THE MEASUREMENT OF COOPERATION AND THE DETERMINATION OF CAUSAL VARIABLES FOR COOPERATION IN A TECHNICAL ENVIRONMENT

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PREFACE

This study is concerned with increasing cooperation in a technical environment, specifically an engineering work group. The primary objective is to develop a model that measures cooperation and the strategic variables that affect it. Cooperation is established by utilizing policy capturing techniques and a regression model is used to determine the relationship between cooperation causal factors and organizational cooperation.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

STATEMENT OF THE PROBLEM

A related trend in modern societies is the increased integration of previously independent activities into organizations, particularly the professions. Many professionals have lost their traditional autonomy and independence and have had to adjust to working in large organizations. We think of the engineering researcher as pursuing his objective of scientific discovery independently. Increasingly, however, engineers work in large organizations and must integrate their efforts with many others. This has placed added emphasis on cooperation for the establishment and accomplishment of organizational purpose.

Cooperation is defined as the willingness and ability to work with others to achieve a common goal. Cooperation originates in the need of any individual to accomplish purposes that he cannot accomplish by himself and rapidly becomes a constantly changing system made up of interrelated elements. The factors that affect cooperation at one time may be forgotten and replaced by other factors at another time. Or the organization itself may alter these factors by reinforcing, replacing, misusing, or ignoring them either intentionally or unintentionally. In the sense that they are of great importance within the integrated whole of the organization, these factors may be referred to as "strategic variables".

Any system, or set of conditions consists of elements, or parts, or variables which together make up the whole system or set of conditions. If this system or set of conditions is approached with a view to accomplishment of a purpose the elements or parts become distinguished into two classes: those which if absent or changed would accomplish the desired purpose provided the others remain unchanged; and those others. The first kind are the strategic variables, the second, complementary variables (Barnard, 1938). The strategic variable is the one whose control, in the right form, at the right place and time will set the complementary variables at work to bring about the results intended. But the strategic and complementary variables are continually changing places. What was the strategic variable becomes complementary, when once it has come under control; then another variable is the strategic one. Organizational cooperation involves the control of the changeable strategic variables at the right time, right place, right amount, and right form in order to enlarge the total output by the expected operation of complementary factors. In this dynamic environment, cooperation must be effective in the sense of achieving organization purpose and efficient in the sense of satisfying individual motives.

In discussing cooperative systems, Barnard describes a formal organization as that kind of cooperation among men that is conscious, deliberate, purposeful. Such cooperation is present everywhere and is inescapable in today's environment, so that it is usually contrasted only with individualism, as if there were no other process of cooperation. Moreover, much of what we regard as reliable, foreseeable, and stable is so obviously a result of formally organized effort that it is readily believed that organized effort is normally successful, that failure of organization is abnormal.

But in fact, successful cooperation in or by formal organizations is the abnormal, not the normal, condition. What are observed from day-to-day are the successful survivors among innumerable failures. The organizations commanding sustained attention, almost all of which are short-lived at best, are the exceptions, not the rule. Thus, most cooperation fails in the attempt, or is short-lived. Failure to cooperate, failure of cooperation, and failure of organization are characteristic facts of human history. Barnard states that it is inevitable that the struggle to maintain cooperation among men should as surely destroy some men morally as battle destroys some physically.

Cooperation then must be an organizational entity and must be managed as such for interests and motivations are as important as skills and abilities in determining what an individual does and how well he does it. This thesis investigates the primary research concerning cooperation, develops a model that measures cooperation in a technical environment and determines the strategic variables that affect it. The objective of the research is to create a managerial tool and technique for increasing technical cooperation in an organizational environment.

CHAPTER II

REVIEW OF THE LITERATURE

Cooperation and Competition

Cooperation is demonstrated through acts of working together for mutual benefit and is often accompanied by a shared or common goal. Competition is reflected in acts of striving to excel, often in order to obtain an exclusive goal. Cooperation involves sharing, helping, and often coordinating efforts between two or more people, while competition includes a reluctance to help or give information, or even a withdrawal of support.

There are a multitude of reasons why a person cooperates or competes. Cooperation and competition may be brought about through certain types of incentives or goals or through other aspects of the environmental situation. An understanding of cooperation and competition requires an awareness of both situational and intrapersonal determinants.

Cooperation and competition can be confused because they both refer to personal motives, behaviors, or the aspects of the situation such as instructions, incentives, or reward structures. To compound the confusion, there is a third type of behavior, individualism, which must be considered along with cooperation and competition. The meanings of each of these types of behavior can be spelled out as a motive and as a reward structure. A real-life situation can be used to illustrate.

Suppose a supervisor describes his performance appraisal procedures as being based on a curve: 10 percent of the work force will get an outstanding rating; 85 percent will get a satisfactory rating; and 5 percent will get unsatisfactory ratings. This situation represents competitive reward structure, where competition is defined as a condition in which the achievement of a goal by one participant prevents attainment of the goal by any other participant. If, in an organization of 100, 10 employees have higher scores than yours, you cannot achieve your goal of earning an outstanding performance rating, regardless of the absolute value of your rating score. Likewise, in a competitive reward structure, if someone succeeds, someone else must inevitably fail. Deutsch (1949a) described this reward structure as "contrient interdependence:" the interdependence of participants is mutually exclusive.

In another organization, a different supervisor may tell his employees that he intends to conduct a different type of performance evaluation. "I want us all to work together. Meeting the goals of the organization is a group task. If the group clearly meets the goals, everyone gets an outstanding rating; if it doesn't, then no one will get one. It is possible for everyone to get an outstanding, or for everyone to get a satisfactory or unsatisfactory." Here is a cooperative reward structure; if one person achieves or moves toward his goal it helps others in achieving their goals. In this situation, goal achievement is an all-or-nothing proposition. Deutsch refers to this reward structure as "promotive interdependence," where the interdependence of participants is mutually beneficial.

We may consider one more supervisor who tells his employees that his performance appraisal grading system is flexible. Your evaluation is based on the number of assignments you carry out successfully. It is possible for each and every employee to receive an outstanding rating; however, it could be that no one will receive an outstanding. The same is true with any other rating. The rating given has no influence upon the ratings the other employees achieve. Evaluation that converts absolute percentages to ratings is an example of "individualistic" reward structure, where goal achievement by one participant has no effect upon the goal achievement of others. In contrast to the two previous situations, goal attainment by one participant is not interdependent upon another. Thus, the reward structure for any task involving more than one person could be competitive, cooperative, or individualistic.

The motives of the individuals in a group also affects cooperation. A cooperative motive is a mutual or shared one; the person who possesses a cooperative motive seeks the outcome that is most beneficial to all participants. In contrast, a competitive motive seeks an outcome that is most beneficial to oneself and most detrimental to the other participants. In other words, a competitive motive seeks not only to achieve personal success but also to cause other participants to fail. A person with the third type of motivation, an individualistic motive, seeks an outcome that is the best for himself, regardless of whether others achieve their goals.

Deutsch based his theory of cooperation and competition upon the Lewinian field orientation and the theory is concerned with the effects of cooperation and competition upon small group functioning. The following hypotheses were proposed and have been restated for convenience (Shaw, Costanzo, 1970). Their meanings remain as intended by Deutsch.

1. Individuals in cooperative situations will perceive themselves to be more promotively interdependent, and individuals in competitive situations will perceive themselves to be more contriently interdependent.
2. Substitutability for similarly intended actions will be greater in the cooperative than in the competitive situation. (Substitutability means that the acts of one person in the group can be substituted for the actions of another; two individuals need not perform the same act.)
3. A larger percentage of actions by fellow members will be positively cathected (become attractive or be regarded favorably) by members of cooperative groups than by members of competitive groups.
4. There will be greater positive inducibility (production and channeling of own forces in the direction induced by the inducing agent) with respect to fellow group members in the cooperative than in the competitive situation.

4a. There will be greater self-conflict among members of cooperative than among members of competitive groups.

5. Members of cooperative groups will help each other more than members of competitive groups will help each other.

5a. Members of competitive groups will exhibit more obstructiveness towards each other than will members of cooperative groups.

6. At any given time, there will be greater interrelation of activities (working together) among members of cooperative groups than among members of competitive groups.

6a. Over a period of time, there will be more frequent coordination of efforts in cooperative than in competitive situations.

7. Homogeneity with respect to amount of contributions or participations will be greater in cooperative than in competitive situations.

8. Specialization of functions will be greater in cooperative than in competitive situations.

9. Specialization of activities will be greater in cooperative than in competitive groups.

10. Structural stability with respect to functions will be greater in cooperative than in competitive situations.

11. Change of roles to adapt to changing circumstances will be greater in cooperative than in competitive situations.

12. The direction of forces operating on members of cooperative groups will be more similar than the direction of forces operating on members of competitive groups.

13. There will be more achievement pressure in cooperative than in competitive groups.

14. The group force in the direction of the goal will be stronger in cooperative than in competitive situations.

15. Cooperative and competitive groups will not differ in total strength of forces (interest and involvement) operating on

members in their respective situations.

16. When the task is such that the production of observable signs (participation) is perceived as a means for locomotion, total signs produced per unit time will be greater in competitive groups than in cooperative groups.

17. When locomotion is possible without the production of signs, total signs produced per unit time will be greater in cooperative than in competitive groups.

18. Attentiveness to the production of signs by others will be less in competitive than in cooperative groups.

19. Communication difficulties will be greater in competitive than in cooperative groups.

20. Communication difficulties will be greater, even when attentiveness is optimal, in competitive than in cooperative groups.

21. There will be more mutual agreements and acceptances of communications by communicators and communicatees in cooperative than in competitive groups.

22. Members of cooperative groups will have more knowledge about its active members than will members of competitive groups.

23. Group orientation will be greater among members of cooperative than among members of competitive groups.

24. Productivity per unit time will be greater for cooperative than for competitive groups.

24a. It will require less time for a cooperative group to produce a given amount than for a competitive group to produce that same amount.

25. The qualitative productivity of cooperative groups will be higher than that of competitive groups.

26. Members of cooperative groups will learn more from each other than will members of competitive groups.

27. There will be more friendliness among members of cooperative than among members of competitive groups.

28. Members of cooperative groups will evaluate the products of their group more highly than members of competitive groups will.

29. Percentage of group functions will be higher in cooperative than in competitive situations.

30. Percentage of individual functions will be greater in competitive than in cooperative groups.

31. The perception of attitudes of others toward one's own functioning in the group will be more realistic in cooperative than in competitive groups.

32. The attitudes of each member toward his own functioning should be more similar to the attitudes of other group members toward his functioning in cooperative than in competitive groups.

33. Members of cooperative groups will perceive themselves as having more favorable effects on fellow members than will members of competitive groups.

34. Incorporation of the attitude of the generalized other will occur to a greater extent in cooperative than in competitive groups. ("Attitude of the generalized other" refers to the internal structure resulting from the introjection of

mutually interacting attitudes of those persons with whom one interacts frequently.)

Major empirical support is provided by Deutsch for his theory (1949b). Five-person groups were studied as they attempted to solve human relations problems and puzzle problems. Extensive observational data were obtained by four observers using formal rating scales, as well as data from subject ratings. The results provided impressive support for the theory. Moderate to strong support was found for twenty-three of the thirty-four hypotheses; weak or ambiguous evidence was found relative to four hypotheses (8, 13, 16, 26); and seven hypotheses were not tested (10, 11, 14, 20, 22, 31, 32). Additional relevant data have been reported by Grossack (1954), who examined the consequences of cooperation and competition on small-group cohesiveness, social influence, and communication. He found that cooperative subjects showed significantly more cohesive behavior, more attempts at influence, greater exertion and acceptance of pressures toward uniformity, and more relevant communications than did competitive subjects. Raven and Eachus (1963) found that members of cooperative groups solved problems more rapidly, evaluated other group members more favorably, showed less hostility, were more attracted to the task, and showed greater concern about own performance than members of competitive groups did. All these findings except the "concern about own performance" are consistent with Deutsch's theory.

Other experimental studies adopting the Deutsch theoretical orientation (Gottheil, 1955; Shaw, 1958; Hammond and Goldman, 1961) also report results that are generally consistent with the theory. The large number of hypotheses stated by Deutsch almost ensures that some will be supported, but the high percentage supported by the experimental evidence is unusual for a social psychological theory.

Since there are such marked differences between cooperative and competitive groups, there must be factors associated with cooperative behavior that cause these differences. These factors can be called attributes of cooperation.

Attributes of Cooperation

Two of the most important factors regarding cooperation are cohesiveness and reward structures. Cohesiveness refers to the degree of liking each member has for the group. Cooperative reward structures are consistently associated with increased communication, greater cohesiveness, and greater congeniality. For example, in a study comparing methods of conducting discussion sections in an introductory psychology course, Haines and McKeachie (1967) varied the reward structures by grading individual versus group projects. In competitive classes, a higher level of tension resulted, often leading to a disruption of the students' performance. The study also showed that students preferred being in a cooperative class. Blau (1954) obtained similar results when comparing the reward structures in a public employment agency.

Certain situations demand that people cooperate with each other in a group, while the group as a whole competes with another group. This can be called team-competitive structure. Studies on the adjustment of group members (Fiedler, 1967) indicate that intergroup competition assists group members in attaining personal adjustment and in eliminating the demoralizing effects of failure. The men involved in intergroup competition became more cohesive than men in other groups and viewed each other as interdependent. To the contrary, intragroup competition divided the members of the group and engendered resentment. Thus, intergroup competition—in contrast to intragroup competition—is associated with group cohesion and cooperation. A group with a cooperative reward structure may increase its cohesiveness by instigating intergroup competition. This point was demonstrated in the Robber's Cave experiment of Sherif, Harvey, White, Hood, and Sherif (1961).

Individual attitudes are another important part of cooperation. An attitude may be defined as a positive or negative affective reaction toward a denotable abstract or concrete object or proposition (Bruvold, 1970). More simply, attitudes can be viewed as internal states which occur within the individual but which are focussed on certain objects in the environment.

Beyond the environment and within the individual, it becomes necessary to postulate what elements make up an attitude. At least three have been mentioned, but not all of them by every theorist (Krech, Crutchfield, and Ballachey, 1962; Secord and Bachman, 1964). First the cognitive component of an attitude refers to the intellectual beliefs or knowledge that an individual might have about an object. For example, one might have a certain belief about the goals that the organization is trying to achieve, if the organization is the attitude object under consideration. The most important cognitions are those which make a positive or negative judgment about the object according to some set of criteria (Krech et al., 1962). The feeling or affective component of an attitude refers to the liking or disliking of the attitude object. Positive feelings might include respect, liking, and sympathy; negative feelings refer to contempt, fear, and revulsion. The conative or behavioral component refers to ones policy orientation toward the attitude object, or ones stance about the way in which persons or attitude objects should be treated in specific social contexts (Hardig et al., 1954). The conative component emphasizes how the respondent would respond.

An attitude is not an observable entity but an underlying construct whose nature must be inferred. Attitudes possess three central characteristics: they always have an object; they are usually evaluative; and they are considered to be relatively enduring. A fourth characteristic of an attitude is often included—that is a predisposition toward action or a state of readiness for motive arousal (Newcomb, Turner, and Converse, 1965). Rokeach (1968) advances a similar orientation, stating that an attitude is a relatively enduring organization of beliefs around an object or situation predisposing one to respond in some preferential manner.

By relating attitudes to readiness to respond, it is implied that attitudes influence concomitant or future behavior toward the object. If we know how a person feels toward working for the government, we should be able to predict how that person will behave when organizational cooperative efforts are required. The relationship between attitudes and behavior is currently being scrutinized and reformulated. It may well be, as Bem (1970) postulates, that in many instances ones behavior determines ones attitude, rather than the reverse.

Two dimensions of philosophies of human nature that affect cooperation are trust and altruism. Trust, is the extent to which one believes that people are basically trustworthy, honest, and responsible as opposed to believing that people are untrustworthy, immoral, and irresponsible. Carl Rodgers (1957) vigorously affirms man's trustworthiness and Weigirt (1962) says that man is a creature who must experience trust. Rotter (1971) has developed a similar concept to trustworthiness, which he calls interpersonal trust. The concept is described as a person's generalized expectancy that the promises of other individuals or of groups with regard to future behavior can be relied upon. The other dimension of human nature is altruism versus selfishness—or the extent to which one believes that people are basically unselfish and sincerely interested in others as opposed to believing that they are basically selfish and unconcerned about others.

Communication is a prime element of cooperation. In general, communication has to do with conveying information from one individual or set of individuals to another. This information may be verbal, physical, or written and it may convey feelings, ideas, or factual material. The two variables which are controlled by the organization that seem to be strongly related to the amount of communication in a group are the task demands and the physical location of the participants. Numerous empirical studies have shown that the way in which people are supposed to work together according to the organization chart influences their communication. Ilgen and O'Brien (1968) showed that more communication took place in groups that were collaborating than those that were coordinating their efforts or working independently. The organization may also facilitate communication simply by placing people physically close to one another. Studies have shown that people communicate more with people that are readily accessible than with those who are more remote (Bavelas, 1951).

Two other variables that are related to communication are under somewhat less control of the organization. It appears that the greater the cohesiveness or attractiveness of the group members the more the communication. The direction of causality here seems to be both ways. That is, we communicate with people we like and we come to like people with whom we communicate.

The final antecedents seem to be related to the flow of communication. More specifically, it has been found that in most organizations the flow of information is downward from supervisor to subordinate. The variable underlying this phenomena seems to be status. The more status the individual has in the organization the more likely he is to be spending more time sending communications to those below him in rank or position than to those above. Reed (1962) has provided some evidence that this flow may be reversed in cases where subordinates both trust their supervisor and feel that he is important for the attainment of their own personal goals. This suggests that when the organization can select or choose individuals who are trustworthy, they will facilitate this type of communication flow (Scott and Mitchell, 1972).

Another important factor of cooperation is predictability; the individual's need to feel that he knows what is going to happen—that he is not subject to the whims of forces beyond his control. It is apparent that this is just as important when the individual is executing a role on behalf of a group as when he is acting for himself. The principle of homeostasis, the concern with maintaining a stable environment, is just as valid here as at the level of simple and routine biological adaptation. The importance of predictability is evidenced by the tension of not knowing what will happen next.

The internal structures of organizations lend confirmation of the need for predictability. Organizations with frequently changing managers and supervisors are likely to be involved in many controversies and difficulties. Changes in leadership mean uncertainty as to what is possible; or, if you assume that relations can be carried on as before, the new man in the office may react to your tactics in an unfavorable manner. Conversely, a secure environment makes for goal achievement—with consequent satisfaction and favorable perceptions of the establishment and management (Stagner, 1956).

Groups strive to achieve goals by following certain norms that constitute the rules of the game. Cooperation is fostered when those norms are accepted and such acceptance in turn is more likely if the relevant norms arise in a large group involving both employees and management. It is clear, that if any group rejects the norms of the large unit, cooperation is made more difficult—almost impossible in fact.

Group norms concerning cooperation are affected by the process of social influence. This process is concerned with the ways in which the situation and especially the group norms or expectations of ones peers, are related to the patterns and amounts of influence that exist in the group. Perhaps the most well-known research in this area was first conducted by Asch (1955). In a series of experiments, Asch demonstrated the profound effect group pressure has on individuals. Asch rigged an experimental situation in which a group was preinstructed to state wrong judgments publicly when asked to match the length of a given line with one of three unequal lines. In 33 percent of the cases, an uninstructed subject who perceived the correct relationship between the lines denied the evidence of his senses when subjected to group pressure. The independent subject did not know he was being plotted against and was placed in the group so that he was the last to state his judgment.

In conditions where the group is interdependent there seems to be greater conformity. It appears that if the individual feels that both he and others stand to suffer as a consequence of his behavior he will deviate less from what the group thinks is the correct thing to do than if only he would suffer (Gerald, 1965). Closeness of supervision also affects conformity. In situations where the group can use surveillance to check the responses of the pressured individual, there is more conformity. The studies cited here are concerned with behavioral conformity, not necessarily attitude change. In many of these cases the individual may do what is required of him but not really believe what he has said or done. The usefulness of this type of conformity depends upon the goals of the organization.

There appears to be ample evidence that people who work together and like each other have greater influence over each other than when this attraction is absent. Lott and Lott (1965) found that highly cohesive groups have both more communication and more influence with group members than groups that were low in cohesiveness. Also, the degree to which one can deviate from group norms appears to be tied to his past record of performance and conformity. Individuals who have displayed competence in the past and have conformed to group norms can deviate from those norms in order to initiate change or move the group in a new direction (Hollander, 1960).

It would appear that an individual's satisfaction or morale in relation to the group's ability to pressure one to conform would depend on the similarity of the opinions of the individual and the group. For those who concur with the group, this pressure might increase morale. For those who disagree, it should be a very unpleasant situation in which to work.

A major attribute of cooperation which requires special attention is motivation. Individuals are not only complex, but also hightly variable. They have many motives which are arranged in some order of importance to them, but this order is subject to change from time to time and situation to situation. Furthermore, motives interact and combine into complex motive patterns which affect cooperation.

Motivation and Cooperation

Individuals act because of certain driving forces within themselves. Whatever the need behind every purposeful human act there is some desire—either conscious or unconscious—that prompts the person to act. It is in seeking to satisfy his needs that man spends his energies. The central problem of motivation from an organizational viewpoint is how to induce a group of people, each having his own distinctive needs and personality, to work together toward the organization's objectives. Thus motivation is an important element of cooperation and is closely intertwined with cooperative behavior.

An individual's motivation has to do with (1) the direction of his behavior, or what he chooses to do when presented with a number of possible alternatives; (2) the strength of the response once the choice is made; and (3) the persistence of the behavior, or how long he sticks with it. The term motivation conveniently includes a number of other variables such as drive, need, incentive, reward, expectancy, and desire.

Theories of motivation may be divided into two groups: (1) process theories, and (2) content theories (Campbell, Dunnette, Lawler, Weick, 1970). Process theories endeavor to explain and describe the process of how behavior is energized, how it is directed, how it is sustained, and how it is stopped. They first try to define the major classes of variables that are important for explaining motivated behavior. For example a theory may talk about rewards, needs, and incentives as three general classes of variables that are important for understanding motivation. Such theories then attempt to specify how the variables interact and influence one another to produce certain kinds of behavior. A simple example of such a process statement might be the assertion that "individuals exert" more cooperative effort to obtain rewards that satisfy important needs than to obtain rewards that do not.

By contrast, content theories are more concerned with the specific identity of what it is within an individual or his environment that energizes and sustains behavior. That is, what specific things motivate people? Thus, the content theories attempt to identify and define the specific entities within a general class of important variables (e.g., promotion, salary, job security, fringe benefits, recognition, and friendly co-workers might make up the general class of variables labeled "rewards"). The content theories are not centrally concerned with specifying the precise form of the interaction between variables.

Process Theories

Process theories may be sub-divided into three areas: (1) stimulus-response, drive x habit theory; (2) expectancy theory; and (3) discrepancy theory.

(1) In stimulus-response, drive x habit theory, behavior is pictured as resulting from a combination of drive and habit strenght. Thus, the motivational process deals with these two classes of variables, and the theory specifies that they combine in a multiplicative fashion to produce effort (Hull, 1943).

Habit strength refers to a connection between stimuli and/or responses that has become virtually automatic through experience, usually thorough repeated trials. So, for example, "1492" automatically elicits "Columbus" from most Americans; a printed word elicits certain manual responses in the skilled typist; a red traffic signal elicits braking by the motorist. Habits do not depend on thinking either for their formation or their execution; as a matter of fact, thinking sometimes interferes with their smooth performance.

Drive level was originally thought of as simply representing the level of doing without relative to assumed needs such as food or water but this was soon expanded to incorporate the need to reduce any strong internal stimulus. This was modified again when it was demonstrated that men will often strive to increase the amount of stimulation they receive (Cofer and Appley, 1964). The current theory seems to view the individual as striving toward an optimal level of stimulation (Cofer, 1967). Obviously, this optimal level may change with time, and Helson (1959) has suggested the idea of adaption level to explain why the value of incentives may change with repeated reinforcement. For example, an initially novel stimulus may become less novel after repeated appearances.

(2) The basis of the expectance theory view of motivation is the idea that individuals have cognitive expectancies concerning the outcomes that are likely to occur as the result of what they do and that individuals have preferences among outcomes. That is, an individual has an idea about possible consequences according to their probability of occurrence and their value to him. Thus, for the expectancy theorist it is the anticipation of reward that gives behavior its direction (Lewin, 1938).

Building on expectancy theory Vroom (1964) has presented a process theory of motivation that he calls instrumentality theory. His basic classes of variables are expectancies, valences, choices, outcomes, and instrumentalities. Expectancy is defined as a belief concerning the likelihood that a particular act will be followed by a particular outcome. Valence refers to the strength of an individual's preference for a particular outcome. Briefly Vroom's formulation postulates that the motivational force, or effort, an individual exerts is a function of (1) his expectancy that certain outcomes will result from his behavior (e.g., a raise in pay for cooperative effort) and (2) the valence, for him of the outcomes. The valence of an outcome is, in turn, a function of its instrumentality for obtaining other outcomes and the valence of these other outcomes.

(3) The central idea in discrepancy theory is that if a discrepancy exists within the individual, he is motivated to reduce it, and the greater the discrepancy, the greater the motivation. The discrepancy

under consideration is that which exists between two sets of elements, for example, two attitudes which do not follow from each other, or a subjective perception and an objective reality that do not fit, such as believing one is a topnotch manager and then not receiving a promotion for a long time (Festinger, 1957).

Content Theories

The discussion of the various process theories of motivation leads to the content theories or suggestions concerning what specific variables should be studied. Accordingly various writers have constructed lists of motives ranging from very short and highly general lists to more specific ones containing as many as fifty or sixty specific needs. One classical scheme reduced secondary motives to four basic "wishes"—for security, recognition, response from others, and new experience (Thomas, 1923). On the other hand, one of the classifications underlying what internal states govern human behavior lists twenty-eight "needs". (For example, need for achievement, need for aggression, need for autonomy, need for affiliation, need for superiority, and need for exposition) (Murray, 1938).

Building on Murray's theory, McClelland and Atkinson have sought to refine and intensively investigate a subset of motives from Murray's list. The three that they have researched the most are (1) the need for achievement, (2) the need for affiliation, and (3) the need for power, with the need for achievement given the most emphasis. The achievement motive is viewed as a relatively stable disposition, or potential behavior tendency, to strive for achievement or success. The motive is presumed not to operate until it is aroused by certain situational cues or incentives, which signal the individual that certain behaviors will lead to feelings of achievement (Atkinson, 1957). According to Atkinson, a particular motive—achievement (n Ach), affiliation (n Aff), or power (n Pow) is actually a label for a class of incentives, all of which produce essentially the same result. This end result is an internal experience of satisfaction such as pride in accomplishment (n Ach), a sense of belonging and being warmly received by other (n Aff), or the feeling of being influential and in control (n Pow). These motives may be conditioned to a wide range of incentives and are learned (McClelland, 1951).

The above idea of motives is embedded in what is essentially an expectancy-valence model of the motivational process. That is, behavior is seen as resulting from (1) the strength of the motive, (2) the valence of the incentive which arouses the motive, and (3) the individual's expectancies that behavior will lead to the incentive or reward. Expectancy and valence are hypothesized to be inversely related, and the implication is that low expectancies or a low subjective probability of success leads to a higher value for the incentive, and vice-versa.

Formally stated, the tendency to approach a task with the intention of performing successfully (Ts) is a multiplicative function of the strength of the achievement motive (Ms), the subjective probability of success (Ps), and the valence or incentive value of success (Is). That is, Ts = Ms x Ps x Is. Conversely, the behavioral tendency to avoid failure by avoiding the task (Tf) is a multiplicative function of the strength of the need to avoid failure (Maf), the subjective probability of failure (Pf), and the incentive value of failure (If). That is, Tf = Maf x Pf x If. For any given task, the observed is the resultant of

Ts and Tf.

However, when variables change over a period of time behavior will also change. For example, the law of effect states that behavior which is rewarded tends to recur at a higher frequency. In need achievement terms this would be true only if the value of the incentive remained constant. This may not happen if the behavior under consideration is prominent for the achievement motive. Under these conditions the incentive value of the reward is negatively related to the perceived probability of success. Thus, if the individual experiences repeated successes on the task, the perceived probability of success will increase, the value of the incentive will decrease, and the individual may go off and do something else (Campbell, Dunnette, Lawler, Weick, 1970).

One of the most useful models of human needs was developed in the 1950's by A. W. Maslow. He envisioned five basic needs and ranked them in the order in which they are usually fulfilled:

1. Physiological - the need for food, shelter, and physical protection.
2. Security - the need for psychological and economic well being.
3. Social - the need to be accepted by others.
4. Ego - the need to achieve, have status, and gain recognition.
5. Self-actualization - the need to fulfill ones potential as a person.

Application of Maslow's theory can be facilitated by translating to more modern terminology. For example, whereas Maslow wrote about self-actualization, ego, and social needs, today's managers speak in terms of the needs of competence, achievement and power, and affiliation. In general, highly technical people are more motivated by a constant (or, at least, relatively continual) desire to demonstrate competence in their work. This competence motive is certainly desirable, but it can also make the engineer adopt a superior attitude toward those who have a desire merely for power or achievement, as well as toward those who have the basic affiliative motives. It is the existence of this underlying competence motive that sometimes causes technical people to behave in a "different" way and to require different managerial strategems to make them truly productive (Steinmetz, 1976).

In conclusion then, it may be summarized that when a particular need is active, it may be considered to serve both as a driving impulse to action and as a director of activities for an individual; it determines what will be important to the individual and shapes his cooperative behavior accordingly. This implies that the nature of the job - what it allows in the way of opportunities for need satisfaction - has implications in characterizing individual cooperative performance. Thus, it is important to examine how these factors relate specifically to engineers and their work environment.

Aspects of Engineering Cooperation and Productivity

There is wide agreement among behavioral scientists that engineers are an unusual occupational group. More than most employees they thrive on challenge and flourish on recognition. Although he is concerned with his salary, the engineer's motivation for sustained productivity is complex and stems from many other aspects of his job. One of these very important aspects is cooperation.

The engineer's emergence as a subject for study is evidenced by the trend of research over the last twenty years. Originally the concern of the human-relations people was with the blue-collar workers. Then the focus began to shift to foreman and to middle management. Now it is concentrated in special areas like research and development and top management. Herzberg's theory was first drawn from an examination of events in the lives of engineers and accountants. At least 16 other investigations, using a wide variety of populations have since been completed, making the original research one of the most replicated studies in the field of job attitudes (Herzberg, 1968).

Paul Strauss (1969) conducted a study among 520 engineers to evaluate how job environments contribute to feelings of satisfaction and productivity. Among the main interesting findings stemming from the survey are the following:

- Supervisors universally see themselves as more satisfied, cooperative and more productive than nonsupervisors. This apparently stems from an opportunity to enhance their status, to influence the work done, to fix their own work schedule, and to be rewarded more directly for their performance.
- Research engineers appear to be the most team-oriented. They tend to see themselves as somewhat less productive individually, but describe their job environment in glowing terms.
- Development engineers are the least satisfied type and describe this dissatisfaction as stemming from little opportunity to enhance their status, having to relocate too often, and not knowing their exact responsibilities.

- Although design engineers report average satisfaction, their job characteristics indicate less than average opportunities to use their total skills, influence the work done, associate with able colleagues, and fix their own work schedules.
- Manufacturing engineers see themselves as most productive and most satisfied. Their job environment, however, is described as offering little job security, little chance to work with interesting colleagues, and little chance to influence the work around them.
- Engineers working for the government seem to reflect the least satisfaction with their jobs. They reflect a similar job environment pattern to design engineers in general, but, in addition, seem concerned with the lack of cooperation on the part of their co-workers.
- On the average, about a third of the engineers surveyed were either neutral or actually disliked their jobs, but only about a fourth felt that their own productivity was lower than others.
- Discernible differences between supervisory and nonsupervisory groups, type of engineering done, and type of employer were found, especially in the characteristics of their job environment, that could lead to high satisfaction, cooperation, and productivity.

From this study it can be generally concluded that, depending upon the actual job environment, engineers can be either happy or productive, or both or neither. In the long run, though, enhancing the opportunities for professional growth and independence seems to have the effect of boosting not only a feeling of "liking" one's job, but the motivation to "produce" as well.

Eugene Raudsepp (1969, 1970) surveyed a thousand engineers from various companies over the United States, including both government and industry, concerning personal-professional-management problems in engineering. Four of the areas of particular interest are (1) what makes a man produce, (2) engineers' attitudes toward their jobs, (3) what causes discontent, and (4) job satisfaction. In the first area recognition, opportunity, and money emerged as the prime motivators; however, a whole set of conditions were introduced. These included the need for more qualified personnel, removal of distractions and interruptions, more realistic work loads, proper incentive system and specific goals, more decision-making authority, and more interest and involvement. It was also established that:

1. An engineer's freedom—to organize his own time, to select and carry out projects as he sees fit, to make decisions, to be innovative—all contribute to increased productivity.
2. The promise of increased opportunity provides a powerful impetus to increased effort, performance, cooperation, and efficiency.
3. An engineer's productivity at any level seems to be affected significantly by the performance of those at the level just below him. Just as the working engineers say their productivity would improve with sufficient assistance from technicians, those in supervisory-management positions mention the effect of subordinates. The same is true for cooperation.
4. Productivity is closely tied to the engineer's own estimation of his ability to perform. When he senses growth and improvement in his abilities, this is an indication that his productivity and effectiveness are increasing correspondingly.

   On the other hand, if he feels stagnant or—even worse—if he feels that his abilities are deteriorating, his performance is very likely to reflect this situation.

The study involving engineers' attitudes toward their jobs established that over 80 percent of the factors mentioned by the panelists as contributing to their job well-being relate, one way or another, to the sense of achievement. Successful completion of projects, accomplishment of very difficult tasks, seeing the results of one's work, obtaining patents and inventing new products and processes, a demonstrated ability to accept any challenge—all are highly interrelated, and all belong to the same family of meaning: achievement. Even recognition which was mentioned by a sizable number of engineers is based, in the majority of cases, on achievement. Two other factors, promotion and increased responsibility which were strongly emphasized also relate closely to feelings of achievement and recognition. The almost exclusive emphasis on achievement indicates that engineers' preponent motivation is self-actualization or self-fulfillment and that their work is the primary area in which their need for self-fulfillment can be met.

While the factors leading to high positive feeling with the job were mostly related to job content, to the actual accomplishment of the job, feelings of unhappiness with the job ties in primarily with the contextual or situational factors of the job, to the conditions surrounding the job. Thus, management inadequacies, poor administration, assignment to routine task, project cancellations, internal politics, lack of authority—all focus on the climate or situations surrounding the job. Essentially the same emphasis is placed on contextual job factors when engineers describe the most difficult aspects of their present jobs. As was pointed out in Herzberg's studies of motivation to work, removing the dissatisfactions connected with the climate or contextual factors of work do not automatically lead to increased efficiency or productivity, nor does it materially add to the individual's positive feelings about his job.

In the third study the basic cause of discontent among engineers, according to one-third of the engineering panelists, can be traced to what they perceive as low wages. In addition to salary compression with the passage of time, the feeling that their salaries do not adequately compensate them for the rigorous effort and preparation they put into their profession, there is now the added factor of inflation and the claim that salaries are not tied to the rapidly increasing cost of living.

Actually, while engineers as a professional group are, perhaps, more vocal about their dissatisfaction with their salaries than are other professional groups, there is evidence that money bothers much of the population, in all occupational groups. A recent Gallop Poll indicated that 30 percent of our populace are clearly dissatisfied with their income.

What is more disturbing than the either fancied or real salary discrepancy between engineers and other professional groups is the feeling that engineers' discontent stems from declining technical challenge, misutilization, and uninteresting, nonprofessional work. Several recent studies show that engineers continue to have lower levels of contentment on general morale indicators (particularly as concerns their jobs) than do other comparable groups in industry. In one study conducted by the Opinion Research Corporation among employees of a large metals company (where relatively high morale prevails) all groups were asked to rate their jobs and the kind of work they do (Raudsepp, 1969). These were rated "very good" by 80 percent of the plant managers and assistants, 59 percent of the sales force, 43 percent of the headquarters staff, 41 percent of the production group, but only 27 percent of the engineers and chemists.

Another major complaint of the engineers surveyed is their feeling of lack of recognition for a job well done or for their contribution to their companies' operations. Lack of professional recognition, which was a considerable source of irritation a few years ago, seems to have subsided.

Other sources of discontent mentioned were: lack of confidence in management, lack of a sense of direction of activities, poor communication between management and engineers, not being involved in general overall planning, and lack of responsibility.

The survey indicates that engineers' discontent is not limited to minor gripes, but focuses on circumstances and problems amenable to change by concerted management action. To be sure, some engineers seem to have made a mistake in their career choice, and their pervasive discontent might not be relieved by even the most enlightened treatment. But the problems of the majority of engineers have to do with legitimate complaints. Particularly, many of their jobs could be reconstructed so they could apply their talents to the full. Supervisors and management could also exercise greater sensitivity to their individual needs and requirements.

Robert D. Best, research director of Opinion Research Corporation, feels that the selection and placement process of engineers deserves searching re-examination. He says that the problem is to define realistically the requirements of individual jobs in the broad spectrum of jobs that the company offers. The next step is to match the man to the job by finding out what the applicant expects or wants from the job situation. Another approach to better selection and placement is to match the psychological demands of the work with the psychological needs of the engineer.

Despite anticipated cuts in government spending and general business slack, both the demand for qualified engineers and the turnover rate remains high. There is still keen competition for qualified people and apparently no reluctance on the part of many engineers to seek greener pastures if their job expectations are not fulfilled. However, many others seem content to stay with their present companies. The fourth area of research showed that the nature of the work—its challenge, interest, and variety; its creative aspects and close correspondence to what the individual trained for—remains the most important factor in job satisfaction. Money runs a close second to challenge and interest in holding engineers on their jobs but it must be recognized that "challenge and interest" incorporates a large number of sub-areas (i.e., opportunities for growth and advancement, opportunities for creative design work).

Other major reasons for staying on the job included not wanting to move from present homes; time invested with company; job security; pleasant, congenial, and capable associates; recognition, respect for technical judgement, high technical and management status and prestige could not be duplicated elsewhere; relative independence; fringe benefits; chances for promotion; reputation of the company; growth potential of the companies; good working conditions; and present level of responsibility.

Engineers' efficiency, productivity, creativity, morale, motivation, cooperation—even absenteeism and turnover—are all greatly affected by their attitudes toward their work. When a man has exceptionally positive feelings about his job, his output and efficiency are correspondingly high. Conversely, negative feelings not only sap his morale and motivation, but they also reduce his cooperation and productivity.

It is recognized that cooperative behavior is a function of the individuals' motives as well as other aspects of the situation. Can we say which factor is most influential or how they interact? These problems can be studied by looking at tasks that pose choices between conflicting motives. The Prisoner's Dilemma is the most frequently studied of these mixed-motive tasks.

The Prisoner's Dilemma Game

The Prisoner's Dilemma Game is a mixed-motive game which has been used extensively in the study of cooperation. A review of this game seems appropriate for this study because: (1) there is the possibility of clearly separating cooperative motives in a quantitative manner; (2) game theory can serve as a model for human behavior; (3) simulation is an important way of studying human behavior; (4) there is the possibility for controlled feedback; and (5) much background work has already been done using the Prisoner's Dilemma Game.

The situation of the Prisoner's Dilemma takes its name from the following predicament described by Luce and Raiffa (1957). Two subjects are taken into custody and separated. The district attorney is certain they are guilty of a specific crime, but he does not have adequate evidence to convict them at a trial. He points out to each prisoner that each has two alternatives: to confess to the crime the police are sure they have done or not to confess. If they both do not confess, then the district attorney will book them on some very minor trumped-up charge; if they both confess, they will be prosecuted and he will recommend a rather severe sentence; but if one confesses and the other does not, then the confessor will receive rather lenient treatment for turning state's evidence whereas the latter will get the "book slapped at him".

There is purposely created dilemma between motives in the above situation. The outcome for each prisoner is determined by the combination of the choices made by him and the other prisoner. Matrices can be developed that represent the choices available to the prisoners (Figure 1). The matrix highlights the fact that the outcome for each person depends upon the responses of the other participant. Using the matrix, the choices can easily be quantified by substituting some hypothetical numerical values (days in jail) for the descriptive punishment (Figure 2).

In experimental Prisoner's Dilemma situations, studies have utilized less severe pay-offs than jail sentences. In fact, rewards have been used instead of punishments, usually in the form of money (Figure 3). In varying studies, the amounts of money have ranged from pennies per trial to as much as 60 dollars for an experiment of ten trials. A typical game matrix with money as a reward is shown in Figure 4. Most of the experiments use simultaneous responding where each person chooses without knowledge of the other's choice. Subjects are usually informed

		2nd Prisoner	
		Not Confess (Cooperate)	Confess (Not Cooperate)
1st Prisoner	Not Confess (Cooperate)	Minor charge for 1st, minor charge for 2nd	"Book" slapped at 1st, leniency for 2nd
	Confess (Not Cooperate)	Leniency for 1st, "book" slapped at 2nd	Severe sentence for 1st, severe sentence for 2nd

Figure 1. Matrix of Choices Available to Prisoners

		2nd Prisoner: Not Confess (Cooperate)	2nd Prisoner: Confess (Not Cooperate)
1st Prisoner	Not Confess (Cooperate)	3 days, 3 days	90 days, 1 day
	Confess (Not Cooperate)	1 day, 90 days	20 days, 20 days

Figure 2. Matrices Showing Days in Jail in a Prisoner's Dilemma

	B_1	B_2
A_1	X_1, X_1	X_2, X_3
A_2	X_3, X_2	X_4, X_4

Where: $2X_1 > X_2 + X_3 > 2X_4$

$X_3 > X_1$

$X_3 > X_2$

$X_4 > X_2$

Figure 3. General Form of Game Involving Money as Rewards

		2nd Person Chooses Between	
		Blue (Cooperate)	Red (Not Cooperate)
1st person chooses between	Blue (Cooperate)	3¢, 3¢	0¢, 5¢
	Red (Not Cooperate)	5¢, 0¢	1¢, 1¢

Figure 4. Matrices Representing Choices Available to Subjects in Experimental Games

of the outcome and the other participant's choice after both have chosen on each trial. The essential nature of the situation is consistent: a choice that seems to lead to the greatest individual gain is, in the long run, self-defeating. The most beneficial combinations of choices—if one can assume that the other will cooperate—is cooperation.

Factors Influencing Cooperation

When subjects participate in the Prisoner's Dilemma game, by no means do they always learn to establish a cooperative relationship whereby each chooses blue on each trial. In fact, the games have produced many varied outcomes. Because of this variation, factors are sought that might explain these variations. Situational factors include the effects of (a) the reward structure of the situation, (b) the value of the pay-offs, (c) the strategy of the other participant, and (d) the opportunities for communication between participants. Intrapersonal factors include the effects of personality, motivational, and attitudinal characteristics.

The Reward Structure. The reward structure creates a conflict between cooperative and competitive choices. Pay-off matrices may have a structure which are entirely cooperative or entirely competitive or the reward structure may be altered to make certain choices even more undesirable. For example, a matrix could be constructed with extremely undesirable pay-offs for both players not cooperating. Sermat (1967) has shown that the rate of cooperation is higher here than in the traditional Prisoner's Dilemma matrix.

The Value of Pay-Offs. Perhaps the low rates of cooperation in the experiments are the results of very small payments per trial (Gallo and McClintock, 1965). In the usual experiment, the pay-off per trial for cooperating is small (approximately 3 cents) and the difference between pay-offs for cooperative as opposed to competitive behavior is even less (usually 2 cents). A group of studies supports the conclusion that trivial pay-offs result in more competition. McClintock and McNeel (1966) varied high (1 cent) versus low (.1 cent) reward and found more competitive responses in the low reward conditions. Other studies found similar results (Ells and Sermat, 1966; McClintock and McNeel, 1964, 1967). Gallo (1966) noted the same results in a bargaining game which also produces cooperative and competitive behavior. In all of the studies mentioned above, the high reward conditions were still quite trivial (a few cents per trial). Radlow (1965) increased rewards so that the lowest cell sum was \$6 (A_2B_2). Subjects played more cooperatively under these conditions. Oskamp and Perlman (1965) found that higher average pay-offs per trial produced more cooperation. But there are also other non-monetary matters at stake—achievement needs, self-esteem, one's public image. Gallo (1968) has accentuated these symbolic rewards and Brown (1968, 1971) also demonstrates the strength of non-monetary motivations and values in game play.

The Strategy of the Other Person. In the Prisoner's Dilemma, a matching strategy appears to be most effective in facilitating cooperation (Oskamp, 1972). According to this strategy (in which the experimenter varies the strategy of one of the players) the second participant responds on each trial with the same choice as that of the first participant. The first participant quickly learns that if he picks red the other player will also pick red, and each will lose or get only a minimal payment. If the first participant picks blue, he finds the other player will likewise pick blue, resulting in a solid payment for each player. When the second player adheres to the matching strategy, in general, the first player will eventually start making a cooperative response in almost every trial (Whitworth and Lucker, 1969, 1970; Wrightsman, Bruininks, Lucker, and Anderson, 1967). Reinforcement theory serves as an explanation for such a phenomenon; the players quickly learn that the other player will choose the same response as theirs. Sermat (1967a) significantly increased cooperative behavior by using a strategy which consisted of 30 consecutive cooperative or competitive responses followed by a matching strategy for 200 trials. Both groups showed this increase, and in some cases subjects chose cooperatively more than 50 percent of the time. Finally, Sermat (1967b) found that subjects responded more cooperatively following a change in preplanned strategies from competitive to cooperative when they thought they were playing against a free-responding partner, as opposed to an absent partner or one committed to a previous strategy.

Opportunities for Communication. The standard Prisoner's Dilemma game does not permit any type of communication between the two players. They know nothing about each other, although they doubtless make certain assumptions. The small amount of evidence available indicates that the lack of communication and/or the lack of knowledge about the other player inhibits the possibilities for cooperation. An impressive demonstration of how communication affects cooperation was carried out in a study by Wichman (1970), who varied the type of communication possible. In one condition, isolated subjects could neither see nor hear each other; in a second condition, they could hear the other; in a third condition, they could see each other; and in the fourth condition, they could both see and hear each other. As a result, the more extensive the communication, the higher the rate of cooperation. In another study, Loomis (1959) used the Prisoner's Dilemma Game to study the effects of communication on cooperative and competitive choices. Half of his subjects received, while the other half sent, standardized notes expressing expectation, intention, retaliation, absolution, or mixtures of these. Subjects who sent or received messages, perceived more mutual trust than subjects who were unable to communicate. The level of trust varied with the complexity of the message allowed. The more complete messages resulted in higher levels of trust. A number of other studies have obtained similar results (Evans, 1964; Horai and Tedeschi, 1969; Radlow and Weidner, 1966; Swenson, 1967; Terhune, 1968). Pilisuk and Skolnick (1968) and Tedeschi, Linkshold, Horai, and Gahagan (1969) found that a conciliatory strategy with honest prior announcement of moves led to higher amounts of cooperation after subjects had been given the motivational set to maximize their own gain. Gahagan and Tedeschi (1968) found increased amounts of cooperation if the subject felt he could predict the strategy of the other, which was a preplanned matching strategy in this case.

Effects of Personality and Attitudes. A field-theory conception of cooperation would emphasize that intrapersonal factors as well as situational factors or environmental states contribute to the degree of cooperation shown in a Prisoner's Dilemma. Experiments have shown that, in one-trial games, the subjects' attitudes, personality characteristics, and motives seem to be reflected in their choices (Terhune, 1968, 1970; Wrightsman, 1966). For example, some subjects superimpose their own motives upon the game structure. Even though the task is described as a choice task rather than as a game, and even though any references to an opponent or to winnings are avoided—some subjects rationalize their competitive choices with statements like "that's the purpose" or "winning the most for myself is what I am supposed to do". Thus, the demand characteristics of the situation are not the same for all participants.

Kelley and Stahelski (1970) have shown that, in the game, cooperative subjects differ from competitors in their beliefs about what people are like. Specifically, cooperators believe that people are different in their cooperative propensities, while competitive subjects believe all other people are competitive. In the study, cooperators and competitors were defined according to the subject's self-expressed intent in the game. Cooperators were those subjects who stated that they intended to cooperate with the other player and be concerned with their score and the other player's score. Competitors were those subjects who said they wanted to work for themselves, against the other player, and be concerned only with their own score. Thus, self-described cooperators and competitors behave differently in a mixed-motive game situation, perceive their opponents differently, and differ in their assumptions about human nature in general. Not only do cooperators see human nature as generally more cooperative and trustworthy, but they also assume the existence of differences among individuals.

In multitrial games, the variations in personality and motives seem to have less influence on the outcome, and situational factors increase in importance. It also appears that the greater the complexity of the situation, the less demonstrable are the effects of the subject's personality or motives. Situational factors and intrapersonal factors interact (Terhune, 1970). The interactions between the two members of a dyad are probably more dominant factors in determining the performance on a multitrial game than the individuals' inherent propensities to cooperate.

Other Variables in the Prisoner's Dilemma Game

Previous interaction can influence choices in the Prisoner's Dilemma Game. Oskamp and Perlman (1965) found that friendship ranging from unacquainted to fairly friendly has no effect on game responses. On the other hand, close friendship may produce either high amounts of cooperation or competition.

If the Prisoner's Dilemma Game matrix is presented in non-matrix form, more cooperation results (Evans and Crumbaugh, 1966). Also subjects who fall behind at the beginning of play cooperate less often than their partners who are ahead (Marwell, Ratcliff, and Schmitt, 1969). In addition, Oskamp and Perlman (1965) conclude that: (1) the level of cooperation is sensitive to the amount of social interaction at the beginning of the experiment; (2) previous public commitment to the norm that cooperation in the game is desirable results in more cooperation; and (3) instructions labeling the experiment as dealing with cooperation and competition have no effect.

Zagonc and Marin (1967) used two-man teams in a game to investigate the effect on interpersonal attitudes of winning or losing. One member of each team, by way of programmed outcomes, always decreased the likelihood of his team gaining points, while the other team member always increased the likelihood. The experiment was set up so that one member of each team played one member of the other team, while their teammates watched the progression of the game. After a fixed number of trials, the observing teammates would play one another. The "winner" of one team always played the "loser" of the other team. The results showed that successful members had more favorable attitudes towards their opponents than their teammates. Pylyshyn, Agnes, and Illingworth (1966) found that two-man teams tended to make more cooperative responses than individuals.

Applying Experimental Game Situations to the Real World

The mixed motive game has proved to be a useful tool for the study of social behavior in the laboratory but does it have any value for understanding cooperation and competition in the real world?

Several researchers have cautioned against applying these findings to real world conflicts. Gergen (1969) lists four limitations. One problem is that the absence of real communication makes the standard, mixed-motive game a highly artificial relationship. (However, more recent studies have introduced opportunities for communication as a variable, thereby rendering more applicable results.) A second limitation is the ambiguity of the dependent variable. One assumption of game researchers, namely, that choosing blue is a cooperative response—has not been proven. This seems too simplified an assumption, and greater interviewing with subjects regarding the reasons for their choices should clarify this point.

The third problem is the range of options. Under conditions where multiple options are available to two people, the processes of exchange may be quite different in character. Exploitation in the real world, for example, is disguised or covered up by a veneer of helpfulness or concern. The creation of opportunities for such subtle reactions is not easily accomplished in a mixed-motive game. The fourth problem is the utility of outcomes. This is the meaningfulness of small rewards. However, some research findings concluded that game behavior remains the same when large rewards are used.

Pruitt (1967) has also criticized the Prisoner's Dilemma game, indicating the following discrepancies between laboratory findings and what is commonly known about real life. The first problem noted is the lack of opportunities for communication. Second, there is no opportunity to try out decisions tentatively and then reverse decisions if the results are unfavorable. Third, the use of pay-offs is unrealistic. Fourth, the reward structure used in the laboratory may not be perceived by participants as being the same as the reward structure in real-life conflicts. And, finally, the absence of norms in the laboratory inhibits cooperation. Pruitt states that in real-life tasks with co-workers, people may feel constrained by custom to be helpful and expect their fellow workers to feel similarly constrained. Such norms may not be so easily available in the laboratory situation because of its novelty.

The absence of norms that foster cooperation seems to relate to Gergen's concern for the artificiality of the laboratory setting. Clearly, the mixed-motive game in the laboratory is artificial in some respects. The crucial question is: does this artificiality absolutely influence responses? Apparently, the lack of norms does influence responses; studies that varied the set of instructions given the subjects produced differences in the extent of cooperative behavior of these subjects (Deutsch, 1960; Terhune, 1968; Loomis, 1959). For example, those subjects who were told that their job was to maximize their winnings cooperated less often than those subjects who were given instructions to facilitate the winnings of both participants as much as possible.

The future of mixed-motive game research may lie in the direction of determining whether findings from the laboratory extend to the real world. Deutsch (1969) claims that the games people play as subjects in laboratory experiments may have some relevance for war and peace. He says that the peoples of a nation, like individuals in the laboratory, seek out and acquire information, make decisions, and take actions; and they act in similar ways under similar conditions. But it seems that the next step in research is to measure the similarity in conditions between the laboratory and the real world. Until such similarities are demonstrated, however, the findings of Prisoner's Dilemma games probably cannot be applied point-for-point to real-world conflicts (Smead, 1972).

Summary

In any situation where a variety of behaviors is acceptable, some people will choose to cooperate, and some will choose to compete. An understanding of cooperation requires an awareness of both situational and intrapersonal determinants. Cooperation is demonstrated through acts of working together for mutual benefit and is often accompanied by a shared or common goal. Cooperation derives from personal motives, behaviors, or aspects of the situation such as instructions, incentives, or reward structures. A person who possesses a cooperative motive seeks an outcome that is most beneficial for all participants while a cooperative reward structure is one in which the achievement of one group member's goal facilitates the achievement of the goals of each other group member. Cooperative reward structures lead to more communication, greater cohesiveness, greater congeniality, and increased interdependence while a cooperative motive is associated with acceptance of group norms, social attraction, trust and confidence, and altruism.

Mixed-motive situations force the person to choose between a cooperative and a competitive response. In a mixed-motive situation, the degree of cooperation shown by a participant is influenced by the reward structure of the situation, by the strategy of the other participant, and by intrapersonal factors such as motives and assumptions about human nature.

CHAPTER III

METHOD AND PROCEDURE

The basic research into cooperation has established many generalities that apply to all engineers in various situations. However, these studies, for the most part, are concerned with a large number of subjects with various backgrounds and do not provide the specifics needed for increasing cooperation in a technical environment. One of the reasons for this is the difficulty in measuring cooperation. It is difficult to assign a value or a rank or a number to cooperation especially when a lot of subjects are involved. So while the importance of cooperation is always emphasized, the measure of cooperation is left to subjective evaluations and comparisons.

But before any effort can be made to increase the cooperation of an engineering group, management must first have a method of evaluating present cooperation and the variables that affect it. Once this has been established, management can then determine which variables to concentrate on for increased cooperation. Expanding this concept, a model can be constructed and utilized to increase organizational cooperation and the output of the organization. This involves measuring cooperation and determining the relationship between the strategic cooperation variables and organizational cooperation.

Development and Application of the Model

Research Group

To apply this theory to reality, a particular engineering group of a government organization was chosen and from this group data was gathered concerning cooperation. The group consisted of 102 engineers, ranging in age from 23-58 years, with salary levels from $14,000 to over $35,000 per year, and work experience from three to 29 years. There were ten separate primary functions among the group resulting in ten work units within the group. In addition to the 102 engineers, 20 supervisors, associated with the group, participated in the study.

Research Model

Measuring cooperation and determining the relationship between the cooperation variables and organizational cooperation requires the following steps:

Step 1 - Establish the measures of cooperation characteristics by talking with the engineering supervisors.

Step 2 - Determine the rating of cooperation for simulated work units using policy capturing techniques.

Step 3 - Using regression techniques, determine the weights of the various cooperation characteristics for the simulated work units.

Step 4 - Determine the level of cooperation characteristics in the actual work units and using these actual measures determine the cooperation of the group.

Step 5 - Determine the measures of the causal factors from the engineering group.

Step 6 - Regress the causal factors on the cooperation measure to determine the relationship between the cooperation variables and organizational cooperation and determine the strategic variables.

Cooperation Characteristics

Cooperation characteristics are the variables which supervisors utilize to evaluate the cooperation of a group. Each of the twenty supervisors was asked the factors he would use to evaluate the cooperativeness of any work group. The results are shown in Table I. The concept here is that supervisors have specific ideas about what constitutes a cooperative work group. None of the supervisors gave all the reasons listed. Some gave two or three reasons, others gave more. However, all the factors were listed and included as cooperation characteristics.

Cooperation Rating of Simulated Work Units

To measure cooperation it is necessary to determine how the cooperation characteristics identified by the supervisors are weighted in their judgment of cooperation. This was done by a technique known as "policy capturing" (for a more detailed discussion of policy capturing see Appendix A). Policy capturing is an empirical analysis of actual decisions and provides a mathematical description of a decision maker's policy. In this study, policy capturing analyzes decisions and cues concerning cooperation and builds a model which weights the cues

TABLE I

GROUP COOPERATION CHARACTERISTICS

Characteristic Number	Characteristic
1	Tact and diplomacy
2	Working harmoniously with others
3	Considering other points of view
4	Giving assistance
5	Interdependent decision making
6	Ease of communication
7	Rapid decisions and resolutions
8	Reaching agreements
9	Task completion
10	Coordination of efforts
11	Productivity per unit time
12	Favorable evaluation of the group and its procedures
13	Cohesiveness
14	Positive feeling about the organization
15	Recognition of priorities
16	Willingness to share information
17	Maturity of the group
18	Awareness of the total situation
19	Recognition of management interest
20	Frequency of interaction

according to their actual influence in the decisions, through multiple regression techniques.

The policy capturing instrument is shown in Appendix B. It consists of 30 case incidents of various simulated work units. The 20 separate cooperation characteristics, previously obtained from the supervisory personnel, which a supervisor might use to determine or measure a work unit's cooperation are presented in each case. Each cooperation characteristic is presented at various levels throughout the cases in order to obtain an array of data that can be analyzed. The range for each characteristic is on a one to five point scale. To present all possible combinations of each characteristic and characteristic level would necessitate thousands of simulated cases. However, this is not necessary. A random sample of 30 simulations representing combinations of cooperation characteristics and characteristic levels will yield a statistically significant duplication of the results which might be obtained by rating the entire population of cases. The random assignment of characteristic level by case is shown in Table II.

Each supervisor read the cases and assessed the cooperation of each simulated work unit on a five-point Likert type scale. The results of these ratings are shown in Table III.

Coefficient of Concordance

Having established the cooperation rating of each of the simulated cases by each of the supervisors, it is important to determine if the supervisors agree on the importance of the cooperation characteristics or if the agreement among the ratings of the cases are simply by chance. This can be decided by having the supervisors rank the importance of the

TABLE II

RANDOM ASSIGNMENT OF COOPERATION CHARACTERISTIC LEVEL BY SIMULATED CASE

Characteristic Number	Simulated Case Number																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1	3	2	3	3	5	3	4	3	5	4	3	4	1	5	5	5	5	1	2	4	1	5	5	3	3	1	5	4	4
2	3	3	4	2	1	4	1	4	3	5	4	3	4	2	3	5	1	3	3	1	5	5	2	3	1	3	2	5	2	1
3	4	3	4	4	5	1	4	1	3	1	1	5	2	5	1	4	2	4	3	2	5	2	4	3	5	1	4	2	5	2
4	2	3	3	3	4	4	3	5	5	3	2	2	2	5	5	4	1	2	4	1	4	1	3	2	5	1	3	5	2	1
5	2	3	1	1	4	3	1	2	2	5	4	4	5	1	4	5	5	3	3	1	2	3	5	4	4	4	5	5	1	3
6	2	3	5	3	2	4	2	3	3	4	3	5	1	1	3	4	1	2	3	4	3	4	1	2	2	1	2	4	4	1
7	1	4	4	4	4	3	1	4	5	3	2	2	2	3	5	2	5	5	4	3	3	5	3	5	5	3	4	4	5	4
8	3	5	1	5	2	2	2	5	5	5	3	1	3	1	5	4	3	5	4	3	2	1	1	3	2	4	5	3	4	1
9	5	4	4	1	3	5	5	3	4	1	3	1	5	5	1	4	5	2	3	1	3	1	2	3	5	3	4	4	2	1
10	1	1	5	2	3	4	3	3	2	5	4	5	3	3	2	5	1	1	3	2	5	4	3	2	1	3	3	4	3	1
11	5	4	1	3	5	1	2	1	1	1	4	4	1	5	4	5	4	5	1	4	4	3	1	1	4	4	2	2	4	4
12	4	1	2	1	1	4	4	4	1	5	3	5	5	3	1	5	3	5	4	4	1	5	4	2	3	1	1	5	5	4
13	4	1	3	2	2	3	2	4	2	4	4	5	3	2	3	4	2	2	4	4	2	5	3	2	3	2	1	5	3	1
14	4	5	1	1	1	5	1	2	2	4	5	1	5	3	3	3	1	3	4	3	4	4	1	5	3	2	3	3	5	4
15	5	2	4	2	2	5	3	3	2	3	4	1	5	3	5	2	3	5	4	1	5	5	2	4	4	4	2	3	2	2
16	2	5	2	4	4	5	1	5	2	5	1	4	1	2	4	2	2	2	2	1	2	4	5	3	1	1	3	4	3	2
17	3	5	1	2	3	5	3	5	4	3	2	2	5	2	3	1	1	5	4	4	3	3	2	1	4	4	1	4	3	2
18	2	2	5	4	1	1	4	4	5	4	4	5	1	2	4	4	4	4	4	2	5	3	3	3	4	3	4	1	4	1
19	2	1	5	4	2	2	4	1	5	4	5	2	1	1	3	4	5	5	2	2	3	2	3	4	5	5	1	3	5	5
20	1	4	5	5	3	4	3	4	2	4	4	3	2	4	3	5	5	1	4	1	1	4	5	2	5	3	5	5	5	5

TABLE III

COOPERATION RATING OF SIMULATED CASES

Supervisor	Simulated Case Number																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	3	2	5	2	2	4	2	4	2	5	4	5	3	2	3	5	1	2	3	3	3	5	3	2	2	2	2	5	3	1
2	3	2	4	1	2	5	2	3	2	5	4	5	3	2	3	5	1	2	4	3	3	5	3	2	2	2	2	5	3	1
3	3	1	4	2	2	4	1	4	2	5	3	4	3	2	3	5	1	2	4	3	3	5	3	2	2	2	2	5	3	1
4	3	2	4	2	1	4	2	3	2	5	3	5	3	2	3	5	1	2	3	3	4	5	2	2	1	2	1	5	3	1
5	3	2	4	2	1	4	2	3	3	5	4	5	3	1	3	5	2	1	3	3	4	5	2	2	1	1	1	5	4	1
6	3	1	4	1	1	4	1	3	3	5	4	5	3	1	3	5	1	2	3	3	3	5	2	2	2	2	2	5	3	1
7	3	2	4	2	2	5	2	3	2	5	4	4	3	2	3	5	1	2	3	3	4	5	3	2	1	2	2	5	4	1
8	3	2	4	2	1	4	2	4	2	5	4	5	3	2	3	5	2	1	3	3	3	5	3	2	2	1	1	5	3	1
9	3	2	5	2	2	4	2	4	2	5	3	5	3	2	3	5	1	2	4	3	3	5	2	2	1	2	2	5	3	1
10	3	2	4	2	2	4	2	3	2	5	3	5	3	2	3	5	1	2	4	3	4	5	2	2	2	2	1	5	3	1
11	3	2	4	2	2	5	2	3	3	5	4	5	3	2	3	5	1	2	3	3	4	5	3	2	2	2	1	5	3	1
12	3	2	4	2	2	4	2	3	2	5	4	5	3	2	3	5	2	2	4	3	3	5	2	2	1	1	1	5	3	1
13	3	2	4	1	1	4	2	4	2	5	4	5	3	2	3	5	1	2	3	3	3	5	2	2	1	2	2	5	3	1
14	3	2	5	2	1	4	2	4	2	5	3	5	3	1	3	5	1	2	4	3	4	5	3	2	2	2	2	5	4	1
15	3	1	4	2	1	4	1	3	2	5	3	4	3	2	3	5	1	3	3	3	3	5	2	2	2	2	2	5	3	1
16	3	2	5	2	2	4	2	3	2	5	3	5	3	2	3	5	2	2	3	3	3	5	3	2	2	2	2	5	3	1
17	3	2	4	2	2	4	2	3	2	5	4	4	3	2	3	5	1	2	3	3	3	5	3	2	2	1	1	5	3	1
18	3	1	4	1	1	4	1	3	2	5	4	5	3	2	3	5	1	1	4	3	3	5	3	2	1	2	2	5	3	1
19	3	2	4	2	2	5	2	4	3	5	4	5	3	2	3	5	1	2	3	3	4	5	2	2	1	2	1	5	3	1
20	3	2	4	2	2	4	2	4	2	5	3	5	3	1	3	5	1	2	4	3	4	5	3	2	2	2	2	5	4	1

cooperation characteristics and determining the agreement among them.

When there are k sets of rankings, the association among them may be determined by using the Kendall coefficient of concordance W. Whereas rank correlation coefficients express the degree of association between two variables measured in, or transformed to, ranks, W expresses the degree of association among k such variables (see Appendix C).

Applying this measure of correlation to the supervisors, Table IV shows that $W = .565$ and $\chi^2 = 214.70$. From the table of critical values of Chi-Square, it is seen that $\chi^2 \geq 214.70$ with df = 19 has the probability of chance occurrence under H_0 of $p \leq .001$. Thus, it can be concluded with considerable assurance that the agreement among the supervisors on the importance of the cooperation characteristics in assessing cooperation is higher than it would be by chance. The very low probability under H_0 associated with the observed value of W allows the rejection of the null hypothesis that the supervisors' ratings are unrelated to each other.

Beta Weights for Simulated Work Units

The relationship between the ratings of simulated work unit cooperation and the measure of cooperation characteristics takes the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_{20} X_{20}$$

where

Y is the rating of cooperation for the simulated work units

β_0 is the intercept of the regression line

$\beta_1, \beta_2, \beta_3, \dots, \beta_{20}$ are the weights of the various characteristics

$X_1, X_2, X_3, \dots, X_{20}$ are the levels of the characteristics

TABLE IV

COMPUTATION AND SIGNIFICANCE OF W

Subject Supervisor	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
	Cooperation Characterististic																			
1	19	6	16	13	2	1	14	20	17	4	15	5	3	8	9	7	18	12	11	10
2	19	5	9	16	1	4	20	18	17	15	14	2	6	11	3	7	10	8	13	12
3	20	8	18	4	7	1	17	19	14	2	16	5	3	10	6	9	13	12	11	15
4	19	7	13	5	3	4	20	18	16	1	15	11	2	9	12	8	17	14	10	6
5	17	1	16	4	10	6	19	20	15	8	18	3	5	7	13	2	9	12	14	11
6	20	2	15	7	10	1	17	18	14	3	16	6	5	9	12	4	19	8	13	11
7	19	4	10	12	3	1	20	17	15	9	18	6	2	11	8	5	14	13	16	7
8	20	7	15	3	6	2	18	17	14	1	16	5	4	12	19	8	11	13	10	9
9	19	6	14	1	9	2	20	18	12	3	15	5	4	11	13	7	17	8	16	10
10	18	9	13	7	2	1	19	17	16	3	12	11	8	15	6	10	14	20	4	5
11	18	5	20	2	4	1	19	17	9	7	13	11	3	14	10	6	16	15	12	8
12	9	12	4	3	18	14	2	19	7	10	5	6	1	20	16	13	8	11	15	17
13	19	8	15	2	1	7	20	17	18	4	13	3	5	6	10	11	14	16	12	9
14	17	4	14	2	8	1	20	19	15	3	13	6	7	10	11	5	16	12	18	9
15	4	1	6	15	8	2	20	9	13	16	5	11	18	3	19	10	77	14	17	12
16	18	5	15	6	10	2	20	17	19	4	12	7	3	1	9	8	16	13	14	11
17	19	8	6	7	16	12	11	20	13	14	2	1	4	18	15	9	3	5	10	17
18	20	5	15	3	2	1	19	18	12	6	10	4	7	8	17	9	13	16	11	14
19	19	1	20	10	4	7	18	16	14	3	11	2	9	15	5	8	17	12	13	6
20	19	10	16	5	1	3	20	18	17	4	9	11	6	2	8	12	14	13	15	7
R_j	352	114	270	127	125	73	353	352	287	120	248	121	105	200	221	158	266	247	255	206

$$\frac{\sum R_j}{N} = 210$$

$$s = \left(R_j - \frac{\sum R_j}{N} \right)^2 = 150{,}366 \qquad W = \frac{s}{1/12\ K^2(N^3-N)} = \frac{150{,}366}{1/12(20)^2(20^3-20)} = .565$$

$$\chi^2 = k(N-1)W = 20(19).565 = 214.70$$

This relationship is in the form of a regression equation and the data generated from supervisor ratings of the 30 simulated work units was analyzed by stepwise multiple regression. This technique enters one of the cooperation characteristics at a time until the sum of squared differences between the predicted and actual value of the dependent variable (cooperation rating) has been reduced to its lowest form. The criteria used to determine whether to add another independent variable to the existing model was:

1. The standard error of the regression model must be reduced by adding the new variable.
2. The new variable must add at least .1% to the explained variance of the model (R^2).

The results of the regression analysis are presented in Table V with the regression model accounting for 89% of the total variance. The criteria established for the model revealed that working harmoniously with others, ease of communication, coordination of efforts, a favorable evaluation of the group and its procedures, cohesiveness, and interdependent decision making accounted for this variance.

Cooperation in the Actual Work Group

The analysis of the data obtained from cooperation ratings of the 30 simulated work units provided the values for the Beta coefficients. With the values of these constants, the regression model can now be used to measure the cooperation of the real work group since the level of any cooperation characteristic can be measured, as it actually occurs in the work group, independently of the cooperation rating. This involves solving for Y in the regression equation where Y is the measure of

TABLE V

COOPERATION COEFFICIENTS FOR SIMULATED WORK UNITS

	Characteristic	Coefficient	F*
B_0	Intercept of regression line	-.80557	
B_6	Ease of communication	.34516	59.69
B_{13}	Cohesiveness	.33848	43.25
B_2	Working harmoniously with others	.25186	44.84
B_{10}	Coordination of efforts	.18912	24.11
B_{12}	Favorable evaluation of the group and its procedures	.09704	10.23
B_5	Interdependent decision making	.06468	5.43
	Multiple Correlation Coefficient (R)	.94480	
	Coefficient of Multiple Determination (R^2)	.89260	198.15

*All values significant at the .001 level cooperation for the actual engineering group being studied.

Each of the 102 engineers was asked to rate the amount of each of the six cooperation characteristics present in the work group on a scale of 1-5 with 5 being the highest rating (see Part II of Appendix D). These results were fed into the regression equation and a measure of cooperation for the work group was obtained. The results are shown in Table VI. The value of 4.108 for the actual work group cooperation is calculated on the basis of all data inputs to the model being on a scale of 1-5. Thus, the value of cooperation for the engineering group has been measured and will be used as the dependent variable in the final regression model.

Strategic Variables (Causal Factors)

Now that a measure of cooperation for the group has been obtained, the cooperation variables (causal factors) that affect cooperation must be established. First an extensive review of the literature was made to determine possible cooperation factors. Then after evaluating the group and its environment, sixteen potential cooperation causal factors were isolated. Theoretically, we would expect that the following hypothesis concerning these causal factors would hold true:

1. Rewarding cooperative efforts will increase cooperation more than rewarding individual efforts (Blau, 1954; Haines and McKeachie, 1967; Sermat, 1967).
2. A positive attitude toward working for the government will increase cooperation more than a negative attitude (Rokeach, 1968; Bem, 1970; Bruvold, 1970).

TABLE VI

MEASURE OF COOPERATION FOR ACTUAL WORK GROUP

Cooperation Characteristic	Level of Characteristic in Work Group	Standardized Level Value (Level/102)
6	408	4.000
13	369	3.617
2	427	4.186
10	364	3.567
5	374	3.667
12	362	3.550

$$Y = -B_0 + B_2X_2 + B_5X_5 + B_6X_6 + B_{10}X_{10} + B_{12}X_{12} + B_{13}X_{13}$$

where

Y = Cooperation of the actual work group

B_0 = Intercept of the regression line

$B_2, B_5, \ldots B_{13}$ = Weights of the cooperation characteristics

$X_2, X_5, \ldots X_{13}$ = Standardized level of the characteristics

$$Y = -.80557 + .25186(4.186) + .06468(3.667) + .34516(4.000) + .18912(3.567) + .09704(3.550) + .33848(3.617)$$

$$Y = 4.108$$

3. Trust and confidence in the work group will create more cooperation than distrust and a lack of confidence (Rodgers, 1957; Weigirt, 1962; Rotter, 1971).
4. Altruism increases cooperation (Wrightsman, 1966; Kelley and Stahelski, 1970).
5. An accepted leadership style produces more organizational cooperation than a forced one (Deutsch, 1960; Radsepp, 1969).
6. Internal drives that favor cooperation will produce more cooperative efforts than negative drives (Maslow, 1954; Vroom, 1964; Steinmetz, 1976).
7. Common group goals will lead to more cooperation than diverse individual goals (Sherif, et al., 1961; Wrightsman, 1966).
8. Acceptance of group norms will produce more cooperation than rejection of the norms (Asch, 1955; Hollander, 1960).
9. Social attraction within the group will cause more cooperation than a dislike of fellow members (Lott and Lott, 1965; Scott and Mitchell, 1972).
10. Job satisfaction leads to more cooperation than job dissatisfaction (Herzberg, 1968; Strauss, 1969; Radsepp, 1970).
11. A coordination of efforts will create more cooperation than non-coordinated activities (Barnard, 1938; Ilgen and O'Brien, 1968).
12. Communication throughout the organization will create more cooperation than one way communication (Loomis, 1959; Reed, 1962; Wichman, 1970).
13. A dependency on others for information required to do a job (technology interdependence) creates more cooperation than a

job that can be done with no dependency on others (Gerald, 1965; Terhune, 1970).

14. A pleasant physical environment produces more cooperation than an unpleasant one (Bravelas, 1951; Strauss, 1969).

15. Familiarity with the work of the group is more conducive to cooperation than not knowing what is going on (Oskamp and Perlman, 1965; McClintock and McNeel, 1967).

16. Predictability regarding organizational activities will lead to more cooperation than uncertainty (Stagner, 1956; Gahagan and Tedeschi, 1968; Oskamp, 1972).

The information concerning these factors was obtained from the 102 engineers of the work group by means of the instrument shown in Appendix D. The original questionnaire consisted of 80 questions concerning the 16 causal factors. To determine the actual number and nature of the underlying variables among the larger numbers of measures, a factor analysis was performed (factor analysis is further delineated in Appendix E). The original questionnaire was administered to 72 government engineers who were not a part of the group of 102 engineers. A correlation matrix was computed from this data followed by an unrotated factor loading matrix according to a principal component model. The factor loading matrix was then orthogonally rotated using a generalized orthomax criterion, including quartimax, varimax, and equamax.

The factor analysis reduced the number of questions from 80 to 60 and grouped them into the 16 causal factors (Table VII). The criteria for determining the number and grouping of questions was the variance accounted for by each factor and the rotated factor loadings greater than .45. Four questions fell into groups other than the ones for which

TABLE VII

FACTOR ANALYSIS GROUPINGS

	Cooperation Factors	Factor Correlated Questions
X_1	Rewards	3, 9, 22, 24
X_2	Attitude toward working for the government	13, 17, 35, 42, 46
X_3	Trust and confidence	30, 32, 41, 48
X_4	Altruism	6, 11, 15, 49
X_5	Leadership style	20, 38, 47, 50
X_6	Internal drives	7, 25, 39
X_7	Goals	4, 33, 36, 43
X_8	Group norms	10, 31, 34, 52, 54
X_9	Social attraction	2, 14, 23, 29
X_{10}	Job satisfaction	19, 28, 37
X_{11}	Coordination	8, 12, 16, 58
X_{12}	Communication	5, 27, 59
X_{13}	Technology interdependence	45, 53, 55
X_{14}	Physical environment	44, 51, 57
X_{15}	Familiarity	1, 26, 40, 60
X_{16}	Predictability	18, 21, 56

they were originally developed. One job satisfaction question was grouped with rewards, one altruism question was grouped with trust and confidence, one trust and confidence question was grouped with group norms, and one communication question was grouped with familiarity. These questions were re-examined and found to be feasible and acceptable as grouped by the analysis. As a check, a factor analysis was performed on the data for the 60 designated questions with the same groups resulting.

The revised questionnaire was then submitted to the 102 engineers in the work group. Responses to items were made on a 5-point scale from "strongly agree" to "strongly disagree". Each item was scored by assigning a weight of 5 to "strongly agree," 4 to "agree," 3 to "uncertain," 2 to "disagree," and 1 to "strongly disagree" if the item was worded in a positive direction (favorable to cooperation). The weights were reversed for negatively stated items. An odd-even reliability coefficient of .87 (corrected to .93 by the Spearman-Brown formula) was found for the engineering group. This indicated that the final questionnaire measured with a high degree of internal consistency and was an accurate and reliable instrument.

A value for each causal factor was obtained for each engineer by summing the values for each item in the causal factor group and dividing by the number of items. This established the separate values of each of the 16 causal factors for each of the 102 engineers or, in effect, produced 102 independent observations of the 16 causal factors. The mean values of the causal factors are shown in Table VIII. With the value obtained for work unit cooperation as the dependent variable and the values obtained for the causal factors as the independent variables,

TABLE VIII

MEAN VALUES OF CAUSAL FACTORS

	Cooperation Factors	Value
X_1	Rewards	2.76
X_2	Attitude toward working for the government	3.67
X_3	Trust and confidence	4.22
X_4	Altruism	4.39
X_5	Leadership style	3.38
X_6	Internal drives	3.35
X_7	Goals	3.50
X_8	Group norms	3.75
X_9	Social attraction	4.00
X_{10}	Job satisfaction	4.12
X_{11}	Coordination	3.25
X_{12}	Communication	3.51
X_{13}	Technology interdependence	3.48
X_{14}	Physical environment	4.04
X_{15}	Familiarity	3.92
X_{16}	Predictability	3.76

Actual values, not mean values were used in the model.

the causal factors were regressed on the cooperation measure to determine the relationship between the causal factors and organizational cooperation and establish the strategic variables.

The relationship between work unit cooperation (dependent variable) and the causal factors (independent variables) takes the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_{16} X_{16}$$

where

Y is the work unit cooperation measure

β_0 is the value of the intercept of the regression line

$\beta_1, \beta_2, \dots, \beta_{16}$ are the weights of the causal factors

$X_1, X_2, \dots, X_{16}$ are the established values of the causal factors

Since the study was concerned with increasing the cooperation of the group as a whole, the value of cooperation established for the group as a unit was used as the dependent variable. [Because the work group established both the dependent and independent variables, there was the chance of a response-response bias in the data. As a check to determine if the bias existed, the causal factors for half the group were regressed on the cooperation measure for the other half. This procedure was repeated with the causal factors for the second half of the group being regressed on the cooperation measure for the first half of the group. In all three regression models, the same strategic variables were identified in the same order with only the magnitudes of the coefficients changing.] With the value of the dependent variable being constant, the value of the intercept of the regression line became zero and did not come into use in the regression equation. The same criteria as presented earlier to determine whether to add another independent variable to the existing model was used.

The regression model established four strategic variables that accounted for 99.8% of the total variance. The variables are social attraction, leadership style, technology interdependence, and rewards. These variables, with their corresponding coefficients, are shown in Table IX. Utilizing this information, management can establish priorities for reinforcing the variables to obtain the greatest increase in technical cooperation.

TABLE IX

STRATEGIC VARIABLES FOR INCREASING TECHNICAL COOPERATION

Strategic Variables	Coefficient	F*
Social attraction	.4541	20.70
Leadership style	.3510	30.85
Technology interdependence	.2243	15.15
Rewards	.1350	2.14
Multiple Correlation Coefficient (R)	.9991	
Coefficient of Multiple Determination (R^2)	.9982	271.44

*All values significant at the .001 level

CHAPTER IV

DISCUSSION

The present study was designed to investigate the effect of specific internal organizational factors on engineering work group cooperation in an effort to increase cooperation. Management viewed cooperation primarily as a function of ease of communication, cohesiveness of the group, working harmoniously with others, coordination of efforts, interdependent decision making, and a favorable evaluation of the group and its procedures. The strategic causal factors for increasing cooperation were determined to be social attraction, leadership style, technology interdependence, and rewards.

The evaluations of cooperation expressed by management are consistent with those found in the literature. The evaluations of unit cooperation were found to be reliable and valid and the data pertaining to these factors was highly correlated. In the study, there was high interrater agreement among the supervisors concerning cooperation and a single regression model was utilized to measure cooperation of all the work units in the group. However, for other studies, it may be that the best model for one group is substantially different from that for another group. This presents no real problem since, if interrater agreement is low, hierarchical grouping techniques can be used to cluster the rating supervisors into groups within which there is high agreement. Separate models can then be developed for each group, taking into account the unique cooperation characteristics important to those groups.

Also the relationship between some cooperation characteristics and cooperation ratings may be curvilinear. This poses no particular problem to the regression model. If a relationship is curvilinear, the cooperation characteristic Xn will be represented by a new variable $(Xn_1)^i$, where i is the correct power term for the curvilinear relationship. These relationships can be fitted to the linear regression model as long as the proper power terms are introduced as the independent variables. The linear restriction is on the weighting system, not on the form of the independent variables.

Though cooperation was measured by policy capturing techniques, any measure may be used in future research that will give an accurate representation. Some groups may be measured on quality of work, quantity of work, input-output figures or other measures that yield accurate numerical measures. The model can be easily adapted to accommodate these measurements.

The strategic variables identified are a combination of individual and environmental factors and represent the areas that management should concentrate on for increased cooperation. The variables indicate that a greater degree of social attraction in the work groups, participative leadership styles, greater emphasis and awareness concerning the interrelationship of organizational activities, and rewarding cooperative efforts will have the greatest effect on increasing cooperation.

Social attraction in the work group is related to liking the members, feeling that they are responsible, trustworthy and honest, and having interpersonal relationships with others in the group. Even though management cannot force people to like each other they can be highly selective in placing people in certain work groups and rearranging existing groups. Leadership style points out that subordinates have a strong desire to have constructive use made of their ideas and opinions, discuss important job related activities and information with management, and establish a relationship built on confidence rather than the exercise of authority. Technology interdependence highlights that each individual job is only part of a whole set of integrated activities necessary to achieve the organizational mission and requires a knowledge of the work being done by other people in the organization. Engineers too often see themselves as individual or independent workers and this has resulted in many conflicts between professional and organizational norms and values. Technology interdependence requires coordination, communication and familiarity, and reinforcement of this variable will have a positive effect on its subset of values. Rewards reflect the fact that cooperative efforts must be recognized. While it is important to recognize individual efforts, accomplishments in working with others toward organizational objectives must be rewarded if the cooperative efforts are to continue.

Even though the strategic variables have been identified, the other causal factors should not be neglected to the extent that cooperation will be impacted. Indeed, by altering the strategic variables some of the remaining variables may be affected. Management must assess the organizational climate that is predictive of cooperation according to the situational conditions present within the work groups.

The instrument used to determine the causal factors was developed specifically for this study, i.e., engineers working for the government. The questions may be modified without invalidating the model simply by changing a few key words. It is not expected that the same variables would be listed in the same order for other engineering groups. Although certainly some of them would be identical, there may be any combination of causal factors that affect cooperation. The important point is to find what these variables are. The same is true of the cooperation characteristics. Many managers may see cooperation in different ways and these may be different from how the employees see cooperation. But these differences are taken into consideration by the model and it may be applied to any organizational activity.

The strengths of the research process are: (1) the cooperation measures are based on criteria pertinent to organizational supervisors, (2) the relative importance of each cooperation characteristic is used in correct combination, (3) supervisory biases pertaining to the units under their supervision are eliminated since the supervisors do not evaluate the units themselves, (4) the engineering groups provide the data which feed into the cooperation model and they are in the best position to know the degree to which a particular characteristic is present, (5) the causal factors are grouped statistically based on the engineering groups' response and are not arbitrarily selected, (6) the tools and techniques are scientifically sound, (7) the model provides consistency, and (8) the approach could prove to be of great potential value to the organization in monitoring cooperation and other organizational factors on a regular basis.

It is fully realized that the foundation for the application of this research rests on several strong assumptions. Foremost among these is that the level or organizational performance is a constantly increasing function of amount of cooperation. In other words, the more cooperation, the more effective the organizational performance. This kind of relationship is shown by the straight line in Figure 5.

There are at least two other plausible alternatives to this type of relationship. The first of these is a negatively accelerated curve approaching an upper limit. This possibility is shown in Figure 5 by a dotted line. It implies a law of diminishing returns—succeeding increments in cooperation of identical amounts result in smaller and smaller increments in performance until a point is reached at which there is no further increase in performance. The second of these two alternative possibilities, an inverted U function, is shown by a broken line. It is similar to the first except for a reduction in performance under high levels of cooperation. Performance is low at low levels of cooperation and then drops off again under high levels of cooperation. These alternatives, however, would be exceptions rather than the rule.

The question is often asked whether engineers are inherently cooperative or competitive. The answer seems to be both. An engineer is likely to be cooperative in situations where he views cooperation to be to his advantage. Similarly, he tends to be competitive if he thinks competition will be advantageous. A similar statement can be made about organizations. And cooperation and competition for any organization can exist at the same time. More generally, perhaps almost all organizational relationships can be described as cooperative-competitive ones. A typical pattern is internal cooperation (within the organization) and external competition (with other organizations) of organizations. Thus, organizations have extremely complicated webs of cooperative competition or competitive cooperation in their interactions. Both cooperation and competition seem equally natural because elements of each are found in

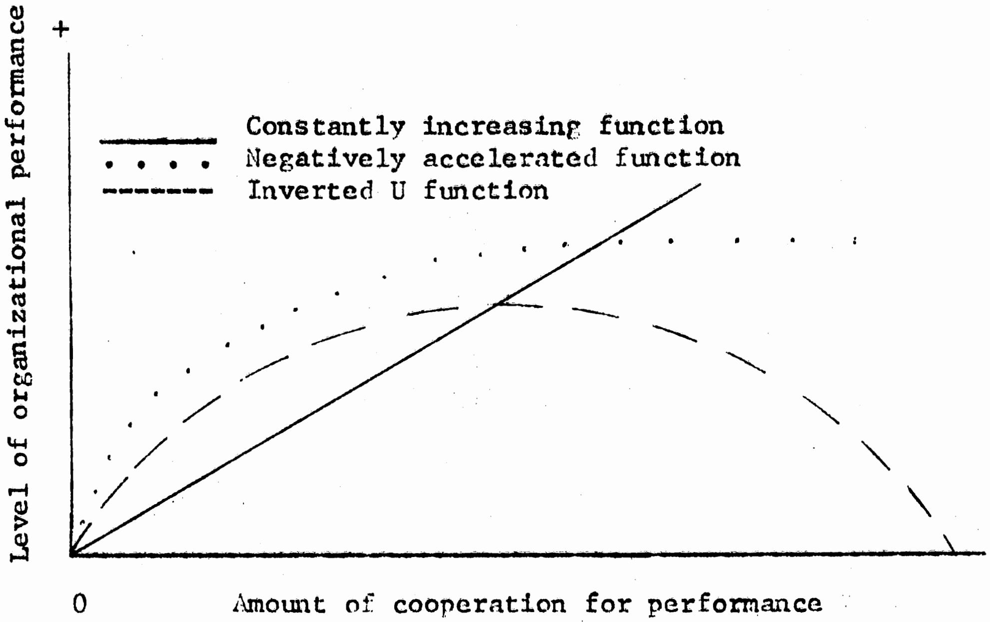

Figure 5. Hypothetical Relationship Between Amount of Cooperation and Level of Organizational Performance

most organizational interactions.

Though competition or other forms of conflict may be functional for organizations and individuals, the more generally desired objective is to increase cooperation of organizations. Increased cooperation of organizations generally produces gains in organizational productivity and effectiveness. The very essence of an organization is that persons interacting in the organization do so because they expect the organization to provide values they otherwise might not have. A parallel concept operates in regard to organizational cooperation. That is, when organizations engage in cooperation interaction, they have the potential of creating values. Vertical interaction—when a subunit of an organization interacts with a higher, larger unit of which the subunit is a part—can produce such values. Horizontal interaction—when an organization interacts with another on its level—also can produce values. Indeed, just as for individual persons, all types of interactions of organizations have the potential for increasing productivity (Hicks, 1975).

There are several implications of the results of the present study. First, cooperation is a useful interactional measure. Second, engineering supervisors appear to have similar cognitive models of the factors and factor weightings which assess cooperation. Thirdly, the causal factors affecting cooperation are interrelated and can be reduced to a smaller number. Finally, it seems that management can increase cooperation by controlling the cues for the strategic variables. The technique presented can promote effective human resource management with the result of greater organizational cooperation. In effect, it forces management to evaluate where they are so that they can see where they are going. The establishment and relationship of the variables evaluates where the group is; the manipulation of the variables determines the direction they are going.

Extensions of the present work could attempt to answer several questions that have resulted: (1) how do the cooperation characteristics as established by engineering supervisors compare with characteristics established by non-technical supervisors; (2) how does the measure of cooperation of the engineering group compare with the cooperation measure of the total organization; (3) how long are the established strategic variables valid; (4) is there any relationship between the cooperation causal factors for government engineers and industry engineers; and (5) how much is cooperation increased by reinforcing the strategic variables. This type of research would be an asset in meeting the challenge of increasing human effectiveness, realizing the advantage in channeling human talent and energy into constructive outlets.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to develop a model that measures cooperation in a technical environment and the strategic variables that affect it. Cooperation was defined as the willingness and ability to work with others to achieve a common goal. Twenty engineering supervisors and 174 government engineers took part in the study. One hundred and two of the engineers served as the population sample and 72 participated in research instrument validation. To measure cooperation, 20 engineering supervisors rated 30 simulated work units for cooperation. The cooperation of the real work group of 102 engineers was then determined and cooperation causal factors were regressed on this measure of cooperation to determine the strategic variables.

The ratings for the 30 simulated cases utilized the technique of "policy capturing". Using these ratings as the dependent variable and the cooperation characteristics of the simulated work units as the independent variables, the coefficients for the cooperation characteristics were obtained. The Kendall coefficient of concordance W for agreement on the importance of the characteristics was significant using a χ^2 statistic. Ease of communication, cohesiveness, working harmoniously with others, coordination of efforts, interdependent decision making, and a favorable evaluation of the group and its procedures accounted for 89% of the variance of the cooperation measure in the simulated units. The value of cooperation in the actual work group was obtained by solving the regression equation utilizing the simulated characteristic weights and the group levels of the characteristics.

Sixteen causal factors were hypothesized to account for the level of cooperation in the work group. An instrument consisting of 80 questions concerning these 16 factors was administered to 72 engineers for validation. A factor analysis was performed reducing the number of questions to 60 and combining the questions into factor groups. The revised questionnaire was administered to the 102 engineers of the work group to obtain the values for the causal factors. With the value obtained for work unit cooperation as the dependent variable and the values obtained for the causal factors as the independent variables, the causal factors were regressed on cooperation to determine the relationship between them. Social attraction, leadership style, technology interdependence, and rewards were determined to be the strategic variables for increasing technical cooperation. The variables were highly correlated and had a significant coefficient of multiple determination (R^2).

The major implications of the present results were seen to be: (1) cooperation is a useful interactional measure; (2) engineering supervisors appear to have similar cognitive models of the factors and factor weightings which assess cooperation; (3) the causal factors affecting cooperation are interrelated and can be reduced to a smaller number; and (4) management can increase cooperation by controlling the cues for the strategic variables. The technique presented was seen as promoting effective human resource management with the result of greater organizational cooperation.

Extensions of the work suggested for further research based on questions raised by the present results were: (1) how do the cooperation characteristics as established by engineering supervisors compare with characteristics as established by non-technical supervisors; (2) how does the measure of cooperation of the engineering group compare with the cooperation measure of the total organization; (3) how long are the established strategic variables valid; (4) is there any relationship between the cooperation causal factors for government engineers and industry engineers; and (5) how much is cooperation increased by reinforcing the strategic variables.

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APPENDIX A

POLICY CAPTURING

POLICY CAPTURING

Technical management personnel often must base judgments and decisions upon complex arrays of information. If they could state explicitly how they used this information, these decision makers—and others—could replicate these judgments in subsequent situations in which the same types of information are available. As a rule, however, managers cannot explain precisely how they use information to reach their decisions.

If it is possible to obtain all the information available to decision makers and an adequate sample of their decisions, we usually can formulate a regression model that satisfactorily accounts for the decisions. Although this model may not use the items of information in the same way as the human judges, it may be said to simulate their decision-making policy, for it leads to decisions similar to those in the sample. Once the model is formulated, we can use it to obtain innumerable decisions without the variability that results from fatigue and other factors that may affect human judgments. Furthermore, if the model predicts the sample of decisions accurately, it seems reasonable to use it to predict other judgments that would be reached in similar situations in which the same items of information are available.

Since the regression equation may adequately simulate the judgment process, this concept can be extended to measure cooperation. Mahoney and Weitzel (1969), Mahoney and Frost (1974), and Hitt and Morgan (1975) have found that global effectiveness assessments made by supervisors are valid and reliable. It is reasonable that the same results apply to cooperation. Thus, if supervisors are able to make evaluations of unit cooperation that are reliable and valid, then supervisors must possess a cognitive model of the factors and factor weightings which assess cooperation. If these cognitive models can be "captured," and actual data pertaining to these factors can be obtained in a more objective manner, not only can cooperation be measured but supervisory biases which distort the models can be eliminated. The process for doing this is formally termed "policy capturing".

Capturing judgment policies for officer promotion boards (Christal, 1969), for citizen participation in planning (Stewart and Gelbard, 1972), for bank loan decisions (Wilsted, Hendrick, and Stewart, 1973), and for performance appraisals (Taylor and Wilsted, 1974) are examples of the application of policy capturing models. The postulate is that when individuals must evaluate other things or make a decision, an underlying judgment policy (cognitive model) governs the way each person integrates the various pertinent items of information or variables into a single judgment. In the measurement of cooperation, this involves discovering the characteristics of cooperation considered by technical supervisors, and determining how these characteristics are weighted in supervisory judgements of cooperation.

This could be accomplished by having supervisors rate the cooperation of several work units for which cooperation characteristics were measured and available. Using the ratings of cooperation as the dependent variable, and the measures of the cooperation characteristics as independent variables, multiple linear regression could be used to determine which characteristics had been used in the ratings, as well as the weighting factors of those characteristics. The main difficulty of this approach is the time it would take for the supervisors to acquaint themselves with unfamiliar work units in order to make measurements of the characteristics, especially since several different units would have to be evaluated by each supervisor.

Therefore, instead of rating actual operating units, samples can be created by ascribing measures of cooperation characteristics to simulated work units. It can be demonstrated that exactly the same results (regression equations) will be obtained using simulated cases as real conditions, provided two conditions are met. First, every case generated must be conceivable to the supervisor rater. Second, the scores must be ascribed in a manner which assures reasonable variance for each cooperation characteristic (independent variable) (Middlemist and Hitt, 1975).

APPENDIX B

COOPERATION EVALUATIONS

COOPERATION EVALUATIONS

The purpose of this exercise is to obtain your evaluation (rating) of the cooperation of 30 simulated engineering work groups. Various information that might be helpful to you in your determination of each group's cooperativeness is presented to assist in your evaluation. It is expected that a "cooperative" group will be considerably different from a "non-cooperative" group in terms of the information presented. The information in the cases presented here varies widely from case to case making it likely that a good spread of cooperative, partially cooperative, and non-cooperative groups have been included.

Instructions. Assume that a management review has been performed of each of the 30 groups represented in the simulated cases. The data collected is in the form of five-point scales (from low to high) which are marked by management to reflect their analysis of each separate activity (factor). Please read each case, considering the information presented on the particular group and record your evaluation of that group's cooperation on the five-point evaluation scale following the report. There are 30 cases so do not spend a great amount of time on any one, but do consider all the information before recording your judgment.

Example. If you felt one group depicted was particularly non-cooperative, you would place an X in the left blank:

non-cooperative	X	: ___	: ___	: ___	: ___	very cooperative
	1	2	3	4	5	

If you felt another group was especially cooperative, you would place an X in the right blank:

non-cooperative	___	: ___	: ___	: ___	: X	very cooperative
	1	2	3	4	5	

Groups that were of average cooperation would be rated in one of the more central blanks.

CASE ___

	Low 1	Moderately Low 2	Average 3	Moderately High 4	High 5
(1) Tact and diplomacy of the group	☐	☐	☐	☐	☐
(2) Working harmoniously with others.	☐	☐	☐	☐	☐
(3) Considering other points of view.	☐	☐	☐	☐	☐
(4) Giving assistance	☐	☐	☐	☐	☐
(5) Interdependent decision making.	☐	☐	☐	☐	☐
(6) Ease of communication	☐	☐	☐	☐	☐
(7) Rapid decisions and resolutions	☐	☐	☐	☐	☐
(8) Reaching agreements	☐	☐	☐	☐	☐
(9) Task completion	☐	☐	☐	☐	☐
(10) Coordination of efforts . . .	☐	☐	☐	☐	☐
(11) Productivity per unit time. .	☐	☐	☐	☐	☐
(12) Favorable evaluation of the group and its procedures. . .	☐	☐	☐	☐	☐
(13) Cohesiveness.	☐	☐	☐	☐	☐
(14) Positive feeling about the organization.	☐	☐	☐	☐	☐
(15) Recognition of priorities . .	☐	☐	☐	☐	☐
(16) Willingness to share information.	☐	☐	☐	☐	☐
(17) Maturity of the group	☐	☐	☐	☐	☐
(18) Awareness of the total situation.	☐	☐	☐	☐	☐

	Low 1	Moderately Low 2	Average 3	Moderately High 4	High 5
(19) Recognition of management interest.	☐	☐	☐	☐	☐
(20) Frequency of interaction. . .	☐	☐	☐	☐	☐

Based upon the information presented above and upon your experience and knowledge, please rate the cooperation of this work group on the following scale by placing an X in the appropriate space:

non-cooperative ____ : ____ : ____ : ____ : ____ very cooperative
1 2 3 4 5

APPENDIX C

THE KENDALL COEFFICIENT OF CONCORDANCE

THE KENDALL COEFFICIENT OF CONCORDANCE

As a solution to the problem of ascertaining the overall agreement among k sets of rankings, it might seem reasonable to find the r_s's between all possible pairs of the rankings and then compute the average of these coefficients to determine the overall association. In following such a procedure, $\binom{k}{2}$ rank correlation coefficients would need to be computed. Unless k were very small, such a procedure would be extremely tedious.

The computation of W is much simpler and W bears a linear relation to the average r_s taken over all groups. Denoting the average value of the Spearman rank correlation coefficients between the $\binom{k}{2}$ possible pairs of rankings as $r_{s_{av}}$ then

$$r_{s_{av}} = \frac{kW - 1}{k - 1}$$

Another approach would be to imagine how the data would look if there were no agreement among the several sets of rankings, and then to imagine how it would look if there were perfect agreement among the several sets. The coefficient of concordance would then be an index of the divergence of the actual agreement shown in the data from the maximum possible (perfect) agreement. Very roughly speaking, W is just such a coefficient.

Suppose three supervisors are asked to rank six variables separately in their order of importance for evaluating cooperation. The three independent sets of ranks given by supervisors X, Y, and Z to variables a through f might be those shown below (artificial data).

	Variable					
	a	b	c	d	e	f
Engineer X	1	6	3	2	5	4
Engineer Y	1	5	6	4	2	3
Engineer Z	6	3	2	5	4	1
R_j	8	14	11	11	11	8

The bottom row of the table labeled R_j, gives the sums of the ranks assigned to each variable.

Now if the three supervisors had been in perfect agreement about the variables, i.e., if they had each ranked the six variables in the same order, then one variable would have received three ranks of 1 and thus, its sum of ranks, R_j, would be $1 + 1 + 1 = 3 = k$. The variable which all supervisors designated as the runner-up would have $R_j = 2 + 2 + 2 = 6 = 2k$. The least important variable would have $R_j = 6 + 6 + 6 = 18 = Nk$. In fact, with perfect agreement among the engineers, the various sums of ranks, R_j, would be these: 3, 6, 9, 12, 15, 18 though not necessarily in that order. In general, when there is perfect agreement among k sets of rankings, the series: k, 2k, 3k, . . . , Nk, for the R_j, is obtained.

On the other hand, if there had been no agreement among the three supervisors, then the various R_j's would be approximately equal.

From this example, it should be clear that the degree of agreement among the k judges is reflected by the degree of variance among the N sums of ranks. W, the coefficient of concordance, is a function of that degree of variance.

To compute W the sum of the ranks, R_j, in each column of a k x N table is found. Then the R_j is summed and divided by N to obtain the mean value of the R_j. Each of the R_j may then be expressed as a deviation from the mean value. (It has been shown above that the larger are these deviations, the greater is the degree of association among the k sets of ranks.) Finally, s, the sum of the squares of these deviations, is found. Knowing these values, the value of W may be computed by:

$$W = \frac{s}{1/12\ k^2\ N^3 - N}$$

Where s = sum of squares of the observed deviations from the mean of R_j, that is,

$$s = \sum \left(R_j - \frac{R_j}{N}\right)^2$$

k = number of sets of rankings, e.g., the number of judges.

N = number of entities (objects or individuals) ranked.

$1/12\ k^2(N^3 - N)$ = maximum possible sum of the squared deviations, i.e., the sum s which would occur with perfect agreement among k rankings.

One difference between the W and the $r_{s_{av}}$ methods of expressing agreement among k rankings is that $r_{s_{av}}$ may take values between -1 and +1, whereas W may take values only between 0 and +1. The reason that W cannot be negative is that when more than two sets of ranks are involved, the rankings cannot all disagree completely. For example, if judge X and judge Y are in disagreement, and judge X is also in disagreement with judge Z, then judges Y and Z must agree. That is, when more than two judges are involved, agreement and disagreement are not symmetrical opposites. k judges may all agree, but they cannot all disagree completely. Therefore, W must be zero or positive.

The method for determining whether the observed value W is significantly different from zero, for N greater than 7, involves computing a value of χ^2 from the formula $\chi^2 = k(N - 1) W$ whose significance, for df = N - 1, may be tested by reference to a table of critical values of Chi Square. (Siegel 1956)

APPENDIX D

CAUSAL FACTOR INSTRUMENT

CAUSAL FACTOR INSTRUMENT

1. This questionnaire is being utilized to gather and evaluate information concerning organizational activities at MICOM.

2. Please read each statement and give the answer that shows how you feel about it. If you do not find the exact answer that fits your case, use the one that is closest to it.

3. There are five possible answers to choose from to indicate your thinking about each question. Remember, the accuracy of your description depends on your being straightforward in answering this questionnaire. You will not be identified with your answers.

4. Questions are answered by marking the appropriate answer spaces as illustrated in this example. Mark each statement (X) whether you strongly agree (SA), agree (A), are uncertain (U), disagree (D), or strongly disagree (SD).

<u>EXAMPLE</u>: For instance, if you felt strongly that your job requirements were very clear you would mark:

	SA	A	U	D	SD
Job requirements are very clear. . .	(X)	( )	( )	( )	( )

5. There are no right or wrong answers, only your opinion.

	SA	A	U	D	SD
1. I frequently discuss the work of my co-workers with them	( )	( )	( )	( )	( )
2. I like the people I work with	( )	( )	( )	( )	( )
3. Individual effort is rewarded more often than group effort in my work group	( )	( )	( )	( )	( )
4. There is no opportunity for participation in the setting of goals.	( )	( )	( )	( )	( )
5. There is much interaction and communication in my work group	( )	( )	( )	( )	( )
6. I enjoy helping people when I can be of assistance.	( )	( )	( )	( )	( )
7. Working together is more important than individual effort in accomplishing tasks	( )	( )	( )	( )	( )
8. Communication is not very accurate and timely.	( )	( )	( )	( )	( )
9. Individual accomplishment is an important rating factor in evaluating my performance	( )	( )	( )	( )	( )
10. My general interests and attitudes are different from those of my fellow workers	( )	( )	( )	( )	( )
11. Willingness to help others is an important individual trait	( )	( )	( )	( )	( )

	SA	A	U	D	SD
12. The direction of communication flow is throughout the organization, not just up and down	( )	( )	( )	( )	( )
13. I would not recommend Government service as a career to my friends . . .	( )	( )	( )	( )	( )
14. The people with whom I work sometimes seem unreasonable in their dealings with me	( )	( )	( )	( )	( )
15. It is important to be unselfish and sincerely interested in others.	( )	( )	( )	( )	( )
16. In my work group, communications are usually accepted by subordinates. . . .	( )	( )	( )	( )	( )
17. The experience you get in working for a private employer is worth more than experience in a Government job.	( )	( )	( )	( )	( )
18. My job will be required as long as there is work to be done.	( )	( )	( )	( )	( )
19. I like my present job	( )	( )	( )	( )	( )
20. Management behaves so that subordinates feel free to discuss important things about their jobs with them.	( )	( )	( )	( )	( )
21. I generally do not "know what to expect"	( )	( )	( )	( )	( )
22. The rewards I receive reflect my accomplishments in working with others toward organizational objectives. . . .	( )	( )	( )	( )	( )

	SA	A	U	D	SD
23. People are basically trustworthy, honest and responsible.	( )	( )	( )	( )	( )
24. I am paid an adequate salary for the job I perform	( )	( )	( )	( )	( )
25. I enjoy participating in activities which reward individual excellence more than participating in activities which reward group accomplishments.	( )	( )	( )	( )	( )
26. I generally receive a lot of messages or communication from others.	( )	( )	( )	( )	( )
27. There needs to be more communication between superiors and subordinates in my work group	( )	( )	( )	( )	( )
28. I derive a lot of satisfaction from my work.	( )	( )	( )	( )	( )
29. I have meaningful interpersonal relationships with others in my work group.	( )	( )	( )	( )	( )
30. Trust and confidence in my co-workers are important factors to me	( )	( )	( )	( )	( )
31. I have made real and lasting friends among my working associates	( )	( )	( )	( )	( )
32. It is not important to have trust in superiors	( )	( )	( )	( )	( )
33. It is necessary for the group to work together to accomplish organizational goals	( )	( )	( )	( )	( )

	SA	A	U	D	SD
34. There are conflicting values in my work group.	( )	( )	( )	( )	( )
35. The good points about the jobs in Government services are greater than the bad points.	( )	( )	( )	( )	( )
36. Within my work group there are few common goals.	( )	( )	( )	( )	( )
37. I dislike my job more than most people.	( )	( )	( )	( )	( )
38. Management does not willingly share information with subordinates	( )	( )	( )	( )	( )
39. I would rather work with a group on a project than to work on my own.	( )	( )	( )	( )	( )
40. I know enough about my co-workers' task achievement to evaluate their competency	( )	( )	( )	( )	( )
41. My co-workers can be relyed on in most situations.	( )	( )	( )	( )	( )
42. The Government is one of the best employers to work for	( )	( )	( )	( )	( )
43. Mutual goals are more encouraged by the organization than individual excellence	( )	( )	( )	( )	( )
44. My desk is located too close to my co-workers	( )	( )	( )	( )	( )
45. The task assigned to me is part of a whole set of tasks rather than an independent effort.	( )	( )	( )	( )	( )

	SA	A	U	D	SD
46. Given a choice between working for the Government and private employment, I would choose the Government job	( )	( )	( )	( )	( )
47. Management generally tries to get subordinates' ideas and opinions and make constructive use of them.	( )	( )	( )	( )	( )
48. I have a high regard for the interests of others	( )	( )	( )	( )	( )
49. If someone genuinely needed help, I would do so even though it might be inconvenient for me at the time	( )	( )	( )	( )	( )
50. Management relies more on mutual confidence and good relationships with people rather than on the exercise of authority to get things done.	( )	( )	( )	( )	( )
51. My supervisor usually keeps the door to his office closed	( )	( )	( )	( )	( )
52. My co-workers are not very responsible.	( )	( )	( )	( )	( )
53. My job is only part of a whole set of integrated activities necessary to achieve the organizational mission. . .	( )	( )	( )	( )	( )
54. There is real cohesiveness in my work group	( )	( )	( )	( )	( )
55. My job could not be done if I had no knowledge of the work being done by other people in the organization. . . .	( )	( )	( )	( )	( )

	SA	A	U	D	SD
56. There is constantly changing leadership in my organization	( )	( )	( )	( )	( )
57. I consider my work surroundings to be pleasant.	( )	( )	( )	( )	( )
58. There are frequent group coordinative meetings in my unit	( )	( )	( )	( )	( )
59. I spend a lot of time talking with my co-workers about task related matters .	( )	( )	( )	( )	( )
60. I am familiar with the work of my co-workers.	( )	( )	( )	( )	( )

PART II

On a scale of 1 to 5, with 5 being the highest value, rate the level of each of the following characteristics in your work group.

EXAMPLE: For instance, if you felt that ease of communication was always present in your work group you would mark:

	1	2	3	4	5
Ease of communication	( )	( )	( )	( )	(X)

	1	2	3	4	5
1. Working harmoniously with others.	( )	( )	( )	( )	( )
2. Ease of communication	( )	( )	( )	( )	( )
3. Coordination of efforts	( )	( )	( )	( )	( )
4. A favorable evaluation of the group and its procedures.	( )	( )	( )	( )	( )
5. Cohesiveness.	( )	( )	( )	( )	( )
6. Interdependent decision making.	( )	( )	( )	( )	( )

APPENDIX E

FACTOR ANALYSIS

FACTOR ANALYSIS

Factor analysis is an extremely powerful and useful approach to behavioral data, one that can help solve intractable research problems. Factor analysis is a method for determining the number and nature of the underlying variables among larger number of measures. More succintly, it is a method for determining k underlying variables (factors) from n sets of measures, k being less than n. It may also be called a method for extracting common factor variances from sets of measures.

Factor analysis serves the cause of scientific parsimony. It reduces the multiplicity of tests and measures to greater simplicity. It tells us, in effect, what tests or measures belong together--which ones virtually measure the same thing, in other words, and how much they do so. It thus reduces the number of variables with which the researcher must cope. It also helps the researcher locate and identify unities or fundamental properties underlying tests and measures.

After tests are administered and scored, coefficients of correlation are calculated between each test and every other test. The coefficients are then presented in a correlation matrix. The problem can be expressed in two questions: How many underlying variables, or factors, are there? What are the factors? They are presumed to be underlying unities behind the test performances reflected in the correlation coefficients. If two or more tests are substantially correlated, then the tests share variance. They have common factor variance. They are measuring something in common.

One of the final outcomes of a factor analysis is called a factor matrix, a table of coefficients that express the relations between the tests and the underlying factors. The entries in the table are called factor loadings. They can be written aij, meaning the loading a of test i on factor j. Factor loadings are not hard to interpret. They range from -1.00 through 0 to +1.00, like correlation coefficients. They are interpreted similarly. In short, they express the correlations between the tests and the factors.

Unfortunately, there is no generally accepted standard error of factor loadings. A crude rule is to use the standard error of r, or easier, to find the r that is significant for the N of the study. For example, with N = 200 an r of about .18 is significant at the .01 level. Some factor analysts in some studies do not bother with loadings less than .30, or even .40. Other do. The use of 1/ N as the standard error of factor loadings is also used. Whatever formula or method used must be used with circumspection.

There are a number of methods of factor analyzing a correlation matrix: principle factors, diagonal, centroid, minres, image and so on. The method that is used the most at present and that is widely available at computer installations is the principal factors method. The principle factors method is mathematically satisfying because it yields a mathematically unique solution of a factor problem. Perhaps its major volution feature is that it extracts a maximum amount of variance as each factor is calculated.

To show the logic of the principal factors method without considerable mathematics is difficult. One can achieve a certain intuitive understanding of the method however by approaching it geometrically.

Conceive test or variables as points in m-dimensional space. Variables that are highly and positively correlated should be near each other and away from variables with which they do not correlate. If this reasoning is correct, there should be groups of points in space. Each of these points can be located in the space if suitable axes are inserted into the space, one axis for each dimension of the m dimensions. Then any point's location is its multiple identification obtained by reading its coordinates on the m axes. The factor problem is to project axes through neighboring groups of points and to so locate these axes that they account for as much of the variances of the variables and possible.

The above description is figurative. Factor loadings are not read from reference axes; they are calculated using rather complex methods. The principal factor method actually involves the solution of simultaneous linear equations. The roots obtained from the solution are called eigenvalues. Eigenvectors are also obtained; after suitable transformation, they become the factor loadings.

Most factor analytic methods produce results in a form that is difficult or impossible to interpret. Thus it is usually necessary to rotate factor matrices to interpret them adequately. The two main types of rotation are called "orthogonal" and "oblique". Orthogonal rotations maintain the independence of factors, that is, the angles between the axes are kept at 90 degrees. This means that the correlation between the factors is zero. Rotations in which the factor axes are allowed to form acute or obtuse angles are called oblique. Obliqueness, of course, means that factors are correlated.

Some researchers prefer to rotate orthogonally. Others insist that orthogonal rotation is unrealistic, that actual factors are not usually uncorrelated and that rotations should conform to reality. Two remarks are relavent to this subject. One, the type of rotation seems to be a matter of taste. Two, the researcher should understand both types of rotation to the extent that he can interpret both kinds of factors. He should be particularly careful when confronted with the results of oblique solutions. They contain peculiarities and subtleties not present in orthogonal solutions (Kerlinger 1973).

Computer Observation Structure for Factor Analysts

The factor analysis for this study utilized an International Mathematical and Statistical Libraries (IMSL) program from the IMSL Library 3, Edition 5 manual and was run on the Control Data Corporation (CDC) 6600 computer.

A Synopsis of the Purpose of Each of the Subroutines

COEF - compute a matrix of factor score coefficients.

COMM - compute an unrotated factor loading matrix according to a common factor model by unweighted or generalized least squares, or by maximum likelihood procedures.

HARR - transformation of an unrotated factor loading matrix to oblique axes by the Harris-Kaiser method.

IMAG - compute an unrotated factor loading matrix according to an image model.

PRIN - compute an unrotated factor loading matrix according to a principal component model.

PROT - oblique transformation of the factor loading matrix using a target matrix, including pivot and power vector options.

ROTA - orthogonal rotation of a factor loading matrix using a generalized orthomax criterion, including quartimax, varimax, and equamax.

SCHN - orthogonal transformation of the factor loading matrix using a target matrix.

SCOR - compute a set of factor scores given the factor score coefficient matrix.

Featured Abilities

With the factor analysis subroutines, a broad class of problems can be solved. It is convenient to approach the solution in five steps:

Step 1 - Calculate the correlation matrix R.

Step 2 - Calculate an unrotated factor loading matrix A (COMM, IMAG or PRIN).

Step 3 - Calculate a rotated factor loading matrix B to enhance interpretability (HARR, PROT, ROTA or SCHN).

Step 4 - If factor scores are desired, calculate the factor score coefficient matrix (COEF).

Step 5 - Estimate the factor scores of a group of subjects (SCOR).

The basic factor analysis problem is as follows:

Suppose NV (number of variables, after an initial data transformations) measurements on NT subjects have been made.

NF factors that represent linear relationships among the observed variables are then constructed. The net result is either

a. data reduction - NF usually less than half of NV and one has most of the "information" contained in the NV variables compressed into NF factors.

b. or a factor analysis model of one of two kinds:

1. taxonomic view - the factors are merely convenient clusters of variables (PRIN - principal components, computationally cheap)

2. explanatory view - the factors are causal in nature, scientifically replicable and of theoretical interest, determining the correlation among the variables (COMM - common factor, most expensive, but most powerful; at a fraction of the cost of COMM, an image analysis may be performed that in the sampling limit is equivalent to common factor analysis (IMAG)).

In factor analysis, as opposed to principal components, the diagonal of the correlation matrix is replaced by the unique variances (or communalities), which will be less than unity. The squared multiple correlation of a variable with all of the other variables should be taken as a lower bound for the unique variance. COMM inputs initial estimates for the unique variances through vector V, while IMAG requires the user to replace the diagonal elements of the input correlation matrix R with the communality estimates.

The result of step 2, then, is the unrotated factor loading matrix $A=(a_{ij})$, $i=1,\ldots,NV$ and $j=1,\ldots,NF$, where a_{ij} is the loading of variable i on factor j. Each column of the matrix A corresponds to one factor and contains the loadings. If the factors are statistically independent, the factors are orthogonal. Otherwise, the factors are oblique. Note that all the loading signs for a factor may be reversed.

The factors (loadings) obtained in step 2 are not unique. So in Step 3, the factors are transformed (rotated) to simplify the interpretation of the "physical significance" of each factor. Ideally, a factor might have non-zero loadings on only a few variables (or alternatively, perhaps each variable may be weighted on only a few factors). Several methods are available to calculate B, the rotated factor loading matrix. Transformed factors that are orthogonal (independent) may be obtained from ROTA or SCHN, and obliquely transformed factors from HARR or PROT. A further distinction may be made stemming from any prior knowledge of the rotated loading matrix. No prior knowledge is referred to as a blind transformation. Prior knowledge is manifested in a target matrix and the terms subjective or Procrustean are applied to such procedures. ROTA, HARR, and PROT (two options) are blind procedures while SCHN and PROT (third option) are subjective procedures.

In summary, an initial structure or unrotated factor loading matrix is calculated in step 2. Since most variables will be loaded on each factor, it is desired in step 3 to obtain a simple structure matrix, one with a greater number of large and zero loadings. Also the pattern matrix is calculated in step 3. If an orthogonal rotation is used in step 3, the structure and pattern matrices will be identical.

Several executions of steps 2 and 3 may be required to determine the number of factors NF, the appropriate model to use, and the rotation method that results in interpretable loadings. Finally, for any subject, NF actual factor scores may be estimated using the subject's NV measurements. COEF is used to obtain a factor score coefficient matrix that can be used to estimate factor scores for any subset of the original data (or new data) using SCOR.

Blocks of computation that may be performed and options that are available are outlined in Figure 6. The step 1 calculation of a correlation matrix may be performed by any correlation routine. The computation flow for the research problem is shown by the dash lines. Algorithms for the three steps are as follows:

Algorithm 1 - Correlation Matrix

Computation of the means of the M variables uses the following formula:

$$\overline{X}_j = \sum_{i=1}^{N} \frac{X_{ij}}{N}, \; j=1,2,\ldots,M,$$

where X_{ij} is observation i on variable j and N is the number of observations per variable.

Standard deviations are computed using the following formula:

$$s_j = \sqrt{\sum_{i=1}^{N} x_{ij}^2/(N-1)}, \; j=1,2,\ldots,M,$$

where, $x_{ij}=X_{ij}-\overline{X}_j$.

Computation of the simple correlation coefficients of the M variables is done as follows:

$$r_{ij}=\begin{cases} \dfrac{\sum_{k=1}^{N} x_{ki}x_{kj}}{(N-1)s_i s_j}, & i\neq j \\ 1 \quad , & i=j \end{cases}$$

Algorithm 2 - Principle Component

The eigenvalues $E=(e_i)$ and eigenvectors $Q=(q_i)$ of the correlation matrix R, with e_1 e_2 ... e_{NV}, satisfy $Rq_i=e_iq_i$. The number of factors NF may be input, or determined by the Kaiser-Guttman criterion of the number of eigenvalues greater than unity. The unrotated component pattern matrix A is given by

$$A = Q_{NF}D_{NF}^{1/2} \quad ,$$

where Q_{NF} is the matrix of the first NF columns of Q and D_{NF} is a diagonal matrix of the largest NF eigenvalues.

Algorithm 3 - Orthogonal Rotation

The rotated factor loading matrix $B=(b_{ij})$ is matrix A, orthogonally transformed to make as many of the b_{ij} coefficients as small in magnitude as possible. A general orthomax criterion function is maximized:

$$\sum_{i=1}^{NF} \sum_{j=1}^{NF} b_{ij}^4 - W \sum_{j=1}^{NF} \left(\sum_{i=1}^{NV} b_{ij}^2 \right)^2$$

where b_{ij} is the loading of variable i on orthogonally transformed factor j, and W is a parameter determinig the kind of solution to be computed.

a. W = 0.0 is the Quartimax method, which attempts to get each variable to load highly on only one (or a few) factor(s).

b. W = 1.0 is the Varimax method, which attempts to load highly a relatively low number of variables on each factor. Varimax is most widely used.

c. W = NF/2.0 is the Equamax method, which is a compromise of of the above two.

d. W can be any real number, but best values lie in the interval [1.0, 5.0*NF]. Generally the larger W is, the more equal is the dispersion of the variance accounted for across the factors.

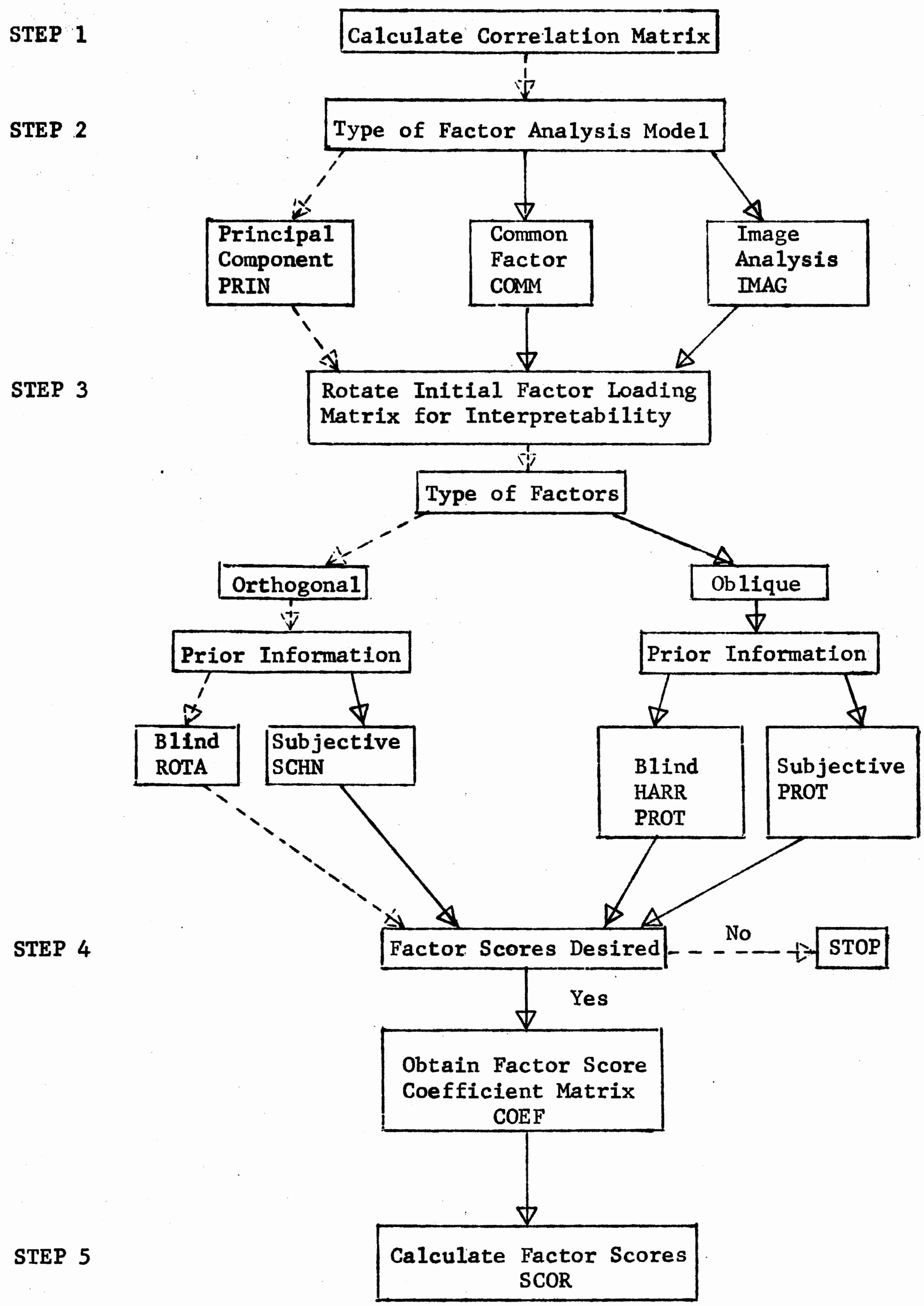

Figure 6. Factor Analysis Flow Chart

VITA

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Doctor of Philosophy

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