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GROUP EFFECTIVENESS AS A FUNCTION OF COMMUNICATION NETWORK, TASK COMPLEXITY AND LEADERSHIP TYPE

by

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I. FORMULATION OF THE PROBLEM

Communication is a central process around which all aspects of small group and organizational behavior are constructed. An aggregate of individuals develops into a functioning group through the formation of a communication system. Similarly, the group is an integral unit of its larger social environment by virtue of the communication links that it establishes with other functioning bodies.

Katz and Kahn (1966) identify three components of a communication system. One element is the content of the messages transmitted within the network (what is being communicated). Message content includes not only such cognitive material as ideas, suggestions and problems, but also motivational and emotional material such as climate or atmosphere, feelings of support and rejection (Likert, 1961).

The second component of the communication system is the direction of information flow. According to Katz and Kahn (1966) communication flow can follow the authority pattern of the group (downward communication); can move among peers (horizontal communication); or can ascend the hierarchical ladder (upward communication). A consideration of message flow is incomplete without pointing out its intimate association with content. For example, Bales (1952) found that individuals who were at the upper level of a hierarchy generally

communicated "Initial Actions" such as information and opinions down to the lower levels. On the other hand, the responses of the low-ranking members were "Reactions," including such passive activities as agreement, disagreement and requests for information.

The structure of the communication network is the third element of the system. Although the content of messages and the direction of flow within a communication system may change frequently (as a function of both internal and external influence), the network within which the information flows generally exhibits resistance to alterations. The relatively stable communication network is the primary focus of this study.

A communication structure consists of differentiated parts or positions and relations or links between these components in a social system. Newcomb (1950) characterizes positions as the construction blocks (or smallest elements) of organized groups and societies. Positions vary in their contributions to group functioning and can be ranked according to the degree to which they help meet task and maintenance requirements. They are to be distinguished from roles which are the behaviors of individuals who occupy given positions.

Members of a group which is in the process of formation are considered to perform various functions and activities rather than fill positions. This distinction is made since the duties required to satisfy the task and maintenance needs of the new group are performed by the participants interchangeably. As the group continues over time, a

division of responsibility tends to occur. When different participants are given or assume regular obligations for completing different functions and activities, these members are said to occupy positions.

Concurrent with the establishment of positions is the formation of somewhat stable communication links between these differentiated parts of the system. Katz and Kahn (1966) indicate that moving from an unorganized to an organized state requires the introduction of constraints and restrictions to establish stable channels appropriate for the achievement of organizational goals. Many groups and organizations restrict communication by developing detailed procedures governing who can communicate with whom. Additional structure is provided when positions are physically separated. This condition necessitates communication via written messages, telephone and other mechanical devices which limits free interaction of each member with every other member.

In summary, a communication network consists of differentiated positions with defined links between the parts. The particular form of the communication pattern develops as the group moves from an unorganized to organized state. Various physical barriers may place additional restrictions on the structure. Although the network sets limits within which the members must operate, the network structure itself does not program the specific interactions. The participants and characteristics of the organizational hierarchy determine communication content and flow of information within the channels.

Research in the area of communication structure was stimulated by Bavelas' (1950) analysis of the imposed patterns of communication that are found in organizational settings. He noted that administrators generally assume that the optimum patterns of communication for a group can be derived from the task requirements. After these networks have been established, their maintenance is regarded as a first principle of effective performance. Bavelas then raised questions about the effects of imposed communication channels on the work and life of a group. Do some networks have structural properties that may limit group performance? Given several communication networks which are logically adequate for the successful completion of a specified problem, will one result in better performance than another?

Tentative answers to these questions are found in Leavitt's (1951) investigation of the behavior of small work groups in various communication networks. Specifically, the effects of different group structures on efficiency and member satisfaction were studied. Two types of network categories were outlined. One was defined as having a centralized pattern while others were described as having less centralized or decentralized communication structures. The essential characteristic of the centralized or relatively restricted network is that one person in a central position communicates with all others in the group and these peripheral members communicate only with the central person. In the decentralized or relatively unrestricted communication network more than one person can communicate with two or

more other members of the group.

Centralized and decentralized groups were asked to solve very simple problems which required merely the collection of data in one location. In this type of task, each member of the group was presented with a card containing several symbols such as rectangle, triangle and square. The problem was to identify the one symbol appearing on all the cards. A participant who obtained information as to the contents of the cards held by the other members easily identified the common symbol by quickly examining all the data.

Comparing the centralized with decentralized networks, Leavitt found that the centralized groups were more efficient (shorter solution times, fewer messages, fewer errors) than the decentralized groups in solving the simple symbol identification problems. On the other hand, members of decentralized networks reported greater satisfaction than the peripheral members in the centralized groups. However, the central persons in the restricted structures were more satisfied than both members of unrestricted groups and peripheral members of centralized groups.

Shaw (1954a) compared the effects of simple identification tasks (similar to those used by Leavitt, 1951) and more complex arithmetical problems in centralized and decentralized networks. As already indicated, a participant merely had to collect all the data in order to solve a simple problem. However, complex problem solving required in addition to information collection that arithmetical operations be

performed on the data. For example, the group was given a task such as determining the number of trucks needed to move various types of office furniture from one building to another. Each member was provided with only a part of the total information required to solve the problem. A person who collected data from all the other participants obtained the correct answer only after performing computations.

In this study it was found that although differences were not statistically significant, centralized networks generally were more effective than decentralized networks when the task was of a simple nature. On the other hand, decentralized groups tended to be more efficient than the centralized groups in solving the relatively complex problems. Participants in decentralized networks generally were more satisfied than the peripheral members of centralized structures regardless of the kind of task. From these results and an analysis of seventeen other experiments (e.g. Leavitt, 1951; Heise and Miller, 1951; Macy, Christie, and Luce, 1953; Shaw, 1954b), Shaw (1964) concluded that the direction of the difference in effectiveness between centralized and decentralized networks is determined to a large extent by task complexity.

According to Shaw (1954a, 1964) the concepts of independence and saturation can help to explain the task-network relationship. Independence is the degree of freedom with which an individual in a given position may operate in the group. It is determined by availability of information to the individual's position in the communication network, behavior of others in the group, situational factors such as the type of

task, and the person's perceptions and cognitions about the situation in which he is functioning. Independence is directly related to both performance and saturation. For example, low independence affects performance not only by limiting the individual's action potential, but also by reducing his willingness to work at an optimum level. Similarly, low independence directly affects satisfaction by inhibiting the gratification of culturally supported needs for achievement, recognition and autonomy.

Saturation is the total communication and task demands placed on a person in a given network position. It is a function of available communication channels, type of information transmitted, and task requirements such as inferences, interpretations and data manipulations. Saturation varies inversely with performance; the greater the saturation the less efficient the performance. For example, high saturation reduces an individual's performance since he cannot process all incoming communications, is required to transmit messages too rapidly through too many channels and/or cannot meet the task demands.

The type of communication network and degree of task complexity influence group performance and satisfaction through their effects on independence and saturation processes (Shaw, 1964). In a centralized network all data are transmitted to one position for processing. When the group task is complex, the demands on the central position are greater than when the problem is simple. Therefore, the probability that this position and hence the network will become

saturated is greater with complex than with simple tasks. Another factor contributing to task performance in the restricted network is that the answers given by the central member are more likely to be accepted by other participants when the problem is simple rather than when it is complex. This occurs because individuals do not perceive the opportunities for achievement and recognition in simple problem solving that they find in complex tasks. Therefore, additional saturation is created in groups with restricted communication networks and complex tasks when members challenge and/or ask for more information pertaining to the answers provided by the central position.

In the decentralized network there are many channels through which participants may communicate with each other. This characteristic is advantageious in complex problem solving since the probability of network saturation is reduced when problem data can be distributed quickly among all group members. Because it is possible for each participant to obtain all information relevant to the complex task, the willingness or unwillingness of members to accept an answer has little influence on network saturation. On the other hand, the efficiency of simple problem solving is reduced in decentralized networks relative to centralized networks. In the restricted communication structure members generally accept the answers to simple tasks that are provided by the central position. However, in the unrestricted network the open channels encourage a flow of messages in excess of what is needed for a routine collection of data.

The independence process affects satisfaction independently of degree of task complexity. Therefore, high independence in decentralized networks and in the central position of restricted networks produce a level of satisfaction greater than that found for peripheral members of centralized structures.

Not all research supports this theoretical interpretation. Mulder (1960) contends that Shaw places too much emphasis on network structure which does not determine which behaviors actually occur but only sets the limits within which the group must function. According to Mulder, group effectiveness is determined by the decision structure which develops as the members gain experience in working together towards task completion, rather than by network structure which does not change over time. Decision structure is the method of group problem solving emerging over time in a communication network. A centralized decision structure, where one person integrates contributions from all members, was postulated to facilitate problem solving independently of task complexity or whether it occurred in a centralized or decentralized network. It was also expected that groups with restricted nets would show a greater vulnerability at the beginning of the work period (i.e. a disturbance in the functioning of the central position would cause poor performance results). However, the formation of a centralized decision structure should cancel these negative effects.

To test this theory, Mulder (1960) compared the performance

of centralized and decentralized groups in solving complex arithmetic problems similar to those used by Shaw (1954a). Mulder extended the work period of the Shaw experiment by using five problems instead of four. Decentralized groups were initially more efficient than groups in centralized nets, but as predicted, this relationship was reversed later on in the work period. Groups that formed centralized decision structures were more efficient than groups with less centralized decision processes in both centralized and decentralized communication networks. It was concluded that a centralized decision procedure is best for both complex and simple problems, and that the development of a centralized decision process takes longer when the problems are complex.

Morrissette, Switzer and Crannell (1965) used information theory to define quantitatively tasks that would be solved in various communication networks. The problems varied systematically on the dimension of difficulty. It was found that the centralized networks were more efficient than the decentralized structures for both easy and hard tasks. Commenting on the inconsistency between their data and the results reported by Shaw (1954a), Morrissette et al. attributed this discrepancy to the different tasks that were used. The complex tasks in the earlier study were more difficult than the hard tasks used in the later study since the average solution time per problem for the former was more than four times greater than for the latter.

Faucheux and Mackenzie (1966) noted the contrary results

obtained by Shaw (1954a) and Mulder (1960) and suggested that the efficiency of complex and simple problem solving in various communication networks can be determined by treating organizational structure as a dependent variable. Given an unrestricted environment, what type of problem solving structures do groups form in response to tasks differing in complexity? Will groups conform to Shaw's theory which predicts that a centralized communication network is more advantageous for simple problem solving whereas a decentralized network is more effective for complex problem solving? Or will the groups behave according to Mulder's hypothesis which states that a centralized decision structure facilitates problem solving independently of the type of task?

To answer this question, groups solved routine deductive (simple) tasks and nonroutine inferential (complex) tasks in unrestricted decentralized networks. It was found that deductive tasks generally led to the establishment of a centralized organizational structure whereas inferential tasks did not cause centralization. The results also indicated that when routine deductive problems were solved, groups that formed highly centralized structures were more efficient than groups that formed less centralized organizations. However, a similar performance comparison between groups solving inferential tasks was not made since none of these groups formed a centralized organizational structure.

Although Faucheux and Mackenzie's data tend to support

predictions derived from independence and saturation processes (i.e. the efficacy of solving simple problems in centralized networks and complex problems in decentralized networks), this research does not represent a definitive resolution of the network-task controversy. First, the complex (inferential) problems used in this study were clearly more difficult than the arithmetic tasks used by Shaw and Mulder. The average time required to solve inferential tasks was 35.50 minutes (Fauchaux and Mackenzie, 1966) as compared with 7.09 minutes for arithmetic problems (Shaw, 1954a and Mulder, 1960 averaged over all conditions). The second and more substantive criticism was raised by the authors themselves. In discussing the type of organization developed by groups that solved inferential (complex) tasks, it was pointed out that decentralization does not imply that the members were organized. Since a detailed content analysis of the transmitted messages was considered beyond the scope of the research, there was no way of explaining what kind of organization, if any, was formed by groups solving inferential problems.

The divergent results obtained by Shaw, Mulder and others indicate the need for further exploration of the task-network relationship. One approach, often overlooked, that shows promise for providing a better understanding of this phenomenon, focuses on the group process which occurs during problem solving in communication networks.

Guetzkow and Simon (1955) suggested that groups with

decentralized communication networks solved simple symbol identification tasks less efficiently than groups with centralized nets because individuals in the former structures had difficulty developing a stable work plan. According to their theory, the development of a stable organization in the centralized net is facilitated by communication restrictions which limit the number of achievable methods. Groups in these networks generally proceed with little difficulty to develop one type of organization--a method where all data are sent to the central position. On the other hand, the establishment of organizational stability in the decentralized network may be retarded by the unrestricted structure which provides opportunities for the formation of various equally feasible procedures. Members of decentralized groups usually expend time and messages choosing among a number of organizations ranging from those where all information is sent to one person, to methods where each member transmits his data to all others. It was predicted, therefore, that additional opportunities for organizational behavior would eliminate performance differences between centralized and decentralized networks.

In order to test this assumption, Guetzkow and Simon reasoned that the group's problem solving activities should not be regarded as unitary. Therefore, they separated problem solving into two phases: the organizational phase (devising a method to solve the problems) and the operational phase (working on the problems). In their study, groups solving symbol identification tasks were provided with two

minute organizational periods prior to each of the problem solving trials. During these intertrial periods members were permitted to transmit messages pertaining to the procedure (e.g. messages pertaining to who should send data to whom). Members of groups with centralized communication networks were found to organize faster than individuals in decentralized structures. Groups that attained a stable and efficient organization performed better than disorganized groups independently of the degree of centralization of the network in which they were functioning. It was concluded that number of available communication channels affect the efficiency of groups only indirectly by influencing the members' ability to organize themselves for effective task performance.

Explicitly separating the organizational phase from the operational phase of problem solving has additional utility since research by Shure, Rogers, Larson and Tassone (1962) demonstrated that members of groups in communication network experiments generally devoted little time to organizing themselves for optimum performance. They found that the pressure to begin work on the task destroyed the normal effort to organize first. Regardless of the type of network, members would generally begin by transmitting task oriented messages without first formulating a procedure. Although this behavior had only a minor delaying effect on problem solving in centralized networks, considerable time was wasted in decentralized structures. In many cases a stable organization was achieved in unrestricted nets by chance rather

than by design.

It also seems that the absence of defined organizational periods and the pressure to begin work on the task differentially affected various groups of subjects. For example, the average time to solve complex problems (across all conditions) for Dutch subjects (Mulder, 1960) was 8.71 minutes as compared with 5.47 minutes for American subjects (Shaw, 1954a). Do these scores indicate that the Dutch subjects spent more time in planning than the American subjects, or do they indicate that the Dutch subjects required more time to solve the problems because they did not organize? It is difficult to answer this question since Mulder and Shaw did not distinguish between organizing efforts and task performance.

A better understanding of the relationship between communication network and task complexity can be gained by examining it in both the organizational and operational phases of problem solving. Although Guetzkow and Simon (1955) used only simple tasks and restricted organizational time to a maximum of two minutes between trials, their approach can be extended to study the task-net interaction in groups that develop stable work procedures. To this end, the organizational phase of problem solving will be defined as that period during which the group devises a stable work method. Stability is achieved when the group develops a procedure for transmitting problem information. The operational phase is defined as the period during which the problem solving method is applied to the task. Predictions about the task-

network relationship in the organizational and operational periods are based on the theoretical implications of the concepts of independence and saturation. However, the hypotheses are not derived exclusively from these processes.

In the organizational phase of problem solving, the group determines the most efficient method for task performance. Since complex problems have more task and communication demands associated with their solutions than simple problems, it follows that the organizational demands will be greater for the former than for the latter. The central position in the restricted network can coordinate the organizational requirements for simple tasks, but may become bogged down by the greater communication requirements of complex problem planning. However, it is expected that occupants of the central position will tend to reduce the effects of saturation either by limiting discussion or by selectively condensing the contributions of others. [1]

The decentralized network provides channels for an unrestricted communication flow. This factor should facilitate planning in complex problem solving since the numerous messages generated by the members are quickly and easily transmitted through the system. Although the decentralized network facilitates planning in the organizational phase of complex problem solving, it impedes the organizational

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[1] Snadowsky, A. Group effectiveness as a function of communication network, task complexity, and leadership type (Preliminary study).

phase of simple problem solving. The open channels should encourage a communication flow in excess of what is required for simple problem planning, thus preventing the prompt adoption of a methodology. Therefore, it is hypothesized that:

Hyp. 1: In the organizational phase of problem solving, groups with complex tasks will take more time and transmit more messages than groups with simple problems.

Hyp. 2: In the organizational phase of problem solving, groups with decentralized communication networks will take more time and transmit more messages than groups with centralized communication networks.

After the problem solving method is determined, the group begins work on the tasks. In a restricted network, all task material is transmitted to the central position. When the task is complex, this position may become saturated since it necessarily receives a large quantity of data for processing. Complex task material can be distributed easily and quickly in a decentralized communication network. If for some reason one position becomes overloaded, redistribution of data is facilitated by the availability of additional channels. Moreover, members of decentralized groups may be motivated by high independence to work harder than members of restricted networks.

Minimum task and communication demands during the operational phase of simple problem solving should produce low saturation in both centralized and decentralized networks. Shaw's (1964) analysis of the

task-net relationship indicated that free flow of information in unrestricted networks hinders simple problem solving. However, it is expected that the procedure derived during the organizational phase should reduce the probability that extraneous problem solving messages will be transmitted. On the other hand, high independence in decentralized groups may motivate the participants to work harder than members of restricted nets. This predicted difference in performance should be small because of the simplicity of the tasks. Therefore, the following hypotheses are proposed:

Hyp. 3: In the operational phase of problem solving, groups with complex tasks will take more time and transmit more messages than groups with simple problems.

Hyp. 4: In the operational phase of problem solving, groups with decentralized communication networks will take less time, transmit more messages and make fewer errors than groups with centralized communication networks.

Hyp. 5: In the operational phase of problem solving, communication network will interact with task complexity: the difference in performance rates (times, errors, messages) between groups with decentralized networks and groups with centralized networks will be greater under conditions of high task complexity than under low task complexity.

In both the planning and operational phases of problem solving,

members of groups with decentralized networks can communicate with all other members of the group. On the other hand, peripheral members of centralized networks are severely restricted in their inter-communication efforts. Since individuals in unrestricted networks have more freedom of action than peripheral members of restricted structures, it follows that:

Hyp. 6: In the organizational phase of problem solving, members of groups with decentralized communication networks will experience greater satisfaction than peripheral members of groups with centralized communication networks.

Hyp. 7: In the operational phase of problem solving, members of groups with decentralized communication networks will experience greater satisfaction than peripheral members of groups with centralized communication networks.

It was shown that the nature of the communication network influences performance and satisfaction in problem solving groups. However, it is expected that the kind of leadership operating in the group should modify the effects of net and task variables. Although there is a dearth of research on the relationship between leadership type and communication network variables, there is some evidence to support this contention.

In one study using complex problems, Shaw (1955) found that authoritarian leadership resulted in better group performance and lower satisfaction than nonauthoritarian leadership in the same network.

These results were explained in terms of saturation and independence processes. According to Shaw, authoritarian leadership decreased independence and saturation for most group members since the leader demanded a minimum of participation from the followers. Non-authoritarian leadership increased independence and saturation for all members since the democratic process involved extensive communication demands.

Shaw's (1955) results, however, do not agree with the many studies conducted in different settings that reported nonauthoritarian leadership to be more effective than authoritarian control. For example, Kahn and Katz (1960) found that human relations oriented supervisors tended to increase productivity and satisfaction in a work environment; Argyl, Gardner and Cioffi (1957) reported that foremen in highly productive groups exhibited more democratic oriented behavior than supervisors of low producing groups; and Likert (1961) indicated that supervisors of high-producing work groups generally were more considerate of their subordinates than were the supervisors of low-producing groups.

In a review of leadership research, Fiedler (1964, 1968) noted that studies of the effects of leadership style (authoritarian versus democratic, permissive versus controlling, etc.) upon group performance have often yielded inconsistent and ambiguous results. As a possible explanation of these contradictory findings, he suggested a model to define the relationship between leader attributes and group

performance in various environments. The basic hypothesis of the contingency theory is that the type of leadership behavior necessary for effective group performance is dependent on the degree to which the group-task situation encourages or inhibits the leader in his attempt to influence group members.

Fiedler points out that the favorableness of the situation is determined by three dimensions. These components are the personal relations between the leader and the group members (good or poor), the degree of task structure (structured or unstructured), and the power associated with the leadership position (strong or weak). An analysis of previous studies was used as a basis for predicting the optimum leadership behavior for each of the eight conditions formed by the levels of the three contingency model factors. For example, when the environment is very favorable for the leader (good leader-member relations, strong leader position power, structured task) or very unfavorable (poor leader-member relations, weak leader position power, unstructured task), the most successful leadership behavior is directive, controlling and task-oriented. Under conditions which are moderately favorable (e.g. good leader-member relations, weak leader position power, unstructured task), the permissive, considerate, nondirective leader will perform most effectively. A variety of different group situations investigated by Fiedler and his co-workers have provided support for this model (e.g. Fiedler, 1964, 1966, 1968).

Shaw and Blum (1966) indicated that Fiedler's theory is open to

objection since it is based on ex post facto interpretations. To test the generality of the contingency model, they experimentally manipulated type of leadership behavior and degree of task structure (one of the components of group-task favorability). The results showed that groups with directive leadership were more efficient than groups with non-directive leadership only when the environment was very favorable for the leader (in the structured task condition). In a critical discussion of their results, Shaw and Blum attributed the finding of only partial support for Fiedler's theory to an ineffective manipulation of group task favorability. The authors indicated that they did not vary the other dimensions postulated as determinants of situational favorability (i.e. leader-member relations and position power).

The research by Shaw and Blum (1966) has an important implication for the contingency theory. It seems that the predictive utility of Fiedler's model is significantly lessened by the unavailability of data pertaining to any of the group-task favorability components. Consider the following example. According to the eight cell contingency model (Fiedler, 1968), an unstructured task can be performed effectively by a group with either a nondirective or directive leader occupying a weak power position (cells 4 and 8). In this case, the type of leadership required is a function of the kind of personal relationships that the leader has with the members. With an unstructured task, weak leader position power and good leader-member relations, nondirective leadership is most effective (cell 4). On the other hand, directive leadership

is needed with an unstructured task, weak leader position power and moderately poor leader-member relations (cell 8). This illustration clearly shows that knowledge about task structure and leader position power cannot be used to predict the type of leadership that will be most effective for the group without information as to the present or potential leader-member relations.

Fiedler's work is significant for this thesis because it demonstrates the complexity of predicting the type of leadership behavior that will be most effective for a given situation. It is apparent from a consideration of the contingency model that an accurate assessment of the group's leadership needs is impeded when only partial data are available about the group-task environment. However, instances where there is a lack of information about the personal relationships among the participants, the task complexity and/or the leader's position power are probably characteristic of many problem solving situations. For example, the potential leader-member relations and the leader's position power generally are indeterminate for strangers who will solve problems in a communication network though the task complexity can be defined. There is a need, therefore, to ascertain the type of leadership that will have the best chance of producing high productivity and satisfaction when only limited prior information pertaining to the group-task situation is attainable.

Maier (1967) discusses a style of discussion leadership which should bring about a high level of group performance in various

situations. It is argued that groups have a potential which under many circumstances can exceed that of individuals acting alone. The crucial elements in the group's potential are organization and integration. The leader facilitates the organizational process by encouraging separation of different aspects of problem solving and delaying the adoption of a solution until all positions and interests are considered. He contributes the integrative requirement by relaying information, facilitating communications between the participants and coordinating member contributions. His ideas are never given as orders--the solution is the group's achievement. When the leader supplies these organizational and integrative functions, the group should emerge as a highly efficient unit.

The leadership technique suggested by Maier (1967) may not at first seem to differ from the traditional distinction between democratic and authoritarian roles. According to Krech, Crutchfield and Ballachey (1962) the democratic leader seeks maximum member involvement in the determination of group objectives and in the performance of group tasks. He shares his resources, delegates responsibility, is supportive and helpful. On the other hand, the authoritarian leader determines all activities relating to problem solving. He gives orders, takes little interest in his subordinates and does not delegate authority. In order to maintain constant control, he establishes a communication system in which interaction among the members are held to a minimum and wherever possible the channels of communication are linked through his position.

Although the democratic pole of the democratic-authoritarian continuum and the leadership role proposed by Maier are similar, the former stresses coordinative behaviors whereas the latter establishes both organizational and integrative activities as critical functions of the role requirement. When the two approaches are combined, the definition of democratic leadership is revised to include behaviors aimed at satisfying the organizational needs of the group.

Returning to Shaw's (1955) study of leadership in communication networks, it seems that one possible reason that the results indicated authoritarian control to be more effective than democratic guidance is that planning and task activity were confounded in this experiment. Since group effectiveness was a function of behavior during the total problem period, the extent to which each of the components (planning and implementing behavior) contributed to the total score cannot be determined. For example, did a democratic leader require more time than an authoritarian leader to organize the members in a centralized network? Did the pressure to achieve a solution, which is generally present in communication network environments (Shure et al., 1962), differentially affect the performance of democratic and authoritarian-led groups? Unfortunately, the answers to these questions cannot be obtained from Shaw's data. The relationship between communication network and leadership type can be clarified by examining these variables in both the organizational and operational phases of problem solving. Predictions generally will be derived from a synthesis of the theoretical implications

of independence and saturation processes, the behavior patterns attributed to democratic and authoritarian leadership by Krech et al. (1962), and the leadership approach recommended by Maier (1967).

During the planning stage, the group leader organizes the members to solve the tasks. It is expected that authoritarian leadership will decrease member saturation since the leader demands a minimum of participation from the group and regulates the flow of communication. The authoritarian leader controls communication demands on his position by dictating the procedure. The nonauthoritarian leader seeks group consensus and encourages the members to explore different methods before reaching a decision. Devising a problem solving procedure in a democratic manner should place many communication demands on both the members and the leader, thus increasing saturation potential in the group. It is postulated, therefore, that:

> Hyp. 8: In the organizational phase of problem solving, groups with authoritarian leadership will take less time and transmit fewer messages than groups with nonauthoritarian leadership.

The method that is derived during the planning period significantly affects task performance. In an authoritarian-led group, all task relevant data are channeled to the leader. This procedure allows the leader to maintain strict control over group functioning. However, a disproportionate amount of material concentrated in one position is a potential bottleneck in the group. On the other hand, democratic

leadership does not demand control of all task relevant data. Information is distributed among the members. There is also a tendency for work to be dispensed equally or according to ability since complaints are possible and "injustices" can be rectified. Moreover, as indicated by Likert (1961) and Katz and Kahn (1966), members of a democratic group are motivated to work hard by a need to implement the very method to whose selection they contributed. On the other hand, members of an authoritarian-led group may lose interest in the task and minimize their effort since they did not determine the procedure. It follows, then, that:

Hyp. 9: In the operational phase of problem solving, groups with nonauthoritarian leadership will take less time, transmit more messages and make fewer errors than groups with authoritarian leadership.

In both the organizational and operational phases of problem solving, authoritarian leadership should decrease the independence of the members. This occurs since the authoritarian leader operates with minimum regard for the desires of members whereas the followers must conform to the wishes of the leader. Independence should be high for all members in nonauthoritarian-led groups since everyone participates in both decision making and implementing. It is expected, therefore, that:

Hyp. 10: In the organizational phase of problem solving, members of groups with nonauthoritarian leadership will

experience greater satisfaction than members of groups with authoritarian leadership.

Hyp. 11: In the operational phase of problem solving, members of groups with nonauthoritarian leadership will experience greater satisfaction than members of groups with authoritarian leadership.

As indicated above, the leader defines the mode of member participation that will be permitted during planning and subsequent problem solving. These ground rules are established in the organizational phase. The communication structure which the authoritarian leader tends to form already exists in the centralized network, whereas the communication pattern preferred by the democratic leader is already present in the decentralized network. Therefore, the authoritarian leader must impose structure in the relatively unrestricted decentralized network whereas the democratic leader must overcome the restrictions in the centralized network. Imposing and overcoming restrictions are generally time consuming activities.

The restrictions of the centralized network, however, inhibit the creation of an optimum democratic environment. In a decentralized network all members can communicate with each other as compared with a centralized structure where it is necessary for the leader to relay messages. It was observed that the democratic leader in a centralized network did not relay notes verbatim. Instead he controlled saturation on his position by selectively condensing the messages.[2] Therefore,

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[2] Ibid.

it is predicted that:

Hyp. 12: In the organizational phase of problem solving, communication network will interact with leadership type: the difference in performance rates (times, messages) between groups with decentralized networks and groups with centralized networks will be greater under conditions of authoritarian leadership than under nonauthoritarian leadership.

There is little difference between the operational activities of authoritarian-led groups in centralized and decentralized networks. However, the open channels in the decentralized network potentially can be used to circumvent the authority if he becomes inoperative.

The operational procedures preferred by nonauthoritarian-led groups can be applied most effectively in a communication network with minimum restrictions. The use of democratic methods in a decentralized network should result in the most efficient distribution of work. However, the nonauthoritarian leader may not be successful in overcoming the barriers in a relatively restricted network. He will saturate his own position to the extent that he strives to increase participation for the other group members. It is assumed, therefore, that:

Hyp. 13: In the operational phase of problem solving, communication network will interact with leadership type: the difference in performance rates (times, errors, messages) between groups with decentralized networks and groups with centralized networks will be greater under conditions of

nonauthoritarian leadership than under authoritarian leadership.

The authoritarian leader reduces the potential levels of member independence in the decentralized network during the planning period. Although it is expected that the reduction will be considerable, movement to the levels found in groups with restricted networks may be prevented by the presence of open channels which are sources of some freedom. The same low levels of independence are also present in the operational phase of problem solving since there is no significant change in the environment when the group is working on the tasks.

A democratic leader attempts to increase independence for members of a group with a centralized structure. However, the formal restrictions impede not only group organization and subsequent problem solving, but also serve as ever present symbols of the leader's potential power. On the other hand, independence is enhanced in decentralized democratic groups since both the communication environment and leadership maximize opportunities for freedom of action. These assumptions lead to the following hypotheses:

Hyp. 14: In the organizational phase of problem solving, communication network will interact with leadership type: the difference in member satisfaction between groups with decentralized networks and groups with centralized networks will be greater under conditions of nonauthoritarian leadership than under authoritarian leadership.

Hyp. 15: In the operational phase of problem solving, communication network will interact with leadership type: the difference in member satisfaction between groups with decentralized networks and groups with centralized networks will be greater under conditions of nonauthoritarian leadership than under authoritarian leadership.

Leadership type also is expected to modify the effects of the group task on organizational requirements and operational performance in a communication network. In the planning phase, the authoritarian leader should quickly prepare all groups for problem solving. However, complex tasks should require more planning time than simple problems since the organizational demands are greater for the former than for the latter. On the other hand, it cannot be stated unequivocally that groups with democratic leadership will take more time to plan for complex problem solving than for simple problem solving.

In democratic-led groups members select the method to be used in the operational period. Although it is expected that a procedure where all members participate equally or according to ability will be developed for complex problem solving, the groups with simple tasks may consider the possibility of choosing a method that limits member participation instead of a procedure in which the work is shared. If the democratic-led groups with simple problems are confronted with this dilemma, then the amount of time and communications required for its resolution will be significantly greater than the organizational demands

associated with complex tasks. Since the form that the organizational discussion will take cannot be deduced from available theory, no formal prediction will be made as to the nature of the leadership-task relationship in the planning period.

Authoritarian-led groups form operational methods where control is centered in the leadership position independently of the type of task. The leadership positions in these groups may become saturated during complex problem solving. Nonauthoritarian-led groups generally devise problem solving procedures that use the resources of all participants. Moreover, members of democratic-led groups are motivated to work hard in order to implement the method that they developed whereas members of authoritarian-led groups may minimize their effort since they have no commitment to the procedure. However, the difference in performance between democratic and authoritarian groups should be small for simple tasks when compared with complex tasks because of the minimal operational demands associated with simple problem solving. Therefore, it is expected that:

> Hyp. 16: In the operational phase of problem solving, leadership type will interact with task complexity: the difference in performance rates (times, errors, messages) between groups with authoritarian leadership and groups with nonauthoritarian leadership will be greater under conditions of high task complexity than under low task complexity.

The above formulation is aimed primarily at attempting to resolve

the major issues of communication network research. These problems were shown to focus on the extent to which communication structure modifies the effects of task and leadership variables on group performance and satisfaction. In many cases researchers have argued completely different conclusions from very similar results. It is thought that progress can be made in understanding the relationships between communication structure and other variables by studying them in both the organizational and operational phases of problem solving.

II. METHOD

Subjects

The subjects were 320 male undergraduates enrolled in the basic psychology, biology or chemistry courses at Brooklyn College of the City University of New York. Participants were selected from the class rosters and contacted by telephone at their homes. The specific recruitment procedure used in this study was as follows.

Instructors in the Departments of Psychology, Biology and Chemistry were asked to read to selected classes a notice announcing a communication study that would take place at Brooklyn College. The statement, which was from a member of the Psychology Department, informed the students that:

> My research staff and I will be conducting communication experiments at Brooklyn College this semester. These studies have also been done at various colleges and universities throughout the United States and Europe. The experiments involve finding out how people communicate with each other in small group situations when they are engaged in various task endeavors. Students enrolled at Brooklyn College have been randomly selected to participate in this research. The students who have been selected will be contacted by telephone in the near future by one of my research associates. We would appreciate it if you would agree to participate in this research. All students who take part will be told in detail the specific questions the research is attempting to answer.

Students were telephoned and asked to volunteer for the experiment. The refusal rate for this method was very low (approximately

one rejection in every ten contacts). Individuals who agreed to participate were formed into groups of four according to their free hours.

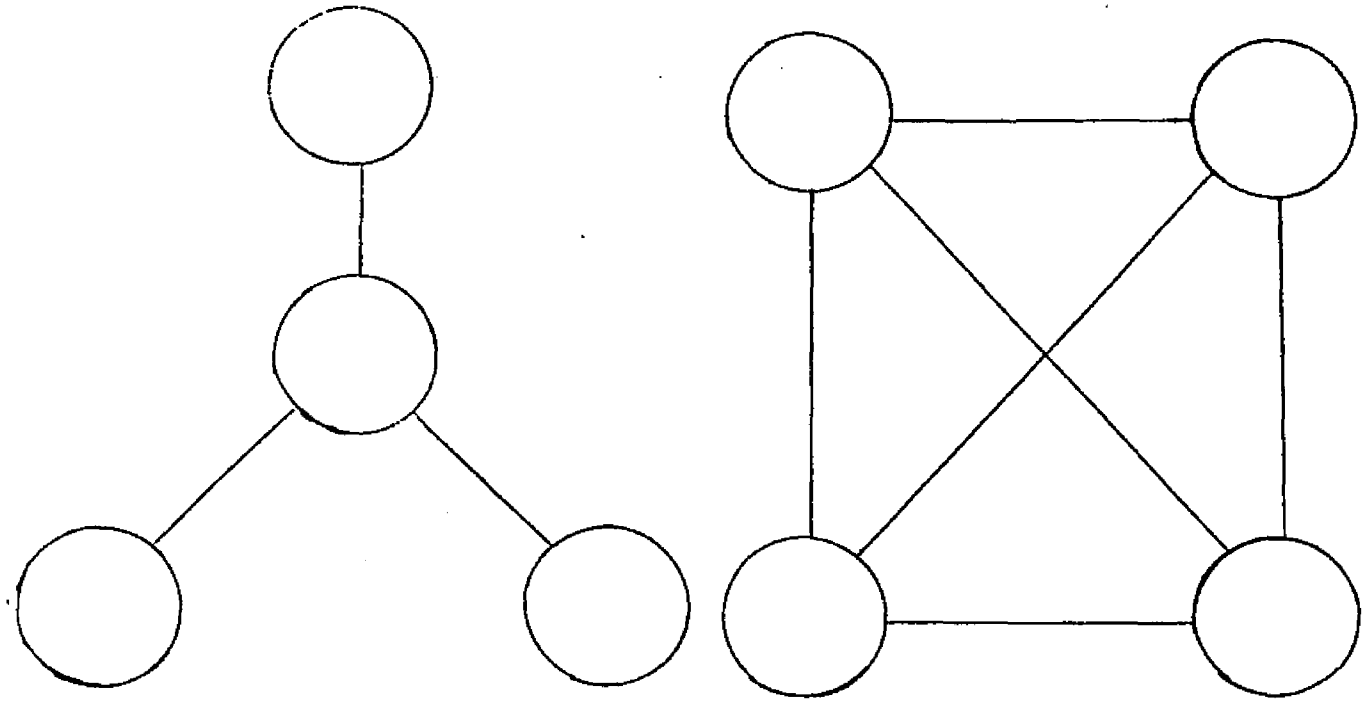
Experimental Design

This investigation used a 2x2x2 factorial design involving two kinds of communication structure (relatively unrestricted or decentralized and relatively restricted or centralized), two types of tasks (complex and simple) and two types of leadership (authoritarian and non-authoritarian). Ten groups of four subjects were randomly assigned to each of the eight cells.

Randomization was achieved as follows. Ten cardboard chips were prepared for each of the eight conditions. The eighty chips were placed in a box which was shaken thoroughly. The chips were drawn one at a time to determine the experimental manipulation that each group would receive.

1. Communication network. --The communication structures used in this study are illustrated in Figure 1. The centralized or relatively restricted network was the 4-man wheel. In this structure each of three peripheral participants could communicate with a central person, but with no one else. The central position, however, was permitted to communicate with all other members. The three peripheral members had equal communication restrictions imposed on them, but were much more restrained than the person occupying the central position.

The decentralized or relatively unrestricted structure was the



WHEEL COMCON

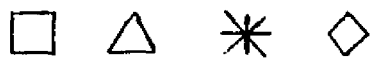
Fig. 1. The experimental communication nets.

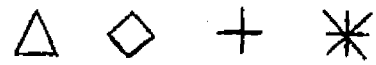
4-man comcon (or completely connected net). In this network each participant had equal communication opportunities. Every member of the group could communicate directly with everyone else.

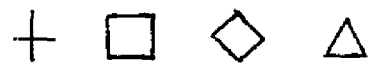
2. Task complexity. --Two kinds of problems were used in this study. The simple tasks required the identification of common symbols (Leavitt, 1951). The complex tasks required arithmetic computations (Shaw, 1954ab). Examples of the simple and complex tasks are illustrated below.

Simple problem: Four out of five symbols were stenciled on each of four 3x5 file cards. There was only one symbol which was common to a set of four cards. The group task was completed when all subjects identified the common symbol.

Items of information

Card (1) 

Card (2) 

Card (3) 

Card (4) 

Complex problem: A statement of the problem and two different items of information were typed on each of four separate 3x5 cards. The group task was completed when all subjects reported the solution.

Problem

A furniture manufacturer is interested in determining the total number of items he can produce in one day. What is the total?

Items of information

(1) Five men work in the desk department.
(2) Each man in the chair department can produce seven chairs per day.
(3) Ten men work in the chair department.
(4) Each man in the bookcase department can produce one bookcase per day.
(5) Two men work in the table department.
(6) Four men work in the bookcase department.
(7) Each man in the desk department can produce four desks per day.
(8) Each man in the table department can produce one table per day.

The order of presentation of problems to a given group was random.

3. Leadership type. --The leadership role was always assigned to the same position in the network by means of instructions to the whole group. In the restricted network, the central position was the one selected for the leadership function. The two types of leadership were introduced through instructions given to the subject who occupied the designated "leadership" position. Krech, Crutchfield and Ballachey's (1962) distinction between democratic and authoritarian behavior and the leadership approach proposed by Maier (1967) served as a basis for the roles used in this study. The authoritarian leader was instructed to give orders to the other members, never accept suggestions uncritically and generally make it clear that he was in charge. The nonauthoritarian leader was instructed to allow members to discuss and decide problem solving methodology, never give orders, and behave in a supportive and helpful manner.

The instructions given to the subjects occupying the leadership positions are presented in another part of this section. These stimuli

represent the results of a series of preliminary studies designed to develop role descriptions that would effectively elicit authoritarian and democratic leadership behaviors. In the first pilot study, the leaders were provided with brief instructions outlining their role requirements. This information, however, was not sufficient to produce the desired difference in leadership activities.

The second preliminary study used a set of more detailed role instructions. In addition, the subjects were told that the leadership behaviors described on their instruction sheet represented the type of activities that were proven to be most efficient in small group communication settings. Some subjects, however, were sufficiently sophisticated to challenge the efficacy of authoritarian behavior. One leader assigned to the authoritarian role decided not to participate in the experiment. A second deficiency in this procedure was that both "democratic" and "authoritarian" leaders did not feel that the instructions adequately guided them through the experiment. They were uncertain as to the exact activities to be performed, especially how to begin.

Information gathered from the initial pilot studies indicated the need for the following procedural revisions. First, the instructions should be presented to the leader in such a way that he perceives himself as a semi-confederate in the experiment. That is, the leader should not be put in a situation where he might question the validity of his role. Second, the role should be clearly defined in language that

would be easily understood by the participants. The instructions should include not only a description of the various required behaviors, but also a procedure for implementing them. Third, the authoritarian instructions should motivate the subject to assume this generally unpopular role. Finally, since the leader participates with the other group members in performing the tasks, it is important that the democratic and authoritarian manipulations should not affect leader satisfaction. Although it is predicted that leader behavior will affect member performance and satisfaction, the results might be confounded if leaders in the various conditions differed significantly in their feelings toward the study. For example, do democratic leaders experience greater satisfaction than authoritarian leaders? It is necessary to answer this question since degree of satisfaction may be related to the extent to which the leader is motivated to work hard at the task.

The instructions for leaders were rewritten and a more comprehensive preliminary study was undertaken to determine the effectiveness of the leadership manipulation. The subjects were[1] 92 male students recruited from the basic psychology sections at Brooklyn College of the City University of New York.[1] Two communication networks (comcon and wheel), two types of problems (simple and complex) and two types of leadership (democratic and authoritarian) were used in this study.

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[1]Subjects tested in the preliminary study were different from those used in the present experiment.

Six groups of 4 subjects were randomly assigned to each cell. In phase one of each experimental session the leader organized the participants (organizational period); in phase two the group solved the problems (operational period). The experimental procedure of this preliminary study was similar to that followed during the present experiment. (The experimental procedure is reported in another part of this section.)

To determine whether the leadership manipulation was successful in producing the desired variation, group members were requested to indicate the extent to which a series of behaviors were characteristic of the leader during the experiment. The instrument which was composed of four nine point rating scales is described at the end of this section and reproduced in Appendix IV - Part 2. Intercorrelations between the four scales were positive and significant at the .01 level (see Appendix I - Table 1). Ratings from the scales, therefore, were combined. The total scores varied from 4 on the authoritarian end of the continuum to 36 on the nonauthoritarian end. Mean ratings of leader behavior as reported by group members and a summary of the analysis of variance performed on these scores are shown in Tables 2 and 3 of Appendix I. The results indicated that subjects exposed to democratic leadership rated their leader higher on the democratic-authoritarian continuum than members exposed to authoritarian leadership independently of degree of task complexity or type of communication structure. This finding provides acceptable evidence that the leaders behaved as instructed.

A series of nine point rating scales were used to determine whether the procedure differentially affected leader satisfaction. Group leaders indicated their satisfaction with the planning period, other group members and themselves as leaders during the organizational phase of problem solving. They also reported their satisfaction with the task, their role, other group members and themselves during the operational period. Mean ratings of leader satisfaction and the results of the analyses of variance are presented in Tables 4 - 7 of Appendix I. No significant effects were found. It appears that leaders, regardless of whether they assumed authoritarian or democratic roles, did not differ in their satisfaction with themselves as leaders, group members, and the experimental situation.

Apparatus

The apparatus used in this research was similar to that used in the Leavitt (1951) study. The subjects were seated around a table so that each was separated from the other by a vertical partition from the center. The compartments were connected by means of slots through which messages written on sheets of paper could be passed. These slots could be closed to form different communication networks. Each cubicle had work space and task material such as message paper and scratch pads.

Each booth also was provided with a panel containing five switches and one light. One of the answer choices appeared adjacent to each switch. To register an answer, the subject threw a switch which

activated a light on the experimenter's master panel. If the answer was correct, the light on the subject's board would flash.

Experimental Procedure

Subjects were met at the entrance of the Brooklyn College Library and taken to the experimental room. Upon entering the cubicle, the subjects were asked to pick a chip from a rectangular box. On the reverse side of each chip was a number which corresponded to one of the four booths. The subjects were seated according to the numbers which they randomly selected.

General instructions were then given to the subjects. They were told that:

> In this study we are interested in finding out the factors involved in problem solving. Your group will complete five tasks of a similar nature. The goal of the group is to solve all the problems as quickly and efficiently as possible. One person will be randomly chosen to be the group leader and the other members are required to follow his directions.
>
> In order to solve the problems you may send and receive messages through slots in your booth. Now look at these slots. These slots represent your channels of communication which are shown on the wall chart (see Appendix II for reproductions of the wall charts).

It was pointed out to groups with decentralized networks that direct contacts among all individuals were readily available. Conversely, groups with centralized networks were informed that direct contacts among all individuals were not readily available.

The experimenter then said:

> To facilitate identification, each member of the group has been assigned a color code. Your color code is shown

on the chart and also appears on the blank message sheets. Each communication slot is labeled showing the color to which it is connected. Note: The person sitting in the yellow position will be the leader.

Only written messages are allowed; under no circumstance may you talk. Messages should be written only on the special message sheets. DO NOT WRITE ON THE PROBLEM CARDS. Write only one message on each piece of paper. There is no limit as to the length of each message. In the space provided on top of each message sheet indicate the color code of the member to whom the message is directed. Messages that are received from other participants should not be transmitted but retained until the end of the trial.

Before beginning work on the tasks, there will be a planning period during which time a quick and efficient organization for solving the problems must be determined. A description of the problems will be provided so that there is a basis for determining a problem solving procedure. The quick and efficient organization should be determined as fast as possible.

After the procedure has been determined, the leader should raise his hand. The group will then begin work on the problems.

Are there any questions?

At this point each member of the group was given an envelope which contained instructions for the planning period and a sample problem. Members of groups that were to solve simple problems were informed that:

During the problem solving period (which will follow), each of you will receive a card on which there appears four out of five symbols. There is only one symbol which is common to a set of four cards. The problem is to identify the common symbol. You will receive five problems.

No one of you can solve the problems working alone because no one has all the information needed to solve them. When you think you know the answer, throw the switch on your control panel which is next to the symbol which you think is

correct. If the answer is correct, the light on your control board will immediately light up. If you discover the common symbol you may pass the answer to the other members of the group with whom you have an open slot. When all members have correctly indicated that they know the common symbol, the trial is ended. Another set of cards with another common symbol will be given to you, and another trial will begin. Your goal is to solve all the problems as quickly as possible with as few errors as possible. An error is any solution by an individual member which is incorrect.

The initial instructions for members of groups that were to solve complex problems indicated the following:

During the problem solving period (which will follow), each of you will receive a card describing an arithmetic task. Each member will receive the same description. In addition to the description, each member will receive two different pieces of information. In order to solve the problem, all eight pieces of information are required. Following the problem are five answer choices: A, B, C, D, E. Only one answer is correct. You will receive five problems. Note: A scratch pad is provided for computations.

No one of you can solve the problems working alone because no one has all the information needed to solve them. When you think you know the answer, throw the switch on your control panel which is next to the letter which represents the correct answer. If the answer is correct, the light on your control board will immediately light up. If you discover the correct answer you may pass the answer to the other members of the group with whom you have an open slot. When all members have correctly indicated that they know the answer, the trial is ended. Another set of cards with another arithmetic problem will be given to you, and another trial will begin. Your goal is to solve all the problems as quickly as possible with as few errors as possible. An error is any solution by an individual member which is incorrect.

Subjects in both the simple and complex problem conditions were then given additional information about the sample problem and the requirements of the planning period (see Appendix III for simple and complex sample problems).

During the planning period, a quick and efficient organization for solving the problems must be determined. A sample problem is provided so that there is a basis for determining the problem solving procedure. DO NOT SOLVE THIS PROBLEM. During the planning period you only should send messages relating to group organization. That is, you should develop a system for transmitting information so that you can solve each of the five problems quickly and efficiently.

THE QUICK AND EFFICIENT ORGANIZATION SHOULD BE DETERMINED AS FAST AS POSSIBLE. When the procedure is determined, the leader will raise his hand and we will begin the problem solving part of the experiment.

THE LEADER IS TO SEND THE FIRST MESSAGES. DO NOT SEND A MESSAGE TO ANYBODY UNTIL YOU RECEIVE A COMMUNICATION FROM THE LEADER.

The requirement that a member should not send messages until he received a communication from the leader was included in the procedure so that each participant would get a similar first message from the leader. In early pilot testing, where initial free communication was permitted, it was found that members sent messages to the leader before he had an opportunity to write to everyone. This not only caused confusion, but also did not permit the leader to begin establishing his role.

Unknown to the other group members, the leader was provided with a set of instructions describing the characteristics attributed to his role. An authoritarian leader was instructed as follows:

****

SPECIAL INSTRUCTIONS FOR THE LEADER
THE OTHER MEMBERS OF THE GROUP ARE NOT AWARE THAT YOU ARE RECEIVING SPECIAL INSTRUCTIONS. THEY SHOULD NOT BE TOLD.

****

In this study you are to play the role of an AUTHORITARIAN leader. WE WILL TELL THE OTHER MEMBERS ALL ABOUT

THE EXPERIMENT AT THE END OF THE HOUR.

As an authoritarian leader, you will determine how the group will solve the problems. You will give orders to the other members, never accept suggestions uncritically, take little interest in your subordinates and generally make it clear that you are the boss. In order to maintain constant control, you should arrange things so that, whenever possible, all information will pass through your position.

Your first message to be sent to all members should be an order. You should decide the method of organization and then write your decision in the form of an order.

After you make sure that everyone understands your orders and/or dealt with any questions, raise your hand (which will signal the end of the planning period). In presenting your orders and dealing with questions always remember: YOU ARE AN AUTHORITARIAN LEADER.

On the other hand, a democratic leader received the following instructions:

****

SPECIAL INSTRUCTIONS FOR THE LEADER
THE OTHER MEMBERS OF THE GROUP ARE NOT AWARE THAT YOU ARE RECEIVING SPECIAL INSTRUCTIONS. THEY SHOULD NOT BE TOLD.

****

In this study you are to play the role of a DEMOCRATIC leader. WE WILL TELL THE OTHER MEMBERS ALL ABOUT THE EXPERIMENT AT THE END OF THE HOUR.

As a democratic leader, you will encourage all the members to participate in a discussion to reach a decision as to the method of organization to be used. You may offer suggestions. NEVER GIVE ORDERS. You should behave in a supportive, helpful and cooperative manner.

Your first message to be sent to all members should convey the following:

> What do you think will be the quickest and most efficient method. Let's discuss this.

> You don't have to use these exact words as long as you convey the thought.
>
> When the members agree on a method of organization, raise your hand (which will signal the end of the planning period). Before raising your hand, it is important to make sure that everyone understands and agrees on the method of organization. In helping the group to decide a method of organization, always remember: YOU ARE A DEMOCRATIC LEADER.

While the subjects were reading the instructions, the experimenter circulated among the booths to answer questions. The start signal was given when the members understood the requirements of the planning period and the leader was familiar with his role. After the leader reported that the group had derived a problem solving method, the instruction sheets and messages were collected.

The members were given envelopes containing problem cards and told that:

> We will now begin the problem solving period. When I say go, you may begin passing messages. You do not have to wait for the leader to begin passing messages as in the planning period.

Subjects were then reminded of those crucial instructions which, from pilot testing, were found to be forgotten shortly after the organizational period. They were told that:

> In working out the problems you should not guess since errors count against the group. If one person solves a problem, he should immediately send the answer to the other members since each trial is ended only when all members signal the right answer.

When the group completed the first trial, the problem cards and messages were collected. Another set of problem envelopes was

distributed to the members. Each group completed five trials. After all the problems were solved a questionnaire was administered.

The purpose of the experiment was then explained to the subjects. Participants were asked to leave their booths and sit in chairs adjacent to the apparatus. They were informed that the aim of the study was to determine how three factors--type of communication network, task complexity and leadership style--affected the speed with which the group worked, the number of messages transmitted by the group, and the extent to which the members liked the experiment.

The details of centralized and decentralized communication networks were explained and the subjects were told to examine the apparatus to see how the different structures were formed by opening and closing communication channels. The type of problems that the group solved was identified as either simple or complex. Simple problems were distinguished from complex tasks by indicating that the latter required the use of arithmetic. The subjects were then told that it was necessary to provide special instructions for the group leader in order to obtain two different leadership styles. It was stressed that the leader's behavior generally was programmed by the instructions. To illustrate this, the experimenter read the instructions given to the leader and contrasted them with the material presented to leaders in the other condition.

Rather than discussing the hypotheses which were considered too involved to be explained in a short time, questions pertaining to the

experimenter's expectations were answered as follows:

> I think it is best not to duscuss hypotheses or results until all data are collected. I will be able to discuss the experiment with you during the summer or fall. Just leave a note in my mailbox in the Psychology Office and we can set up an appointment.

The subjects were thanked for their help and asked not to discuss the experiment with others since many Brooklyn College students were expected to participate in the study.

Measurement Procedures

1. Performance

(a) Organizational phase of problem solving:

(1) Time--Time to devise a method was measured from the "start" signal of the experimenter to the point when the leader raised his hand.

(2) Messages transmitted--This score represented a count of the number of messages sent by each group during the organizational phase.

(b) Operational phase of problem solving:

(1) Time--Time to solve a problem was measured from the "start" signal of the experimenter to the time the last person in the group threw his switch indicating the correct answer.

(2) Messages transmitted--This score represented a count of the number of messages sent by each group during a given trial.

(3) Errors--An error occurred when a subject registered an incorrect answer.

2. Satisfaction

Satisfaction was measured by questionnaire items designed to elicit feelings about the job, the task and interpersonal relationships (e.g. Leavitt, 1951; Shaw, 1955; Cohen, Bennis and Wolkon, 1961). In this study, subjects answered each of the following questions by placing a check in one of the boxes on a nine point scale. Each scale was marked "LIKE" at one end and "DISLIKE" at the other (see Appendix IV - Part 1).

(a) Planning period:

(1) How did you feel about the planning period?

(2) How did you feel about the leader during the planning period?

(3) How did you feel about the other group members (other than the leader) during the planning period?

(b) Problem solving period:

(1) How did you feel about the problems your group was asked to solve?

(2) How did you feel about your job in the group during the problem solving period?

(3) How did you feel about the leader during the problem solving period?

(4) How did you feel about the other group members

(other than the leader) during the problem solving period?

3. Leader Behavior

To measure the success of the leadership manipulation, subjects were asked to indicate on a series of nine point rating scales the degree to which various activities were characteristic of the leader during the experiment (see Appendix IV - Part 2). Each scale was marked "CHARACTERISTIC" at one end and "NOT CHARACTERISTIC" at the other end. The instrument was composed of the following items:

(a) Encouraged group discussion and decision.

(b) Helped to integrate the contributions of group members.

(c) Facilitated communication between members.

(d) Acted in a helpful and supportive manner.

III. RESULTS

Establishing the Leadership Manipulation

Before the findings pertaining to the experimental hypotheses are considered, it is necessary to determine the effectiveness of the leadership manipulation. Whereas communication structure and task complexity were varied from outside the group (i.e. the communication network and task were given by an external authority), leadership style was a function of the degree to which a selected individual in the group followed a prescribed role. The best evidence that the leaders acted according to instructions comes from member ratings of leader behavior.

Members indicated on a series of four nine point scales the extent to which various activities were characteristic of the leader during the experiment. Intercorrelations between the scales ranged from .38 to .63. All correlation coefficients were positive and significant at the .01 level (Table 1). Ratings from the scales were combined so that scores varied from four on the authoritarian end of the dimension to 36 on the nonauthoritarian end.

Mean ratings of leader behavior as reported by group members are given in Table 2. It can be seen that subjects in the nonauthoritarian

TABLE 1

INTERCORRELATIONS OF LEADER BEHAVIOR SCALES (GROUP MEMBERS N = 240)

Scale	2	3	4
1	.38*	.62*	.51*
2		.44*	.63*
3			.40*

*$p < .01$

TABLE 2

MEAN RATINGS OF LEADER BEHAVIOR

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
Nonauthoritarian	26.67	25.63	27.53	26.73
Authoritarian	13.73	16.07	15.63	15.30

groups rated their leaders higher on the democratic-authoritarian dimension (average score across conditions=62.64) when compared with members of authoritarian groups (average score across conditions=15.18). The difference in member ratings of the leader between democratic and authoritarian groups was significant at the .01 level (Table 3) and occurred independently of task complexity or type of communication network. From these findings it seems reasonable to conclude that group members perceived the leaders as being different along a democratic-authoritarian continuum and that this perceived difference is evidence that the leaders behaved as directed.

TABLE 3

SUMMARY OF THE ANALYSIS OF VARIANCE OF MEMBER RATINGS OF LEADER BEHAVIOR

Source	df	Mean Square	F	p
Task Complexity (T)	1	108.11		
Leadership Type (L)	1	23632.81	137.38	$< .01$
Communication Structure (C)	1	.31		
T x L	1	7.81		
T x C	1	66.61		
L x C	1	165.31		
T x L x C	1	94.64		
Within	72	172.03		

It also was necessary to determine whether the leadership manipulation differentially affected leader satisfaction. Since the leader participated with the other group members in solving the problems, the performance results might have been confounded if leaders in the several conditions differed in their feelings toward various aspects of the experiment. For example, did individuals who assumed a non-authoritarian leadership role experience greater satisfaction when compared with individuals who assumed an authoritarian leadership role? This question was worth considering since leaders who differed significantly in satisfaction also might have varied in the degree to which they were motivated to work hard at the tasks.

A series of rating scales were used to measure leader satisfaction. Scores for each item could range from one on the very dissatisfied end of the scale to nine on the very satisfied end. Group leaders indicated their satisfaction with the organizational phase of problem solving by assessing the planning period, other group members and themselves as leaders. Mean ratings of leader satisfaction are given in Table 4. All means were above the midpoint on the nine point scale and ranged from 6.10 to 7.70. The analyses of variance presented in Appendix V - A showed no significant effects.

Leaders also indicated their satisfaction during the operational period. The mean ratings of leader satisfaction with the problems, the job, themselves, and other group members are given in Table 5. It can be seen that the means for all conditions were above the midpoint

TABLE 4

MEAN RATINGS OF ORGANIZATIONAL SATISFACTION (LEADER)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
With Planning Period				
Nonauthoritarian	6.70	6.60	7.00	6.70
Authoritarian	6.20	6.10	6.60	6.60
With Leader (Self)				
Nonauthoritarian	7.30	6.60	7.20	6.90
Authoritarian	7.30	6.40	7.60	7.40
With Other Group Members				
Nonauthoritarian	7.30	7.10	7.30	7.50
Authoritarian	6.80	7.50	6.40	6.60

TABLE 5

MEAN RATINGS OF OPERATIONAL SATISFACTION (LEADER)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
With Problems				
Nonauthoritarian	6.90	6.80	7.20	7.60
Authoritarian	6.80	7.50	7.50	6.00
With Job				
Nonauthoritarian	7.10	7.10	7.20	8.00
Authoritarian	6.80	7.30	8.00	7.40
With Leader (Self)				
Nonauthoritarian	7.80	7.10	7.70	7.90
Authoritarian	8.00	7.30	8.00	7.70
With Other Group Members				
Nonauthoritarian	8.10	7.30	7.80	7.90
Authoritarian	7.30	7.10	8.30	7.40

on the nine point scale and ranged from 6.00 to 8.30. A majority of the means (25 out of 32) fell between points 7.00 and 8.00. The results of the analyses of variance are presented in Appendix V-B. As with the organizational period, there were no significant effects. It appears that leaders, regardless of the roles that they assumed, did not differ significantly in their satisfaction with themselves, group members and the situation.

Test of Hypotheses

A. Task-Network Relationship

Hypothesis 1. The organizational phase of problem solving was the period during which the group developed a procedure for solving tasks quickly and efficiently. It was predicted that in the planning phase, groups with complex tasks would take more time and transmit more messages than groups with simple problems. The mean time scores for the planning period are given in Table 6. Examining these results, it is clear that groups with complex problems required more time for organizing than groups with simple tasks. The average time (across conditions) for planning complex problem solving was 11.23 min. and the average time for planning simple problem solving was 9.94 min. As expected, the difference of 1.29 min. was statistically significant (Table 7).

The means of number of messages transmitted during the organizational phase of complex and simple problem solving are shown in Table 8. Comparing the message requirements of complex and

TABLE 6

MEAN TIME (MIN.) FOR ORGANIZATIONAL PERIOD

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
Nonauthoritarian	13.35	12.14	11.85	11.83
Authoritarian	12.84	6.59	11.30	4.79

TABLE 7

SUMMARY OF THE ANALYSIS OF VARIANCE OF TIME REQUIRED TO COMPLETE THE ORGANIZATIONAL PERIOD

Source	df	Mean Square	F	p
Task Complexity (T)	1	33.26	4.24	$<.05$
Leadership Type (L)	1	232.71	29.68	$<.01$
Communication Structure (C)	1	244.50	31.19	$<.01$
T x L	1	2.96		
T x C	1	1.08		
L x C	1	166.52	21.24	$<.01$
T x L x C	1	2.57		
Within	72	7.84		

TABLE 8

MEAN NUMBER OF MESSAGES TRANSMITTED DURING ORGANIZATIONAL PERIOD

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
Nonauthoritarian	38.90	16.00	30.10	15.70
Authoritarian	31.70	11.10	29.10	9.10

simple problem solving groups in various conditions, it is apparent that the former groups had greater communication needs than the latter. Across conditions, the average number of messages transmitted by groups with complex tasks was 24.43 whereas groups with simple problems averaged 21.00 messages. This effect was found to be significant at the .05 level (Table 9).

TABLE 9

SUMMARY OF THE ANALYSIS OF VARIANCE OF NUMBER OF MESSAGES TRANSMITTED DURING ORGANIZATIONAL PERIOD

Source	df	Mean Square	F	p
Task Complexity (T)	1	234.61	5.82	$<.05$
Leadership Type (L)	1	485.11	12.03	$<.01$
Communication Structure(C)	1	7585.51	188.04	$<.01$
T x L	1	25.31		
T x C	1	103.51	2.57	
L x C	1	13.61		
T x L x C	1	78.03	1.93	
Within	72	40.34		

Hypothesis 2. Participants determined the problem solving procedure by transmitting messages through either centralized (wheel) or decentralized (comcon) communication networks. Groups with decentralized communication nets were expected to require more organizational time and send more messages than groups with relatively restricted communication structures. Table 6 shows that mean organizational time scores were greater for the groups with unrestricted networks. The average time (across conditions) needed by these groups to plan a procedure was 12.33 min. as compared with 8.84 min. for restricted groups. This effect was found to be significant at the .01 level (Table 7).

As indicated in Table 8, groups with unrestricted communication networks also transmitted more messages during the planning period. Across conditions, the mean number of communications sent by decentralized groups was 32.45 whereas centralized groups required an average of only 12.98 messages. The difference in messages transmitted between unrestricted and restricted groups was significant at less than the .01 level (Table 9).

Hypothesis 3. After the procedure was determined, the group began work on the problems. It was anticipated that more time and messages would be needed to solve complex problems than simple tasks. The mean time per problem scores are reported in Table 10. These results show that, as expected, complex arithmetic problems took substantially more time to complete than did simple symbol

TABLE 10

MEAN TIME (MIN.) PER PROBLEM REQUIRED FOR EVERY SUBJECT IN THE GROUP TO REGISTER THE CORRECT ANSWER

Trial	Complex Problems				Simple Problems			
	Nonauthoritarian Leadership		Authoritarian Leadership		Nonauthoritarian Leadership		Authoritarian Leadership	
	Comcon	Wheel	Comcon	Wheel	Comcon	Wheel	Comcon	Wheel
1	3.47	3.40	4.31	4.19	1.14	1.13	1.64	1.82
2	2.10	2.36	2.87	2.93	.87	.84	1.23	1.30
3	2.22	2.14	2.75	2.66	.67	.71	.93	1.06
4	2.15	2.06	2.81	2.90	.67	.72	.87	.90
5	2.23	2.25	3.27	2.95	.69	.72	.86	.99
Mean	2.43	2.44	3.20	3.13	.81	.82	1.11	1.21

identification tasks. Averaging across conditions, a complex task required 2.80 min. to be solved as compared with only .99 min. for a simple problem. The difference between these means was found to be statistically significant at the .01 level (Table 11).

Although not directly related to the issues focused on in this research, it is interesting to note that learning occurred in all conditions. An examination of the mean time per problem scores in Table 10 clearly reveals this trend and the analysis of variance of the time scores (Table 11) shows that the Trials Effect was significant at less than the .01 confidence level. These results are in accord with the findings from previous experiments (e.g. Shaw, 1954 ab).

As indicated by the significant Task Complexity x Trials interaction, however, the learning trend was a function of the degree of task complexity. The mean time per problem scores as a function of Task Complexity and Trials are shown in Table 12. It appears that: (a) for complex problems (across conditions) learning occurred from the first to the second trial with performance leveling off after the second trial; and (b) with simple tasks (across conditions) learning took place from the first to the third trial with performance leveling off after the third trial.

Hypothesis 3 and other predictions relating to number of messages transmitted in the problem solving period could not be tested with parametric statistics since most of the groups used the same number of communications to solve the problems. This generally uniform message

TABLE 11

SUMMARY OF THE ANALYSIS OF VARIANCE OF TIME REQUIRED FOR EVERY SUBJECT IN THE GROUP TO REGISTER THE CORRECT ANSWER

Source	df	Mean Square	F	p
Task Complexity (T)	1	327.83	565.22	$<.01$
Leadership Type (L)	1	28.62	49.34	$<.01$
Communication Structure (C)	1	.02		
T x L	1	3.61	6.22	$<.05$
T x C	1	.23		
L x C	1	.00		
T x L x C	1	.17		
Error (a)	72	.58		
Trials (D)	4	14.28	89.25	$<.01$*
T x D	4	2.58	16.13	$<.01$*
L x D	4	.24	1.50	
C x D	4	.05		
T x L x D	4	.21	1.31	
T x C x D	4	.11		
L x C x D	4	.04		
T x L x C x D	4	.08		
Error (b)	288	.16		

* The effect is also significant at $<.01$ after a maximum reduction in the number of degrees of freedom was made in order to allow for the affects of intercorrelations among the trials.

TABLE 12

MEAN TIME PER PROBLEM REQUIRED FOR EVERY SUBJECT IN THE GROUP TO REGISTER THE CORRECT ANSWER AS A FUNCTION OF TASK COMPLEXITY AND TRIALS

Task	Trials				
	1	2	3	4	5
Complex Problems	3.84	2.56	2.44	2.48	2.67
Simple Problems	1.43	1.06	.84	.79	.81

sending behavior resulted from the centralized problem solving procedure which was adopted by all groups in all conditions. The leader solved the problems in all groups except in six where members were selected as task coordinators.

The centralized method that the groups used was as follows: (1) all members transmitted their information to the leader (or task coordinator), (2) the leader solved the problem, and (3) the leader transmitted the correct solution to each member. Therefore, the minimum number of messages required to solve a problem was six.[1] Since 301 out of 400 possible trials (5 problems x 10 groups x 8 conditions)

[1]Three of the groups which solved complex problems in decentralized communication networks varied from this procedure. In these groups the leader passed the solution to one member who then relayed it to the others. However, six messages also were required for this method.

were solved with the minimum number of messages, the use of analysis of variance was not appropriate to test the experimental hypotheses.

When examining the hypotheses concerning messages transmitted during the operational phase, graphic analyses will be used to interpret the experimental results. Trends will be indicated but no assertions will be made as to the statistical reliability of the findings.

Figure 2 shows the means of the number of messages transmitted per trial for each experimental condition. It can be seen that groups with complex problems generally sent more messages than groups with simple problems. The mean number of messages per trial ranged from 6.0 to 12.9 for the former and from 6.0 to 8.3 for the latter. This trend was in the direction predicted by Hypothesis 3.

Hypothesis 4. Groups solved the problems in either centralized or decentralized communication networks. It was expected that groups with decentralized communication networks would take less operational time, transmit more messages and make fewer errors than groups with centralized nets. Examining Table 10, it is clear that the times required to solve problems in decentralized and centralized networks were very similar. Mean times for decentralized and centralized groups in the various treatments were 2.43 and 2.44 min., 3.20 and 3.13 min., .81 and .82 min., and 1.11 and 1.21 min. Across conditions, the average time to solve a problem in decentralized networks was 1.89 min. and in centralized networks the average time was 1.90 min. Analysis of variance (Table 10) substantiated that the section of

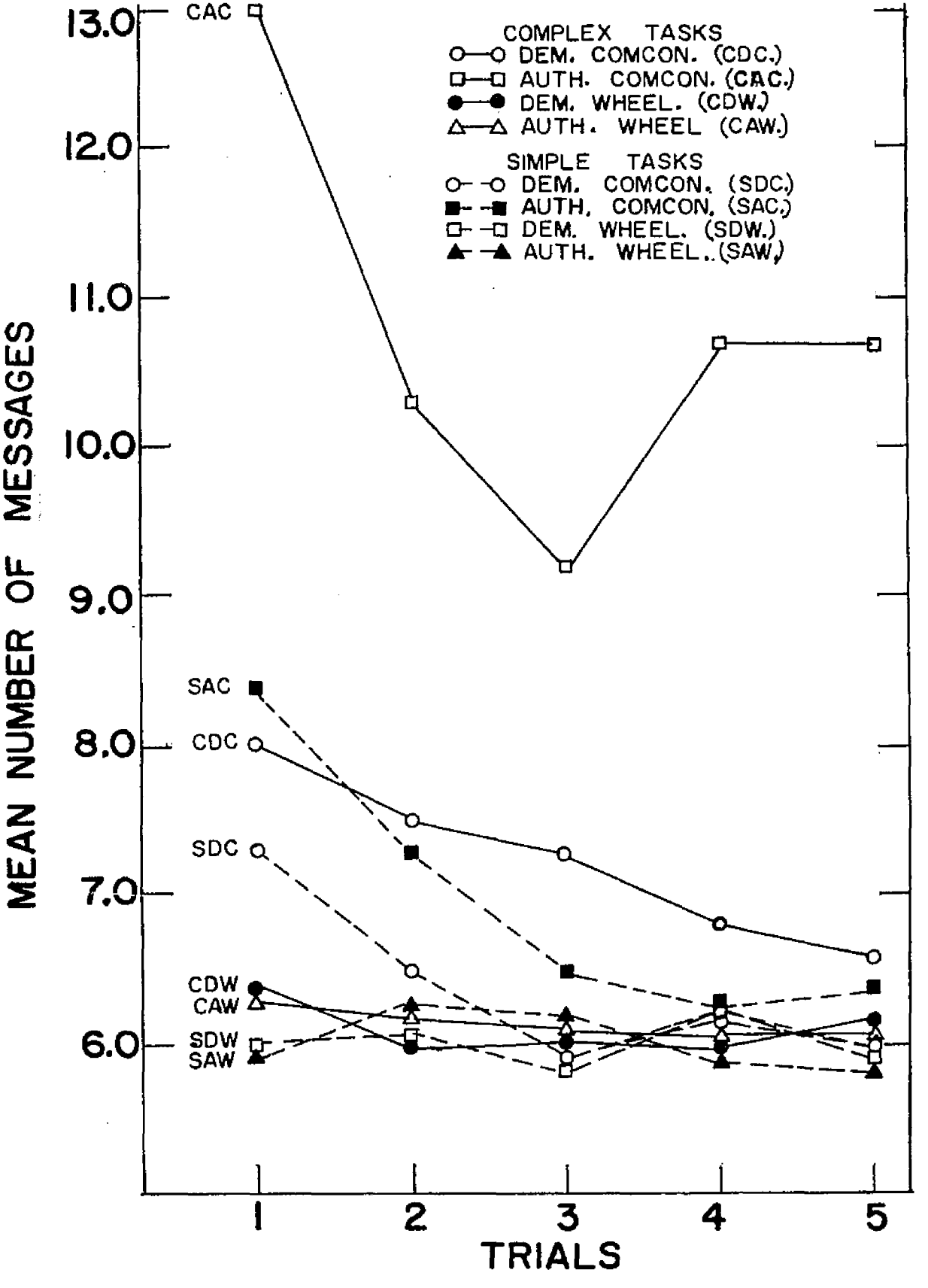

Figure 2. Mean number of messages transmitted per trial.

Hypothesis 4 pertaining to time was not confirmed.

From Figure 2 it can be seen that decentralized groups transmitted more operational messages than centralized groups. This trend was very prominent. The range of mean messages per trial sent by restricted groups was 6.0 to 6.4 while for unrestricted groups the means ranged from 6.0 to 12.9. These results were in accordance with Hypothesis 4.

The findings that decentralized and centralized groups did not differ significantly in time required to solve problems, whereas the former groups transmitted more operational messages than the latter, seem to represent an apparent inconsistency. The relationship between number of communications transmitted and facility in group problem solving can be clarified by an analysis of message content. As already indicated, all groups used centralized problem solving procedures in which six messages were required for task completion. In most cases the groups used only the basic six messages to achieve a solution. However, in some groups additional task related communications were sent between the leader (or task coordinator) and one or more other members. These messages were transmitted to obtain clarification of information, offer suggestions for solving a particular problem, or offer help to the leader. The six basic messages required to solve the problem and any other communications to and from the leader (or task coordinator) will be referred to as the core communication unit.

All messages transmitted in the centralized network during

each trial comprised a core communication unit since the restricted structure precludes communication among members (other than through the leader). Members of groups with decentralized communication networks, on the other hand, transmitted two types of messages. They sent messages that were classified as part of a core communication unit and excess communications which were messages sent among the members who were not solving the problem. Excess messages were problem data and/or communications about the task, the leader, or the experiment in general.

To determine whether experimental conditions differed in number of messages comprising core communication units, excess messages were separated from core units in all decentralized communication groups. The mean number of messages per trial comprising core communication units for decentralized and centralized groups were then compared (Appendix VI). Differences between conditions and between trials were negligible. Apparently, the number of messages transmitted to complete the tasks was not a factor contributing to the efficiency of groups solving the particular problems used in this study.

Hypothesis 4 also predicted a difference in error scores between centralized and decentralized groups. However, an analysis of errors was not undertaken because only 13 out of 1600 possible responses were initially registered incorrectly. The 13 errors were distributed over all conditions. Therefore, error scores will not be considered in tests of the operational performance hypotheses.

Hypothesis 5. The difference in operational performance rates (times, messages, errors) between groups with decentralized communication networks and groups with centralized communication networks was expected to be greater under conditions of high task complexity than under low task complexity. The mean times required for complex and simple problem solving in restricted and unrestricted networks were computed from the results presented in Table 10. A complex problem needed an average of 2.82 min. to be solved in decentralized structures and 2.79 min. in centralized nets. In decentralized networks a simple problem was solved in .96 min. and in restricted nets the same task averaged 1.02 min. The operational time score difference of .03 min. between restricted and unrestricted structures under conditions of high task complexity was less than the .06 min. difference between the two nets under conditions of low task complexity. This trend, although in the direction opposite to our prediction, was not statistically significant (Table 11).

Means of operational messages per trial for groups that solved simple and complex problems in restricted and unrestricted communication networks are presented in Figure 2. It can be seen that the means of number of messages transmitted per trial for complex problems solved in decentralized networks ranged from 6.6-12.9, whereas the message range for these problems solved in centralized patterns was 6.0-6.4. On the other hand, the means of number of messages transmitted per trial for simple problems completed in

unrestricted nets ranged from 6.0-8.4 and the message range for these tasks was 6.0-6.2 in restricted networks. It appears that, as predicted, the difference in number of messages between centralized and decentralized groups was greater under conditions of high task complexity than under low task complexity.

Evidence of the task-network interaction postulated by Hypothesis 5 was found for messages but not for time scores. This discrepancy is a function of excess messages sent in decentralized groups. It previously was pointed out that whereas both centralized and decentralized groups did not vary in the core communication units required to solve simple and complex problems, members of decentralized groups transmitted excess communications that served to fill their free time while the leader (or task coordinator) was working on the problems.

Mean number of excess messages per trial for groups with decentralized communication nets are shown in Figure 3. It is apparent that groups with complex problems sent more excess communications than groups with simple problems. The greater time required in decentralized networks to solve complex problems (average time per trial: 2.82 min.) when compared with simple problems (average time per trial: .96 min.) gave members of groups with relatively difficult tasks more opportunities to transmit excess messages.

Hypothesis 6. Members of groups with decentralized networks were expected to experience greater organizational satisfaction than peripheral members of groups with centralized communication nets.

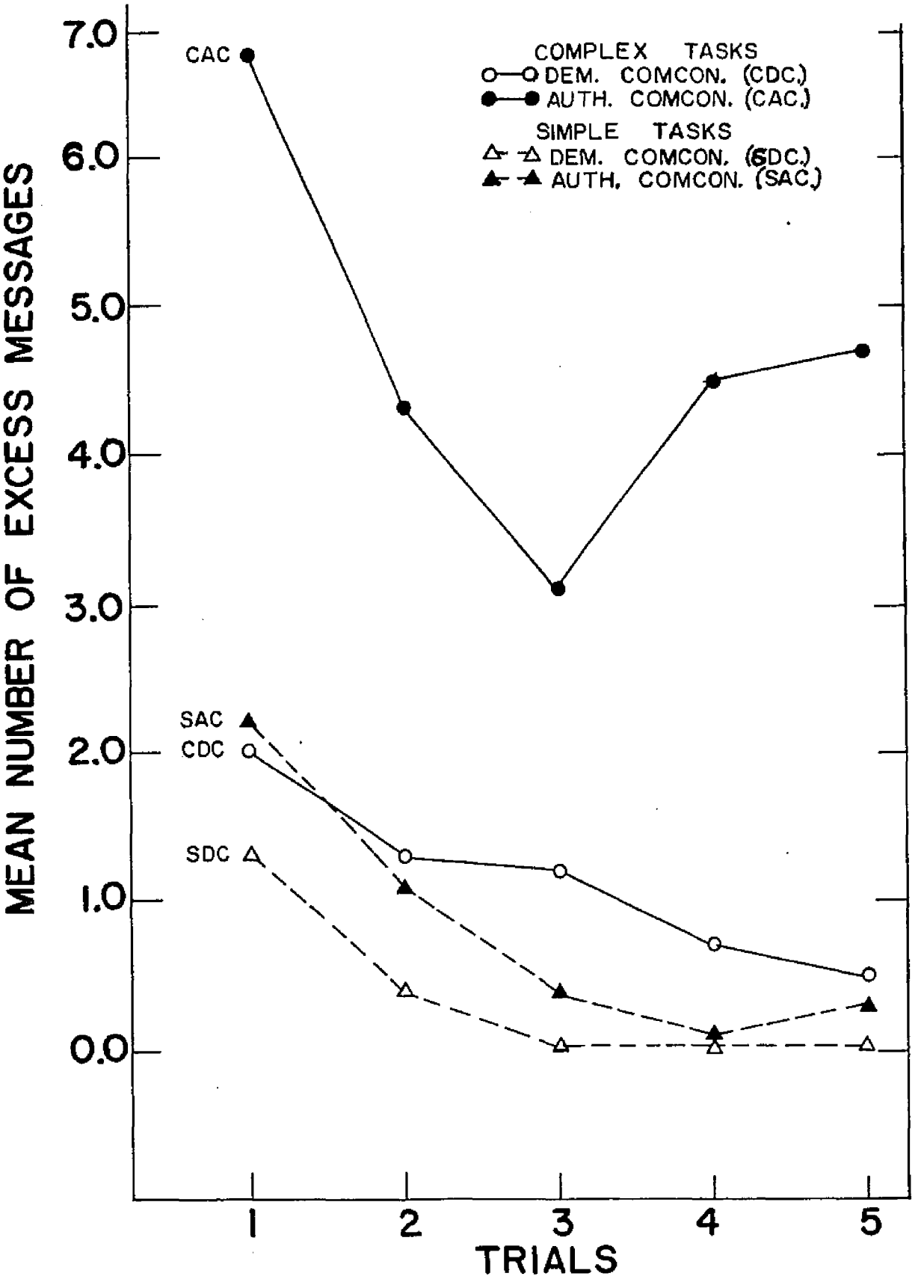

Figure 3. Mean number of excess messages transmitted per trial.

A series of rating scales were used to determine the extent to which members were satisfied with the planning period, the leader and other group members. Scores observed for each item ranged from one on the very dissatisfied end of the scale to nine on the very satisfied end.

Mean ratings of the members' organizational satisfaction are presented in Table 13. Averaging across conditions, it was found that the mean rating of satisfaction with the planning period was 6.19 in decentralized groups as compared with 5.60 in centralized groups;

TABLE 13

MEAN RATINGS OF ORGANIZATIONAL SATISFACTION (GROUP MEMBERS)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
With Planning Period				
Nonauthoritarian	6.67	5.80	7.07	6.57
Authoritarian	5.30	4.93	5.70	5.10
With Leader				
Nonauthoritarian	6.80	6.47	6.83	6.60
Authoritarian	4.53	5.07	5.77	5.57
With Other Group Members				
Nonauthoritarian	7.13	6.40	7.40	6.17
Authoritarian	6.30	5.70	5.70	4.93

the mean rating of satisfaction with the leader was 5.98 in unrestricted nets and 5.93 in restricted structures; and the mean rating of satisfaction with other group members was 6.63 in decentralized networks and

5.80 in centralized nets. Although these results show that members of decentralized groups tended to report greater organizational satisfaction than members of centralized groups, the effect was statistically significant only for ratings of satisfaction with the other group members (Table 14). Hypothesis 6, therefore, was only partially supported.

Hypothesis 7. Members of groups with unrestricted networks also were expected to experience greater operational satisfaction than peripheral members of groups with centralized communication nets. The participants indicated on a series of rating scales the extent to which they liked the problems, the job, the leader and other group members. Observed scores for each item ranged from one (very dissatisfied) to nine (very satisfied).

Table 15 shows the mean ratings of operational satisfaction as reported by group members. When scores were averaged over conditions, the mean ratings of satisfaction were as follows: satisfaction with the problems was 6.36 in decentralized nets and 5.95 in centralized nets, satisfaction with the job was 4.44 (decentralized) and 4.19 (centralized), satisfaction with the leader was 6.62 (decentralized) and 6.41 (centralized), and satisfaction with other group members was 6.54 (decentralized) and 5.90 (centralized). With all aspects of operational satisfaction, members of unrestricted networks reported greater satisfaction than members of restricted structures. However, the Communication Network variable produced a statistically reliable

TABLE 14

SUMMARY OF THE ANALYSES OF VARIANCE OF RATINGS OF ORGANIZATIONAL SATISFACTION (GROUP MEMBERS)

Source	df	Mean Square	F	p
With Planning Period				
Task Complexity (T)	1	33.80	1.84	
Leadership Type (L)	1	288.80	15.69	<.01
Communication Structure (C)	1	61.25	3.32	
T x L	1	4.05		
T x C	1	.20		
L x C	1	1.80		
T x L x C	1	4.05		
Within	72	18.41		
With Leader				
Task Complexity (T)	1	40.61	1.90	
Leadership Type (L)	1	374.11	17.49	<.01
Communication Structure (C)	1	.61		
T x L	1	27.61	1.29	
T x C	1	4.51		
L x C	1	9.11		
T x L x C	1	7.83		
Within	72	21.39		
With Other Group Members				
Task Complexity (T)	1	20.00	1.51	
Leadership Type (L)	1	224.45	16.97	<.01
Communication Structure (C)	1	125.00	9.45	<.01
T x L	1	22.05	1.67	
T x C	1	5.00		
L x C	1	4.05		
T x L x C	1	1.25		
Within	72	13.23		

TABLE 15

MEAN RATINGS OF OPERATIONAL SATISFACTION
(GROUP MEMBERS)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
With Problems				
Nonauthoritarian	6.80	6.47	6.67	6.40
Authoritarian	6.30	5.50	5.67	5.43
With Job				
Nonauthoritarian	5.17	4.87	5.67	5.50
Authoritarian	3.33	3.07	3.60	3.30
With Leader				
Nonauthoritarian	7.20	6.97	7.60	7.23
Authoritarian	5.20	5.67	6.47	5.77
With Other Group Members				
Nonauthoritarian	7.17	6.23	7.17	6.60
Authoritarian	5.90	5.33	5.93	5.43

difference only for ratings of satisfaction with other group members (Table 16). These findings, which parallel the results reported for organizational satisfaction, provided partial confirmation of Hypothesis 7.

B. Leadership-Network Relationship

Hypothesis 8. During the planning period the group leader organized the members to solve the problems. It was predicted that groups with authoritarian control would require less time for planning and transmit fewer messages in the process than groups with

TABLE 16

SUMMARY OF THE ANALYSES OF VARIANCE OF RATINGS OF OPERATIONAL SATISFACTION (GROUP MEMBERS)

Source	df	Mean Square	F	p
With Problems				
Task Complexity (T)	1	9.11		
Leadership Type (L)	1	132.61	8.45	< .01
Communication Structure (C)	1	30.01	1.91	
T x L	1	2.81		
T x C	1	4.51		
L x C	1	2.11		
T x L x C	1	2.83		
Within	72	15.69		
With Job				
Task Complexity (T)	1	30.01	1.14	
Leadership Type (L)	1	702.11	26.55	< .01
Communication Structure (C)	1	12.01		
T x L	1	4.51		
T x C	1	.11		
L x C	1	.11		
T x L x C	1	.32		
Within	72	26.44		
With Leader				
Task Complexity (T)	1	46.51	3.25	
Leadership Type (L)	1	391.61	27.39	< .01
Communication Structure (C)	1	7.81		
T x L	1	5.51		
T x C	1	19.01		
L x C	1	1.51		
T x L x C	1	12.03		
Within	72	14.30		
With Other Group Members				
Task Complexity (T)	1	2.81		
Leadership Type (L)	1	234.61	15.99	< .01
Communication Structure (C)	1	74.11	5.05	< .05
T x L	1	.61		
T x C	1	2.11		
L x C	1	2.11		
T x L x C	1	1.03		
Within	72	14.67		

nonauthoritarian leadership. Examining the mean time scores presented in Table 6, it can be seen that groups with authoritarian leaders organized faster than groups with democratic leaders. When time scores were averaged across conditions, it was found that authoritarian-led groups required 8.88 min. for the planning process as compared with 12.29 min. used by nonauthoritarian-led groups. The difference of 3.41 min. was significant at less than the .01 level (Table 7).

It can be seen in Table 8 that groups with authoritarian leadership also sent fewer messages during the organizational phase. The average number of communications sent by authoritarian-led groups (across conditions) was 20.25 whereas groups with democratic leadership averaged 25.18 messages. This effect was statistically significant at the .01 level (Table 9).

Hypothesis 9. Although groups with authoritarian leaders organized faster than groups with democratic leaders, it was expected that democratic-led groups would perform more efficiently in the operational period (i.e. take less time and make fewer errors) than groups with authoritarian control. However, the democratic-led groups should require more messages to solve the problems than groups working under an authoritarian leader. An examination of the mean time per problem scores presented in Table 10 reveals the apparent efficacy of the democratic method when compared with authoritarian control. Averaging the time scores across conditions, democratic-led

groups used 1.62 min. to solve a problem whereas authoritarian-led groups needed 2.16 min. to complete a task. The difference of .54 min. was found to be statistically significant at less than the .01 level (Table 11).

Contrary to expectations, groups with authoritarian control generally sent more messages than groups with nonauthoritarian leadership (Figure 2). The range of mean number of messages per trial transmitted by the former groups was 6.0-12.9 whereas for the latter groups the range was 6.0-8.0. The content of the messages was used to clarify the meaning of this trend.

As already indicated, the number of messages sent by a group per trial were classified either as part of the core communication unit (the six basic messages and other communications to and from the leader or task coordinator) or as excess communications (messages sent among members who were not solving the problem). Appendix VI shows that differences in mean number of messages per trial comprising core communication units between authoritarian and nonauthoritarian-led groups were negligible. Therefore, the greater number of total messages sent per trial by groups with authoritarian leaders should be attributed to increased interactions among non-solving members rather than to the need for additional essential communications.

Hypothesis 10. Members of democratic-led groups were expected to experience greater organizational satisfaction than members of authoritarian-led groups. Participant ratings of various aspects of

organizational satisfaction ranged from nine (very satisfied) to one (very dissatisfied). The means of these scores are shown in Table 13. Averaged over conditions, satisfaction with the planning period, the leader and other group members were higher in groups with democratic leadership (6.53, 6.68, 6.78) when compared with groups operating with authoritarian control (5.26, 5.24, 5.66). In accordance with our hypothesis, the differences in member satisfaction produced by the two types of leadership were all statistically significant (Table 14).

Hypothesis 11. It was anticipated that members of groups with democratic leadership also would experience greater operational satisfaction than members of groups with authoritarian control. Members indicated their satisfaction on scales that ranged from nine (very satisfied) to one (very dissatisfied). Mean ratings of operational satisfaction are shown in Table 15. Across conditions, average ratings in nonauthoritarian-led groups were as follows: satisfaction with the problems, 6.59; with the job, 5.30; with the leader, 7.25; and with other group members, 6.79. On the other hand, the satisfaction levels were lower in authoritarian-led groups. In these groups the average scores were: satisfaction with the problems, 5.73; with the job, 3.33; with the leader, 5.78; and with other group members, 5.65. As with organizational satisfaction, the Leadership Effect produced statistically significant differences for all aspects of operational satisfaction at less than the .01 level (Table 16).

Hypothesis 12. The difference in organizational performance

(time, messages) between groups with decentralized communication networks and groups with restricted communication patterns was expected to be greater under conditions of authoritarian control than under nonauthoritarian leadership. The findings presented in Table 10 were used to compute the average time required by authoritarian and nonauthoritarian-led groups operating in decentralized or centralized networks to devise a problem solving procedure. The organizational time for democratic-led decentralized groups averaged 12.60 min. whereas democratic-led centralized groups required 11.99 min. for planning. Groups with authoritarian control, on the other hand, needed an average organizational time of 12.07 min. in unrestricted groups and only 5.69 min. in restricted networks. The organizational time score difference of 6.38 min. between decentralized and centalized networks under conditions of authoritarian leadership was significantly greater than the .61 min. difference between the two nets under conditions of democratic leadership (Table 7). Therefore, the section of Hypothesis 12 pertaining to time was supported.

The mean number of organizational messages transmitted by groups with democratic and authoritarian leaders functioning in restricted or unrestricted communication networks were computed from the results shown in Table 8. Democratic-led groups sent an average of 34.50 messages in decentralized structures and 15.85 messages in centralized nets. Groups with authoritarian leaders required an average of 30.40 messages to organize in unrestricted nets and 10.10

messages to organize in restricted structures. The organizational message score difference of 20.30 between restricted and unrestricted networks under conditions of authoritarian leadership was greater than the difference score of 18.65 between the two nets under conditions of democratic leadership. Although this trend was in the predicted direction, it was not statistically significant (Table 9).

Failure to obtain a significant Leadership Type x Network interaction effect for total messages transmitted by the group may be a function of the specific theoretical basis of Hypothesis 12. It was expected that authoritarian leaders would work to structure decentralized communication networks whereas democratic leaders would work to overcome the restrictions of centralized nets. As already shown, the processes of imposing and overcoming restrictions significantly affected group time scores in the predicted direction. However, the leaders' activities may not have been reflected in the total messages since these scores represented not only communications between leaders and members but also communications among members in decentralized networks.

To determine the correctness of our analysis, the communications transmitted by the leader during the organizational period were separated from the messages sent by members. An examination of the content indicated that the activities of the authoritarian leader in decentralized groups were directed at establishing control whereas democratic leaders in restricted nets worked most of the time at

selectively condensing individual contributions and then transmitting these summaries. Authoritarian leaders in restricted nets communicated orders which were met with no or minimum resistance. Democratic leaders of decentralized groups engaged in some summarizing activities but suggested that the members communicate their ideas to everyone.

The means of number of messages transmitted by leaders are reported in Table 17. When conditions were averaged, it was found that authoritarian leaders sent 10.45 messages in decentralized networks and 5.90 messages in centralized structures. Democratic

TABLE 17

MEAN NUMBER OF MESSAGES TRANSMITTED BY LEADERS DURING ORGANIZATIONAL PERIOD

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
Nonauthoritarian	11.00	8.60	9.90	8.50
Authoritarian	10.70	6.30	10.20	5.50

leaders transmitted an average of 10.45 messages in unrestricted networks and 8.55 messages in restricted nets. The message score difference of 4.55 between the networks under conditions of authoritarian control was significantly greater than the difference score of 1.90 between the nets under conditions of nonauthoritarian leadership (Table 18). Clearly, the processes of imposing and overcoming structure are

associated with increased communication requirements for the group leader.

TABLE 18

SUMMARY OF THE ANALYSIS OF VARIANCE OF NUMBER OF MESSAGES TRANSMITTED BY LEADERS DURING ORGANIZATIONAL PERIOD

Source	df	Mean Square	F	p
Task Complexity (T)	1	7.81	1.17	
Leadership Type (L)	1	35.11	5.26	$<.01$
Communication Structure (C)	1	208.01	31.19	$<.01$
T x L	1	.01		
T x C	1	.61		
L x C	1	35.11	5.26	$<.01$
T x L x C	1	2.13		
Within	72	6.67		

Hypothesis 13. It was predicted that the difference in operational performance rates (times, messages, errors) between groups with decentralized communication networks and groups with centralized nets would be greater under conditions of democratic leadership than under authoritarian control. The mean time per problem scores are presented in Table 10. Averaging across conditions, it was found that authoritarian-led groups required 2.15 min. in decentralized structures and 2.17 min. in centralized nets to solve a problem. Operational time for democratic-led decentralized groups averaged 1.62 min. per problem whereas democratic-led restricted groups used 1.63 min. It

is apparent that the time score difference of .01 min. between the two networks under conditions of nonauthoritarian leadership did not differ significantly from the .02 min. difference between the nets under conditions of authoritarian leadership (Table 11).

Although the democratic-led decentralized groups did not perform significantly better than democratic-led centralized groups, the communication structure of the former groups permitted members other than the leader to serve as task coordinator. The six groups (out of 80) in which the leader did not solve the problems were decentralized--five democratic-led decentralized groups that solved complex problems (CDC groups) and one democratic-led decentralized group that solved simple problems (SDC groups). Four of the five CDC groups chose members who were the most proficient in mathematics as the task coordinators. The fifth CDC group selected a rotation procedure which gave each member the opportunity to solve a problem.[2] In the SDC group, the task coordinator was a volunteer. The implications of these findings will be discussed later.

The means of operational messages per trial transmitted in authoritarian and nonauthoritarian-led centralized and decentralized

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[2]The four democratic-led decentralized groups that selected coordinators to solve the complex tasks had a mean time per problem score of 2.17 min. as compared with the mean time score of 2.62 min. computed from the five comparable groups in which the appointed leaders solved the tasks (one group in this condition used a rotation procedure and was not considered in this comparison). The difference between these means was not statistically significant ($t=1.96$, $p > .05$ with 7 d.f.).

groups are shown in Figure 2. It can be seen that the means of number of messages sent per trial for democratic-led unrestricted groups ranged from 6.0-8.0 whereas the message range produced by democratic leadership in centralized groups was 6.0-6.4. The range of the means of messages sent per trial produced by authoritarian-led decentralized groups was 6.1-12.9 whereas the message range yielded by authoritarian control in centralized groups was 6.0-6.3. Contrary to our prediction, these findings indicated that there was a tendency for the difference in number of messages between restricted and unrestricted networks to be greater under conditions of authoritarian control than under democratic leadership.

As already pointed out, however, an analysis of message content showed that variations in number of operational communications among conditions were caused by differences in excess messages transmitted among members in the decentralized groups. From Figure 3, it can be seen that members of authoritarian-led decentralized groups sent more excess messages than members of democratic-led decentralized groups. Although the latter groups consistently solved the tasks faster than the former, the small actual time difference between groups (.77 min. for complex tasks and .30 min. for simple problems) does not seem to account for the large excess message discrepancy (especially for complex problems). This inconsistency will be considered in the discussion section.

Hypothesis 14. It was anticipated that the difference in member

organizational satisfaction between groups with decentralized communication networks and groups with centralized communication structures would be greater under conditions of nonauthoritarian leadership than under authoritarian control. Mean ratings of organizational satisfaction as a function of communication network and leadership type are presented in Table 19. Differences in satisfaction between groups with decentralized and centralized networks were computed from these scores. The satisfaction differences found when the two networks were compared under conditions of nonauthoritarian leadership (satisfaction with planning period, .68; with leader, .28; with other group members, .98) did not differ significantly from the differences between the nets under conditions of authoritarian control (satisfaction with planning period, .48; with leader, .17; with other groups members, .68). Therefore, Hypothesis 14 was not confirmed (Table 14).

TABLE 19

MEAN RATINGS OF ORGANIZATIONAL SATISFACTION AS A FUNCTION OF COMMUNICATION NETWORK AND LEADERSHIP TYPE

Satisfaction	Nonauthoritarian Leadership		Authoritarian Leadership	
	Comcon	Wheel	Comcon	Wheel
With Planning Period	6.87	6.19	5.50	5.02
With Leader	6.82	6.54	5.15	5.32
With Other Group Members	7.27	6.29	6.00	5.32

Hypothesis 15. It also was expected that the difference in member operational satisfaction between groups with decentralized communication networks and groups with centralized networks would be greater under conditions of democratic leadership than under authoritarian control. Table 20 shows the mean ratings of operational satisfaction as a function of communication network and leadership type. Examining these scores, it is apparent that differences in satisfaction between unrestricted and restricted networks under conditions of non-authoritarian leadership (satisfaction with problems, .34; with job, .23; with leader, .30; with other group members, .63) did not differ significantly from the differences between the two nets under conditions of authoritarian control (satisfaction with problems, .42; with job, .28; with leader, .12; with other group members, .54). Paralleling the findings for organizational satisfaction, Hypothesis 15 also was not supported by the data (Table 16).

TABLE 20

MEAN RATINGS OF OPERATIONAL SATISFACTION AS A FUNCTION OF COMMUNICATION NETWORK AND LEADERSHIP TYPE

Satisfaction	Nonauthoritarian Leadership		Authoritarian Leadership	
	Comcon	Wheel	Comcon	Wheel
With Problems	6.78	6.44	5.99	5.47
With Job	5.42	5.19	3.47	3.19
With Leader	7.40	7.10	5.84	5.72
With Other Group Members	7.17	6.42	5.92	5.38

C. Leadership-Task Relationship

Leadership type also was expected to modify the effects of the group task on organizational requirements. It was thought that authoritarian leaders would prepare quickly all groups for problem solving, although planning time would be greater for complex problems than for simple tasks. On the other hand, it could not be stated unequivocally that democratic leaders would take more time to plan for complex problem solving than for simple problem solving. Whereas democratic groups with complex tasks were expected to select a procedure where all members shared the work, democratic groups with simple problems might expend excessive time and messages choosing between procedures which limit member participation and methods in which all individuals participate equally or according to ability.

The mean times and number of messages required by groups with democratic and authoritarian leaders to organize for simple or complex problem solving are presented in Tables 6 and 8. Averaging across conditions, it was found that groups with authoritarian leaders organized in 9.72 min. with 21.40 messages when the problems were complex whereas the planning process required 8.05 min. with 19.10 messages when the problems were simple. Democratic-led groups with complex problems transmitted 27.45 messages in 12.75 min. to plan a procedure whereas democratic-led groups with simple problems used 22.90 messages in 11.84 min. for the organizational period. The results of the analyses of variance showed that there was no interaction effect between Leadership Type and Task Complexity (Tables 7 and 9).

Apparently, the organizational requirements were greater for complex tasks when compared with simple tasks independently of the type of leadership operating in the group.

An analysis of message content can serve to explain this finding. As already noted, it was found that contrary to expectations all groups in all conditions developed centralized problem solving procedures. In 18 of the 20 democratic-led groups with simple problems and in the same number of democratic-led groups with complex tasks, a decentralized method also was considered during the discussion. The form of the organizational discussion, therefore, was similar for democratic-led groups with complex and with simple problems. Since most of the democratic-led groups expended time and messages choosing between a centralized and decentralized method, the greater organizational requirements for complex problems when compared with simple problems can be attributed only to the greater task and communication demands associated with the former problems.

Hypothesis 16. The difference in operational performance rates (times, messages, errors) between groups with authoritarian leadership and groups with nonauthoritarian leadership was expected to be greater under conditions of high task complexity than under low task complexity. When the mean times per problem scores reported in Table 10 were averaged across conditions, it was found that a complex problem was solved in 2.44 min. by groups with democratic leaders whereas this type of task was solved in 3.17 min. by

authoritarian-led groups. For a simple task, democratic-led groups achieved a solution in .82 min. as compared with an average of 1.16 min. per problem required by groups with authoritarian control. As predicted, the time score difference of .73 min. between authoritarian and democratic-led groups under conditions of high task complexity was significantly greater than the .34 min. difference between the groups with democratic and authoritarian leadership under conditions of low task complexity (Table 11).

Figure 2 shows that the mean number of messages sent by groups with complex problems ranged from 6.0-8.0 when the leadership was democratic and 6.0-12.9 when the leadership was authoritarian. The mean number of messages used in the process of solving simple problems ranged from 6.0-7.3 in democratic-led groups and 6.0-8.3 in authoritarian controlled groups. Although there was a tendency for the difference in number of operational messages between democratic and authoritarian-led groups to be greater under conditions of high task complexity than under low task complexity, these data do not support our prediction. Hypothesis 16 was based on the assumption that democratic-led groups would require more messages than authoritarian-led groups for complex problem solving rather than vice-versa.

It previously was pointed out that variations in number of operational messages among conditions were a function of differences in excess communications transmitted among members of decentralized groups. Appendix VI shows that the mean number of messages per trial

comprising core communication units were similar in all conditions. On the other hand, Figure 3 illustrates that the difference between the number of excess messages transmitted by authoritarian-led groups and the number of excess messages sent by democratic-led groups was greater for complex tasks than for simple problems. Therefore, the finding that authoritarian leadership elicited more messages than democratic leadership during complex problem solving can be attributed to the excess messages sent by members who were not performing the arithmetic manipulations necessary for completing the task.

Figure 3 also shows that members of authoritarian groups with complex problems decreased the number of excess messages transmitted in the network from the first to the third trials and then reversed the trend in the fourth and fifth trials. However, the number of excess messages sent by members of groups in the other conditions with decentralized nets tended to decline as the problem solving period progressed.

To determine whether the content of the excess communications varied among the conditions, an analysis of the messages was made. Table 21 presents a summary of the content analysis. The most interesting finding is that only members of authoritarian-led groups with complex problems expressed dissatisfaction with the leader and the procedure. Members communicated such thoughts as: "I don't trust him.", "He is having all the fun.", "He is Louis XIV.", "I don't like the system." In one group, a member suggested an overthrow of the

leader but was discouraged by the other participants. Clearly, the group leader affected the number and type of excess messages transmitted.

TABLE 21

SUMMARY OF EXCESS MESSAGES CONTENT ANALYSIS (DECENTRALIZED GROUPS)

Type of Message	Complex Problems				Simple Problems			
	Non-authoritarian Leadership		Authoritarian Leadership		Non-authoritarian Leadership		Authoritarian Leadership	
Problem Data	39	(6)[a]	134	(9)	12	(4)	32	(4)
Communications Relating to Task (e.g. requests for problem data)	16	(5)	51	(8)	5	(4)	8	(4)
Dissatisfaction with Leader			15	(4)				
Dissatisfaction with Procedure			22	(3)				
Miscellaneous	2	(2)	11	(3)			1	(1)
TOTAL	57	(7)	233	(10)	17	(5)	41	(6)

[a]Figure in parenthesis is the number of groups represented in total. There were 10 groups in each condition.

IV. DISCUSSION

The first objective of this study was to clarify the conflicting findings relating to the extent to which task complexity affects performance in a communication network. This controversy has its roots on the one hand with Shaw's (1954a, 1964) contention that optimum efficiency is achieved by performing simple problems in restricted networks and complex tasks in unrestricted nets and on the other hand with Mulder's (1960) postulation that a centralized decision structure is more effective regardless of the physical characteristics of the network or complexity of the task. However, both formulations erred in not considering the phases which occurred during problem saving.

Guetzkow and Simon's (1955) analysis of group behavior during problem solving in communication structures revealed that previous studies did not allow sufficient opportunities for organizational activities. They suggested that problem solving behavior should not be regarded as unitary. They, therefore, experimentally separated the organizational phase (planning) from the operational phase (working on the task). This manipulation had the effect of changing the environment from one where time pressure inhibited normal planning efforts to one that encouraged the group to organize itself for optimum performance. When we viewed the situation in this new context, it was

apparent that some previous conceptions about behavior in communication networks needed modification while others were no longer adequate.

Although the independence process has a similar effect in the organizational and operational periods, saturation cannot be considered to have the same consequences in both phases of problem solving. In the planning stage the participants have flexibility in controlling the number of messages communicated within the system. If the central member in a restricted network anticipates the possibility of his position becoming bogged down during complex problem planning, he can use methods such as limiting discussion or summarizing to reduce saturation. This behavior may affect subsequent problem solving, but the consequences of a poor procedure may not immediately be evident. On the other hand, when the group is working on the actual task there are essential operations that must be performed. An attempt by any member to reduce saturation created by a complex task through a circumvention of the required steps (e. g. not performing the necessary arithmetic operations) generally would result in an immediate error.

It follows, therefore, that since the central member of a restricted network generally can control saturation during the organizational period, centralized groups will require less time and transmit fewer communications in planning when compared with decentralized groups independently of task complexity. The results of the experiment support this contention. On the other hand, saturation

caused by the communication demands of complex problem solving in restricted networks during the operational period cannot easily be reduced. In addition, high independence in decentralized groups should motivate members to work hard. Since saturation and independence processes do not influence significantly the minimal task and communication demands associated with simple problem solving, the difference in performance between groups with unrestricted networks and groups with restricted structures was expected to be greater under conditions of high task complexity than under low task complexity. It was found, however, that although groups with complex tasks needed more time and sent more messages than groups with simple tasks, the degree of network centrality did not affect performance significantly.

Failure to find a network effect during the operational period can be attributed in part to the similar procedures which were formed by all groups. It was originally thought that decentralized groups would distribute the work involved in complex problem solving among all members. Restricted groups, however, were expected to concentrate the data in the cental position thereby causing network saturation. What actually happened was that both restricted and unrestricted groups formed centralized procedures where all information was transmitted to one individual.

There are a number of co-acting factors which can be given to explain the development of a uniform problem solving method. First, the establishment of a centralized procedure probably was

stimulated by the appointment of leaders for all groups. Perhaps more important were the effects of separating the organizational from the operational phase of problem solving. During the planning period there was time provided for an analysis of the task demands. It seems that participants in unrestricted nets realized it would take less time to send all the information to one person as opposed to rewriting the material three times so that each member would have all the data necessary for solving the problems. Although the complex tasks required more operations than the simple problems, the additional work could be managed by one person without causing a network breakdown. Apparently, the saturation experienced by groups solving complex problems in Shaw's experiments resulted from confusion arising from the confounding of organizational and operational functions.

Independence also was expected to have a differential influence on the performance of complex tasks in communication nets. The freedom of action represented by the open channels in the decentalized networks should have motivated the members functioning in these communication structures to work harder than the participants in the restricted nets. Members of unrestricted groups experienced this freedom during the planning period and used the open channels to transmit excess messages while the leader or task coordinator was working on the problems. However, the structurally determined independence was not sufficiently potent to increase performance to a level

significantly above that found in restricted environments.

The results also indicated that independence did not necessarily cause members of decentralized groups to experience greater satisfaction than peripheral members of restricted groups. In both the planning and operational phases of problem solving statistically significant differences between restricted and unrestricted networks were obtained only in the case of satisfaction with other group members. Apparently, freedom of action did not produce a generalized satisfaction which was transferred to all phases of the problem solving environment. Aspects of the situation such as the leader's behavior, the problems and the job, which were similar in both types of networks, were not perceived as being more satisfying as a function of greater autonomy. However, the networks differed in one important way--decentralized structures permitted communication among all the members whereas in centralized nets the peripheral members were isolated. It seems that individuals who interact during non-controversial problem solving will experience greater liking for each other when compared with participants who contribute information to a coordinator but cannot communicate among themselves.

A number of implications about the task-network relationship can be drawn from the evidence presented so far. However, generalizations from the problems used in this experiment must be limited. Although the arithmetic problems were associated with more task and communication demands than the symbol identification

problems, they differed in degree rather than in kind. Both types of tasks required the collection of information at one location and had only one solution which could be verified without difficulty. Omitted from this study was the class of problems with many solutions; the correctness of each potential solution would not be immediately verifiable (e.g. human relations problems, political issues).

Many of the problems encountered by groups, however, fall into the "routine" category of the tasks used in this study. When the task is relatively simple, a centralized network is adequate for both planning and subsequent problem solving. The findings indicated that the increased time taken to plan a procedure for solving symbol identification tasks in unrestricted structures did not yield a more effective method than the one devised in restricted nets. Groups formulated centralized procedures independently of the type of network. The only advantage that the unrestricted network offered was that mutual liking among the participants was greater in this open system than under conditions where members were isolated from each other.

As the complexity of the problem increases, determining the most favorable communication structure becomes difficult. For problems that require the performance of operations in addition to the routine collection of data in one location, it is probably advantageous to use a decentralized communication system during the planning period. It is too easy for the group leader in restricted networks to

decrease saturation potential by limiting discussion or summarizing the contributions of others. Although this behavior did not prevent centralized groups in the present experiment from devising the same procedure as formulated in decentralized structures, attempts by the central member in a restricted network to reduce saturation may inhibit planning when the task is more complex than arithmetic problems.

The optimum communication structure for the operational phase of complex problem solving will depend on a number of considerations. Though all groups in this study established centralized procedures where one member received data from all others and then performed the required arithmetic operations, it does not follow that the centralized method necessarily should be used in a restricted communication network. This is so because the position in a restricted net that integrates the material and completes the task is vulnerable. As Mulder (1960) suggests, a disturbance in the functioning of the central member will quickly disrupt the group operation. However, whereas Mulder indicates that the potential for this vulnerability is high only at the beginning of the work period, the view taken here is that a central position can become inoperative during any phase of problem solving. It is obvious, therefore, that if a breakdown in the central link occurs, there will be a need to develop a new set of connections among the remaining members. In a restricted environment, establishing these new channels may require much time and effort. A decentralized structure, however, has alternate channels which may

be used to bypass a nonfunctional member.

It also seems that whereas members of groups operating in restricted networks have little control over the potential vulnerability of a member occupying a coordinating position (e.g. replacing a leader who cannot perform the required operations), participants in decentralized systems are aware that a new coordinator may be substituted for an undesirable one. There is some evidence to support this contention. In the present study, five decentralized groups discussed the need to select the most competent member as the task coordinator. In four of these groups it was discovered that participants other than the leader were skillful in solving arithmetic problems. These individuals, rather than the appointed leaders, coordinated the problem solving activities.

A potential disadvantage of the unrestricted network is that it furnishes channels for the transmission of excess messages during routine complex problem solving. In this study, group members prepared and communicated these messages while the leader or coordinator was performing arithmetic operations on the data. Although in similar circumstances other task related responsibilities can be provided to fill the members' time, it will be difficult to eliminate excess messages since an open system encourages their preparation and transmission. Such irrelevant behavior may decrease group productivity if it successfully competes with the task activity for the participants' attention.

The complex problems used in this study, however, were of such a nature that the type of communication network in which they were solved did not seem to affect productivity. Groups in both centralized and decentralized communication systems achieved the same level of performance. As with simple problems, the only advantage that the unrestricted network had over the restricted structure was that it promoted a higher degree of mutual liking among the group members. Generalizing to other complex tasks that require a centralized problem solving procedure, it seems that a decentralized network is needed in the operational period when the characteristics of the problem necessitate protection against a system breakdown. On the other hand, a restricted system may be advantageous in those situations where the transmission of irrelevant communications will inhibit the achievement of optimum group productivity and where the probability is low that the central position will become inoperative.

In light of this new information it is now possible to reconcile the Shaw-Mulder controversy. For simple problems, as the two theories predict, centralization is adequate in both the planning and operational phases of problem solving. On the other hand, Shaw contends that complex problems will be solved more effectively in decentralized nets whereas Mulder indicates that a centralized decision structure is needed in order to solve these tasks with optimum efficiency. Here it is necessary to distinguish between Mulder's decision structure or procedure and Shaw's communication structure.

It seems that Mulder is correct in proposing a centalized procedure for solving the complex tasks used in this study. All groups selected this method; some groups chose this procedure after a careful evaluation of alternatives. Although it may be that a centralized procedure is optimum for the operational phase of all tasks in the category represented by the arithmetic problems, even tasks of a much more complicated nature where many individuals perform various kinds of operations on the data, it is our contention that the organizational period should be sufficiently flexible to allow the group to consider all possibilities before formulating a method. This can be accomplished in the unrestricted communication network as proposed by Shaw.

If a centralized complex problem solving method is developed in the planning period as Mulder would predict, it can be executed during the operational phase in either a restricted or unrestricted network. The structure used will depend on such aspects of the task situation which were not fully considered by Shaw and Mulder as vulnerability of the central position in the restricted net and the transmission of irrelevant communications in the unrestricted net. However, it should be pointed out that if a decentralized procedure is formulated, then an unrestricted net is preferred in the operational period.

The second objective of this research was to determine the extent to which the kind of leadership operating in a group modifies the effects of network and task variables. A part of this aim was to

explain the inconsistency between Shaw's (1955) finding that authoritarian controlled groups performed more efficiently than nonauthoritarian-led groups in the same communication network and the many studies conducted in other settings that reported democratic leadership to be more effective than authoritarianism. The leadership type-communication network relationship was clarified when these variables were examined in the organizational and operational phases of problem solving.

When the phases of problem solving were separated, authoritarian-led groups required less time for planning than democratic-led groups whereas the f mer were less efficient in solving the tasks. Apparently, a combined score of organizational and operational performance as used in Shaw's experiment was not an adequate measure of group effectiveness. It seems that the effect reported in his study represented an artifact of an experimental situation where planning and working on the problems were confounded (i.e. the proportion of time devoted to each of the two phases of problem solving could not be determined from his data).

Although authoritarian methods generally are associated with fewer organizational demands than democratic procedures, the extent of the group's communication requirements are dependent on the type of network in which it is functioning. The communication structure which the authoritarian leader prefers already exists in the restricted net. The characteristics of this network permit an easy introduction

of a centralized problem solving procedure. On the other hand, the authoritarian leader must impose structure on the open-channeled decentralized system. It follows, therefore, that considerable time and effort must be expended to establish authoritarian control when the group has a relatively unrestricted communication network. The results of our study support this assumption. Apparently, authoritarian behavior significantly shortens the planning period only when the communication structure is already restricted.

A democratic leader functioning in a centralized communication network is confronted with an organizational task similar to that of an authoritarian leader in a decentralized net. The type of network which is most suitable for democratic activities is an unrestricted system. In order to establish a nonauthoritarian process in a centralized net, much work is required to overcome structural restrictions, However, as the democratic leader attempts to increase participation for peripheral group members, he increases the probability of saturating his own position. The results indicated that in order to avoid a system breakdown that would occur if original messages were transcribed and relayed, the leader selectively condensed the messages from other members and then transmitted these summaries. It will be shown in the course of the discussion that the nonauthoritarian leader's organizational behavior in restricted nets, although limiting the free flow of information, did not prevent the establishment of a democratic atmosphere.

As stated previously, it was found that democratic-led groups solved the problems more efficiently than groups with authoritarian

control. It was hypothesized that this difference would be a function of (1) the efficient decentralized problem solving procedure that would be devised by democratic-led groups during the planning period as opposed to the inhibiting centralized method formed by authoritarian leaders, (2) the tendency for work to be distributed equally or according to ability in the democratic-led groups when compared with authoritarian-led groups where data are concentrated in one position, and (3) the need by members of democratic-led groups to work hard to implement the shared procedure to whose selection they contributed as contrasted with the minimal effort exerted by members of authoritarian-led groups who have no commitment to the imposed method. However, the factors attributed to democratic-led groups should operate at an optimum only in decentalized groups. Non-authoritarian leadership should have difficulty overcoming the barriers in a relatively restricted system. Therefore, democratic leadership was expected to achieve better group performance in decentralized networks relative to centralized nets.

The results showed, however, that democratic-led groups performed more efficiently than authoritarian-led groups independently of the degree of network centrality. This finding is explained by the failure of two of the anticipated determining factors to operate in the groups. It was anticipated that democratic leadership would lead to the formation of decentralized problem solving procedures in unrestricted networks and to limited decentralized methods in restricted

nets. On the other hand, authoritarian-led groups were expected to develop centralized operational procedures. As already noted, however, all groups in all conditions formed centralized problem solving methods. Apparently, democratic-led groups in both the restricted and unrestricted situations decided that the problems were of such a nature that it would be more efficient to limit group participation in favor of cental coordination.

It also was thought that the distribution of work equally or according to ability would contribute to superior performance in democratic-led decentralized groups. In six of the twenty unrestricted groups with nonauthoritarian leadership, a participant other than the leader was chosen as the task coordinator. Four of these coordinators were selected because of their proficiency in executing operations required by the task. However, the results showed that the performance of these members did not increase average efficiency of the democratic-led decentralized groups to a point significantly above the effectiveness level achieved by democratic-led centralized groups. That not all democratic-led decentralized groups considered selecting the most competent individual as task coordinator or the possibility that those who were chosen as coordinators did not have significantly better skills than the leaders selected at random probably account for this finding.

The results showed that nonauthoritarian-led groups did not develop decentralized problem solving procedures where work was

distributed equally or according to ability. Since all groups used a centralized problem solving procedure and all information was channeled to the leader or task coordinator, the speed with which information was sent to the central position and the speed with which each member pressed the switch upon receipt of the correct answer seems to be the only factor that could account for the leadership effect.

The operational behavior of members in different leadership conditions appears to be a function of the process used to develop the problem solving procedure during the organizational period. In democratic-led groups the members chose a centralized procedure whereas in authoritarian-led groups the centralized method was imposed. Members of democratic-led groups were motivated to work hard by a need to implement the procedure to whose selection they contributed whereas members of authoritarian-led groups had no commitment to the method. A commitment to implement the procedure caused members of democratic groups to send their information to the leader and report the correct answer significantly faster than members of authoritarian-led groups. It also should be pointed out that since democratic-led decentralized groups did not perform better than democratic-led centralized groups, the organizational process in the latter groups, where the free flow of information was limited, did not prevent members from developing an operational method to which they were committed.

One also might argue, however, that a difference in problem

solving competence between democratic and authoritarian leaders or task coordinators would explain the observed leadership effect. The skill of the leaders or coordinators did not contribute to differences in operational effectiveness between conditions for two reasons. First, since leaders were selected randomly, the problem solving aptitudes of these participants should be distributed normally in each of the conditions. Second, it was found that when members other than the leader were selected to solve the problems, the performance of their groups were not significantly better than comparable groups where the leader served as coordinator.

Members of democratic-led groups were more satisfied with all aspects of the organizational and operational phases of problem solving when compared with members functioning under authoritarian control. The freedom to determine the problem solving procedure which was experienced by members of democratic-led groups on the one hand and the subjection to control experienced by members of authoritarian-led groups on the other hand seems to explain the difference in organizational satisfaction.

Degree of satisfaction in the operational period is probably a function of both the planning process in the organizational period and experiences in the actual task situation. In the problem solving period, democratic-led groups were given the opportunity to put the procedure that theydeveloped into effect. Since errors were seldom made and the groups did not have information relating their performance to a

standard, it can be assumed that members perceived that they were performing well rather than poorly. Therefore, members of democratic-led groups received satisfaction from the knowledge that they successfully implemented their procedure. On the other hand, members of authoritarian-led groups were required to carry out an imposed problem solving procedure. Although members serving under authoritarian leaders may also have perceived that they were doing well since their groups seldom made errors, it appears that satisfaction is greater when the individual experiences the success of his own decision rather than when he most vicariously experience the success of another person's judgment.

It was expected, however, that the leadership effect on satisfaction would be modified in both the organizational and operational phases of problem solving by the degree of communication network centrality. The authoritarian leader reduces considerably the potential level of independence for members of unrestricted groups by imposing centralization, but movement to the levels found in restricted groups may be prevented by the presence of open channels which are sources of freedom. On the other hand, members of unrestricted democratic-led groups should experience significantly greater satisfaction than members of democratic-led groups with restricted nets since the type of system which the nonauthoritarian leader prefers, one where there is a free flow of information and everyone has opportunities for freedom of action, is enhanced by decentralization and impeded by centralization.

Contrary to our prediction, the results showed that members of democratic-led groups were more satisfied than members of groups with authoritarian control in both phases of problem solving independently of the type of network in which they were working. It seems that the method used by democratic leaders to overcome structural barriers in centralized nets (i. e. selective summarization of individual contributions) did not prevent the members from experiencing freedom of action. Since both restricted and unrestricted democratic-led groups selected a centralized problem solving procedure, degree of member operational satisfaction was influenced by the same factor in all of these groups (i. e. the satisfying experience of bringing the procedure to successful fruition).

The experiment also was concerned with determining the degree to which leadership modifies the effects of the group task on organizational and operational performance. The results showed that planning requirements were greater for complex tasks than for simple tasks independently of the type of group leadership. Although no formal prediction was made, it was suggested that democratic-led groups with simple problems might require more organizational time and messages when compared with democratic-led groups with complex tasks if the former expended excessive time and messages choosing between a centralized or decentralized procedure; the latter groups were expected only to consider procedures where the work is distributed equally or according to ability. However, <u>all</u> democratic-led groups selected centralized

procedures and ninety per cent of these groups also considered a decentralized procedure in the course of planning. Since the form of the planning discussion in democratic-led groups was similar for both complex and simple problems, the greater task and communication demands associated with the former problems when contrasted with the latter problems was the factor that determined the observed difference in organizational performance between tasks.

As predicted, the difference in operational performance between groups with authoritarian leadership and groups with nonauthoritarian leadership was greater under conditions of high task complexity than under low task complexity. Achieving solutions to complex tasks was expected to be negatively affected in authoritarian-led groups by both the network saturation resulting from the centralized procedure dictated by the leader and the members' lack of commitment to the method. Effectiveness would be positively influenced in democratic-led groups by both the shared decentralized procedure and the members' motivation to work hard to implement the method to whose selection they contributed. Since all groups used a centralized problem solving procedure, the difference in performance found between democratic and authoritarian-led groups with complex tasks is attributed to the greater speed with which the members of the former groups worked. Simple problem solving in democratic-led groups was not influenced significantly by increased work effort because of the minimal demands associated with these tasks.

Leadership also influenced the number of excess messages sent

by groups in unrestricted communication nets. Although members of authoritarian-led groups sent more irrelevant messages than participants in democratic-led groups, the difference was greater for complex tasks than for simple tasks. Since excess messages were transmitted while the leader or coordinator was solving the tasks, the greater time required to complete complex problems when compared with simple problems gave members of groups with the former tasks more opportunities to send irrelevant communications.

In addition to sending the most excess messages, members of decentralized authoritarian-led groups with complex problems were the only participants exchanging communications which expressed dissatisfaction with the leader and procedure. For example, a member of one group requested support for a proposed seizure of control but was discouraged by the other participants. It seems that the activities of members in these groups were a reaction to the frustration experienced in both phases of problem solving. Their organizational period consisted of being subjected to an uncompromising leader who dictated a centralized task procedure. In the operational period they were forced to accept the answer given by the authoritarian leader. As Shaw (1964) reported, it is easier to accept another person's solution when the problem is simple than when it is complex.

The results of this study indicate that the communication structure modifies the effects of task and leadership variables on group performance and satisfaction. The experiment also shows that it is

necessary to distinguish between degree of network centrality and degree of procedure centrality; the degrees of centrality of the communication structure and the method may or may not be similar. A synthesis of the findings leads to some general conclusions about the relationships between network structure and other variables in the organizational and operational phases of problem solving and also suggests research problems for further exploration.

When it is feasible to control the problem solving situation, the group should plan a strategy for completing the task during a formal organizational period. Separating problem solving into organizational and operational phases has the advantage of reducing the pressure that individuals may feel to begin work immediately on the task. It seems that the most efficient procedure is developed when the participants have sufficient opportunities to consider all task and situational requirements. The present study showed that the network saturation which occurred in previous experiments where complex problems were solved in restricted communication structures (e. g. Shaw, 1954a) could be neutralized by effective planning.

The type of leadership that is most effective during the planning period encourages the members to develop an efficient procedure that they are committed to implement. Democratic leadership can be practiced in both centralized and decentralized communication systems. However, the form that the behavior takes varies as a function of network centrality. When the communication structure is restricted, the

democratic leader selectively condenses individual contributions and transmits these summaries to the members. Although this behavior tends both to control network saturation and limit the free flow of information, it does not prevent the group from making a decision. On the other hand, a democratic leader in an unrestricted network promotes an open dialogue among the participants while acting as coordinator only at critical points in the discussion. The most appropriate communication network and associated mode of democratic leadership in a given situation is a function of the problem requirements.

Effective planning for problems with minimal task and communication demands is accomplished by a democratic leader operating in a restricted network. Although democratic organizational requirements for simple tasks are generally not greater in decentralized nets when compared with centralized structures, the latter is preferred for two reasons. First, the unrestricted net does not enhance the planning process for these problems. Since simple tasks are not likely to cause network saturation, the only potential advantage that a decentralized network offers is greater structural independence. However, structural independence in the organizational phase of simple problem solving does not lead to the development of a more efficient procedure or greater general satisfaction when compared with restricted situations.

The second reason for suggesting a restricted planning environment for simple tasks is related to the operational procedure and the communication network in which this method is executed. It is assumed

that the group will develop a centralized procedure for solving simple tasks during the organizational process. Therefore, a decentralized communication system is not needed in the operational period because increased structural independence is not associated with more efficient simple problem solving and there is low probability that the minimal task demands will lead to network saturation. On the other hand, the restricted network will reduce the possibility of members communicating irrelevant messages that may cause a decrease in productivity. Since simple tasks should be solved in a centralized communication net, it would be hazardous to use a decentralized network for planning. Cohen, Bennis and Wolkon (1962) found a significant decrease in member satisfaction when groups were shifted from an unrestricted to restricted network.

Although democratic leadership is suggested for simple problem solving, it should be noted that in the present study this form of behavior did not produce a superior procedure or lead to significantly better group performance when compared with authoritarian control. On the contrary, the democratic-led groups required more time and communications than authoritarian-led groups during the organizational period. However, members of the former groups were significantly more satisfied with all aspects of problem solving than members of the latter groups. To the extent that satisfaction is related to performance and other components of the work period, productivity may be influenced by satisfaction in a work period of greater duration than that used in this experiment. It

would be interesting to determine whether there is a decrease in group productivity over time as a function of authoritarian leadership.

When the task requires the performance of operations more complex than collecting data at one location, democratic planning should be accomplished most effectively in an unrestricted communication system. Although in this study the unrestricted network did not facilitate the development of a more efficient procedure than the one formulated in the centralized structure, the leader in a restricted net may not be able to maintain a democratic environment when the task is more complex than arithmetic problems. It is expected that as the saturation potential increases for the central position of the restricted net, the leader will be required to protect his position by reducing the degree to which the members influence decision making. On the other hand, the unrestricted not not only permits the continuation of optimum group participation with increasing task complexity, but also encourages the development of a procedure where work is distributed according to ability. Such division of responsibility may not lead to more efficient performance (e.g. in the present experiment democratic-led groups that chose task coordinators did not perform significantly better than democratic-led groups in which the appointed leader solved the problems), but it seems that the potential for reassignment of work can reduce the probability of a decrease in group productivity.

The task and communication requirements generally determine the type of procedure that is developed for solving complex problems.

A decentralized procedure requires an unrestricted communication system whereas a centralized procedure can be put into operation in either a restricted or unrestricted communication net. If the central position in the centralized procedural arrangement is vulnerable, a decentralized communication system is preferred. On the other hand, a restricted structure should be used if there is low probability of a procedural breakdown and it is thought that the communication of excess messages among the members will cause a decrease in productivity. However, shifting from a decentralized planning method to a centralized operational communication system may cause a significant decrease in member satisfaction (Cohen et al., 1962).

In the present study democratic-led groups in both centralized and decentralized nets derived only centralized procedures for solving complex problems. Furthermore, network centrality did not influence the efficiency with which these groups completed the tasks. Research is needed to determine (1) the type of methods that are formulated by democratic-led groups in various communication networks for solving tasks with requirements more demanding than the performance of arithmetic operations, and (2) the effectiveness of the procedures that are developed for these problems.

One of the assumptions of this thesis is that authoritarian behavior generally does not lead to maximum group effectiveness. Under certain circumstances where response time is at a minimum (e.g. during an emergency) the leader may consider it necessary to limit member

participation in decision making. The results of this study provide some evidence that the effects of this behavior will be a function of network centrality and task complexity. Control is easily instituted in a restricted communication structure. On the other hand, when the net is decentralized the leader who dictates a procedure may have to overcome resistance. It was found that in a decentralized network, the time and communication requirements for introducing organizational control did not differ from the requirements for implementing the democratic process. Furthermore, whereas simple problem solving was not affected significantly by type of leadership, complex tasks were solved more efficiently in groups with democratic leadership when compared with groups with authoritarian control. This analysis shows that with increasing problem complexity and decreasing communication restrictions, the probability that authoritarian behavior will succeed decreases. Therefore, the use of authoritarian behavior for the purpose of achieving a quick reaction to a relatively complex situation will be counter-productive. Admittedly, the data from which we are generalizing was not obtained from a situation where individuals were required to take immediate action. It will be necessary to determine whether effects similar to those found in the present study are obtained when an authoritarian leader organizes a group in an emergency situation.

As we continued further in our generalizations, the tendency was to describe the ideal where the problem solving situation is controlled.

In many instances, however, the communication system is fixed and the problem solving procedure must be implemented within the limits of the structure. For example, a decentralized problem solving procedure developed for a complex task may have to be modified for a centralized communication network. What emerges most clearly from this study, however, is the minimal importance of static communication structure when compared with the dynamic nature of leadership behavior. The potential or lack of potential for saturation and independence in a given communication network are not the primary factors determining group effectiveness. Performance and satisfaction are a function of the independence and saturation that are experienced by the members, and the experiences of the members are directly related to the leader's behavior in all phases of problem solving. A democratic leader can reduce the saturation potential of a centralized communication net while increasing independence for members working in this system. On the other hand, an authoritarian leader can reduce freedom of action for participants in an unrestricted structure and at the same time increase the probability of network saturation. Although the communication network may define the limits within which the group must work, the leadership has considerable leeway in maximizing or minimizing the positive and negative aspects of a given communication structure.

V. SUMMARY

This study focused on the extent to which communication structure modifies the effects of task and leadership variables on group performance and satisfaction. Within this framework the major issues of communication network research were explored. In one controversy, Shaw contends that optimum efficiency is achieved by performing simple problems in restricted networks and complex tasks in unrestricted nets, whereas Mulder postulates that a centralized decision structure is more effective regardless of network type or task complexity. A second problem was the inconsistency between Shaw's finding that authoritarian-led groups performed more efficiently than nonauthoritarian-led groups in the same network and the many experiments conducted in different settings that reported democratic leadership to be more effective than authoritarianism. It was indicated that a better understanding of the relationship between communication structure and other variables can be gained by examining them in both the organizational and operational phases of problem solving.

The investigation used a 2x2x2 factorial design involving two kinds of communication structure (relatively unrestricted or decentralized and relatively restricted or centralized), two types of tasks (complex and simple) and two types of leadership (authoritarian and

nonauthoritarian). In phase one of each experimental session the leader organized the participants (organizational period); in phase two the groups solved the problems (operational period).

In the organizational period centralized groups required less time and transmitted fewer messages when compared with decentralized groups. In the operational period, however, network centrality did not have a significant effect on performance. The latter finding was attributed to the centralized procedure formed by all groups. For complex problems, the open channels in the unrestricted net not only served as protection against vulnerability in a coordinating position but also encouraged the preparation and transmission of excess messages.

These results suggest a possible reconciliation of the Shaw-Mulder controversy. For simple problems, centralization is adequate in both phases of problem solving. Considering complex tasks, it is necessary to distinguish between Mulder's decision structure or procedure and Shaw's communication structure. Although the data showed that Mulder is correct in proposing a centralized operational procedure for solving the complex tasks used in this study, only the decentralized network as proposed by Shaw permits the organizational flexibility necessary for the group to consider all possibilities before formulating a method. A centralized complex problem solving method can be implemented during the operational phase in either a restricted or unrestricted network depending on vulnerability of the central position in the former and the transmission of excess communications in the latter.

Authoritarian-led groups required less time for planning than democratic-led groups, whereas the former were less efficient in solving the tasks. It was suggested that a combined score of organizational and operational performance as used in Shaw's experiment was not an adequate measure of group effectiveness.

The difference in organizational requirements between groups with decentralized nets and groups with centralized nets was greater under conditions of authoritarian control than under democratic leadership. In the operational period, the difference in performance between groups with authoritarian leadership and groups with nonauthoritarian leadership was greater under conditions of high task complexity than under low task complexity. Members of democratic-led groups were more satisfied than members of authoritarian-led groups in both phases of problem solving.

Based on these findings democratic leadership behavior is recommended for both simple and complex problem solving situations. The organizational and operational phases of simple problem solving can be accomplished effectively in a restricted communication network. For complex problem solving, planning should be conducted in an unrestricted communication system. A decentralized procedure for solving complex tasks requires an unrestricted network whereas a centralized procedure can be implemented in either a restricted or unrestricted net.

APPENDIX

APPENDIX I

ESTABLISHING THE LEADERSHIP MANIPULATION

(Analysis of Preliminary Data)

Table 1

INTERCORRELATIONS OF LEADER BEHAVIOR SCALES (Members N = 144)
(Preliminary Study)

Scale	2	3	4
1	.39*	.41*	.45*
2		.31*	.35*
3			.43*

*$p < .01$

Table 2

MEAN RATINGS OF LEADER BEHAVIOR
(Preliminary Study)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
Nonauthoritarian	26.72	25.72	28.11	28.50
Authoritarian	17.17	17.56	18.00	17.89

Table 3

SUMMARY OF THE ANALYSIS OF VARIANCE OF MEMBER RATINGS OF LEADER BEHAVIOR
(Preliminary Study)

Source	df	Mean Square	F	p
Task Complexity (T)	1	192.00	1.10	
Leadership Type (L)	1	9976.33	56.95	$< .01$
Communication Structure (C)	1	.75		
T x L	1	60.75		
T x C	1	4.08		
L x C	1	4.08		
T x L x C	1	26.59		
Within	40	175.17		

Table 4

MEAN RATINGS OF ORGANIZATIONAL SATISFACTION
(LEADER)
(Preliminary Study)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
With Planning Period				
Nonauthoritarian	6.17	6.83	5.50	6.50
Authoritarian	7.67	6.17	6.17	5.83
With Leader (Self)				
Nonauthoritarian	8.33	8.17	6.67	7.83
Authoritarian	8.33	8.17	7.00	6.83
With Other Group Members				
Nonauthoritarian	8.00	7.17	6.83	7.50
Authoritarian	6.50	6.67	7.67	8.00

Table 5

MEAN RATINGS OF OPERATIONAL SATISFACTION
(LEADER)
(Preliminary Study)

Leadership Type	Complex Problems		Simple Problems	
	Comcon	Wheel	Comcon	Wheel
With Problems				
Nonauthoritarian	6.17	5.50	8.00	5.83
Authoritarian	6.67	7.33	6.17	5.17
With Job				
Nonauthoritarian	7.17	8.33	6.33	8.33
Authoritarian	7.50	7.00	7.67	7.17
With Leader (Self)				
Nonauthoritarian	7.00	7.50	6.83	8.33
Authoritarian	8.83	8.00	8.17	7.67
With Other Group Members				
Nonauthoritarian	7.50	6.83	7.83	8.17
Authoritarian	7.83	6.83	7.83	8.17

Table 6

SUMMARY OF THE ANALYSES OF VARIANCE OF RATINGS OF ORGANIZATIONAL SATISFACTION (LEADER)
(Preliminary Study)

Source	df	Mean Square	F	p
With Planning Period				
Task Complexity (T)	1	6.02		
Leadership Type (L)	1	.52		
Communication Structure (C)	1	.02		
T x L	1	.52		
T x C	1	1.69		
L x C	1	9.19	1.29	
T x L x C	1	.52		
Within	40	7.11		
With Leader (Self)				
Task Complexity (T)	1	16.33	3.86	
Leadership Type (L)	1	.33		
Communication Structure (C)	1	.33		
T x L	1	.33		
T x C	1	1.33		
L x C	1	.02		
T x L x C	1	2.67		
Within	40	4.23		
With Other Group Members				
Task Complexity (T)	1	2.08		
Leadership Type (L)	1	.33		
Communication Structure (C)	1	.08		
T x L	1	8.33	2.46	
T x C	1	2.08		
L x C	1	.33		
T x L x C	1	1.36		
Within	40	3.38		

Table 7

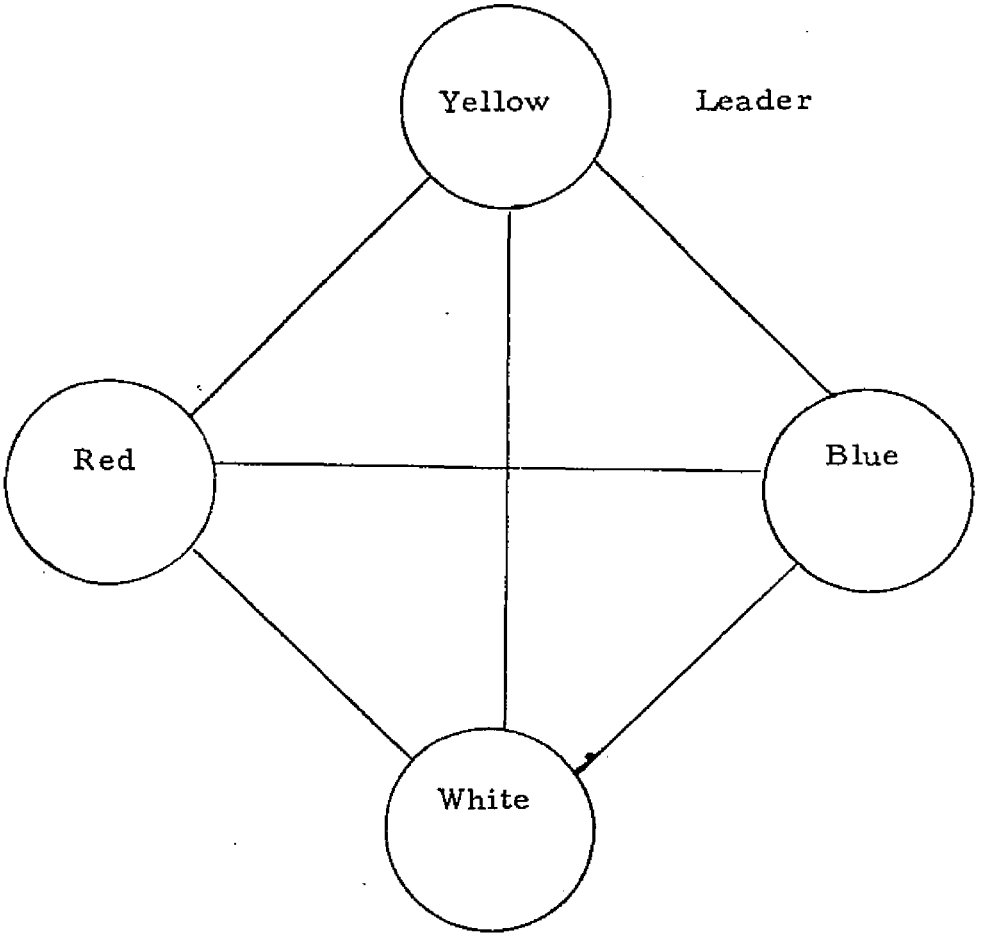
SUMMARY OF THE ANALYSES OF VARIANCE OF RATINGS OF OPERATIONAL SATISFACTION (LEADER)
(Preliminary Study)

Source	df	Mean Square	F	p
With Problems				
Task Complexity (T)	1	.19		
Leadership Type (L)	1	.02		
Communication Structure (C)	1	7.52	1.62	
T x L	1	17.52	3.78	
T x C	1	7.52	1.62	
L x C	1	4.69	1.01	
T x L x C	1	.02		
Within	40	4.64		
With Job				
Task Complexity (T)	1	.19		
Leadership Type (L)	1	.52		
Communication Structure (C)	1	3.52		
T x L	1	1.02		
T x C	1	.52		
L x C	1	13.02	2.18	
T x L x C	1	.52		
Within	40	5.96		
With Leader (Self)				
Task Complexity (T)	1	.08		
Leadership Type (L)	1	6.75	2.27	
Communication Structure (C)	1	.33		
T x L	1	2.08		
T x C	1	1.33		
L x C	1	8.20	2.76	
T x L x C	1	.48		
Within	40	2.97		
With Other Group Members				
Task Complexity (T)	1	6.75	2.19	
Leadership Type (L)	1	.08		
Communication Structure (C)	1	.75		
T x L	1	.08		
T x C	1	4.08	1.32	
L x C	1	.08		
T x L x C	1	.10		
Within	40	3.08		

APPENDIX II

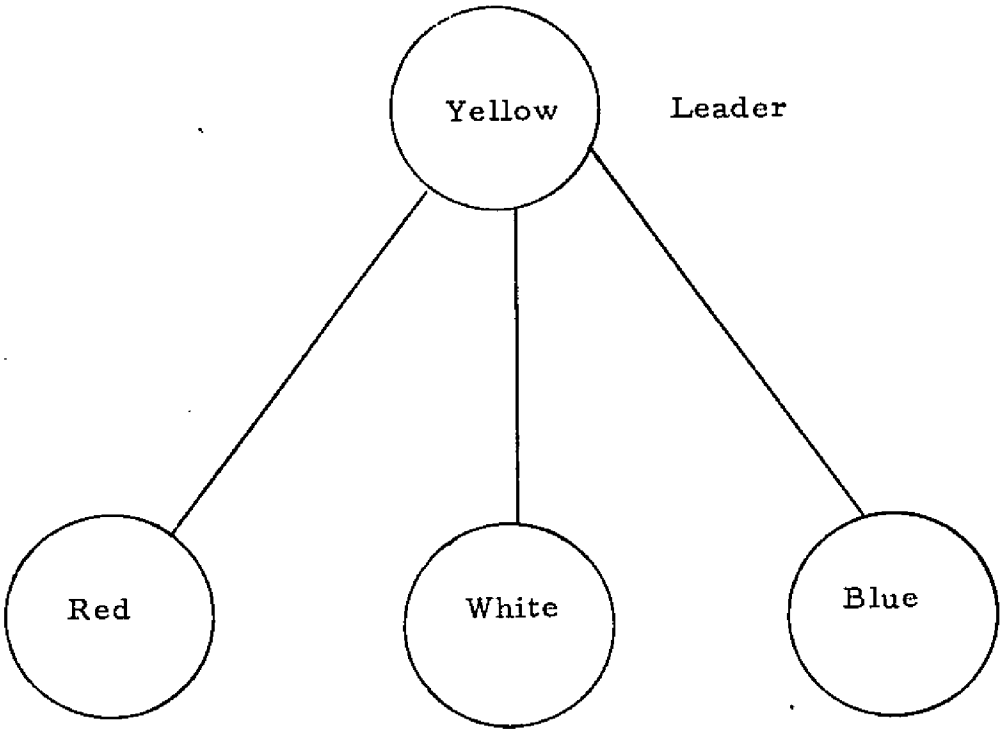
WALL CHARTS DISPLACED IN BOOTHS

A. Comcon Wall Chart



___ Communication Channels

B. Wheel Wall Chart

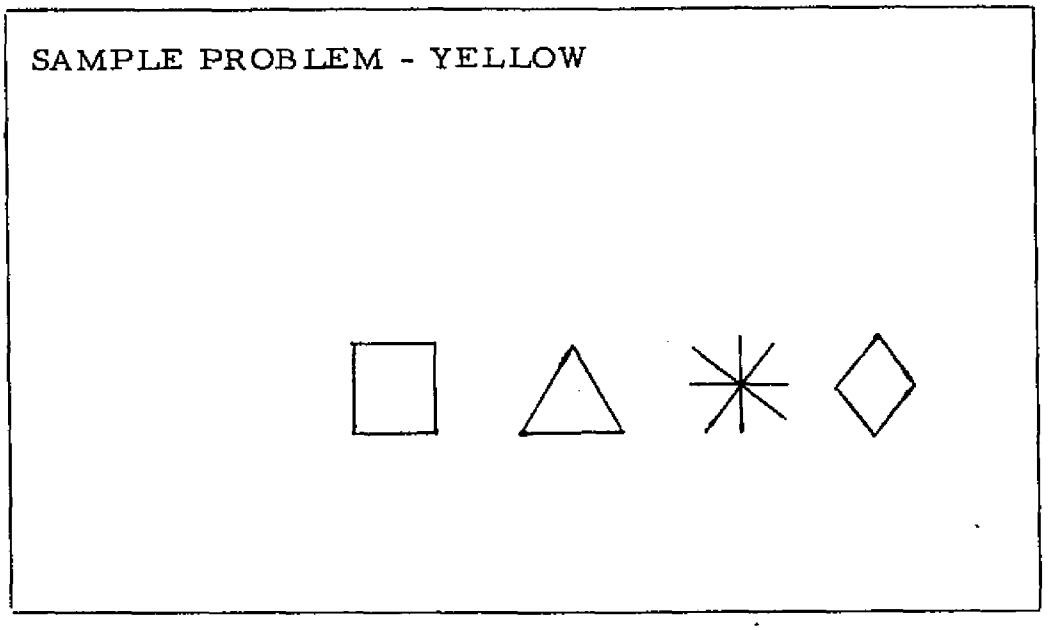


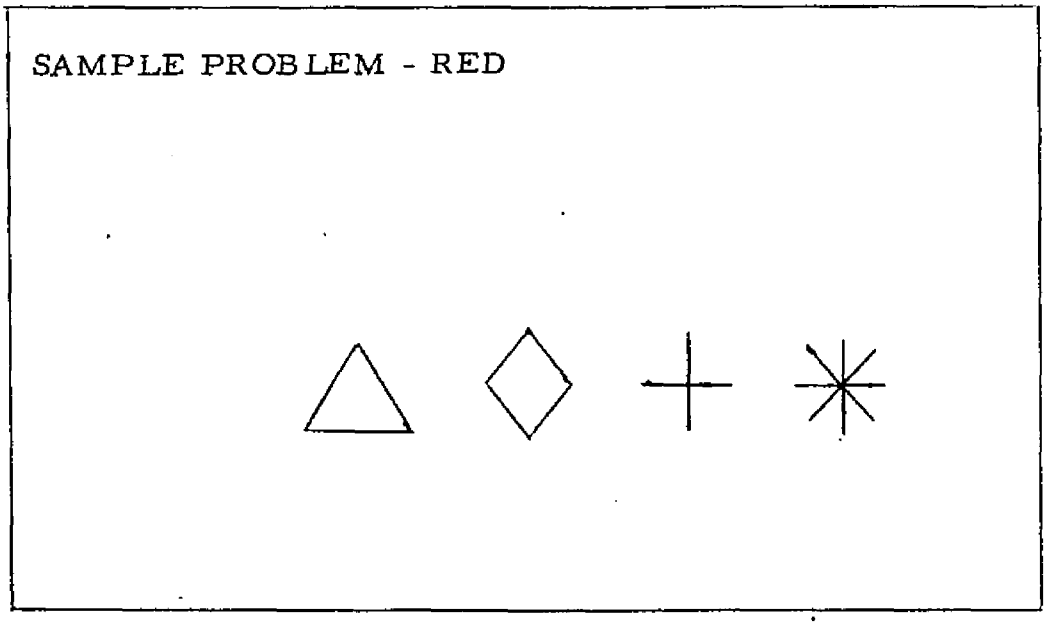
____ Communication Channels

APPENDIX III

SAMPLE PROBLEM CARDS

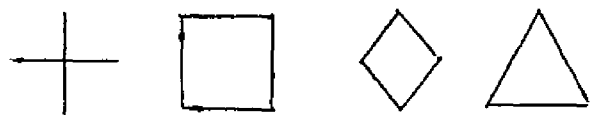
A. Simple Problem



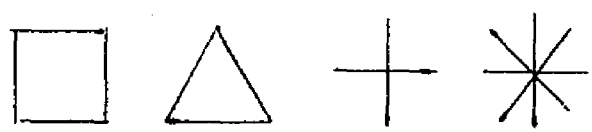


A. Simple Problem (continued)

SAMPLE PROBLEM - WHITE



SAMPLE PROBLEM - BLUE



B. Complex Problem

SAMPLE PROBLEM - YELLOW

A furniture manufacturer is interested in determining the total number of items he can produce in one day. What is the total?
Each member of the group has a different set of information. All the information is needed to solve the problem. Your information is:

Five men work in the desk department.
Each man in the chair department can produce seven chairs per day.

A) 87 B) 96 C) 102 D) 98 E) 94

SAMPLE PROBLEM - RED

A furniture manufacturer is interested in determining the total number of items he can produce in one day. What is the total?
Each member of the group has a different set of information. All the information is needed to solve the problem. Your information is:

Ten men work in the chair department.
Each man in the bookcase department can produce one bookcase per day.

A) 87 B) 96 C) 102 D) 98 E) 94

B. Complex Problem (continued)

SAMPLE PROBLEM - WHITE

A furniture manufacturer is interested in determining the total number of items he can produce in one day. What is the total?
Each member of the group has a different set of information. All the information is needed to solve the problem. Your information is:

Two men work in the table department.
Four men work in the bookcase department.

A) 87 B) 96 C) 102 D) 98 E)94

SAMPLE PROBLEM - BLUE

A furniture manufacturer is interested in determining the total number of items he can produce in one day. What is the total?
Each member of the group has a different set of information. All the information is needed to solve the problem. Your information is:

Each man in the desk department can produce four desks per day.
Each man in the table department can produce one table per day.

A) 87 B) 96 C) 102 D) 98 E) 94

APPENDIX IV

Color Code_____

PART 1

Part of our research involves finding out how people feel when they perform certain tasks when working in small groups. It is extremely important, therefore, that you answer the following questions as honestly as possible. Do not put your name on this sheet, since the questionnaire is anonymous.

EACH QUESTION IS FOLLOWED BY A NINE POINT SCALE. PLEASE CHECK THE BOX WHICH BEST INDICATES YOUR ANSWER.

QUESTIONS 1-3 REFER TO THE PLANNING PERIOD

1. How did you feel about the planning period? Indicate on the scale directly below how much you liked or disliked the planning period.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

2. How did you feel about the leader during the planning period? Indicate on the scale directly below how much you liked or disliked the leader during the planning period.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

3. How did you feel about the other group members (other than the leader) during the planning period? Indicate on the scale directly below how much you liked or disliked the other members during the planning period.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

QUESTIONS 4-7 REFER TO THE PROBLEM SOLVING PERIOD

4. How did you feel about the problems your group was asked to solve? Indicate on the scale directly below how much you liked or disliked these problems.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

5. How did you feel about your job in the group during the problem solving period? Indicate on the scale directly below how much you liked or disliked your job during the problem solving period.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

Part 1 (continued)

6. How did you feel about the leader during the problem solving period? Indicate on the scale directly below how much you liked or disliked the leader during the problem solving period.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

7. How did you feel about the other group members (other than the leader) during the problem solving period? Indicate on the scale directly below how much you liked or disliked the other members during the problem solving period.

LIKE ___ ___ ___ ___ ___ ___ ___ ___ ___ DISLIKE

PART 2

We are interested in finding out the degree to which various activities were characteristic of the leader during the experiment. Indicate the extent to which each activity was characteristic or not characteristic of the leader by checking the appropriate box on the scale.

1. Encouraged group discussion and decision.

CHARACTERISTIC ___ ___ ___ ___ ___ ___ ___ ___ ___ NOT CHARACTERISTIC

2. Helped to integrate the contributions of group members.

CHARACTERISTIC ___ ___ ___ ___ ___ ___ ___ ___ ___ NOT CHARACTERISTIC

3. Facilitated communication between members.

CHARACTERISTIC ___ ___ ___ ___ ___ ___ ___ ___ ___ NOT CHARACTERISTIC

4. Acted in a helpful and supportive manner.

CHARACTERISTIC ___ ___ ___ ___ ___ ___ ___ ___ ___ NOT CHARACTERISTIC

APPENDIX V

ANALYSES OF VARIANCE RESULTS OF SATISFACTION RATINGS (LEADER)

A. Summary of the Analyses of Variance of Ratings of Organizational Satisfaction (Leader)

Source	df	Mean Square	F	P
With Planning Period				
Task Complexity (T)	1	2.11		
Leadership Type (L)	1	2.81		
Communication Structure (C)	1	.31		
T x L	1	.31		
T x C	1	.01		
L x C	1	.05		
T x L x C	1	.19		
Within	72	5.28		
With Leader (Self)				
Task Complexity (T)	1	2.81		
Leadership Type (L)	1	.61		
Communication Structure (C)	1	5.51		
T x L	1	1.51		
T x C	1	1.51		
L x C	1	.01		
T x L x C	1	.13		
Within	72	6.12		
With Other Group Members				
Task Complexity (T)	1	1.01		
Leadership Type (L)	1	4.51	1.05	
Communication Structure (C)	1	1.01		
T x L	1	3.61		
T x C	1	.01		
L x C	1	1.01		
T x L x C	1	1.03		
Within	72	4.28		

B. Summary of the Analyses of Variance of Ratings of Operational Satisfaction (Leader)

Source	df	Mean Square	F	p
With Problems				
Task Complexity (T)	1	.11		
Leadership Type (L)	1	.61		
Communication Structure (C)	1	.31		
T x L	1	4.51	1.31	
T x C	1	3.61	1.05	
L x C	1	1.51		
T x L x C	1	9.13	2.65	
Within	72	3.44		
With Job				
Task Complexity (T)	1	6.61	1.24	
Leadership Type (L)	1	.01		
Communication Structure (C)	1	.61		
T x L	1	.11		
T x C	1	.11		
L x C	1	1.01		
T x L x C	1	4.53		
Within	72	5.33		
With Leader (Self)				
Task Complexity (T)	1	1.51		
Leadership Type (L)	1	.31		
Communication Structure (C)	1	2.81		
T x L	1	.11		
T x C	1	2.11		
L x C	1	.31		
T x L x C	1	.33		
Within	72	3.41		
With Other Group Members				
Task Complexity (T)	1	2.81		
Leadership Type (L)	1	1.51		
Communication Structure (C)	1	3.61	1.06	
T x L	1	1.01		
T x C	1	.11		
L x C	1	.11		
T x L x C	1	2.83		
Within	72	3.40		

APPENDIX VI

MEAN NUMBER OF MESSAGES PER TRIAL COMPRISING CORE COMMUNICATION UNITS

Trial	Complex Problems				Simple Problems			
	Nonauthoritarian Leadership		Authoritarian Leadership		Nonauthoritarian Leadership		Authoritarian Leadership	
	Comcon	Wheel	Comcon	Wheel	Comcon	Wheel	Comcon	Wheel
1	6.00	6.40	6.20	6.30	6.00	6.00	6.10	6.00
2	6.20	6.00	6.00	6.20	6.10	6.10	6.20	6.20
3	6.10	6.00	6.10	6.00	6.00	6.00	6.10	6.20
4	6.10	6.00	6.20	6.00	6.10	6.10	6.00	6.00
5.	6.10	6.20	6.00	6.10	6.00	6.00	6.10	6.00

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