This is to certify that the

thesis entitled

THE EFFECTS OF TEAM COMPOSITION AND INCENTIVES ON TEAM PERFORMANCE ON AN INTERDEPENDENT TASK

presented by

Ronald Stephen Landis

has been accepted towards fulfillment of the requirements for

M. A. degree in Psychology

Major professor

Date 4-14-92

THE EFFECTS OF TEAM COMPOSITION AND INCENTIVES ON TEAM PERFORMANCE ON AN INTERDEPENDENT TASK

By

Ronald Stephen Landis

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Psychology

1992

ABSTRACT

THE EFFECTS OF TEAM COMPOSITION AND INCENTIVES ON TEAM PERFORMANCE ON AN INTERDEPENDENT TASK

By

Ronald Stephen Landis

This thesis sought to address two factors which contribute to team task performance: incentives and team composition. Literature on incentives and composition was reviewed and hypotheses were proposed concerning the anticipated interactive effect of these two variables on team performance. The task used was adopted from Hollenbeck, Sego, Ilgen, & Major (1991) and required participants to assume roles within a hypothetical naval carrier team. As members of such a team, participants were asked to make decisions regarding the threat level presented by a hypothetical target aircraft which had entered the team's airspace. Results suggested that neither incentives nor team composition affected team performance. However, previous research on the relationship of team member ability and team performance (i.e. Tziner & Eden, 1985) was replicated. A discussion of the results, possible limitations of the current study, and avenues for future research are presented.

ACKNOWLEDGMENTS

I would like to take this opportunity to thank several people who have been instrumental in helping me complete this thesis. First, I would like to thank Dan Ilgen and John Hollenbeck, not only for their guidance as members of my committee, but also for providing me with the use of laboratory space, materials, and finances I needed to collect this data. I would also like to thank several of my colleagues, notably Mickey, Jose, Jeff, Keith, and Stephen for helping me work through some of the issues and problems that naturally arose along the way. Also, Jean Phillips and Doug Sego deserve thanks for helping me collect data and showing me around the lab. In particular I would like to thank Neal Schmitt who, as my Chairperson, helped me through all phases of this project by providing me with invaluable advice and incredible turnaround of revisions. Thanks a lot Neal for keeping me focused and helping me produce a thesis for which I can be proud. Finally, I would like to say thanks to Sandy. You helped and supported me through all those times that I thought about trashing the whole thing and, more importantly, showed me what you can accomplish if you believe in something.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

As Sundstrom, De Meuse, and Futrell (1990) suggested, two terms commonly used interchangeably in discussions of today's organizations are work team and work group. The increased use of these terms in discussions of business reflects the fact that teams occupy a pivotal role in what has been described as a management revolution (Sundstrom et al. 1990). As Hackman (1986) predicted and Peters (1988) advised, organizations should organize every function into self-managing work teams.

In addition to forming a critical link between the individual and the organization, task groups are the central building blocks for getting work done in organizations (Goodman, Ravlin, & Schminke, 1987). And as Mills (1979) points out, because groups are so pervasive in organizations, determine, in part, the effectiveness of organizations, and greatly affect the lives of group participants, it is becoming increasingly important that we understand the factors that determine high performance in task groups. It has been over eighteen years since Steiner (1972, p. vii) suggested that, "the group seems to have gone out of fashion." He points specifically to the fact that researchers had shown much interest in groups until the late 1950's, when the focus was shifted to the individual level of analysis.

After that time, Steiner suggests that task groups, as a research area, were largely ignored. Similarly, Goodstein and Dovico (1979) asserted that research on groups has become relatively dormant. In a recent review, Austin and Bobko (1985) also suggested that there has been relatively little research conducted on group processes and group performance given the fact that the productivity of a work group is a critical component of an organization's productivity. The relative paucity of research on groups and the growing importance of performance involving interdependent work groups on organizational success suggest there is a need to better understand the factors which affect group performance.

Given the large body of research earlier in this century that examined the extent to which incentives alter motivation and behavior (e.g. Hull, 1943; Skinner, 1938, Taylor, 1947), and, more recent reviews of this relationship (Campbell & Pritchard, 1976; Guzzo, 1979), it is quite clear that financial and nonfinancial incentives can lead to higher performance, if the incentive system is properly designed. These conclusions have been reached by many researchers examining the issue of incentives affecting individual performance (Guzzo, 1979; Korman, Glickman, & Frey, 1981; Lawler & Porter, 1967; Opsahl & Dunnette, 1966; Pritchard & Sanders, 1973). Recent literature indicates that group-based incentive systems may also be effective in motivating groups and increasing group performance (Bullock & Lawler, 1984; Deutsch, 1985; Kim, Park, & Suzuki, 1990). However, the conditions under which different group incentive systems may be successful has received

less attention and would seem to be an important area of research interest (Deutsch, 1975, 1985).

Because members of a small group are its most important resource, and the subsequent outcomes of a group are a function of the people who belong to it, Levine and Moreland (1990) assent that understanding the characteristics and attributes of group members is important to understanding the ultimate effectiveness of the group. Research in the area of group composition has sought to address such concerns. Although there have been some studies looking at how group composition affects various group outcomes (Kerr, 1989; Mannix, Thompson, & Bazerman, 1989; Shaw, 1981; Wood, 1985), very little is known about how composition affects performance in highly interdependent tasks (Tziner & Eden, 1985).

Group composition may be conceptualized in several different ways (Levine & Moreland, 1990). In the research described in this paper, the mix of abilities of the group's members constitutes the manipulation of group composition. This definition of composition is consistent with the fact that member ability is positively related to group productivity (Hill, 1982). However, as O'Brien and Owens (1969) pointed out, the specific ways that the different combinations of ability and motivation affect group productivity have yet to be satisfactorily investigated. Therefore, because group performance on interdependent tasks remains an integral part of the success, or failure, of organizations, it is important to determine the factors which may affect performance. It will be argued here that (1) the incentive system the group is operating under and (2) the ability

composition of the group members are two critical factors which influence group performance.

Group Performance

McGrath & Kravitz (1982) pointed out that one major thrust of group research has been a concern with the task performance effectiveness of groups, as opposed to individuals, and with effects of a variety of input factors and operating conditions on such task performance. While no comprehensive theories of group behavior have been systematically developed and tested (Dyer, 1984), several researchers have offered descriptive models of group behavior. A cursory examination of these existing "models" of group effectiveness (Dyer, 1984, Klein & Mulvey, 1989) may serve to illustrate the numerous factors which have been suggested as influential in determining group performance. For example, Steiner (1972) proposed that group productivity was a function of potential productivity (the combined capability of group members) minus process losses (factors such as those related to low motivation and/or coordination). However, this conceptualization of group productivity suggests that group processes always must have a negative effect on group output.

Another general model of groups is the systems input-process-output approach (Hackman & Morris, 1975; Roby, 1968; Shiflett, 1979). The Hackman & Morris (1975) view hypothesized three major variables, effort by group members, task performance strategies, and member knowledge and skills, as the primary

influences of group performance. Specifically, it was expected that the group interaction process would influence these variables in that in instances where individual skills are most important in determining effectiveness, process loss should be low, whereas in situations requiring interdependence, this process loss should be high. In contrast, Roby (1968) viewed group performance as resulting from inputs to the group from the task environment. At the time these input observations are made, they are "digested" and placed in the service of an "executive" faculty, which in turn relates the input information into group goals and tactics (Dyer, 1984). According to Dyer, four input subfunctions are related to this processing of information by the group; observation, information routing, storage and forecasting, and patterning, while three functions are seen as handling the cumulative effects of actions, the pacing of the performance cycle, and procedural changes during continuous group performance; mapping and planning, addressing, and phasing. While this approach is potentially the most detailed general input-process-output model, it has received little empirical support.

Gladstein (1984) offered a model which included variables like group composition and structure, group process, and the task itself as possible factors which might influence group performance. Specifically, Gladstein suggested that factors such as the group composition, group structure, resources available to the group, and rewards would influence certain group processes (i.e. communication, strategy development, etc,). These variables were then expected to

influence group effectiveness, through the moderator of task type. Once again, however, this model has received limited support. Two other theorists, Shaw (1976) and Dieterly (1978), have also focused on the task as central to understanding group performance and behavior. For example, Shaw (1976) proposed that group tasks differ on the following dimensions: difficulty, solution multiplicity, intrinsic interest, cooperation requirements, population familiarity, and intellectual-manipulative requirements. Alternatively, Dieterly (1978) discriminated between tasks not dependent upon a team context and those that did depend upon use of a team. Along similar lines, Naylor and Dickinson (1969) suggested that team performance was a function of task structure, work structure, and communication structure (Dyer, 1984).

While these models represent several researchers' attempts at describing group behavior and performance, Goodman, Ravlin, & Argote (1986) and Goodman, Ravlin, & Schminke (1987) criticized these, and other current, models of group productivity for being too general and difficult to test. They have suggested that theorists' time would be better spent developing more specific models, defining group effectiveness more carefully, and considering new ways in which effectiveness is influenced by a group's task, structure, reward systems, and composition.

From the above discussion it is obvious that much ambiguity exists with respect to understanding the antecedents of group performance. Taking the advice of Goodman et al. (1986, 1987), the proposed research represents an attempt to develop a more specific

model of group performance. Examining the current models of performance, it becomes apparent that while these authors differ with respect to what specific aspects of groups they believe are likely to affect group performance, they do have some aspects in common. Specifically, most all of them contain some notion that the composition of the group and certain other factors (i.e. task, motivation) influence group performance.

While these variables represent only two types of variables commonly associated with models of group performance, the consistency with which they appear in various discussions would seem to indicate their importance as influences of group performance. As a result of this importance, any attempt at developing a more specific model of group performance, as suggested by Goodman et al. (1986, 1987), should include these two types of variables at a minimum. Theoretically, these variables are appealing as potential influencers of group performance, in that at the individual level, performance has often been defined simply as some function of ability and motivation (Locke & Latham, 1990). Thus, it would seem reasonable to expect similar relationships at the group level, with the incentive serving as the motivation component and group composition, in terms of member abilities, serving as the group ability component.

One of the aims of developing a model of group performance is to aid organizations in increasing productivity, satisfaction, etc (Dyer, 1984). Because of this, variables which are included in such a model should be variables which are relevant to, and controllable by

organizations. Clearly, the incentive system is one such variable which could be easily manipulated by organizations. In addition, the composition of work groups within an organization is also under that organization's control. Member abilities, however evaluated, are known by the organization and could easily be used to establish work groups comprised of varying ability levels.

As a result of the above discussion of the current state of group performance research, it should be apparent that there exists little in the way of well established and tested models of performance. Also, it is clear that attempts at developing newer theories of this type would be most likely beneficial if they adopted a relatively narrow focus. Thus, the purpose of this research proposal is to present and test a relatively simple model of group performance using variables, group composition and incentive system, which are expected to be important from both past research and theory. Further knowledge of the effects of these variables may be practically useful to organizations as they can be controlled or manipulated by these organizations.

The next two sections of this paper provide the empirical research and theoretical arguments supporting the position that incentives and group composition are major determinants of group performance.

Incentives

The Empirical Law of Effect states that "...the consequence of a response is an important determiner of whether the response will be

learned" (Wilcoxon, 1969, p. 28). In other words, people tend to do those things that they find positive and they tend not to do those things that they find negative (Pinder, 1984). This is the primary proposition on which reward and incentive systems are based. At the individual level, there is abundant literature suggesting that when the incentive system is properly designed, individual performance can indeed be increased (Campbell & Pritchard, 1976; Guzzo, 1979; Guzzo, Jette, & Katzell, 1985; Pinder, 1984; Steers & Porter, 1987). Understanding how the incentive system affects individual performance is crucial in determining how to pay individuals working on independent tasks. However, given that much of the work in today's organizations is accomplished by task groups (Austin & Bobko, 1985), it becomes important to understand how the incentive system influences the performance of groups.

More than thirty years ago, March and Simon (1958) suggested that the issue of group incentives was important in that so much of the work that is accomplished in many organizations results from the efforts of several individuals, often working at separate but highly interdependent jobs. Parceling out rewards among members of a work group, all of whom have something to do with the successful accomplishment of the group's goals, is often a sticky problem (Pinder, 1984). As Hackman (1987) suggests, when rewards are given to individuals on the basis of managers' judgments about who has contributed most to a group product, dissension, low productivity, and conflict often develop within the group. It is a problem routinely faced by managers where the reward system has

traditionally focused on the identification and recognition of excellent individual performers.

Recent research on incentives has offered two contradictory suggestions concerning the effect of group-based reward systems on performance. Pritchard, Jones, Roth, Stuebing, & Ekeberg (1988) examined the effects of feedback, goal setting, and group-based incentive interventions on group performance. A three stage intervention was implemented in which task groups were first given feedback using the Productivity Measurement and Enhancement System (ProMES), which was based on the theory of organizational behavior presented by Naylor, Pritchard, and Ilgen (1980). Goal setting was then added to feedback. And, finally incentives, in the form of time off, were added to feedback and goal setting. Results indicated that feedback produced a gain in productivity over baseline of 50%; feedback plus goal setting, 75%; and feedback plus goal setting and incentives, 76%. From these results, Pritchard, et al. concluded that incentives added nothing beyond feedback and goal setting.

Although, based on the design and results of the study, these conclusions may be warranted, they are, nonetheless, problematic. For example, it may be that incentives added nothing to performance due to an order effect in the interventions. That is, there may have been a ceiling effect operating, such that because units were already working under two other interventions, further increases in performance were not really possible. Pritchard, et al. discount this

possibility by arguing that if productivity can be increased to its maximum without incentives, they may not be necessary.

However, there are other alternative interpretations of the results that make the assumption that incentives do not serve to increase group performance a bit premature. For example, these results were obtained from one specific situation in which incentives were not found to be effective. One must proceed with caution when generalizing these results to all situations in which incentive systems may influence performance. To illustrate, it may be that time off is not an incentive which is offered in all situations, or moreso, even feasible in all settings. Also, there is nothing to suggest that time off is an equivalent motivator to monetary incentives. It may be that although time off seemed to be something that the participants in the Pritchard, et al. study valued, in other settings, other incentives (i.e. monetary incentives) may be valued more.

This contention has support in research that has been conducted comparing the effectiveness of group incentive systems with individual incentive systems, as they impact performance (London & Oldham, 1977; Milkovich & Newman, 1987). One of the problems with group incentive research which these researchers note may have led others to erroneously conclude that group incentives may not be effective, is that prior studies have often failed to include one important factor: In comparisons of group versus individual incentive plans it is typical to contrast one group plan against multiple individual incentive plans. Thus, a specific group plan may not be as effective as an individual one, but that

does not necessarily mean that no group plans are as effective as individual plans. As London and Oldham suggest, "before the conclusion is reached that group incentive systems are less effective than individual incentive systems in enhancing employee work performance, several types of group incentive schemes should be examined".

London & Oldham (1977) proceeded to test this proposition by comparing multiple group plans versus multiple individual incentive plans. The group plans were (1) incentives based on the average performance of the entire group, (2) incentives based on the highest performer in the group, and (3) incentives based on the lowest performer in the group. Productivity under these group plans was compared against results using an individual piece-rate system and a fixed-rate system. Performance was about equal under the high-performance group incentive system and the individual piece-rate system, with both plans resulting in significantly higher performance than any of the other plans.

While London and Oldham acknowledge that these results need to be replicated before any firm conclusions can be reached about the effectiveness of group incentive plans, they do suggest that group plans can be structured to approximate the productivity results obtained under individual plans. In fact, many of the field studies reporting results from group incentive plans, which were primarily Scanlon- or Rucker-type plans, indicated productivity increases in the range of 4.5 percent to 23.7 percent for periods of time between 1 and 17 years (Milkovich & Newman, 1987; Puckett, 1978), From

these results it seems that it is reasonable to believe that group plans in general can be effective motivators of performance. And, given that groups are completing much of the work in organizations, finding incentive plans which increase performance in these settings seems to be of increasing importance.

Given that the study of group incentive plans is important, the next issue is what types of plans are effective and feasible in what settings. Although the results expressed by Milkovich and Newman (1987) and Puckett (1978) suggest that group plans may be effective, they reflect somewhat dated research and do not employ group incentive systems which may or may not be effective in today's work settings. For instance, Scanlon plans, which were one of the primary group incentive systems studied, are generally applied at an organizational level. As a result, these types of plans may not be effective as a motivator of task group performance. In comparison, the type of incentive systems that London and Oldham (1978) employed in their study allowed rewards to be distributed to individuals within a task group based more directly on individuals' performance within the group than does a Scanlon-type plan.

However, even the incentive systems used by London and Oldham (1978) may be subject to problems when applied in other settings. For instance, while being effective in a non-interdependent work group, pay based on the highest performing individual may not be so effective when the setting is an interdependent one. This is possible since the performance of any individual on an interdependent group task is, to some degree, constrained by the

performance of all other members. This could result in the performance of the best individual, and subsequently the group performance being determined by the lowest performing member. Thus, the reward system, as manipulated by London and Oldham, may actually be based on the lowest performer, and not the highest performer. This inconsistency may result in low group performance and dissatisfaction, as a result of the perceived inequity of the reward system.

Organizational Justice.

A related line of research has been concerned with individuals' perceptions of fairness of organizational rewards (Kanfer, 1989). In this literature a distinction is made between two distinct perceptions of fairness: procedural justice and distributive justice (Greenberg, 1987). Procedural justice refers to the degree to which individuals feel that the process in which they are rewarded is fair. Alternatively, distributive justice addresses the individuals' perceptions of fairness related to the allocation of rewards across persons (i.e. fairness of outcomes). While procedural justice concerns are relevant in many real world settings, within a particular situation (i.e. controlling for procedural justice perceptions) issues of distributive justice would be a primary component in an individual's perceptions of fairness of a reward system.

Research across several areas (Karambayya & Brett, 1989; Organ, 1990; Pfeffer & Langton, 1988) has examined the impact of perceptions of distributive justice fairness using a number of

outcome variables. In general, this research has suggested that "in cooperative relations within which economic productivity is a primary goal, equity rather than equality tends to be the chief principle of distributive justice" (Kabanoff, 1991). In contrast, when fostering or maintaining an enjoyable social relationship is the goal, equality tends to be the dominant distributive principle. Thus, in a cooperative situation (i.e. one which requires high interdependence) in which individuals are working toward a common production goal, it would be expected that individuals would feel more fairly treated when rewards are distributed relative to individual inputs, rather than equal rewards based on total team performance.

Some research related to this suggestion has been conducted in the area of incentive research. Lawler (1981) suggested that when pay is based on level of aggregated individual performance, cooperation is normally increased dramatically. Moreover, as Organ and Konovsky (1989) point out, research in the area of incentives with respect to cooperative behaviors indicates that reward systems that cause sharp differences in member outcomes may inhibit cooperation. Thus, from this study it would appear that group incentive systems in which individuals receive equal outcomes based on the performance of the group would lead to high levels of cooperation. However, given the above discussion, it may be that what appears to be a principle of equality may in fact be equity. That is, in teams where individuals contribute the same amount to the team's performance, one would expect that greater satisfaction would result from equal rewards to all members from both an

equality and equity perspective. Alternatively, when individuals contribute different amounts to task performance, one would expect that greater satisfaction, and thus greater cooperation, would result if member outcomes were distributed in an equitable manner. If the task is interdependent, this increased cooperation should translate into increased performance.

Groups versus Teams

An issue that arises whenever one does research with groups, and one that deserves attention before undertaking a review of the group composition literature, is that of defining the terms team and group (Dyer, 1984). This distinction is difficult to draw in that since few researchers have explained why they have called the groups they studied "teams", ambiguity exists as to the precise meaning of the two terms. Indeed, as the presentation of work teams by Sundstrom, De Meuse, and Futrell (1990) highlights, the terms work team and work group are used interchangeably to suggest the same concept. Sundstrom et al. (1990) suggest that a work team (or group) is an "...interdependent collection of individuals who share responsibility for specific outcomes for their organizations." Similar discussions of this type by other authors (e.g. Komaki, Desselles, & Bowman, 1989; McGrath & Kravitz, 1982) also indicate a lack of clear distinction between the two terms.

Given this ambiguity with respect to the difference between work groups and work teams, an examination of the global definitions of group and team may prove illuminating. Forsyth

(1987) provides a clear, succinct definition of groups by suggesting that a group may be defined as any setting in which two or more individuals interact. While this definition may, at first, seem overly broad, it should provide a basis for comparison with one potential definition of team. Dyer (1984) proposed the following as an integration of some of the previous attempts: "A team consists of (a) at least two people, who (b) are working towards a common goal/objective/mission, where (c) each person has been assigned specific roles or functions to perform, and where (d) completion of the mission requires some form of dependency among the group members". From these two definitions it would appear that the concept of team is encompassed under the rubric of group. That is, teams are specific instances of groups. Further evidence for this conceptualization is provided by McGrath and Kravitz (1982), where they point out that "...one major thrust of group [italics added] research has been a concern with the task performance effectiveness of groups". This suggests that the research on work teams or work groups is a subset of the research on groups in general.

While this information may provide a distinction between the concepts of groups and teams, there remains the problem of distinguishing between the use of the specific concepts of work teams and groups. The inconsistency would appear to be that while at a macro level, groups and teams are different concepts, when the term work is added to both they are often operationally equivalent. As Dyer (1984) suggests such definitional issues are not trivial. How does one decide if researchers are really studying the same entity?

Perhaps the difference between the use of the terms work group versus work team arises out of the differences between the disciplines of social psychology and industrial/organizational (I/O) psychology. That is, in social psychology literature, the term group is predominantly used (e.g. Levine & Moreland, 1990; McGrath & Kravitz, 1982), while in I/O the term team may be the preferred term (e.g. Sundstrom et al., 1990).

While the differences, if any, between these terms deserve attention from researchers, the present study is not that large in scope. Instead, the previous discussion was undertaken to provide a background of the issues that were considered in choosing the term that will be used in the present study to describe the unit of analysis. Because of the constraints of the definition of team as provided by Dyer (1984), as well as others (e.g. Komaki, Desselles, & Bowman, 1989), the term which will be adopted in the present study is work team. This term reflects the notion that the unit of analysis of interest in this study is a collection of individuals working on an interdependent task. This conceptualization of work teams is consistent with that offered by Dyer (1984) in that these groups (a) are comprised of three individuals, (b) require individuals to pursue a common goal, and (c) require interdependency of actions of the group members.

Task Interdependence

Given the above discussion of work teams, the next issue that must be addressed is that of task interdependence. Task

interdependence has been defined as a situation in which "...the members of a group must actually work together to accomplish a task" (Mitchell & Silver, 1990). Mitchell and Silver suggest that several conditions define a task as interdependent: Team members may exchange information and/or resources (Thompson, 1967), they have roles that require a coordinated division of labor (Thomas, 1957), or they use behaviors that contribute to their own performance plus the performance of the other members, and vice versa (Van de Ven, Delbecq, & Koenig, 1976). Thus, there is some latitude in distinguishing situations that can be considered examples of interdependent tasks.

Another issue is that of individual task interdependence and team task interdependence. The difference is that individuals can work alone at a task yet be interdependent with people performing other tasks or jobs (individual interdependence) or a team can work on the same task and be interdependent in carrying it out (team interdependence) (Mitchell & Silver, 1990). It is the latter type of interdependence that is of interest here. Examples of this type of team include strategic planning committees, semiautonomous work teams, symphonies, and surgical teams (Mitchell & Silver, 1990).

Team Composition

Team composition can be defined as the mix of characteristics and attributes of the members of the team. Because members of a team are its most important resource, team composition should lead to the subsequent outcomes realized by the team (Levine &

Moreland, 1990). Because of the importance of understanding the factors which affect team performance, there has been considerable research which has focused on team composition issues. However, within the area of team composition, there has been considerable diversity with respect to what characteristics of the members, and also the team as a whole, are important. Research has examined issues of team size (Kerr, 1989; Markham, Dansereau, & Alutto, 1982; Gooding, & Wagner, 1985), team demographics (Wagner, Pfeffer, & O'Reilly, 1984; Wood, 1985), member personalities (DeBiasio, 1986), and member opinions.

Because team size is a variable which naturally acts as a constraint on other team variables, it is a matter which deserves to be addressed at this point. Size has several consequences for the functioning of a team (Mannix, Thompson, & Bazerman, 1989). For instance, size impacts on the range of knowledge, skills, and abilities that are available to the team (i.e. the resources of the team). It is possible then, that larger teams, have access to more resources within the team. However, as Levine & Moreland (1990) point out, as a team grows larger, it generally changes for the worse. People who are members of larger teams are normally less likely to cooperate with other members. And, although larger teams are potentially more productive, coordination problems and motivation losses often hinder the achievement of this potential (Gooding & Wagner, 1985). Also, as Mannix, Thompson, & Bazerman (1989) suggest, as the size of the team increases, so do the problems associated with explaining what occurs within the team. Given that

team size influences the potential problems associated with researching team phenomena (Mannix, Thompson, & Bazerman, 1989), it is desirable to clearly specify the size of the team when testing the impact of variables, interpreting the results, or when giving procedural advice.

With that in mind, at this point it would be useful to define the team size that will be assessed in the proposed research. Because the focus of this study is interdependent work teams in organizations, and also the aforementioned problems associated with conducting research using large teams, small teams will be the unit of analysis. In the literature, a small team is defined as having fewer than 20 members, although most research on small teams has focused on teams with fewer than five members (Shaw, 1981). As a result of these considerations and the task which will be used in this study, team will be defined as, and hereafter referred to, as a three-member team of individuals working on an interdependent task.

It should be noted that defining team size in this manner may restrict the generalizability of results. For this reason, it is important to recognize that any conclusions which may be drawn must take this fact into account and recognize that three person teams do not encompass the spectrum of possible team sizes. Although it would be optimal to use teams of varying sizes to allow conclusions about small teams in general, it was not feasible in the current study. Also, given that the area of team performance has received such little attention, any results obtained would prove beneficial for stimulating further research in this area. However, the impact of the

manipulated variables must be assessed keeping in mind the specific size of the team under examination.

As Foushee (1984) and Hill (1982) suggest, individual member abilities are a major determiner of the ultimate performance of the team. Given that team performance is the outcome of interest here, the other composition factor which becomes important is that of member abilities. And, although there have been many studies of team performance, Tziner and Eden (1985) point out that very little is known about how composition factors affect performance on interdependent tasks.

The abilities of team members have been the focus of some studies on team composition (Bantel & Jackson, 1989; Tziner & Eden, 1985). Specifically, Tziner and Eden proceeded to examine the effects of the ability and motivation distribution of team members using three person tank crews. Each crew contained three soldiers who were either high or low in general abilities. Results indicated that the more high-ability soldiers a crew contained, the better the crew performed. However, the abilities of different members of the team produce interactive effects on performance. For instance, crews with all high ability members performed better than expected, while those crews with all low ability members performed more poorly than expected. These results would seem to support the suggestion of Hill (1982) that member abilities are a critical factor in determining the team's performance.

Another issue involved in dealing with team composition as a variable of interest is whether it is considered an outcome of other

situational factors or whether it is a determinant of team performance (Levine & Moreland, 1990). The examination of team composition as a consequent variable has primarily focused on naturally occurring teams, where composition can vary freely. The primary finding of this line of research is that people strongly prefer smaller teams (Levine & Moreland, 1990). Also, most naturally occurring teams contain members who strongly resemble each other in terms of certain key characteristics (e.g. age, interests). These results would seem to suggest that in teams which are not naturally occurring (i.e. work teams), member satisfaction would be highest in small homogeneous teams.

Other researchers see composition as a variable which, if changed, results in the change of a target (dependent) variable. Research cited previously (i.e. Foushee, 1984; Tziner & Eden, 1985) viewed composition as just such a variable. Given that the purpose of this study is to examine the effects of composition and incentives on team performance, composition will be similarly viewed as a causal variable. Following the work of Tziner and Eden (1985), it is proposed that teams which contain uniformly high ability individuals will perform much better than those teams which are mixed, and those teams which contain all members of low ability will perform much worse than those teams with members of mixed abilities.

Proposed Model

Given the above discussion of the literature on incentive systems and team composition effects on team performance, it is proposed that both incentive system and team composition will directly influence team performance. In addition, given the research on the effects of team incentive systems on the degree of cooperation that is exhibited by team members, it is proposed that cooperation will be a function of the type of incentive system under which a team is operating. Specifically, it is expected that individuals receiving equal allocation in teams will engage in more cooperative behaviors than those in the individual incentive condition. Also, because cooperation leads to greater performance on interdependent tasks (Mitchell & Silver, 1990), it is expected that the degree of cooperation will serve to mediate the relationship between incentives and performance. The hypotheses briefly described here and implicitly in Figure 1 are explicitly stated below.

Hypotheses

The first hypothesis relates to the expected effect of team composition, manipulated with respect to individual ability on the task, on team performance.

Hypothesis 1: The performance of three person teams on an interdependent task will be positively correlated with the average ability level of the team members (See Figure 2).

Figure 1

Proposed Model of the Relationships Among Key Variables

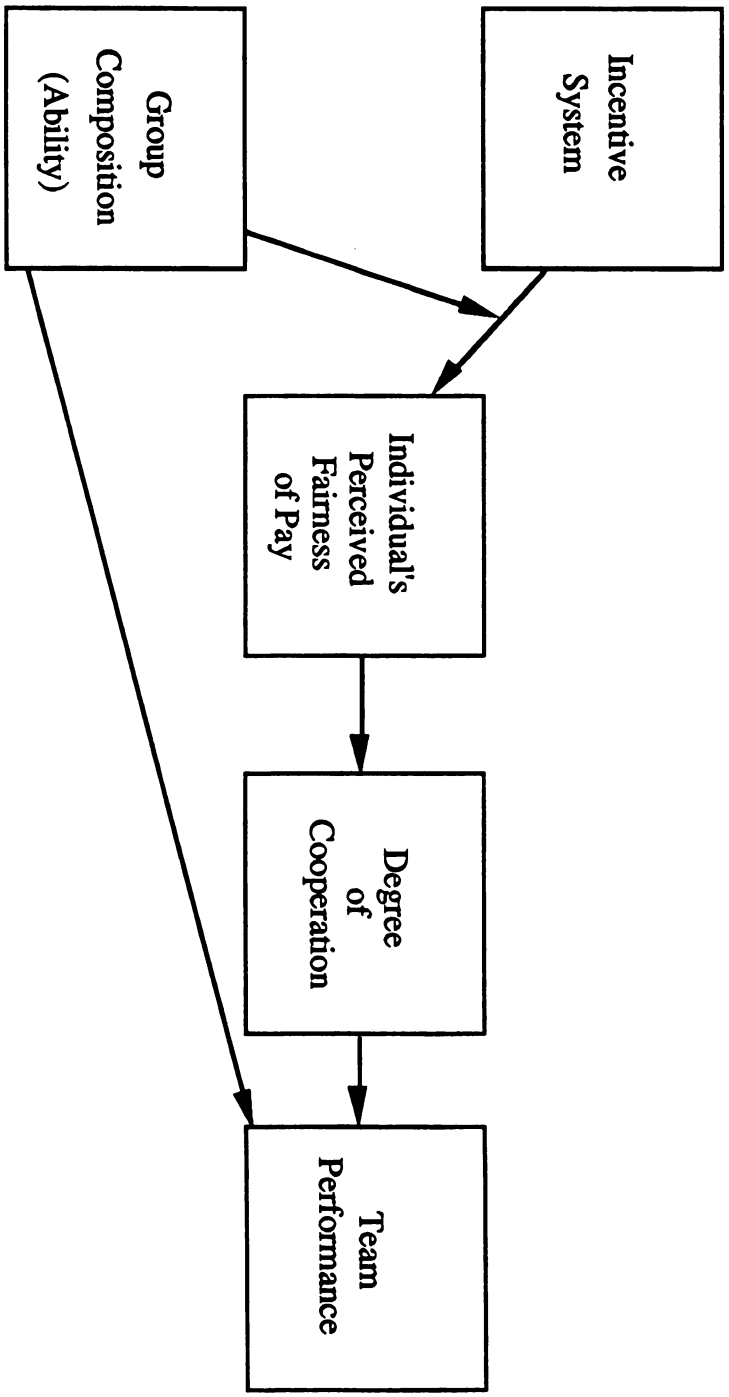
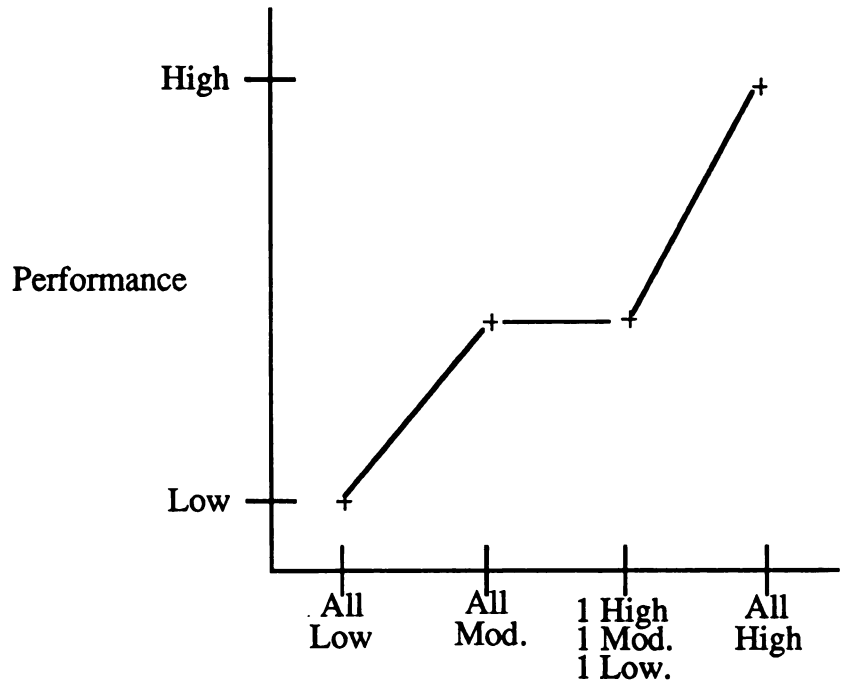


Figure 2

Proposed Effect of Team Ability on Team Performance



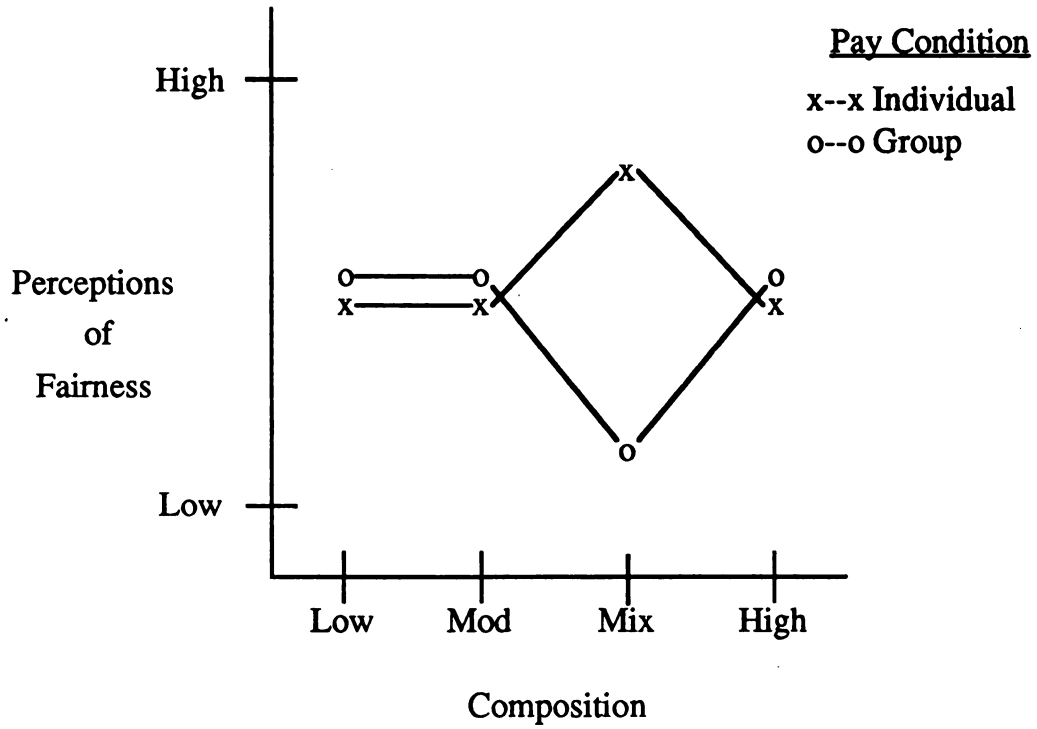
Interaction Effects on the Endogenous Variables. The following set of hypotheses deals with the expected effect of the interaction between team composition and incentive system on the three endogenous variables: perceptions of fairness, degree of cooperation, and team performance. These hypotheses are stated below along with a rationale for each.

As suggested by the distributive justice literature (e.g. Greenberg, 1987), individuals make judgments regarding the fairness of the allocation of outcomes. Expectations regarding distributive fairness are met when there exists an equitable distribution of rewards across individuals relative to their inputs. Thus, perceptions of fairness are based primarily on individuals' expectations of congruence between what a person puts into and gets out of a task. That is, if inputs are congruent with outcomes (i.e. equitable), then the individual will perceive a situation of fairness. If they are not congruent, then an unfair situation will be perceived. In this experiment, these inputs are likely to be most heavily influenced by an individual's ability, while the outcome is the money they receive. The specific hypothesis is stated below and depicted in Figure 3.

Hypothesis 2: In three person teams working on an interdependent task, team composition will interact with the incentive system in such a way that in:
(a) heterogeneous ability teams in which team members are paid for their individual performance, perceptions of fairness will be greater than in teams in which members receive equal pay based on team performance, while in

Figure 3

Proposed Interaction of Pay and Composition on Fairness Perceptions



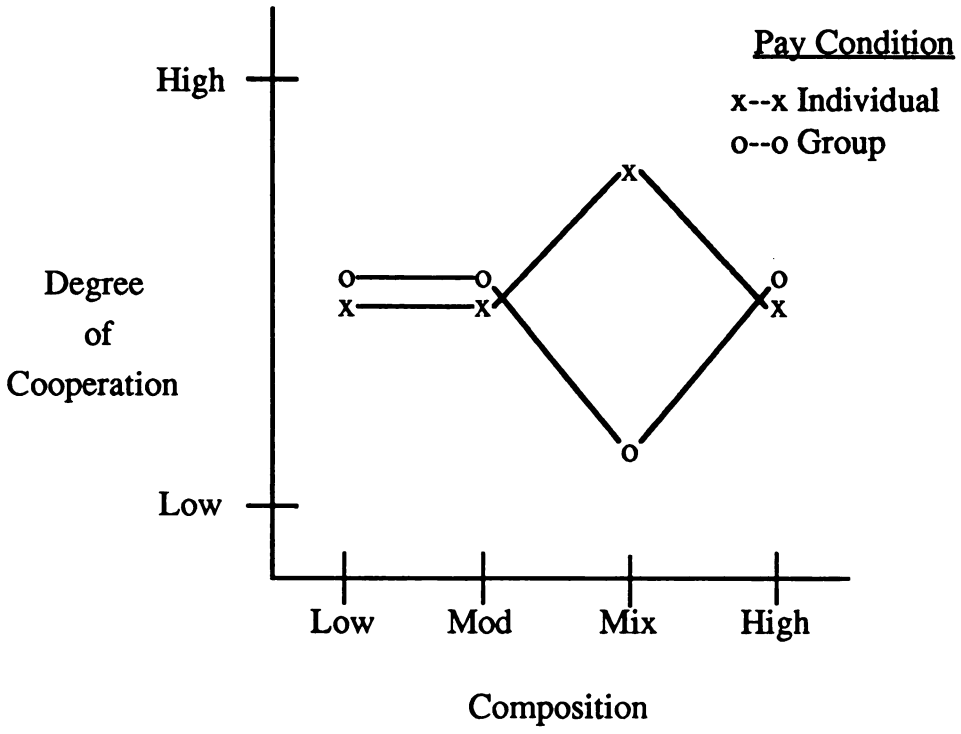
(b) homogeneous ability teams, method of pay will not influence individual perceptions of fairness.

Katz and Kahn (1978) suggested that reward systems that result in sharp differences in member outcomes would result in less cooperation among team members. The implicit assumptions of this position are (1) that individuals contribute equally to the task and (2) that equality is the overriding concern of team members. However, these assumption may not always be tenable (Adams, 1964). For instance, when the task is interdependent and individual members contribute differentially to the task, equal rewards may result in less cooperation due to feelings of inequity, as the previous review of the fairness literature illustrates. Thus, the nature of the task (i.e., the degree to which task completion requires interdependent effort) and the relative inputs of each team member must be taken into account when examining the effect of the incentive system on the degree of cooperation exhibited by team members.

Hypothesis 3: In three person teams working on an interdependent task, team composition will interact with the incentive system in such a way that in:
(a) heterogeneous ability teams in which team members are paid for their individual performance, members will exhibit a higher degree of cooperation than members in those teams paid equally based on team performance, while in
(b) homogeneous ability teams, method of pay will not influence the degree of cooperation exhibited by team members (See Figure 4).

Figure 4

Proposed Interaction of Pay and Composition on Degree of Cooperation Exhibited



As previously stated, ability and motivation are the two primary influencers of task performance. The fourth hypothesis addresses the expected effect of these two variables, at the team level, on team performance. It is briefly stated below and graphically presented in Figure 5.

Hypothesis 4: In three person teams working on an interdependent task, method of pay will interact with team composition such that: (a) in heterogeneous ability teams, team performance in conditions where persons are paid based on individual performance will be greater than teams in which individuals are paid equally based on team performance, while (b) in homogeneous ability teams, method of pay will have no influence on performance.

The next two hypotheses address the expected relationships among the variables in Figure 1 which have not previously been discussed.

Hypothesis 5: The three endogenous variables, perceived fairness, degree of cooperation, and team performance, will be positively correlated.

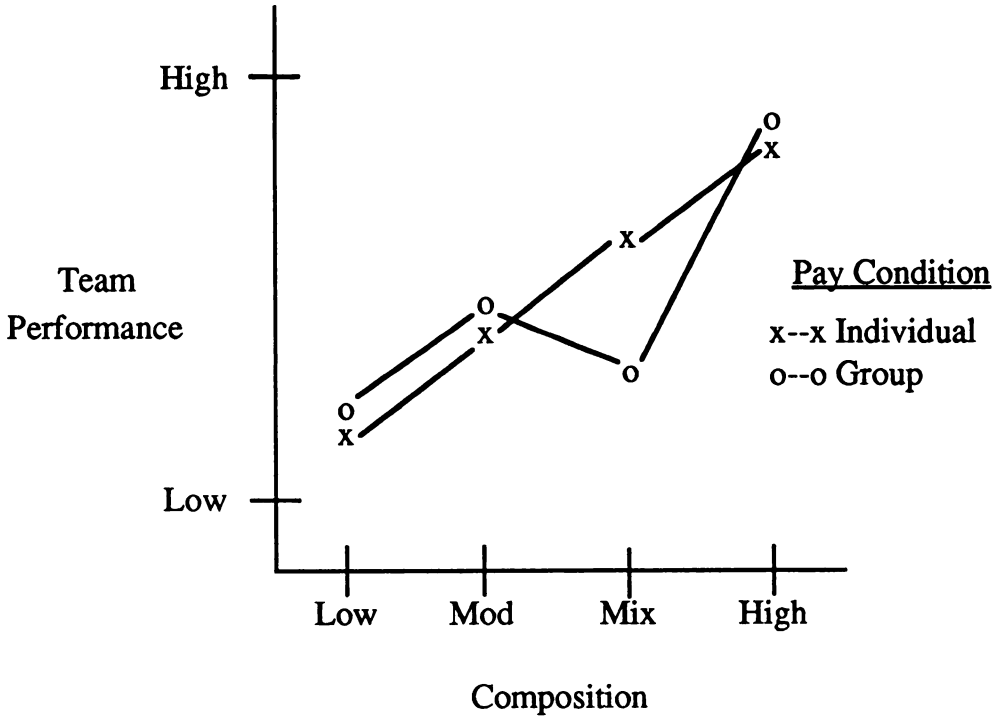
Hypothesis 6a: As depicted in Figure 1, it is hypothesized that perceptions of fairness will mediate the relationship between the interaction of team composition and incentive system and degree of cooperation.

Hypothesis 6b: As similarly depicted in Figure 1, degree of cooperation is expected to mediate the relationship between perceptions of fairness and team performance.

While not central to the present experiment, the data also allow for the examination of a final hypothesis. This hypothesis is related

Figure 5

Proposed Interaction of Pay and Composition on Team Performance



to the expected effect of the interaction of team composition and incentives on the performance of all homogeneous teams versus all heterogeneous teams. Because the average ability level of these two types of teams is equivalent, this question of how to best divide up a set of individuals with different abilities can be addressed. That is, should a team consist of individuals whose abilities are similar, or should teams be comprised of individuals with a mix of ability levels to maximize performance.

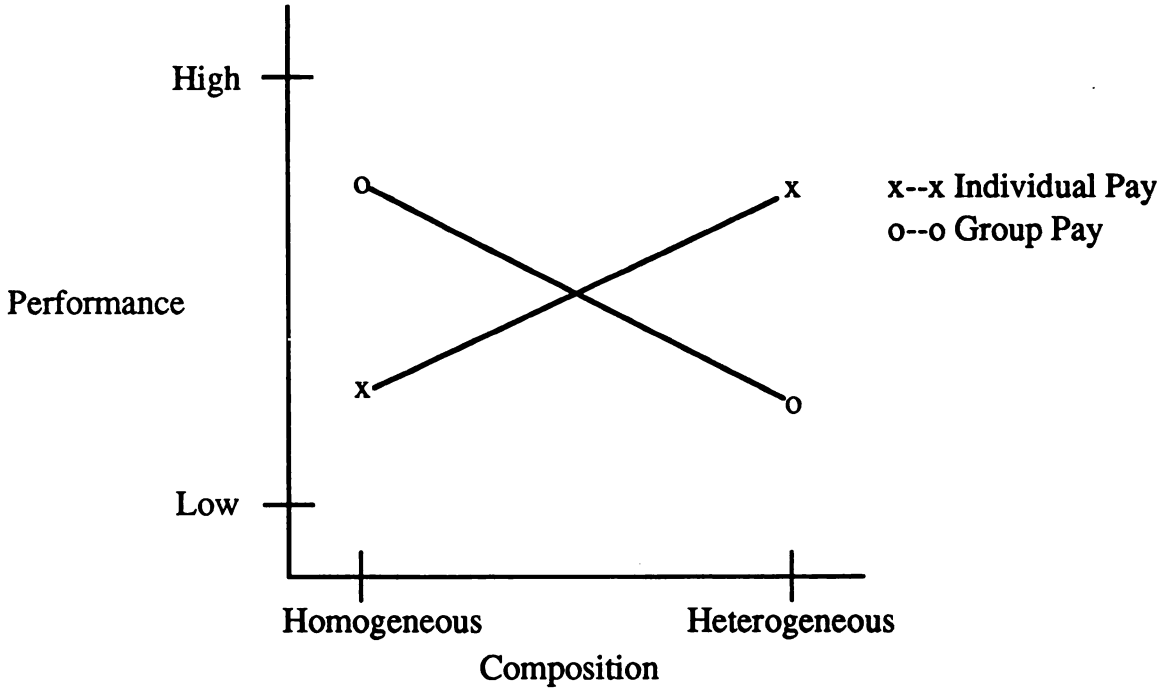
Practically, this issue is dealt with most dramatically in the professional sports venue. Managers and coaches regularly are required to make the decision of how to best combine the team's talent in order to achieve maximum performance. For example, in hockey, this issue might be manifested in the following scenario. Given that a team has several "all-stars", several average players, and several lower ability players, how should lines be formed from this team of individuals. That is, is it better to use all the "all-stars" on the same line, or is it better to distribute them across several lines? One might reasonably suggest that the answer to this question could be answered by saying that in some situations (e.g. who is the opposing team, are there injuries, etc.) one combination scheme would be best and in others, the other approach might be most beneficial. Certainly, other types of organizations are confronted with similar problems with how best to distribute employees' abilities. In these settings one of the key situational variables would be the pay system which the employees are being rewarded under. Thus, operating under some pay systems it may be more productive

to assemble people with similar talents, while with other systems it might be more useful to team people together who vary on their task proficiency. The following hypothesis is proposed as what might be expected in two such instances.

Hypothesis 7: Team composition will interact with the incentive system such that the mean performance of all homogeneous ability teams will be higher than heterogeneous teams under conditions of equal pay based on team performance, while heterogeneous teams are expected to perform better than homogeneous teams in the individual pay condition (See Figure 6).

Figure 6

Proposed Effect of Pay on Team Performance with Homogeneous or Heterogeneous Teams



METHOD

Participants

Participants were 126 undergraduate students from introductory psychology and management courses at Michigan State University. These individuals were combined to form 42 three-person teams. A power analysis conducted assuming a medium effect size suggested that this sample size provided statistical power at the .60 level (Cohen, 1988) . Due to the nature of the ability manipulation, complete random assignment of persons to teams was not possible. As a result, after trichotomizing individuals relative to ability level, within ability level individuals were randomly assigned to the resulting 42 teams.

Design

The design was a 2 (team incentive) x 4 (team composition) x 15 (Trials) mixed model. Incentives and team composition were manipulated as between-subjects facets, while trials was a within-subjects facet.

Simulation Task

A computer simulation of a navy "command and control" team developed by Hollenbeck, Sego, Ilgen, and Major (1991) was chosen for use in this study. This team is comprised of persons who assume

the roles of Commanding Officer (CO) of a Carrier, an AWACs reconnaissance plane, a Coastal Air Defense (CAD) unit, and a Cruiser unit. Each individual is seated in front of a computer which corresponds to her/his role. These computers are then networked such that individuals can communicate with each other. Slight modifications to the original task were made to allow for the use of three-person teams. The team's mission is to monitor aircraft (i.e. targets) that come through the "airspace" surrounding the carrier group and to make team decisions about how to respond to the aircraft. Instructions stress the importance of correct decisions by asking team members to make certain that decisions be made which minimize loss of life resulting from attacks on ships in the task force, while at the same time making sure that no friendly military or civilian aircraft are shot down.

Simulation Roles. There were four roles in this simulation, corresponding to each of the four members of the Carrier Group. The leader was the CO of the Carrier. Within the context of the current experiment this role was played by a confederate. The other roles included the CO of the AWACs unit, the CO of the Cruiser unit, and the CO of the CAD unit. Each of these persons could measure a certain number of characteristics of the incoming aircraft entering the airspace. Based on these measured attributes, each team member was asked to decide on one of seven alternatives for each incoming aircraft (i.e. target). These alternatives ranged from ignore (least aggressive) to defend (most aggressive). See page two of Appendix A for a complete description of each of the alternatives. After

measuring and communicating with one another regarding the incoming target, individual members were asked to send their recommendation to the CO of the Carrier. The Carrier then simply averaged these recommendations to arrive at the team decision for that target.

Attributes of Targets. The incoming targets could be measured on nine attributes. These attributes included speed, altitude, size, angle, IFF, direction, corridor status, radar type, and range. Page three of Appendix A provides a list of these attributes with the ranges of possible values for each. The level of threat of each target could be determined by its standing on these attributes. Five combination rules determined the danger associated with any target. These rules are summarized on page four of Appendix A along with an example of how they might be combined.

Coordination of Roles. As previously stated, each team member had the ability to measure four attributes related to the incoming target. This resulted in individual members having access to two unique pieces of information related to the aircraft (i.e. neither of the other members has access to these attributes) and two redundant pieces of information (i.e. one of the other members also has information on that attribute). In addition to being able to measure these pieces of information, individuals were trained to know exactly how raw data on these attributes can be translated into terms of "non-threatening," "somewhat threatening," and "very threatening." With respect to determining the level of threat, individuals were trained on several combination rules. Thus, while all individuals

knew how the information should be combined, they were not able to measure all of the necessary information.

Sharing of information among the team members was accomplished through the use of several available functions. In addition to being able to measure certain characteristics of the target, individuals also had the options of querying, receiving, and sending information from other team members. The query command allowed any team member to ask any other team member for information regarding a given characteristic of the target. Receiving allowed a team member to look at a query from another member, while the send command transmitted the response to a query. Another function which was available to team members was a transmit command. This allowed individuals to send text messages to each other. However, it was stressed to participants that this function potentially required more time than the other communication sequence and they would be making their decisions in a relatively short amount of time. Through the utilization of these commands, team members can exchange information with each other and gain characteristics of the target which alone they could not measure.

By way of example of a completed sequence using the above commands is the communication between the Cruiser and the CAD. If the Cruiser needs the speed of the target and knows that the CAD can measure this attribute, the Cruiser would query the CAD as to this attribute. The CAD would receive this query and then send the speed information to the Cruiser. The communication sequence would be completed by the Cruiser receiving this information from

the CAD. It is important to note that, at any point in this sequence, the communication could break down. For example, the CAD could choose not to respond to, or even to look at, the query sent by the Cruiser. Also, assuming the CAD actually responded to the Cruiser's request for speed, the Cruiser may not look at the CAD's response. Thus, while opportunity exists for individuals to cooperate with each other, this process may not always lead to a successful coordination of effort.

Patrol Session. Patrol sessions refer to the time that the team is responsible for monitoring the airspace. During this time, each individual team members' monitor had four icons representing the four stations of the carrier group. Also included on this screen was a blinking red dot indicating that an aircraft was in the team's airspace. During each of these sessions the team had a certain amount of time, which also appeared on the screen, in which to make a recommendation regarding this target. When there was 30 seconds left in the session the red dot began to blink and beep at an increasing rate. Because the leader had to make a final decision before time ran out, each of the other team members were required to send their recommendations before this point. As the leader (i.e. the Carrier) was a confederate in this experiment, the team's judgment was the average of the three recommendations made by the other members. If any individual failed to make a recommendation regarding the target, their response was treated as an ignore recommendation.

Feedback. When a trial (i.e. a patrol session) was over, all team members received both a computer and an oral report as to how well the team performed. The computer report appeared on the computer screen after the trial and gave them information on what their individual decisions were, what the team's decision was, and what the correct response should have been. The oral feedback presented by the experimenter closely resembled that presented by the computer except that it presented a cumulative total of the responses made by individuals, the team, and the correct decisions. This feedback was designed to allow participants to monitor their own, as well as other members and the team's, performance over the fifteen trials.

As previously described, there were seven potential recommendations individuals and teams could make (see Appendix A). From these seven decisions, there were five potential outcomes from a trial ranging from a hit, which indicated that the team's or individual's recommendation was exactly correct, to a disaster, which indicated that the recommendation was off by four places in terms of their aggressiveness level. Team and individual effectiveness was then expressed in terms of points associated with each outcome. More detailed descriptions and point values of all possible outcomes are provided on page six of Appendix A.

Procedures

The need to classify individuals in terms of task ability required participants to attend two sessions of the experiment.

Session 1. Participants were asked to read and study a packet of information which provided them with a brief description of the simulation, the ranges of the attributes which characterized each target, and the various rules for combining the attributes of the targets (See Appendix A). Following this, individuals were asked to take a test on the materials they just read. The test was designed to assess their knowledge of the various levels of the attributes and the combination rules. After completion of this test, individuals were informed that they were to be notified as to the time and place of the second session of the experiment.

Composition Manipulation. Ability in this experiment was defined as the amount of job knowledge relative to this task displayed by the participants on the test in Session 1. Scores on this test were trichotomized. Teams were then randomly formed comprised of either members with homogeneous ability or members with heterogeneous abilities. Specifically, an equal number of three person homogeneous teams were formed for three ability levels: high, moderate, and low. Alternatively, heterogeneous teams were composed of one high, one moderate, and one low ability person.

Session 2. When participants arrived for the second session, they were first seated in a room equipped with a television and VCR. When all members arrived, individuals were given a handbook similar to the one they received at the first session. The only difference was that this handbook provided them with a description of their specific role, what attributes they could measure, and a review of the various combination rules. The tape was started ten

minutes after they were given the handbook and they received video instructions on how the simulation functioned.

After watching the tape and reading through this handbook, participants were taken to their computer terminals and taken through two practice trial targets by the experimenter. At this point, any questions they had regarding the functioning of the simulation were answered. They were then told that they had the opportunity to go through five more practice trials before the experiment actually began.

Incentive Manipulation. Incentives were manipulated based on past research. As such, two incentive systems were used in this study: (1) individuals within the team were rewarded based on their individual performance (i.e. the accuracy of their recommended decision), irrespective of team performance, (individual condition) and (2) individuals received equal rewards based on the performance of the team (i.e. the accuracy of the team decision), irrespective of individual performance, (team condition). In the individual incentive condition, individuals received $1.00 for a hit, $0.50 for a near miss, and $0.25 for a miss. Decisions which resulted in outcomes worse than a miss resulted in the individual receiving no money for that trial. In the team condition, teams whose average recommendation resulted in a decision which was a hit earned $3.00 ($1.00 per person), a near miss earned $1.50 ($0.50 per person), and a miss earned the team $0.75 ($0.25 per person). Any decisions worse than a miss resulted in the team receiving no money for the trial.

After the fifth trial, participants were informed of their incentive condition (See Appendix D), that the next fifteen trials were going to be scored, and that their performance on these trials was to be used to determine their pay for the session.

After the final trial, participants were given a brief questionnaire to complete. They were then debriefed as to the actual nature of the experiment, paid their money, and allowed to leave.

Manipulation Checks

The questionnaire included an item concerning the individual's knowledge of the incentive system (See Appendix C, Item 1). Also included in this questionnaire were items assessing certain demographic variables (See Appendix C, Items 10-14).

Dependent Measures

Dependent variables came from both the questionnaire distributed to participants after the team task and summary statistics based on actual behavior on the task. These measures included team and individual performance, perceived equity of pay, and degree of cooperation.

Performance. The amount of money earned over the fifteen trials served as an indicator of both team and individual performance. The use of pay as a dependent variable resulted in a criteria with four levels, rather than the five which would have resulted if points earned had been used as the indicator. This use of pay as a proxy measure of performance was acceptable given the high correlation between the two measures (r = .96) and the fact that team members were informed of their performance in dollar terms.

Perceived Equity. Included on the questionnaire were items assessing individuals' feelings about the fairness of the incentive system they were working under (See Appendix E, Items 2 through 9). These items were rated on 5-point scales and combined to form a Fairness of Pay Scale (alpha = .83) and a Fairness of Pay System Scale (alpha = .83).

Cooperation. As previously stated, cooperation was defined in terms of the communication sequence detailed in Appendix E. While several indices were generated from this sequence, several of them were not deemed measures of cooperation. As a result, only those indices which indicated either individuals not attending to the requests of team members or not responding to those requests were used in the operationalization of cooperation. More specifically, cooperation was defined as the extent to which teams minimized the occurrence of "slights" and "unresponsives". These two indices were summed across the fifteen trials for each team yielding a measure of cooperation. Thus, those teams which were acting cooperatively would receive lower scores on this variable than those teams with uncooperative members.

RESULTS

Manipulation Check

Manipulation checks were collected with a questionnaire that was administered following the simulation. One manipulation check which was used in this experiment was related to the participants' ability to correctly identify which pay condition they were operating under and was obtained via an item on the questionnaire. Of the 142 individuals completing the questionnaire, 131 (92%) correctly identified their pay condition.

Adequacy of the Individual Ability Variable

Analyses of individual level data were conducted in order to determine if the initial classification of individuals as high, moderate, or low ability was supported by individuals' actual task performance as well as perceptions of ability by self and others. The first step was to conduct an ANOVA using individual performance as the dependent variable (DV), initial classification of ability as the between-subjects factor (high, moderate, and low), and trials (15) as the within-subjects factor. Results showed no significant interaction ($p > .05$) between ability and trial suggesting that computing a performance measure by summing across the trials was acceptable. Subsequently, a one-way ANOVA was then performed comparing

mean total performance, expressed in dollars earned, across the three teams. Results indicated a significant main effect for ability ($F(2,123) = 5.80$, $p < .05$) with the following observed means and standard deviations: M_{low} = \$6.77 (1.81), M_{mod} = \$7.06 (1.25), and M_{high} = \$7.90 (1.55). Post hoc tests indicated that the means for low and moderate ability individuals significantly differed from the high team ($p < .05$), but not each other ($p > .05$).

While differences in performance at the individual level are crucial in establishing the foundation for assessing the group-level data, they are not sufficient. As the relationships between the exogenous and endogenous variables rely on perceptions of the fairness of pay among individuals, it should be true that individuals of varying abilities should be perceived as having differences in abilities. To assess this, individuals rated each other, as well as themselves on a five-point scale (1 = Well below average ability to 5 = Well above average ability). This led to each individual receiving three ratings of their performance. A one-way ANOVA, with ratings as the DV, was conducted to assess perceived differences in ability across ability levels. Results indicated no significant differences between the three means ($p > .05$). However, while not significant, the means were in the expected direction (M_{low} = 3.35 (.78), M_{mod} = 3.40 (.70), and M_{high} = 3.68 (.64)). Further, the correlation between ratings and performance was significant ($r = .66$, $p < .05$), suggesting that the individuals' perceptions were congruent with team members' actual task performance. These results of the individual-level data were taken as support that the initial classification of

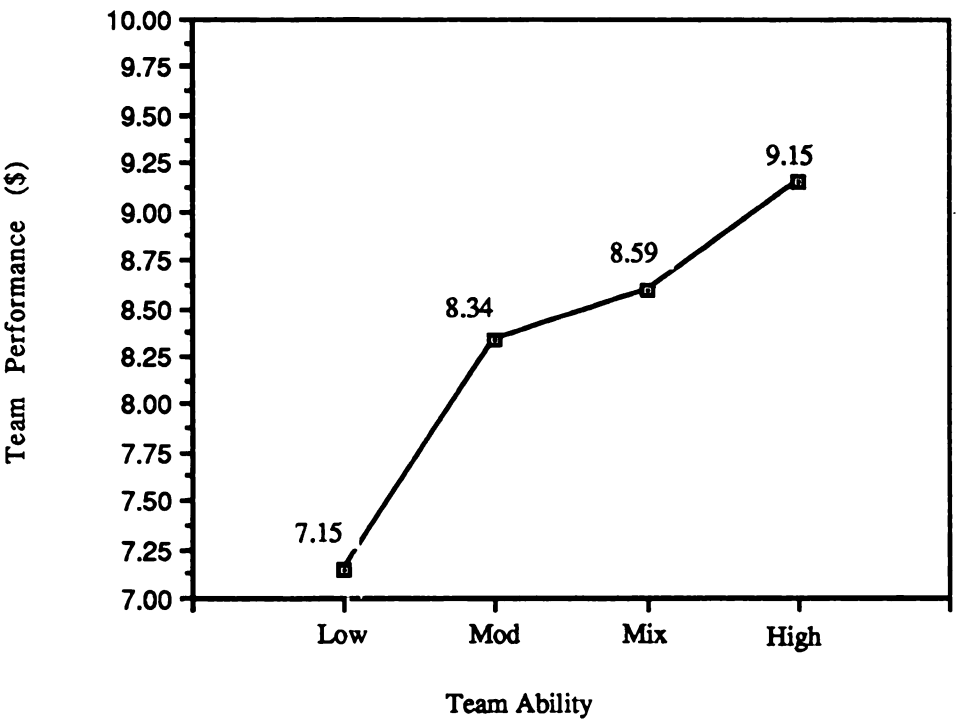
individuals as low, moderate, or high ability was adequate in the development of the three-person teams.

Analyses of Primary Hypotheses

Hypothesis 1: The first hypothesis was concerned with the relationship between team composition, as stated in the introduction, and team performance, measured in dollars earned. Specifically, it was predicted that there would be a positive correlation between the two. An ANOVA with team performance as the DV, trials (15) as a within-subjects factor, and team composition (4 levels) as a between-subjects factor indicated that there was no significant trial by ability interaction ($p > .05$). As a result, performance was summed across the fifteen trials to produce an index of team performance. Across the teams, performance measured in dollars earned per team ranged from \$6.00 to \$10.50 with a grand mean of \$8.44. The correlation between team ability and performance ($r = .40$, $p < .05$) provided support for the first hypothesis. This relationship is depicted in Figure 7. Post hoc tests for differences between the means indicated that the means for teams comprised of all low ability performers (\$7.15, SD = .89) and all moderate ability performers (\$8.34, SD = .98) differed from those teams composed of all high ability performers (\$9.15, SD = 1.28) ($p < .05$). The mean for the mixed-ability team (8.59, SD = 1.21) did not differ significantly from any of the other means. While the difference between the moderate teams and the mixed ability teams was not significant, it is worth noting that while these teams had essentially the same total ability (3 moderate ability equal 1 high, 1 moderate, and 1 low ability), those teams that

Figure 7

Effect of Team Ability on Team Performance



included a high ability performer performed somewhat better than those with all moderate ability individuals.

Hypothesis 2. The second hypothesis was concerned with the expected interaction of team ability and team pay on team members' perceptions of the fairness of their pay. Observed means and standard deviations for the fairness variable by condition are presented in Table 1. A 2 (pay system) x 4 (team ability) ANOVA with perceptions of pay as the DV revealed no significant main effects for either variable (F's < 1.00) (see Table 2), nor was the interaction significant (F (3,34) = 1.25, p = .31). Figure 8 presents a graph of the observed means and standard deviations (SD's) for this interaction.

Of particular interest in the examination of these means is the difference in the high ability condition as a function of pay. Those teams composed of all high ability performers and paid equally based on the team's performance expressed higher (more than 2 standard deviations) perceptions of fairness than their individually paid counterparts. In no other condition were these perceptions so divergent. A potential explanation for this finding has to do with the performance of individuals versus teams. Generally speaking, team performance was higher than the performance of any one individual in the team. Thus, in those cases where there were three high ability members and team performance was high, being paid individually would most likely result in earning less money than would have been the case had pay been based on the team's performance. Because performance tended not to be as high in the other teams,

Table 1

Means and Standard Deviations for the Endogenous Variables

Condition	N	Fairness M (SD)	Cooperation M (SD)	Performance M (SD)
Group Pay:				
Low	2	57.50 (6.36)	37.00 (1.41)	7.00 (1.41)
Mod	4	62.25 (12.82)	70.75 (26.03)	8.19 (1.03)
Mix	12	64.33 (11.66)	47.92 (14.92)	8.33 (1.24)
High	2	71.00 (7.07)	46.00 (8.49)	8.50 (2.12)
Individual Pay:				
Low	3	58.33 (12.42)	36.67 (21.22)	7.25 (0.75)
Mod	4	62.50 (8.89)	41.00 (17.11)	8.50 (1.06)
Mix	12	64.58 (8.89)	47.33 (15.87)	8.85 (1.16)
High	3	51.67 (10.97)	53.33 (7.51)	9.58 (0.58)

Table 2

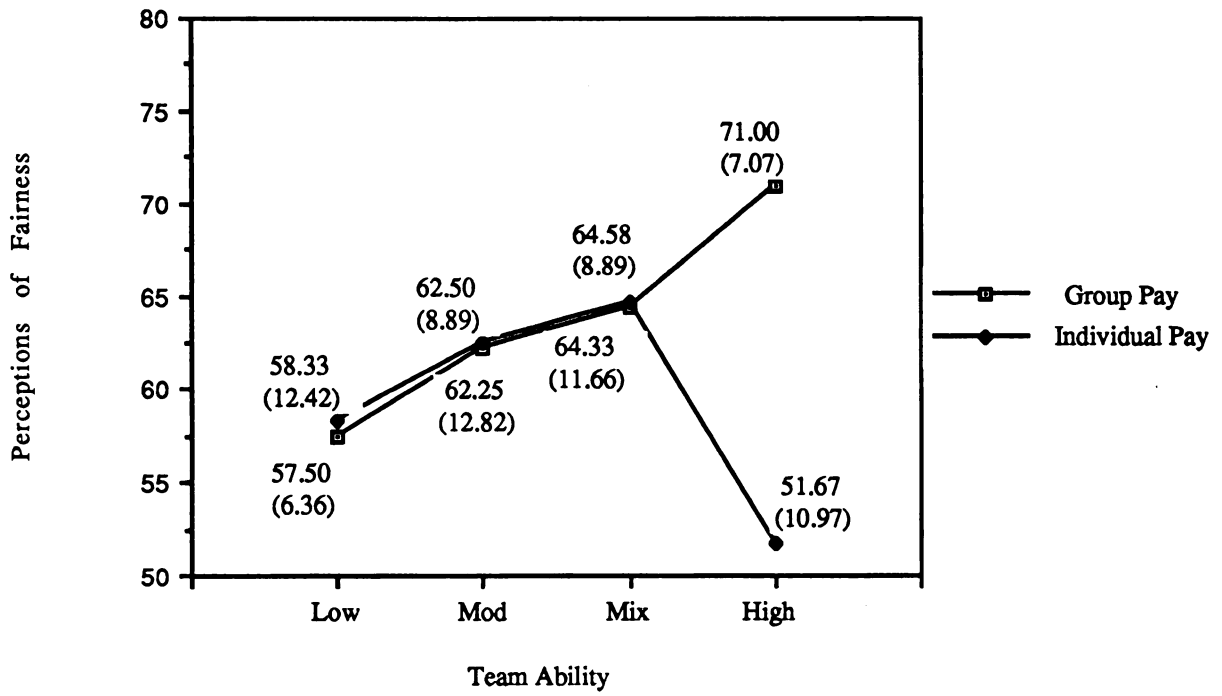
Analysis of Variance Summary for Endogenous Variables

		FAIR	COOP	PERF
Independent Variable	df	F	F	F
Ability (A)	3	.68	1.40	2.87*
Team Pay (P)	1	.36	1.09	2.00
A x P	3	1.25	1.96	.14
Within	34	(109.80)	(263.28)	(1.37)

Note: FAIR = Perceptions of Fairness, COOP = Degree of Cooperation, and PERF = Team Performance. Values in parentheses represent mean square terms. * $p < .05$

Figure 8

Interaction Between Pay and Team Ability on Perceptions of Fairness



this difference between team and individual outcomes would not have been so large.

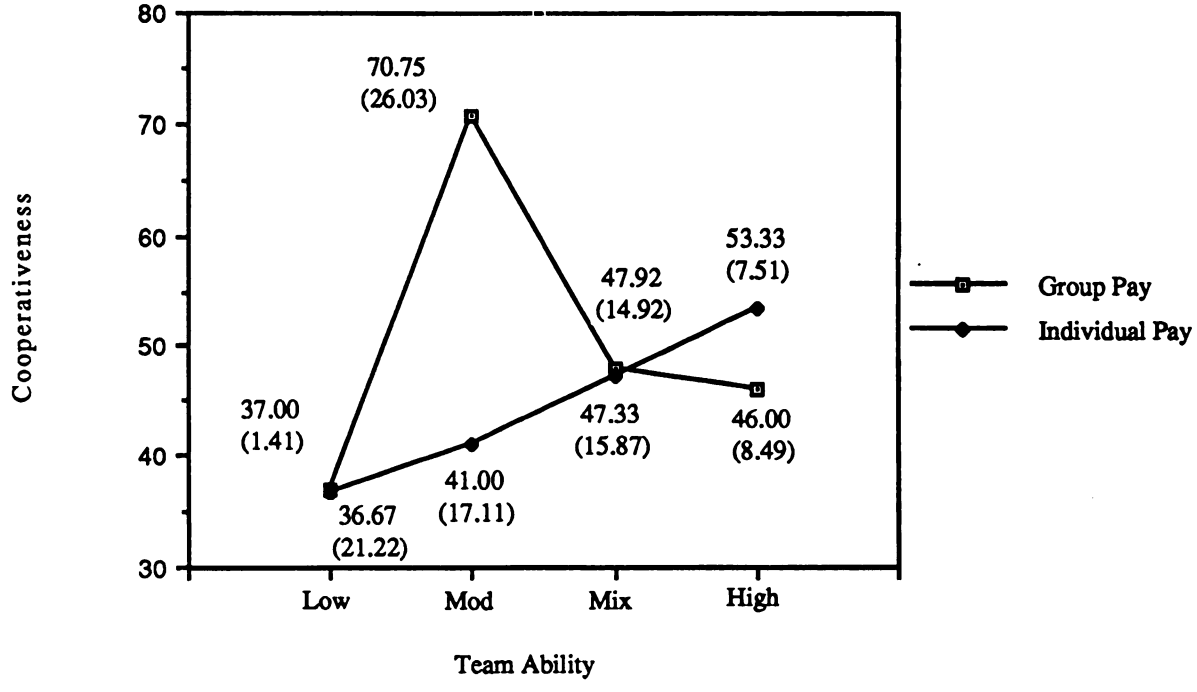
Also of interest is the fact that this difference was not significant. Most likely, this was due to the problem of low power as a function of small sample size. Given a larger sample and no change in the pattern of means, this difference would probably have resulted in a significant interaction.

Hypothesis 3. Hypothesis 3 focused on the expected effect of the interaction between pay and ability on the degree of cooperation exhibited by team members. The index of cooperation used in this set of analyses was computed through the process described in the Methods section as well as Appendix E. Means and standard deviations are presented in Table 1. As with the other analyses which were examining a variable assessed at each of the fifteen trials, an ANOVA was conducted using cooperation (COOP) as the DV. No significant interaction was observed ($p > .05$). As a result, cooperation across trials was collapsed to produce a single index for each team with a minimum value of zero (indicating perfect cooperation). A subsequent ANOVA using this measure of cooperation as the DV yielded neither a significant main effect for ability, nor pay (p's $> .05$). The interaction of these two variables was also non-significant (see Figure 9).

Hypothesis 4. The effect of the interaction between pay and ability on team performance was the focus of the fourth hypothesis. An ANOVA, using performance as the DV, indicated no significant interaction between trials and the between-subjects variables ($p >$

Figure 9

Interaction of Ability and Pay on Cooperation



.05). As a result, performance over the trials was summed to yield an index of team performance. A 2 x 2 ANOVA revealed a significant main effect for ability (F (3,34) = 2.87, p < .05). However, there were no significant effects for either the main effect of pay or for the interaction (p's > .05). Figure 10 shows the pattern of means (SD's) for the interaction of team ability and pay on team performance.

Hypothesis 5. Hypothesis 5 suggested that all three dependent variables would be intercorrelated. Table 3 includes the correlation matrix for these, as well as all other relevant, variables. As indicated in this table, none of the intercorrelations is significant (p's > .05). Due to this fact, the analyses for Hypotheses 6a and 6b were not conducted, as the basic criterion for testing mediation was not met. Figure 11 does display the path coefficients of the hypothesized model; the only significant relationship being that between ability and performance.

Hypothesis 7. Hypothesis 7 discussed the expected effect of the interaction on team performance when teams were categorized as either homogeneous or heterogeneous (i.e. ability was equal in these teams). No significant main effects were found (p's > .05). Similarly, no interaction effect was demonstrated using the 2 x 2 ANOVA with team performance as the DV (p > .05). However, while not significant, results were consistent with earlier analyses in that individual pay resulted in higher performance (M = 8.67) than did group pay (M = 8.19) for both homogeneous and heterogeneous teams (see Figure 12).

Figure 10

Interaction of Ability and Pay on Team Performance

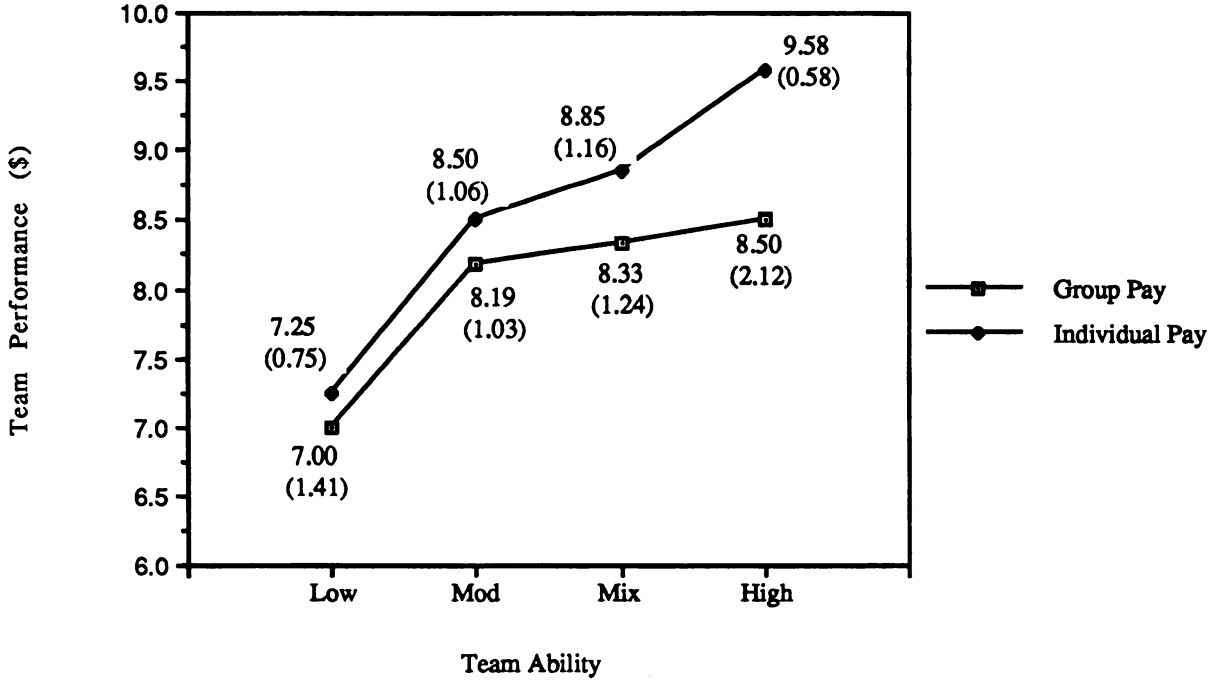


Table 3

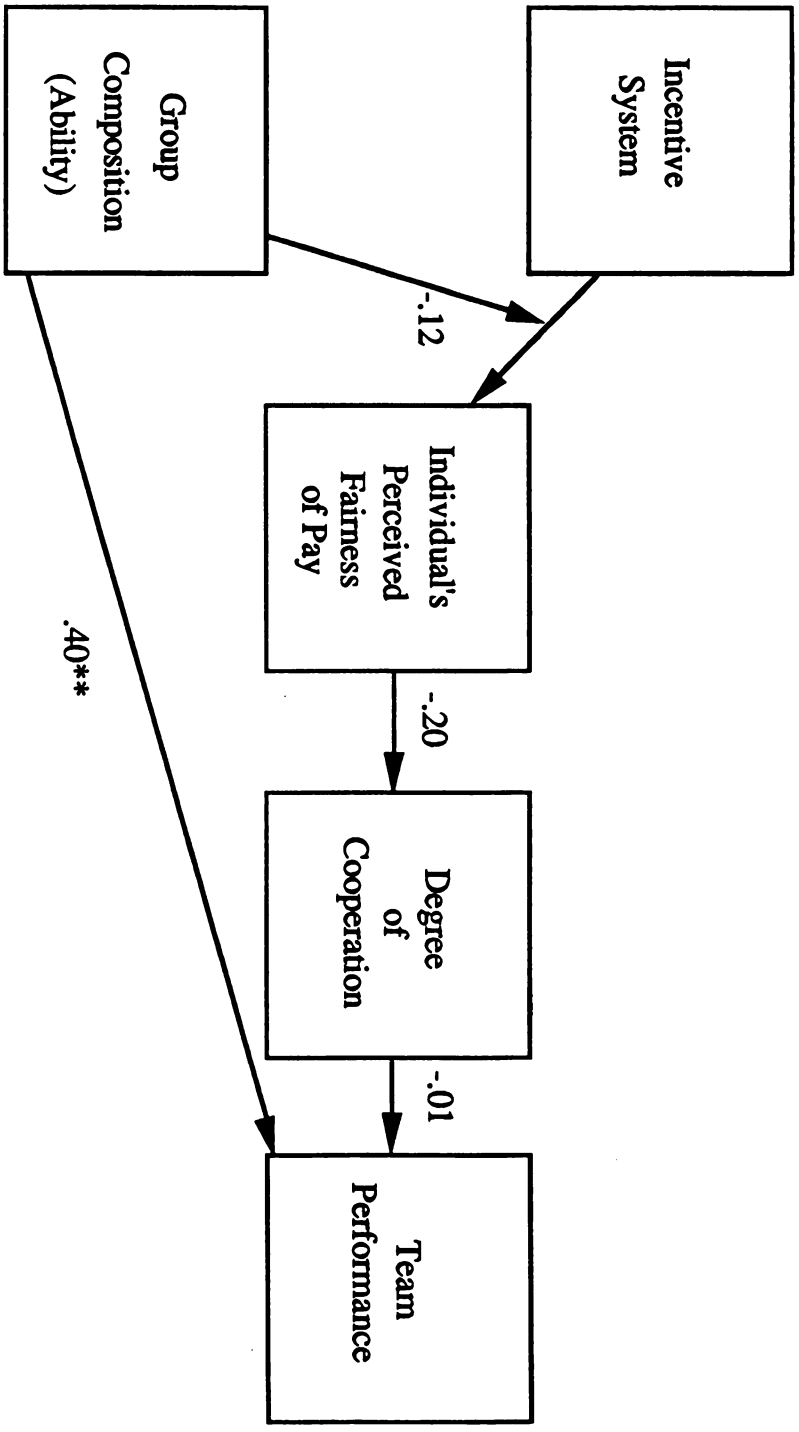
Intercorrelations Among Key Variables

	(1)	(2)	(3)	(4)	(5)
Teamab(1)	1.00				
Teampay(2)	-.01	1.00			
Fairness(3)	.09	-.11	1.00		
Cooperation(4)	.11	-.16	-.20	1.00	
Teamperf(5)	.41**	.20	.11	-.01	1.00

Note: ** ($p < .01$)

Figure 11

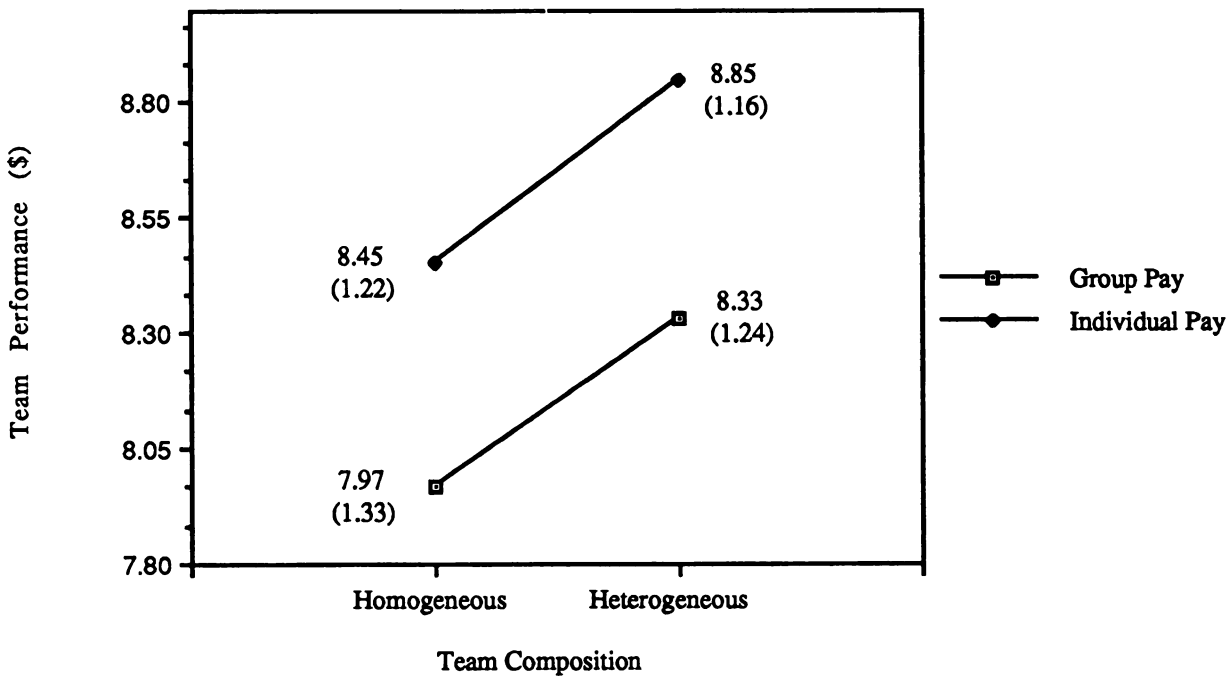
Observed Relationships Among Key Variables



Note: ** ($p < .01$)

Figure 12

Relationship Between Pay and Homogeneous versus Heterogeneous Teams and Performance



DISCUSSION

This discussion will be divided into three sections. The first will provide a brief review of the strengths of the current procedure for studying team performance, what the interesting findings were and where these findings fit into current literature on team performance. Following that, the second section will be devoted to a discussion of possible limitations of the study and their potential impacts on the obtained results. Finally, a discussion of potential directions for future research will be presented.

Review of Results and Integration with Current Literature

This study had several strengths associated with it which should be incorporated in the design of future research on team performance. First, and most importantly, the operationalization of ability proved useful and provided some support for the importance of ability as a determinant of performance in this task. The ability measure allowed for the pre-classification of individuals as high, moderate, or low performers. Further, this task allowed for these individual differences to be manifested both at the individual and team level. That is, not only did high ability persons perform better than low ability persons, but also these individual differences were realized in the team's performance. A task which allows for the

simultaneous collection and examination of both individual and team level variables is certainly an asset to the team performance literature.

In addition to the strengths associated with the task itself, the results of this study also add to the literature. For example, consistent with previous research in the area of team performance (cf. Tziner & Eden, 1985), results from this study supported the position that the higher the ability level of the team, the better the team's performance. All else being equal, it would appear that the intuitive position that "more is better," is supported by these results. Teams with three high ability persons performed better than those with three moderate ability persons which, in turn, performed better than those with three low ability people. Further, these results seem to suggest that high ability individuals aid team performance more than low ability individuals detract from team performance. This was demonstrated by the fact that teams with three moderate and teams with one high, one moderate, and one low ability person both had an equal pool of ability to draw from, but did not have equal subsequent performance. On average, though not significantly so, the mixed ability teams performed better than teams with all moderate ability individuals. This evidence suggests that when combining individuals into teams, performance will be more influenced by the number of high ability people in the team than the average talent within the team.

Also of potential interest was the effect of pay on team performance. Results indicated that those teams whose members

were paid based on their individual performance tended to perform better than teams whose members were paid equal amounts based on team performance. That is, even on a "team" task, teams may tend to perform better when individuals are rewarded for their individual performance. While the main effect for pay was not significant, the results nonetheless suggest that this may be an important variable and warrants further investigation.

Results indicated that the best performing teams under the group pay condition (3 high ability members) performed only as well as the teams comprised of three moderate ability members in the individual pay condition. This finding is interesting in that it suggests that the reward system can make up for ability deficits in the team context. Further, this is consistent with the notion that, at the individual level, motivation can make up for ability deficiencies.

Another interesting finding with respect to the effect of both the incentive system and team ability level on performance was that associated with the final hypothesis. Specifically this hypothesis was concerned with the question of how to best divide up a fixed set of talent. Teams which are composed of members with varying ability levels tend to outperform those teams which are comprised of members with similar abilities. Drawing back on the analogy used in the introduction, it would be better to put together a "line" of hockey players who had varying ability levels, rather than putting the best players together, then the next best, and so on. Thus, the old saying that you "should not put all your eggs in one basket" seems to have found some support, albeit weak, in the current study.

Limitations

Several problems may have detracted from my ability to adequately test the hypotheses presented above. The first, and possibly the most critical, is the problem of low power. With a sample size of only 42 teams and the types of interactions being examined, it is clear why many of the observed results were not significant. Given that when looking at individual level data manipulations appeared to be working (manipulation checks were, in fact, significant) it is highly likely that more significant results would have been observed with the group-level data had more teams been examined.

Another problem which almost certainly affected the nonsignificant results observed with respect to the proposed model was the operationalization of both the cooperation and fairness variables. To begin with, the cooperation measure which was adopted from Hollenbeck et al. (1991) did not appear to adequately capture the construct of interest. This was evidenced by apparent unsystematic differences across teams. It may be that for this particular task cooperation may be better measured using another set of indices. Whatever the problem may have been, clearly the cooperation measure used in this study should be redeveloped and refined. In addition to the objective measures, perhaps a questionnaire item, or set of items, assessing the participants' perceptions of the degree of cooperation would prove valuable in attempting to measure this construct.

The measure of fairness was also a potential cause for concern in this study. Perceptions of fairness were gathered following the last trial, while the other measures (i.e. cooperation and performance) were gathered after each of the fifteen trials. It may have been that fairness perceptions changed from the first to the last trial as a result of team and/or individual performance outcomes. Given that it was measured at one point in time, it was impossible to assess whether this occurred. While it may have been cumbersome to gather these perceptions after each of the trials, and the participants may have been reactive, perhaps it may have been worthwhile to collect them after every fifth trial or so.

One other issue that may have reduced the observation of significant results that deserves to be addressed at this point is the fact that participants received both course credit and money for participating in this experiment. Given that participants knew that they were going to be getting something for their time (i.e. credit), the monetary incentive may have been reduced in importance. To truly test the model that was presented in the introduction, incentives should be the only reward used.

Directions for Future Research

In addition to being aware of the problems which plagued the current study, future research in the area of team performance should also try to get the teams to perform for a longer period of time. Such a longitudinal approach would allow for team members to develop a sense of team identity. Variables such as pay and ability would be manipulated in an environment which would further allow

for their influence on team performance. While such an approach to the study of team performance would certainly provide many benefits over the current study, other problems would likely arise. For example, time may create a situation in which other processes could influence performance over and above those being manipulated. For this reason, while future research should be directed more towards examining teams in a dynamic environment, control over key variables remains a critical issue.

While the current study did not find support for the proposed model, future researchers should continue to rely on careful theory development in this area. As Goodman and his colleagues (1986, 1987) suggest, it makes sense to attempt to understand the phenomena of team performance by taking a simple approach to model development. That is, begin with a few testable variables. Team performance is far too complex a process to develop and test a comprehensive model in a single experiment. Although the model presented was not supported, future research should continue to examine the influences of both team composition and incentives as potentially important determinants of team performance.

Finally, given the ubiquity of teams in the current work environment, more research is clearly needed so that we can more fully understand how teams should be formed, how they operate, and how we can make them more effective. Researchers should not only look to the industrial/organizational psychology literature as a potential source for developing models of team performance, but they should also examine the research on teams in social psychology,

case study information detailing teams from the business literature, and perhaps most importantly the factors which are at work in today's work settings.

LIST OF REFERENCES

LIST OF REFERENCES

Adams, J. S. (1965). Inequity in social exchange. In L. Berkowitz (Ed.), Advances in Experimental Social Psychology, (Vol. 2), New York: Academic Press.

Austin, J. T. & Bobko, P. (1985). Goal setting theory: Unexplored areas and future research needs. Journal of Occupational Psychology, 58, 289-308.

Bantel, K. A. & Jackson, S. E. (1989). Top management and innovations in banking: Does the composition of the top team make a difference? Strategic Management Journal.

Bullock, R. J. & Lawler, E. E. III (1984). Gainsharing: A few questions and fewer answers. Human Resource Management, 23, 23-40.

Campbell, J. P. & Pritchard, R. D. (1976). Motivation theory in industrial and organizational psychology. In M. D. Dunnette (Ed.), Handbook of industrial and organizational psychology. Chicago, Ill: Rand-McNally.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Erlbaum Associates.

DeBiasio, A. R. (1986). Problem solving in triads composed of varying numbers of field-dependent and field independent subjects. Journal of Personality and Social Psychology, 51, 749-754.

Deutsch, M. (1975). Equity, equality, and need: What determines which value will be used as the basis of distributive justice? Journal of Social Issues, 31, 137-149.

Deutsch, M. (1985). Distributive justice. New Haven, Conn: Yale University Press.

Dieterly, D. L. (1978). Team performance: A model of research. In E. J. Baise and J. M. Miller (Eds.), Proceedings of the human factors society 22nd annual meeting. Santa Monica, CA: Human Factors Society.

Dyer, J. L. (1984). Team research and team training: A state-of-the-art review. In F. A. Muckler (Ed.), Human factors review: 1984 (pp. 285-323). Santa Monica, CA: Human Factors Society.

Forsyth, D. R. (1987). Social psychology. Monterey, CA: Brooks/Cole.

Foushee, H. C. (1984). Dyads and triads at 35,000 feet: Factors affecting group process and aircrew performance. American Psychologist, 39, 885-893.

Gladstein, D. L. (1984). A model of task group effectiveness. Administrative Science Quarterly, 29, 499-517.

Gooding, R. Z. & Wagner, J. A. (1985). A meta-analytic review of the relationship between size and performance: The productivity and efficiency of organizations and their subunits. Administrative Science Quarterly, 30, 462-481.

Goodman, P. S., Ravlin, & Argote, L. (1986). Current thinking about groups: Setting the stage for new ideas. In P. S. Goodman (Ed.), Designing effective work groups. San Francisco: Jossey-Bass.

Goodman, P. S., Ravlin, E. & Schminke, M. (1987). Understanding groups in organizations. In Research in Organizational Behavior(Vol. 9). JAI Press, 121-173.

Goodstein, L. D. & Dovico, M. (1979). The decline and fall of the small group. Journal of Applied Behavioral Science, 15, 320-328.

Greenberg, J. (1987). A taxonomy of organizational justice theories. Academy of Management Review, 12, 9-22.

Guzzo, R. A. (1979). Types of rewards, cognitions, and work motivation. Academy of Management Review, 4, 75-86.

Guzzo, R. A., Jette, R. D., & Katzell, R. A. (1985). The effects of psychologically based intervention programs on worker productivity. Personnel Psychology, 38, 275-291.

Hackman, J. R. (1987). The design of work teams. In J. Lorsch (Ed.), Handbook of organizational behavior (pp. 315-342). Englewood Cliffs, NJ: Prentice-Hall.

Hackman, J. R. & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz (Ed.), Advances in experimental social psychology, Vol. 8. New York: Academic Press.

Hill, G. W. (1982). Groups versus individual performance: Are n + 1 heads better than one? Psychological Bulletin, 91, 517-539.

Hollenbeck, J. R., Sego, D. J., Ilgen, D. R., & Major, D. A. (1991). Team interactive decision exercise for teams incorporating distributed expertise (TIDE^2): A program and paradigm for

team research. (ONR Report No. 2011). Arlington, VA: Office of Naval Research.

Hull, C. L. (1943). Principles of behavior. New York, NY: Appleton-Century-Crofts.

Kabanoff, B. (1991). Equity, equality, power, and conflict. Academy of Management Review, 16, 416-441.

Karambayya, R. & Brett, J. M. (1989). Managers handling disputes: Third-party roles and perceptions of fairness. Academy of Management Journal, 32, 687-704.

Kanfer, R. (1989). Motivation theory and industrial/organizational psychology. In M.D. Dunnette (Ed.) Handbook of Industrial and Organizational Psychology, Vol. 1, Palo Alto, CA: Consulting Psychologists Press.

Kim, K. I., Park, H., & Suzuki, N. (1990). Reward allocations in the United States, Japan, and Korea: A comparison of individualistic and collectivistic cultures. Academy of Management Journal, 33, 188-198.

Kerr, N. L. (1989). Illusions of efficacy: The effects of group size on perceived efficacy in social dilemmas. Journal of Experimental Social Psychology, 25, 287-313.

Klein, H. J. & Mulvey P. (1989). The setting of goals in groups: An examination of processes and performance. Journal of Applied Psychology, (under review).

Komaki, J. L., Desselles, M. L., & Bowman, E. D. (1989). Definitely not a breeze: Extending an operant model of effective supervision to teams. Journal of Applied Psychology, 74, 522-529.

Korman, A. K., Glickman, A. S., & Frey, R. L. (12981). More is not better: Two failures of incentive theory. Journal of Applied Psychology, 66, 255-259.

Lawler, E. E. III (1981). Pay and organization development. Reading, MA: Addison-Wesley Publishing Co.

Lawler, E. E. III & Porter, L. W. (1967). Antecedent attitudes of effective managerial performance.

Levine, J. M. & Moreland, R. L. (1990). Progress in small group research. Annual Review of Psychology, 41, 585-634.

Locke, E. A. & Latham, G. P. (1990). A theory of goal setting and task performance. Englewood Cliffs, NJ: Prentice Hall.

London M. & Oldham, G. (1977). A comparison of group and individual incentive plans. Academy of Management Journal, 20, 34-41.

Mannix, E. A., Thompson, L. L., & Bazerman, M. H. (1989). Negotiation in small groups. Journal of Applied Psychology, 74, 508-517.

March, J. G. & Simon, H. A. (1958). Organizations. NY: Wiley.

Markham, S. E., Dansereau, F., & Alutto, J. A. (1982). Group size and absenteeism rates: A longitudinal analysis. Academy of Management Journal, 25, 921-927.

McGrath, J. E. & Kravitz, D. A. (1982). Group research. Annual Review of Psychology, 33, 195-230.

Milkovich, G. T. & Newman, J. M. (1987). Compensation. Plano, TX: Business Publications, Inc.

Mills, T. M. (1979). Changing paradigms for studying human groups. Journal of Applied Behavioral Science, 15, 407-423.

Mitchell, T. R. & Silver, W. S. (1990). Individual and group goals when workers are interdependent: Effects on task strategies and performance. Journal of Applied Psychology, 75, 185-193.

Naylor, J. C. & Dickinson, T. L. (1969). Task structure, work structure, and team performance. Journal of Applied Psychology, 53, 167-177.

Naylor, J. C., Pritchard, R. D., & Ilgen, D. R. (1980). A theory of behavior in organizations. New York, NY: Academic Press.

O' Brien, G. E. & Owens, A. G. (1969). Effects of organizational structure on correlations between members' abilities and group productivity. Journal of Applied Psychology, 53, 525-530.

Opsahl, R. L. & Dunnette, J. D. (1966). The role of financial compensation in industrial motivation. Psychological Bulletin, 66, 94-118.

Organ, D. (1990). The motivational basis of organizational citizenship behavior. In B. M. Staw and L. L. Cummings (Eds.), Research in organizational behavior, Vol. 12. Greenwich, CT: JAI Press.

Organ, D. W. & Konovsky, M. (1989). Cognitive versus affective determinants of organizational citizenship behavior. Journal of Applied Psychology, 74, 157-164.

Pfeffer, J. & Langton, N. (1988). Wage inequality and the organization of work: The case of academic departments. Administrative Science Quarterly, 33, 588-606.

Pinder, C. C. (1984). Work motivation: Theory, issues, and applications. Glenview, Ill: Scott, Foresman, and Company.

Pritchard, R. D., Jones, S. D., Roth, P. L., Stuebing, K. K., & Ekeberg, S. E. (1988). effects of group feedback, goal setting, and incentives on organizational productivity. Journal of Applied Psychology, 73, 337-358.

Pritchard, R. D. & Sanders, M. S. (1973). The influence of valence, instrumentality, and expectancy on effort and performance. Journal of Applied Psychology, 57, 55-60.

Puckett, E. S. (1978). Productivity achievements - A measure of success. In F. C. Lesieur (Ed.), The Scanlon Plan (pp. 109-118). Cambridge, MA: MIT Press.

Roby, T. B. (1968). Small group performance. Chicago, IL: Rand McNally.

Shaw, M. E. (1976). Group dynamics: The psychology of small group behavior (2nd ed). New York: McGraw-Hill.

Shaw, M. E., (1981). Group dynamics: The social psychology of groups. New York: Wiley.

Shiflett, S. (1979). Toward a general model of small group productivity. Psychological Bulletin, 86, 67-79.

Skinner, B. F. (1938). The behavior of organisms: An experimental approach. New York, NY: Appleton-Century-Crofts.

Steers, R. M. & Porter, L. W. (1987). Motivation and work behavior (4th ed). New York: McGraw-Hill.

Steiner, I. D. (1972). Group process and productivity. New York, NY: Academic Press.

Sundstrom, E., De Meuse, K. P., & Futrell, D. (1990). Work teams: Applications and effectiveness. American Psychologist, 45, 120-133.

Taylor, F. W. (1947). Scientific management. New York, NY: Harper.

Thomas, E. J. (1957). Effects of facilitative role interdependence on group functioning. Human Relations, 10, 347-366.

Thompson, J. D. (1967). Organizations in action. New York, NY: McGraw-Hill.

Tziner, A. & Eden, D. (1985). Effects of crew composition on crew performance: Does the whole equal the sum of its parts? Journal of Applied Psychology, 70, 85-93.

Van de Ven, A. H., Delbecq, A. H., & Koenig, R., Jr. (1976). Determinants of coordination modes within organizations. American Sociological Review, 41, 322-328.

Wagner, W. G., Pfeffer, J., & O'Reilly, C. C. (1984). Organizational demography and turnover in top management groups. Administrative Science Quarterly, 29, 74-92.

Wilcoxon, H. C. (1969). Historical introduction to the problem of reinforcement. In J. T. Tapp (Ed.), Reinforcement and behavior. NY: Academic Press.

Wood, W. (1985). Meta-analytic review of sex differences in group performance. Psychological Bulletin, 102, 53-71.

APPENDICES

APPENDIX A

HANDBOOK FOR TEAM MEMBERS
TEAM PERFORMANCE EXPERIMENT
COMMAND AND CONTROL SIMULATION

Michigan State University

Summer, 1991

COMMAND AND CONTROL TEAM SIMULATION

INTRODUCTION:

The year is 1994 and you are part of a U.S. naval carrier group's command and control team stationed in the Middle East. A regional conflict between two nations in this area has recently broken out, and your mission is to protect seagoing commercial traffic in the area from accidental or intentional attacks. As history indicates, this is a highly sensitive task. For example, in 1987, an Iraqi jet accidentally fired two Exocet missiles into the Frigate U.S.S. Stark, killing 37 American servicemen and crippling the vessel. One year later, the U.S.S. Cruiser Vincennes accidentally shot down an Iranian passenger plane killing 290 innocent civilians. Any repeat of mistakes of this kind will probably lead to a withdrawal of American forces from the area. Such a withdrawal would have disastrous economic and political ramifications that would spread well beyond this region.

THE TASK FORCE:

A naval carrier battle group team is an awesome array of ships and support units. It has a concentric ring of missile firing warships which protect the aircraft carrier at its center. The aircraft carrier in return provides an overall umbrella of air protection for the entire task force. The carrier's 90 planes can unleash air strikes against targets at land, sea, and even under water. A carrier group can dominate up to 196,000 square miles of Ocean. A standard carrier group consists of six ships; the Carrier itself, two Ticonderoga class Aegis Cruisers, two anti-air Destroyers, and a submarine.

A carrier group is also supported by AWACs reconnaissance planes and a land based Coastal Air Defense (CAD) unit. Although the Carrier itself is equipped with some air patrol capacities, the Cruisers, AWACs, and CAD units provide the bulk of air traffic patrol. Taken together, the air patrol groups on the Carrier, the Cruiser, the AWACs, and the CAD unit make up the command and control team.

TEAM MISSION:

The team of which you are a part, will role play the Commanding Officers of various units in the carrier group. Your mission is to monitor the air space surrounding the carrier group, making sure that neutral ships are not attacked. In performing this role, you must make certain that you do not allow loss of life resulting from accidental or intentional attacks on ships in the task force. At the same time, it is also of paramount importance that you do not inadvertently shoot down friendly military aircraft or any civilian aircraft. Many passenger flights move in and out of the region, and friendly military aircraft from nations not involved in the conflict also patrol the area. The navy can ill-afford any mistakes of either the Stark or Vincennes variety.

OVERVIEW OF ROLES:

There are four roles in this simulation, one for each member of a four person team. The leader is the Commanding Officer (CO) of the Aircraft Carrier. The other team members include the CO of an AWACs air reconnaissance plane, the CO of an Aegis Cruiser, and the CO of a Coastal Air Defense (CAD) unit located on the mainland. The team's task is to decide what response the carrier group should make toward incoming air targets. These decisions are based on data they collect by measuring characteristics of aircraft that enter the group's airspace. These measures are obtained from sophisticated radar equipment. Aircraft that are being tracked on radar are called targets. There are seven possible choices to make for each incoming target. These responses are graded in terms of their aggressiveness. Each of these is described below, moving from least to most aggressive:

(1) **IGNORE:** This means that the carrier group should devote no further attention to the target and instead focus on other possible targets in the area. The group should never ignore a target that might possibly attack. This would most assuredly lead to loss of lives on the ship attacked.

(2) **REVIEW:** This means to leave this target momentarily, so that the team can monitor other targets, but to return to this target after a short period of time to update its status. A carrier group can review a large number of targets, but not an infinite number of targets.

(3) **MONITOR:** This means that the carrier group should continuously track the target on radar. A carrier group can monitor fewer targets than it can review, and thus, monitoring diminishes the group's overall capacity.

(4) **WARN:** This means that the carrier group sends a message to the target identifying the group and alerting the target to steer clear. Warning targets that should be ignored detracts from the salience of legitimate warnings. Warning targets that intend to attack is also bad, since the warning makes it easier for the attacker to locate the ship.

(5) **READY:** This means to steer the ship into a defensive posture and to set defensive weapons on automatic. A ship in a readied position is rarely vulnerable to attack. This stance should not be taken to non-threatening targets since weapons set to automatic often fire mistakenly at innocent targets that fly too close to the carrier group. A ship in this position cannot readily take offensive action toward the target.

(6) **LOCK-ON:** This synchronizes the ship's radar and attack weapons so that the weapons fix themselves on the target. A ship at Lock-On position can take offensive action at a moments notice. However, a ship's capacity to track other targets in severely constrained once it has Locked-On a single target. Thus, this should be reserved for targets that are almost certain to be threatening.

(7) **DEFEND:** This is "weapons away" and means to attack the target with Tomahawk cruise missiles. A defend decision cannot be aborted once initiated and thus must only be used when the group feels attack is imminent.

CHARACTERISTICS OF TARGETS:

The incoming air targets can be measured on nine attributes. These are listed below along with the ranges of possible values on the attributes:

(1) **Speed:**	150 to 800 mph.
(2) **Altitude:**	5,000 to 35,000 ft.
(3) **Size:**	15 meters to 50 meters
(4) **Angle:**	-15 Degrees (rapid descent) to +15 Degrees (rapid ascent).
(5) **IFF:**	stands for "Identification Friend or Foe," this is a radio signal that identifies whether an aircraft is civilian, para-military or military which ranges from 0.2 Mhz (an airliner) to 1.6 Mhz (a fighter).
(6) **Direction:**	from +40 Degrees (passing far to the east or west of the carrier) to 00 Degrees (coming straight in to the carrier).
(7) **Corridor: Status**	a corridor is a 20 mile lane open to commercial air traffic, and this is expressed in terms of miles from the center of the corridor, ranging from 1 mile (in the middle of it) to 50 miles (way out of it).
(8) **Radar Type:**	the kind of radar possessed by the aircraft range from Class 1 (weather radar only) to Class 9 (weapons radar).
(9) **Range:**	distance of the aircraft from the carrier ranging from anywhere from 20 to 200 miles.

DETERMINING THE LEVEL OF THREAT:

In general, the degree to which an incoming target is threatening depends on its standing on the previous nine attributes. There are five simple rules to remember in determining the danger associated with any target:

(a) all else equal, in terms of IFF, **military targets** are more threatening than civilian targets (see attribute **#5**).

(b) SPEED and DIRECTION go together, so that **fast targets coming straight in** are most threatening (see **#1 & #6** above). Speed alone and direction alone mean nothing. There is nothing to fear if fast targets are not headed toward the group. Likewise, there is nothing to fear from objects headed directly for the group that are moving slowly.

(c) ANGLE and RANGE go together, so that **descending targets that are close** are especially threatening (see **#4 & #9** above). Angle alone and range alone mean nothing. Descending targets that are far away, or close targets that are on the way up are not threatening.

(d) ALTITUDE and CORRIDOR STATUS go together, so that **low flying targets that are way outside the corridor** are especially threatening (see **#2 & #7** above). Altitude alone and corridor status alone mean nothing. There is nothing to fear from high targets flying well outside the corridor or low flying targets in the middle of the corridor.

(e) SIZE and RADAR go together, so that **small objects with weapons radar** are especially threatening (see **#3 & #8** above). There is nothing to fear from small targets with weather radar or from large targets with weapons radar.

HOW RULES COMBINE TO DETERMINE JUDGMENTS:

The five rules combine to determine the overall threat represented by the target. So for example, if the team detected an (a) military aircraft that is (b) flying in straight and fast, (c) was close and descending, (d) was flying low and way outside the corridor and (e) was small and had weapons radar; the ship is being attacked and should DEFEND.

If the team detected (a) a civilian aircraft, (b) passing slow at an angle, (c) was far away and ascending, (d) was flying high and in the middle of the corridor and (e) was large and had weather radar; this is a passenger plane that should be IGNORED.

Intermediate responses like MONITOR, WARN, or READY are to be used when the target is threatening according to some of the rules, but not all. For example, a military aircraft that is close and descending (**see Rule c**), small and with weapons radar (**see Rule e**), but is travelling slowly at an angle to the group (**see Rule b**), and is high and in the middle of the corridor (**see Rule d**) might need to be WARNED. You would not want to ignore it, but you would not want to shoot it down either.

AREAS OF EXPERTISE:

The CO of the Carrier is the leader of the team and the person to whom each of the other COs must make their recommendation for each target. Each team member, other than the CO of the Carrier, has expertise that is unique to his or her role. That expertise comes in the form of the person's (a) ability to **measure attributes** and **translate raw data** into judgments regarding threat, and (b) the person's **knowledge of the rules.**

For example, although all team members know that military aircraft are more threatening than non-military aircraft, only two people in the team can actually measure this characteristic of the target. In addition, only these two players will be trained to know exactly how raw data on IFF (i.e. radio signal Mhz.) can be translated into terms of "non-threatening," "somewhat threatening," and "very threatening."

Each member of the team will have to memorize all of the four combination rules. Thus, while all members will know how the various attributes combine to determine threat, they will only be able to measure **and** interpret a subset of the raw information.

PATROL SESSIONS:

The "Sea Screen". Patrol session refer to the time that you and your teammates are responsible for monitoring air traffic in your designated area. While you are monitoring traffic, you will be stationed at a computer monitor. When this screen has four icons on it (i.e. the carrier, plane, ship, and land mass), you are in the "Sea Screen" mode. This means that there is a target (i.e. a red dot) in your airspace that needs to be assessed. The target will begin to blink and beep at an increasing rate when there is less than 30 seconds to respond. If the leader (CO of the Carrier) fails to make any decision with respect to the target, this will be treated as if the team decided to **IGNORE** it. In making the team decision, the leader will simply average the three recommendations made by each of the other COs. If there are less than 10 seconds to go in a session and one, or all, of the other three members haven't made their recommendations to the Carrier, it will also be treated as an **IGNORE** when determining the average response.

The "Feedback Screen". When the trial is over, all team members will receive an immediate report telling them how well the team, and they as individuals, performed. This will be presented both on the computer and on a chart in the room. The computer feedback will inform them of the team decision, each individuals recommendation, and the correct decision. The chart will present cumulative information of this type after each trial. There are five possible outcomes from an encounter, and the team's, and individual's, total effectiveness will be expressed in terms of points associated with each outcome:

HIT -- A hit means that the team's decision was exactly correct. For example, the target should have been "warned" and that was exactly what the team decided. A hit is worth 2 points to the team's overall score. The color bars at the top and bottom of the screen will be green when this occurs.

NEAR MISS -- A near miss means that the team was off by one place in terms of their aggressiveness level. For example, if the team decision was **WARN**, when it should have been **MONITOR**, this would be a near miss (a little too aggressive). It would also be a near miss if the decision was **WARN** when it should have been **READY** (a little too passive). A near miss is a pretty good outcome, however, since the ships will be able to adjust to the target if the initial stance is this close. A near miss is worth 1 point. The color bars at the top and bottom of the screen will be aquamarine when this occurs.

MISS -- A miss means that the team decision was off by two places. For example, if the team decision was **WARN** when it should have been **REVIEW** the team was too aggressive. Similarly, if the decision was **WARN** when it should have been **LOCK-ON**, the team was too passive. The ships will usually be able to adjust if the initial stance is this far off, but this is not guaranteed. Thus, this outcome is worth 0 points. The color bars will be purple when this occurs.

INCIDENT -- An incident means that the team was off by three places in their response to the target. An incident means that the team just narrowly avoided disaster (i.e., being hit itself or mistakenly shooting down a friendly target). This outcome results in the loss of 1 point. The color bars will be red when this occurs.

DISASTER -- A disaster means that the team decision was off by four places. That is, the team said to **IGNORE** or **REVIEW** when they should have said **LOCK-ON** or **DEFEND** or; the team said **LOCK-ON** or **DEFEND** when they should have responded **IGNORE** or **REVIEW**. This means that one of the ships was struck by a missile (if overly passive), or that one of the ships shot down a friendly target (if overly aggressive). Remember that the ship set to **READY** or **LOCK-ON** will have activated automatic weapons. So, you can shoot down targets by mistake, even when you are not explicitly "defending." This outcome results in a loss of 2 points. The color bars will be black in this case.

RANGE OF ATTRIBUTES AND COMBINATION RULES:

First Session. Presented below is a brief review of the combination rules for determining the threat level associated with any target along with the ranges for all nine attributes and the threat level associated with these ranges. For this session, it is important that you learn the various threat levels associated with each corresponding attribute and range.

Degree of Threat

	Non-Threatening	Somewhat Threatening	Very Threatening
Speed	100-275 mph	325-500 mph	600-800 mph
Altitude	35,000-27,000 ft	23,000-17,000 ft	13,000-5,000 ft
Size	65-43 mtr	37-23 mtr	17-10 mtr
Angle	+15 to +8 dgs	+3 to -3 dgs	-8 to -15 dgs
IFF	.2 to .6 Mhz	.9 to 1.1 Mhz	1.4 to 1.8 Mhz
Direction	30 to 22 dgs	18 to 12 dgs	8 to 0 dgs
Corridor St.	0 to 8 mi	12 to 18 mi	22 to 30 mi
Radar Type	Class 1 & 2	Class 5	Class 8 & 9
Range	200 to 110 mi	90 to 60 mi	40 to 1 mi

Summary of How to Determine Threat Levels

(a) all else equal, in terms of IFF, **military targets** are more threatening than civilian targets (see attribute **#5**).

(b) SPEED and DIRECTION go together, so that **fast targets coming straight in** are most threatening (see **#1 & #6** above). Speed alone and direction alone mean nothing. There is nothing to fear if fast targets are not headed toward the group. Likewise, there is nothing to fear from objects headed directly for the group that are moving slowly.

(c) ANGLE and RANGE go together, so that **descending targets that are close** are especially threatening (see **#4 & #9** above). Angle alone and range alone mean nothing. Descending targets that are far away, or close targets that are on the way up are not threatening.

(d) ALTITUDE and CORRIDOR STATUS go together, so that **low flying targets that are way outside the corridor** are especially threatening (see **#2 & #7** above). Altitude alone and corridor status alone mean nothing. There is nothing to fear from high targets flying well outside the corridor or low flying targets in the middle of the corridor.

(e) SIZE and RADAR go together, so that **small objects with weapons radar** are especially threatening (see **#3 & #8** above). There is nothing to fear from small targets with weather radar or from large targets with weapons radar.

APPENDIX B

Task Knowledge Test
Individual Session

Summer, 1991

1. 600 miles per hour represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

2. 05 degrees of direction represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

3. 50 meters represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

4. Class 2 radar type represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

5. 1.5 Mhz represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

6. +20 degrees of angle represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

7. 250 miles for range represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

8. 30,000 foot altitude represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

9. 5 miles outside the corridor represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

10. 20 meters represents which of the following?

   (a) A non-threatening target.
   (b) A somewhat threatening target.
   (c) A very threatening target.
   (d) A target on the border between two threat levels.
   (e) A target that is out of the possible range of values.

11. Class 7 radar type represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

12. .5 Mhz represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

13. 850 miles per hour represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

14. 35 degrees of direction represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

15. 0 degrees of angle represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

16. 80 miles for range represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

17. 7,500 foot altitude represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

18. 25 miles outside the corridor represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

19. .7 Mhz represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

20. 200 miles per hour represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

21. 25 degrees of direction represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

22. 15 meters represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

23. Class 8 radar type represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

24. 15,000 foot altitude represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

25. 20 miles outside the corridor represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

26. +10 degrees of angle represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

27. 120 miles for range represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

28. 300 miles per hour represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

29. 10 degrees of direction represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

30. 2.0 Mhz represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

31. 25 meters represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

32. Class 5 radar type represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

33. -5 degrees of angle represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

34. 50 miles for range represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

35. 40,000 foot altitude represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

36. 40 miles outside the corridor represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

37. 70 meters represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

38. Class 10 radar type represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

39. 400 miles per hour represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

40. 15 degrees of direction represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

41. 1.2 Mhz represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

42. -12 degrees of angle represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

43. 35 miles for range represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

44. 22,000 foot altitude represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

45. 13 miles outside the corridor represents which of the following?

(a) A non-threatening target.
(b) A somewhat threatening target.
(c) A very threatening target.
(d) A target on the border between two threat levels.
(e) A target that is out of the possible range of values.

46. All else equal, which of the following is/are characteristic(s) of a threatening target?

    (a) Low flying targets.
    (b) Military targets.
    (c) Targets with weather radar
    (d) 2 of the above are characteristics of a threatening target.
    (e) 3 of the above are characteristics of a threatening target.

47. All else equal, which of the following is/are characteristic(s) of a threatening target?

    (a) Targets that are high flying.
    (b) Targets with weapons radar.
    (c) Targets that are fast and inside the traffic corridor.
    (d) Targets that are descending and close.
    (e) Targets that are large and descending.

48. All else equal, which of the following is/are characteristic(s) of a threatening target?

    (a) Targets that are large.
    (b) Targets with weather radar.
    (c) Targets that are fast and coming straight in.
    (d) Targets that are small and inside the traffic corridor.
    (e) Targets that are ascending and close.

49. Which of the following combinations represents a more threatening target?

    (a) Weapons radar and small targets.
    (b) High flying and inside the traffic corridor.
    (c) Fast and straight on targets.
    (d) Close and land radar targets.
    (e) Outside the traffic corridor and descending targets.

50. Which of the following combinations represents a more threatening target?

(a) Slow and land radar targets.
(b) High flying and fast targets.
(c) Descending and inside the traffic corridor targets.
(d) Outside the traffic corridor and low flying targets.
(e) Close and ascending targets.

APPENDIX C

Incentive Manipulations

Group Incentive Condition

"That concludes the learning trials. For each of the next fifteen trials you will be scored on this task as a team, based on the accuracy of the team's decision. If the team's decision is a 'hit', each of you will receive one dollar, if the decision is a 'near miss', each of you will receive fifty cents, and if the team's decision is a 'miss', each of you will get twenty-five cents. Anything worse than a 'miss' will result in each of you earning nothing for that trial. I will keep track of your performance on this board so that you can see how you are doing."

Individual Incentive Condition

"That concludes the learning trials. For each of the next fifteen trials you will be scored on this task individually, based on the accuracy of your individual decisions, irrespective of the team's decision accuracy. If your decision were to be a 'hit' you will earn one dollar, if it is a 'near miss', you get fifty cents, and if it is a 'miss', you get twenty-five cents. Anything worse than a 'miss' will result in you earning nothing for that particular trial. I will keep track of your performance on this board so that you can see how you are doing."

APPENDIX D

Questionnaire

Name (Print) _____ ID#_____

1. Please circle the method by which you and the members in your team were paid?

   A. We were paid equal amounts depending on the accuracy of our team's decisions regarding targets.

   OR

   B. Each team member was paid based on her/his individual accuracy regarding targets.

Please indicate your responses to items 2 to 9 using the scale below:

5-Strongly Agree
4-Agree
3-Neither Agree nor Disagree
2-Disagree
1-Strongly Disagree

2. My pay was fair, considering what other group members were paid. _____

3. I was dissatisfied with the amount of my pay. _____

4. Considering the skill and effort I put into this task, I was satisfied with my pay. _____

5. I didn't make the kind of money I wanted to on this task. _____

6. All in all, my pay was about what I wanted on this task. _____

7. The way I was paid was fair. _____

8. The method of paying people was as fair as it could be. _____

9. The amount of pay that I received was fair. _____

10. Using the following scale, please rate the ability level of yourself and the other two members of your team in the spaces provided:

5 -- High Ability
4 -- Slightly Above Average Ability
3 -- Average Ability
2 -- Slightly Below Average Ability
1 -- Low Ability

CAD Rating _____

AWACs Rating _____

Cruiser Rating _____

11. Sex: M or F (Circle one)

12. Age: _____

13. Year in school: Fr. So. Jr. Sr. (Circle one)

14. Major: _____

15. Current GPA: _____

APPENDIX E

Communication Measures Used in the Calculation of the Cooperation Index

"Perfect Communication Sequence"

(a)	(b)	(c)	(d)
QUERY -------->	RECEIVE -------->	TRANSMIT -------->	RECEIVE
(Air to Land) (Re: Speed)	(Land from Air)	(Land to Air)	(Air from Land) (Speed)

Raw Indices (Terms and Descriptions)

Negative Actions

"Slight"	--	a, but no b
"Unresponsive"	--	a and b, but no c
"Forget"	--	a, b, and c, but no d

Positive Actions

"Learn"	--	a, b, c, and d
"Lecture"	--	c and d, but no a or b

Cooperation Index

"Cooperation"	=	"Slights" + "Unresponsives"