communication between the two. Two individuals are counted as connected when their average frequency of communication is greater than some predetermined cutoff point. In this context communication rates of once a week or more were considered as active "ties" or connections.

Column one shows the relationship between "degree", which is the total number of communication ties between all members of each pair of functional groups, and the integration outcomes of the study. The correlations above .30 suggest that a higher degree score is related to higher reported levels of cooperation, greater use of a "work it out" conflict resolution style and less reliance on the other modes, and greater satisfaction with

conflict resolution. The second column of table 1 shows the results using density of communication ties. Density is degree, the total number of ties between groups, divided by the potential number of ties between groups (the number of group one members multiplied by the number of group two members). This measure is a proportion and thus adjusts for differences in the size of the interaction pairs of groups. Consistent with the findings using degree, we find that more densely connected groups report higher levels of satisfaction with conflict resolution. Unlike degree, however, higher density is related to a greater reliance on the "ignore" mode of conflict resolution.

These two sets of hypotheses provide mixed support for hypothesis one. The number of individuals in communication across the functional interface is related to functional integration, at least those aspects concerned with cooperation and conflict resolution.

The second hypothesis concerns the amount of communication occurring between functional groups. The total frequency measure in the first column of table 2 is the number of ties between groups multiplied by the appropriate symetrized frequency for each tie. It reflects the total amount of work-related communication occurring between the two groups. The second measure in table 2, adjusted frequency, is this total frequency divided by the maximum potential amount of communication if every individual in one functional group were in contact with every individual in the other group at the highest possible frequency, several times a day.

Hypothesis two also has mixed support. Greater total frequency of communication between groups is positively related to cooperation, reliance on a "work it out" conflict resolution mode, satisfaction with conflict resolution, and shows a tendency toward higher

reported performance. It is negatively related to the use of the other three styles of conflict resolution; ignoring, smoothing over, and reliance on higher authority.

The effects of the adjusted frequency measure are, in general, of smaller magnitude. Greater adjusted frequency is positively related to the "work it out" conflict resolution mode, and shows a tendency toward greater cooperation and functional performance. Groups with higher levels of adjusted frequency rely less on smoothing over conflicts and show a tendency to rely less on the other two conflict resolution modes as well.

Column three of table 1, average distance, shows that hypothesis three was not supported. Only one correlation was of interest; greater communication distances were associated with less reliance on the "ignoring" conflict resolution mode and a trend toward more reliance on the "work it out" mode. These relationships were counter to those expected. The discussion below of the "distance" results for the friendship patterns may be informative with regard to this finding.

In toto, the current results support the general hypothesis that higher levels of work-related communication are associated with more effective working relationships between functional groups. Consistent among the degree, density, total frequency and adjusted frequency measures is the finding that a greater level of communication across the functional interface is related to higher levels of cooperation, reliance on a "work it out" conflict resolution mode, and greater satisfaction with the resolution of conflicts.

The effects are generally stronger for the raw measures than for measures adjusted for the size of groups. This indicates that, at least within range of group sizes considered here (which seems fairly representative), the actual number of ties or amount of communication

across the interface impacts functional integration equally regardless of the size of the groups. Thus, while larger groups may have greater internal communication requirements, they do not necessarily have greater interface communication requirements.

Finally, the comparison between tables 1 and 2 show that measures based on the number of ties have a marginally greater impact on integration outcomes than those based on frequencies. The implication to be drawn here is that the most efficient way to improve functional integration is to have a greater number of individuals communication across the interface at the fairly minimal level of between once and twice a week.

Table 2 also shows the relationship between the variance of communication frequencies and integration outcomes. The variance is a standard measure of the amount of difference between observations and, in this application, indicates the relative degree of concentration in rates of communication among pairs. A small variance would indicate that all pairs communicate at roughly the same frequency while a large variance indicates that some pairs engage in communication much more frequently than others. This statistic provides a way of comparing the effects of a concentrated versus diffuse pattern of contact.

Column three of table two shows that larger variances are associated with more cooperative relations and higher reported functional performance. Thus, a concentrated communication pattern has positive effects primarily on functional performance while a greater number of contacts (diffuse pattern) has positive effects on several process criteria, especially satisfaction with conflict resolution.

The next set of results, presented in tables 3 and 4, concern the pattern of friendships across the functional interfaces. A tie was counted if both individuals reported each other as

a friend or close friend. As before, degree indicates the total number of these ties while density is the total number of ties divided by the potential number of ties.

Hypothesis four received mixed support. Both the degree and density measures, shown in table 3, are positively associated with greater cooperation, information sharing, responsiveness to requests, a "work it out" conflict resolution mode, and satisfaction with conflict resolution. The degree score is also positively related to functional performance and negatively related to "smoothing over" and reliance on "hierarchical authority" modes of conflict resolution. The density score is negatively related to conflict frequency and reliance on "hierarchy".

Both measures support the hypothesis that friendships across organizational interfaces are related to greater functional integration. This finding holds whether group size is adjusted for or not; five outcomes are at least marginally stronger for the size adjusted density measure while four are stronger for the raw degree measure. Again, it appears that for this sample the size of the groups interacting had little effect on nature of the interface.

Average distance is another measure of how tightly two group are connected in terms of friendships. Not every individual in one group is friends with every individual in the other, but they may be linked to every individual in the other group through multiple "steps", i.e., the friend of a person, either in the same or the other group, who is in turn friends with a member of the other group. Given a fairly well connected network (such as is the case here), everyone in one group will be connected to everyone in the other through some finite number of steps. Average distance is the average number of steps between pairs of people in the corresponding groups.

Hypothesis five also received mixed support. Column three of table 3 shows that a larger average distance is associated with less responsiveness between groups, and less reliance on the "work it out" conflict resolution style. The "ignore" style is more heavily relied on to resolve conflicts when groups are less closely associated through friendships. Surprisingly, however, the groups also report more information sharing as they are less closely related.

Project personnel were asked to rate the intensity of each social relationship on a four point scale, ranging from "not acquainted" to "close friend". Table four shows the results using the full range of these responses, instead of the dichotomized data of table 3. Column one, the "total weighted ties" variable, is the sum of all the ties between respective pairs of groups multiplied by their corresponding level of intensity. The second column, "adjusted weighted ties" is this value divided by the maximum potential number and is thus adjusted for the size of the two groups.

"Total" is positively related to "cooperation", the "work it out" conflict resolution mode, and satisfaction with conflict resolution while it is negatively related to the other three conflict resolution styles. This is consistent with the results using the dichotomized data. When this measure is adjusted for group sizes ("adjusted"), however, some additional interesting results emerge. The adjusted friendship variable is negatively related to responsiveness to requests, the "work it out" conflict resolution mode, satisfaction with conflict resolution, and functional performance.

First, how to interpret this result. While table three showed that having a greater number of friendship ties has a positive impact on several of the integration outcomes, the