The Impact of Reward Structure on Project Team Effectiveness

by

Brian W. Cunningham

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Approved:

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Dr. Eileen M. Van Aken (Chair)

_____ _____

Dr. Brian M. Kleiner Dr. Robert C. Williges

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Abstract

There have been thousands of studies on teams and their performance, but there are still many unanswered questions. An important one is how an organization's reward structure supports the growing trend of using teams. Many organizations implement teams without changing the organizational systems to align with and support the use of teams, i.e., training, feedback, information and reward systems. As predicted by many authorities in the field of team effectiveness research, these teams often fail. One organizational subsystem that has been determined to be important is the reward structure. If the reward structure is not changed to support a team-based structure, the misalignment could negatively impact team effectiveness.

This research investigated the relationship between reward structure and team effectiveness using a laboratory experiment. This experiment involved groups of students working as a team on a design problem. The independent variable is the type of reward structure, manipulated over three levels: interdependent (group), independent (individual) and mixed rewards (both group and individual). The experiment used a design task, intended to be more representative of project team work where team members were assigned a functional discipline and worked together to solve a design problem.

The primary dependent variable in this study was team effectiveness: team performance as measured by the quality of the team's design, satisfaction of team members, and the ability and desire of team members to work together in the future. Other control variables investigated for their effect on these dependent variables included: cooperative behaviors, reward valence, effort, and autonomy preferences.

Few significant effects of reward structure were found. The reward treatment had a significant main effect on both cooperation and effort, but little difference existed between reward treatments. Some unusual results were found in the relationship between effort and cooperation with performance. Both effort and cooperation were negatively related to team performance. Cooperation, satisfaction and ability to exist were all found to be correlated. No one reward structure was found to be significantly better than any of the others in terms of team effectiveness or team process.

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1. Introduction and Scope of Research

This chapter introduces the research topic by presenting background for the topic, demonstrating the need for this research. An explanation as to why this research should be conducted within Industrial and Systems Engineering is given. The research objectives and questions are presented in the context of a conceptual and operational model. Finally, an explanation of the premises and delimitations of the study are outlined.

Previous research related to the research problem is described in more detail in Chapter 2: the review of the literature. Chapter 3 describes the methodology (an experiment) used in this study. Results of this study are presented in Chapter 4, and conclusions and interpretations are presented in Chapter 5.

1.1. Background

Teams are a common organizational structure in today's business. Eighty-two percent of companies with more than 100 employees report they use teams (Gordon, 1992) and the use of self-managed work teams in particular has increased in Fortune 1000 companies from 28% to 68% between 1987 and 1993 (Lawler, Mohrman & Ledford, 1998). Organizations also reported that they planned to increase their use of teams, with 68% planning to increase their use of self-managed work teams (Lawler et al., 1998). Despite their widespread use, a study done by A. T. Kearney (1994) found nine out of ten teams fail. Shaw and Schneier (1996) attribute this failure to ambiguous or inappropriate objectives and reward structures that do not support teams.

It is increasingly apparent that the alignment of different organizational subsystems is required for optimal performance; Cacioppe (1999), Davis and Coleman (1999), Hackman (1997), Lawler (1977), Meyer (1980) and Shea and Guzzo (1987) have all emphasized the importance of aligning rewards with the use of teams. Despite this emphasis, few companies have changed their reward structures (Geber, 1995; LeBlanc, 1994). Failure to align reward structures with team structures is also contrary to expert advice on aligning organizational systems (Kaplan & Norton, 1992; Shaw & Schneier, 1996; Davis &

Coleman, 1999), and using team level feedback and rewards (Cummings, 1978; Gebber, 1995; Mower & Wilemon, 1987; Saunier 1994; Tjosvold, 1991). This misalignment may send conflicting messages to employees about what behaviors are expected, and how they should perform (Meyer, 1980). Part of the reason for the lack of alignment may be the confusion over how tasks and rewards should be designed for maximum benefit when using a team-based work system (Wageman & Baker, 1997). This confusion may be caused by the conflicting evidence found in research exploring the effect of reward structure on different types of teams and tasks.

Research on teams has been prolific in the last several decades. Hackman and Morris (1973) claim that literally thousands of studies of team performance have been done. Since then, the number has greatly increased. Unfortunately, little of this research focused on reward structures and the few that have were not generalizable (Barr & Conlon, 1994; Bowen, 1995). Most of the research on rewards has focused on the motivation and performance of individuals and not on teams (Campion, 1993; Shea & Guzzo, 1987; Tjosvold, 1986a).

One type of team where the issue of using team-based rewards is even more complex than with other teams is a project team. These types of teams usually engage in more interdependent tasks than most teams (Ancona & Caldwell, 1990; Hackman, 1997; Montemayor, 1994). Since the amount of interdependence in the task affects the effectiveness of different reward structures (Wageman, 1997), it is worthwhile to investigate the type of task project teams undertake separately from less interdependent tasks. This study will investigate the effectiveness of teams involved in a more interdependent task than tasks used in most group research.

Project teams are typically composed of members drawn from different functions or departments to better design a product or service (Ancona & Caldwell, 1990; Cohen & Bailey, 1995; Lawler & Cohen, 1992). Since the members may be rewarded differently, and on different performance measures depending on their “home” department, the decision to reward the team as a whole is difficult. What value will using team-based rewards offer to an organization? How will team-based rewards help teams improve performance? What changes in team effectiveness can organizations expect when implementing team-based rewards? Will team-based rewards help teams improve factors such as

cooperation and effort? Answering these questions is difficult, and changing to team-based rewards may require a redesign of the overall performance appraisal and reward system. Clearly, organizations are often reluctant to make these costly changes and often use patchwork measures to integrate the existing reward structure into the new team structure (Geber, 1991; Hackman, 1997; LeBlanc, 1992). This reluctance may be due to the lack of solid evidence on the benefit of using team-based rewards, particularly for project teams. This research will try to answer these questions, providing information to practitioners involved with design of reward systems and team structures.

This research investigated the relationship between interdependent, independent, and mixed reward structures (defined later) and project team effectiveness. It focused on project teams working on a highly interdependent task, and uses university students as participants.

1.1.1. An Industrial and Systems Engineering Perspective

The problem of determining the optimum type of reward structure for use in teams relates to many disciplines. It is a psychology problem in that the use of rewards is intended to motivate the team members. The field of psychology has included studies of both individual and group reactions to rewards. Many theories, such as: social learning theory (Bandura, 1971), equity theory (Adams, 1965), hierarchy of needs (Maslow, 1943), and valence-instrumentality-expectancy (VIE) theory (Vroom, 1964), have been developed in psychology that attempt to explain the reactions of individuals to rewards in groups (Guzzo & Shea, 1992; Kanfer, 1992). Rewarding teams is also a human resources problem, in that reward structures and performance measurement usually fall within the domain of human resources. It is also an organizational design problem, in that the organizational structure determines the types of teams used. Depending on the number of levels of an organization, the types of communication used, and the interdependence between units, different types of teams may be called for (Hackman, 1973; Mower & Wilemon, 1987; Thompson, 1967) These different types of teams require different reward structures (Lawler and Cohen, 1992). Finally, it is a management problem in that using rewards is an attempt to manage the activities and behavior of the team. All of this suggests that any expert in these disciplines could address the problem of how to reward teams, but the industrial and systems

engineering (ISE) discipline is well suited to integrating all these aspects to research the impact of reward structure on team effectiveness.

The industrial and systems engineering discipline effectively brings all of these perspectives together using a systems and engineering approach. This integration of other academic disciplines can be seen in the following definition.

> *Industrial and Systems Engineering is concerned with the design, improvement, and installation of integrated systems of people, materials, information, equipment, and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems (Turner, Mize & Case, 1987 p. 17).*

Team-based reward structures deal primarily with the integration of a system of people and information. As such, designing team-based reward systems primarily uses knowledge of the social sciences. While the study of team-based reward structures can be seen to be a part of industrial and systems engineering, it is also aligned with management systems engineering (MgtSE), a graduate option in the Department of Industrial and Systems Engineering at Virginia Tech. MgtSE is defined as:

> *MgtSE is concerned with the design of group and organizational systems, structures, and processes, using the engineering approach. The focus is on systems comprised of decision-makers, decision tools, and work processes, with an emphasis on the interactions among these components (ISE Graduate Manual, 1998).*

In order to better design group systems, structures, and processes it is important to know what types of rewards work best for individuals working in groups. Management systems engineering focuses on studying and designing at the group or organizational level. While management systems does not specifically focus only on the design and implementation of reward systems, the reward system an organization uses is an important factor in overall system design. When designing group and organizational level processes, structures, and systems, the reward system must be integrated and well designed to enable the success of the overall system.

One of the defining aspects of industrial and systems engineering is the systems view. A systems view recognizes the importance and the relationships between components in a system

(Kurstedt, 1998). Although all disciplines of ISE use the systems view, MgtSE focuses on complete organizational units, such as a department or a team, and always with consideration for how the unit fits within the organization as a whole. Team-based reward systems can be seen from an MgtSE perspective using this systems view.

A team can be classified as a system, where each individual in the team constitutes a component in the system. As in any system, optimization of the individual components will not result in optimization of the whole system (Deming, 1986; Sink & Morris, 1995). For the system to be optimized, a focus on system performance should be used. In this case, the system (team) should be optimized as opposed to the components (individuals). Despite this relationship between the system and components, traditional reward structures encourage optimization of the individual rather than the team (Caudron, 1994; Geber, 1991; Hackman, 1997; LeBlanc, 1992; Yeatts et al., 1996). In team tasks that are not interdependent, where each member's contribution does not depend on other team members, individual reward structures may be appropriate (Geber, 1991; Lawler & Cohen, 1992). A more interdependent system (in this case the team) increases the need for communication and cooperation (Deming, 1993). When a team has a more complex task, such as design of a new product, the team output is more than just the sum of the individual contributions; cooperation is necessary (Guzzo, 1988; Tjosvold, 1991). Cooperation could be encouraged by rewarding team behaviors (Mower & Wilemon, 1987).

From an MgtSE perspective it can be seen that team-based rewards would best serve a team-based organizational structure. Team-based rewards focus on the overall task of the group rather than the tasks of the individuals. This focus prevents sub-optimization of resources. Rather than attempting to maximize the performance of any one component, a team-based reward structure allows individuals on a team to perform in a way that maximizes the overall team performance.

1.1.2. Defining Teams

There are numerous frameworks for describing types of teams and there are also many definitions of teams. While the type and definition used by the team may have little impact on the actual

team characteristics, it is important to specify the framework and definition used in this experiment so that it can be compared to other team research. In much of the literature, the terms: group and team, are used interchangeably (Cohen & Bailey, 1997; Sundstrom & McIntyre, 1995), and are also not distinguished here. A detailed analysis of which term is most appropriate is beyond the scope of this research, but is further discussed in section 2.1.1.

The definition of a team has evolved and become more specific over time. In 1938 Barnard said "A group is evidently a number of persons plus some interrelationships or interactions to be determined." (Barnard, 1968 pp. 69). This early definition is vague and does not differentiate between a work group and any other social group. Alderfer (1977) defined a work group as a bounded social system whose members are interdependent for a shared purpose and who interact as a unit with other individuals and groups in achieving that purpose. This definition introduces the concept that a team has a specific purpose and is an intact social unit. Hackman & Oldham (1980, p. 178) elaborated on Alderfer's definition by stating three attributes of a team:

> *First the group is an identifiable (if small) social system in which members have interdependent relations with one another, in which differentiated roles develop over time, and which is perceived as a group both by members and non-members. Second, the group has a defined piece of work to do that results in an identifiable product, service, or decision for which the group can be held accountable. Third, the group has the authority to manage its own internal processes to generate the group product, with members planning and labouring collectively to get the group task accomplished.*

This definition of a team was used in this study. The teams used in this experiment worked interdependently, and roles were created by assigning team members to identifiable functions. The teams worked on a defined task, for which they shared responsibility. Each team also managed the methods and processes they used in solving the problem as a group. Further discussion of the characteristics of the teams used in this study and how they relate to Hackman and Oldham's definition can be found in section 5.5.3.

A number of different frameworks have been developed to categorize different types of teams. Saunier and Hawk (1994) identify two dimensions that describe teams; dedication and permanence.

Dedication refers to the proportion of time team members give to the team task, compared to the amount of time they spend on other tasks. A dedicated team does most of their work with the team. A non-dedicated team performs a significant amount of work outside of the team or in other teams. Permanence describes the length of time the team will be together. Permanent teams are stable in their membership and task over long periods of time. Temporary teams perform a task that can be completed in a defined period, at which time team members will begin work on other tasks.

Cohen and Bailey (1997) identify four types of teams: work teams, parallel teams, project teams, and management teams. Work teams are the most common type and refer to teams that produce a product or service on an ongoing basis. These teams may be further differentiated by the type of management and autonomy present: self-managed, autonomous, semi-autonomous or self-directed are some examples (Sundstrom & McIntyre, 1995). Parallel teams utilize people from different functions to complete a task outside of the normal organizational structure. Project teams involve short term tasks that produce one-time outputs. Management teams manage other individuals or groups as a team.

There are many other frameworks and definitions developed for differentiating types of teams; these are discussed more thoroughly in Chapter 2. This experiment concentrated on cross-functional teams working on an interdependent task for a defined period of time. Using Saunier and Hawk's framework these teams are non-dedicated, temporary teams. This type of team would be considered a project team using Cohen and Bailey's framework. While these frameworks imply that teams are easily classified, this is not always the case. As such, a number of descriptive variables will be used to describe the teams used in this study.

1.1.3. Team Effectiveness

In order to study the effect of rewards on team effectiveness, effectiveness must be defined. Hackman and Oldham (1975) propose three components of team effectiveness, based on an early model of McGrath's (1966): output of the team (performance), satisfaction, and the ability of the team to exist over time. Performance is the degree to which the team's productive output meets the standards of quantity, quality, and timeliness of the people who receive, review, and/or use that output (Hackman,

1990). McGrath (1986) lists four possible group actions: generate plans or ideas, choose among alternatives, negotiate conflicts, or execute activities, each of which produce a different output. McGrath also notes that all teams carry out all the actions to some degree. Output for this study will be measured by the effectiveness of meeting the task requirements (in terms of quality). This output is a hybrid of generating plans and choosing among alternatives.

Hackman's (1990) second component is the degree to which the team experience contributes to the growth and personal well-being of team members. This construct can best be measured as satisfaction (Gladstein, 1984). Satisfaction cannot be measured directly but can be assessed by participants' self-evaluation on a questionnaire.

Ability to exist over time is defined by Hackman (1990) as the degree to which the process of carrying out the work enhances the capability of members to work together interdependently in the future. This construct also cannot be directly measured in this experimental design. A self-reported measure of the team member's desire to work together in the future was used to measure this construct.

1.1.4. Defining Rewards

In early motivation research, the term reward was used to describe anything that reduces a drive (McClelland, 1985). Skinner's (1953) work rejected drive theories, and instead defined rewards as anything that increases the frequency of a response. More recent research has attempted to characterize rewards into two types, intrinsic and extrinsic. Deci (1975) defined intrinsic rewards as those that induce perceptions of personal causation, and those that produce perceptions of external causation as extrinsic rewards. Although there is some debate whether separating rewards into intrinsic and extrinsic types is possible or even necessary (Guzzo, 1979), this research focuses on extrinsic rewards.

In a business setting a reward is generally used to describe something given or done to employees to encourage a specific response. However, rewards do not always have the intended effect, as the desirability of the reward influences the individual's actual behavior (Kanfer, 1992). Because of this, a reward is not always a reinforcer, though it may be intended to be one (Luthans, 1981). Rewards

also give feedback to individuals and groups on what behavior is expected. Stone (1971) claims that to the extent that a reward system provides a person or a group with knowledge of the relative quality of a given performance, a reward system is a feedback system.

Motivational theories generally fall into three categories: need-motive-value theories, cognitive choice theories, and self-regulation-metacognition theories (Kanfer, 1992). Need-motive-value theories emphasize the role of personality and values. Maslow's (1943) need hierarchy theory and Alderfer's (1969) existence-relatedness-growth theory are two well-known examples. Cognitive choice theories focus on the role of conscious choice in deciding between actions or the amount of effort exerted in a situation. The most well known of these theories is Vroom's (1964) valence-instrumentality-expectancy theory. Many researchers have added to his basic model including Campbell and Pritchard (1976), Graen (1969), and Porter and Lawler (1968). Self-regulation-metacognition theories focus on the motivation caused by goal-directed behaviors. A number of researchers have developed theories and conducted research in this area (see Bandura 1986; Kanfer, 1970; and Locke 1968, as examples). Another area related to motivation research is operant conditioning. Operant conditioning, whose most notable proponent was B. F. Skinner, focuses on the type and intensity of a response paired with a reinforcer. It does not view that the increase in frequency of a response is caused by learning or habit, only that a certain reinforcer does or does not increase the frequency (Skinner, 1953).

This research uses elements of the valence-instrumentality-expectancy theory (Vroom, 1964) as the underlying construct in predicting how rewards can motivate increased performance. Specifically, Porter and Lawler's 1968 model was used as the basis for the conceptual model. This model was chosen because it best fits the conditions under which project teams work. Since project teams are typically together for only one project, frequency of response was not as important as intensity of effort. As such basic operant conditioning can not be used to fully explain the motivational process in project teams. Also the complexity of work done by project and design teams (as opposed to a work team) would indicate that a cognitive choice model might best describe the motivation taking place. While metacognition theories might be useful in describing the behavior brought about through rewards in a project team, these theories focus on goal setting, which was not the focus of this research. Need-

motive-value theories, while possibly important in motivating and managing teams, focus more on values and intrinsic motivation. This research was mainly concerned with the role that extrinsic (specifically monetary) rewards play in motivating team effectiveness.

The change in behavior brought about by rewards can be explained by Valence-Instrumentality-Expectancy (VIE) theory. VIE theory maintains that behaviors are chosen according to a combination of anticipated outcomes and expectations of the likelihood of these outcomes (Nadler & Lawler, 1977). VIE theory describes the motivational force of a reward as a product of the valence of the reward and the expectancy that the reward will come from the effort. The valence of the reward is the desirability of the outcome, and is also called value, incentive, attitude or expected utility. A person may consider the monetary reward as the desired outcome, or that the valence of the desired outcome is increased because of the reward. Expectancy refers to the perceived probability that effort will lead to a first level outcome. Expectancy depends mostly on the individual's perception that he or she can obtain the performance necessary. Instrumentality is the probability that the first level outcome will lead to the desired second level outcome. While the individual may feel strongly that they can achieve a certain level of performance, there is still uncertainty that this performance will result in the desired outcome. This theory concentrates on the motivation created by rewards as opposed to the pure reinforcement effect of rewards (Luthans, 1981).

Even though a reward is intended to motivate, this will not always be the case. Different individuals will react differently to a reward. For some, a reward may be highly motivating; in VIE theory it would be considered to have a high valence. For others, the same reward may have less motivational impact, and will not elicit the desired response. Without customizing the reward to individual preferences, it is impossible to get a consistent response using a single reward. For this reason, this study also measured the participant's perception of value of the reward. It was expected that participants that place higher value on the reward would be more likely to be influenced by the reward.

A number of different dimensions can be considered in determining the reward to be given. The method of payment can differ (bonus, salary increase, stocks or other benefits) and the level of distribution can range from the individual to the whole organization. Performance can be measured at

different levels and for different types of performance (Lawler, 1991). Deutsch (1949) differentiates three types of interdependence of reward: cooperative, competitive, and independent. Cooperative rewards are distributed in such a way that for one person to receive the reward another must also receive it. Competitive rewards are distributed in such a way that the reward that one person receives reduces the size of the reward another receives. Independent rewards are distributed in such a way that the size of the reward an individual receives does not depend on others' performance. From this it can be seen that cooperation and competition do not necessarily reflect different levels of reward interdependence; both cooperative and competitive reward situations can be, and usually are, highly interdependent.

For this study three factors of reward type were combined to create one independent variable with three levels of reward interdependence. The level of distribution varied between a pure group reward and a pure individual reward, and the interdependence of the reward varied between cooperative and independent levels. From these two dimensions it was necessary to vary the level of performance measurement (group or individual). The group reward created a cooperative situation while the individual rewards were distributed independently (as opposed to competitively). The mixed reward situation distributed the reward equally based on a cooperative and an independent factor (group and individual). Situations where rewards are distributed competitively are contrary to the cooperative nature of a project team and would not be expected to offer any performance benefits (Deutsch, 1973; Guzzo, 1986; Lawler, 1991; Tjosvold, 1984). As such, competitive rewards were not used in this study.

1.1.5. Team Reward Research

Traditional performance appraisal systems focus exclusively on individual performance and rewards (LeBlanc, 1992). While this method of measuring performance is effective and may make sense for independent tasks, it is incompatible with the recent trend toward team work (Caudron, 1994; Geber, 1991; LeBlanc, 1992; Yeatts, Hyten, Wagner, Maddox, & Barritt, 1997). The biggest concern with traditional reward structures is that they encourage competition between employees, even in tasks that require a great deal of collaboration (Yeatts et al., 1997).

Previous research on team-based reward structures has been mixed. In some cases individually-rewarded participants perform better than group-rewarded participants (London & Oldham, 1976; London & Oldham, 1977; Scott & Cherrington, 1974; Weinstein & Holzbach, 1972). In other experiments, the team-rewarded treatment groups performed better (Barr & Conlon, 1994; Matsui, Kakyama & Onglatco, 1987; Wageman, 1995). Miller and Hamblin (1963) proposed that the reason for the mixed results in earlier research was the failure to include the interdependence of the task as a variable. Despite this observation, few of these more recent studies used interdependence as a variable (Wageman, 1995 being the most notable exception).

Subsequent research began to control for task interdependency, but often used very simple tasks. These overly simplistic tasks have been criticized for not being representative of the work that real teams undertake (Bowen, 1995). While there has been some field research on team rewards, most notably Wageman (1995), it is difficult to control the level of interdependence in both the rewards and the task. Wageman's study on work groups found that independently- and interdependently-rewarded groups perform similarly, but the task the group was performing was not inherently interdependent. Wageman studied teams of photocopier repairpersons. Each team member visited sites, and did their work alone. The teams met as a group to make tactical decisions, but the actual work was carried out as individuals.

Most recommendations on team implementation emphasize that the amount of interdependency in tasks should be considered in determining the type of team structure (Goodman, 1986; Lawler & Cohen, 1992; Shea & Guzzo, 1987). The more interdependency, the more beneficial a team structure is. In any case where a team structure is desirable, there would necessarily be a high level of task interdependence. Because of the necessity of interdependence of task, especially in project teams, this research used an interdependent task in the experiment.

Rewards may not even be effective in increasing team effectiveness in situations outside the laboratory. This perspective, whose most vocal proponent is Alfie Kohn, maintains that rewards, at best, produce short term compliance. Kohn claims that most research showing a positive effect of rewards looked at only short-term results and involved simple tasks (Kohn, 1998). This claim was supported by

the literature review done for this study (see literature review in section 2). Kohn also claims that the detrimental effect of rewards is more pronounced in more complicated tasks (Kohn, 1993).

A meta-analysis of reward research (Cameron & Pierce, 1997) found that rewards could produce negative effects on performance, but only in certain circumstances. Tangible rewards can have detrimental effects if they are performance independent, but have positive effects if the reward is given for meeting a performance standard. Rewards tended to have no effect if they were based on completion of a task or if they were given unexpectedly.

While this study did not attempt to look at the long-range effects of rewards, it did use a more complex task than most previous reward research. The task used in this experiment involved the design of computer system, where each participant had specialized knowledge of specific aspects of the design. The task required group members to share information and to work together to solve the problem. The reward given was expected, and was based on the team's performance.

1.1.6. Task and Outcome Interdependency

The amount of interdependency in a team can be described by two constructs: task and outcome interdependence (Wageman, 1995). Shea and Guzzo (1987) define task interdependence as the degree of task-driven interaction among group members. In a highly interdependent task, group members interact and depend on one another to accomplish the work (Campion, Medsker & Higgs, 1993). Outcome interdependency measures the degree to which the performance of a group is assessed and rewarded as a group. Shea and Guzzo (1987) define outcome interdependency as the fate shared by group members that is contingent on group performance. A group with high outcome interdependence would be assessed and rewarded as a group, while a group with low outcome interdependence would be assessed and rewarded as individuals. These two constructs are not dependent. A team could have high task interdependence but low outcome interdependence (Wageman, 1995).

1.1.7. Cooperation and Conflict

One of the reasons there is interest in using team-level rewards is that these will theoretically encourage cooperative behaviors (Montemayor, 1994; Mower & Wilemon, 1987). Tjosvold (1986b) characterizes cooperation as the belief of employees that they are moving in the same direction, communicate well, and understand each other. Deutsch (1949) defined a cooperative social situation as one in which there is positive correlation between group members' goal attainments. Cooperation is essential in project teams, where the task depends on the coordinated efforts of the members, and the team members must share their diverse knowledge (Hackman, 1997). This requires higher levels of cooperation than a team that does work in a pooled or sequential fashion (Lawler & Cohen, 1992). In a project team, cooperation is important because each step requires most or all of the team members to work together reciprocally rather than sequentially or in parallel.

1.2. Problem Statement

This research attempted to determine the effect of different reward structures on project team performance. It used three levels of reward structure: group, individual, and a mixture of both group and individual rewards. The research explored the effects of the reward structure on team processes (effort, and cooperation) and on team-level outcomes (performance, satisfaction and the ability of the team to exist). Additionally, it explored how selected moderating variables (autonomy preferences, and valence of the reward) moderate this effect.

1.3. Research Objectives

The objectives of this research describe what this research aimed to accomplish. The following were the research objectives for this study.

1. Determine the impact of reward structures (group, independent, and mixed) on project team performance, satisfaction, and ability to exist.
2. Determine the impact of reward structure (group, independent, and mixed) on team process variables: effort and cooperation.
3. Determine the effect of moderating variables (autonomy preferences, and reward valence) on the relationship between reward structure and effectiveness.

1.4. Conceptual Model

The conceptual diagram for this research (Figure 1.1) was adapted from the work of Porter and Lawler. Porter and Lawler's model (1968) is based on the theory of VIE, and focuses on the effects of rewards on individual performance. Hackman (1973) expanded this model to include group processes and how groups influence individual behavior. Combining the two models shows how rewards influence individual behavior in groups.

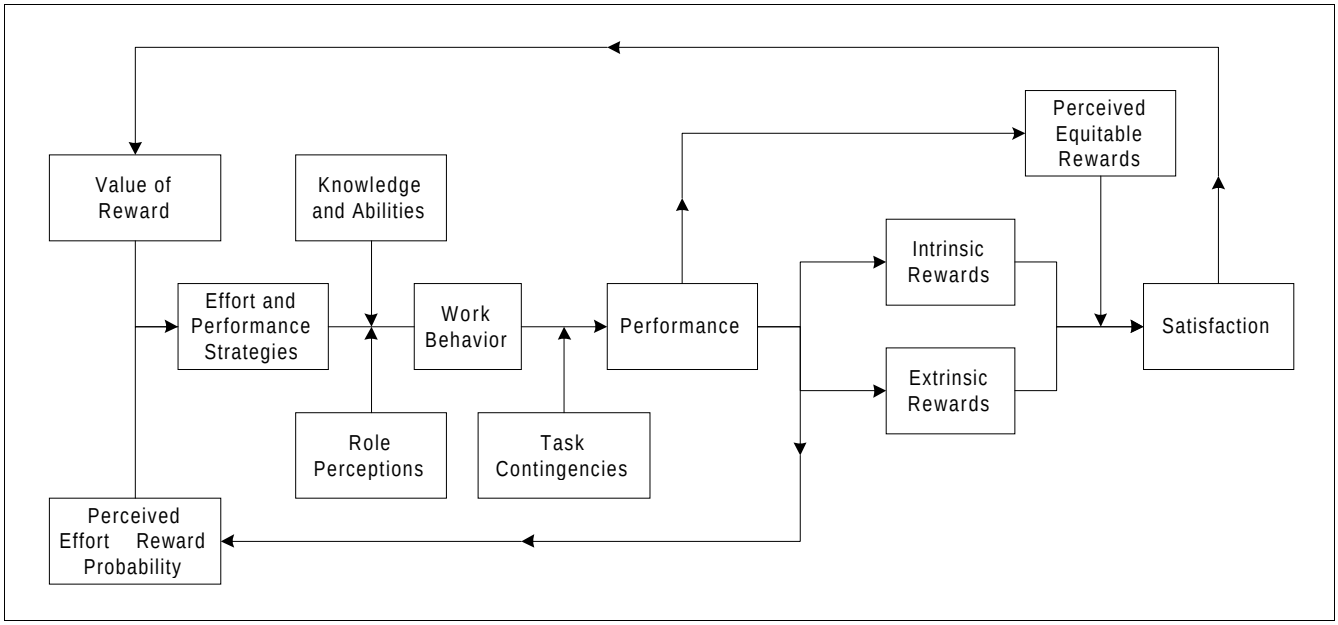


Figure 1.1 Conceptual Model: How Rewards Impact Performance.

(Adapted from Porter & Lawler 1968, and Hackman 1973)

1.5. Operational Research Model

The operational research model in Figure 1.2 shows the proposed relationship of the independent variables to the dependent variables, as well as the related research questions. This model was derived from the conceptual model, and portrays variables and relationships representing the teams in this research.

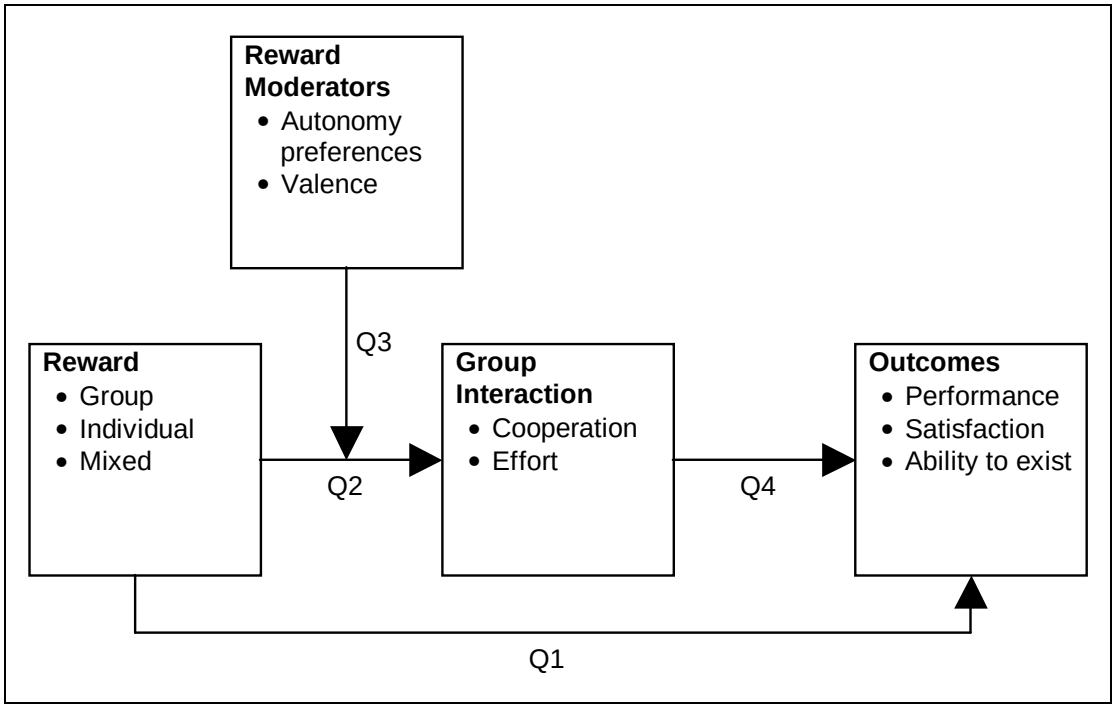


Figure 1.2 Operational Research Model

1.6. Research Questions and Hypothesis

The research questions and hypotheses in this section have been developed from the proposed relationships in the operational research model.

1.6.1. Question and Hypothesis One

Question 1. *How will different types of rewards affect measures of group process such as cooperation and effort?*

It was expected that, under group rewards, since an individual's reward depends on the performance of the team as a whole, individuals would exhibit more cooperative performance strategies (i.e., sharing information vs. working individually and then combining efforts). Tjosvold (1986b) found that group members exhibit more cooperation if they are rewarded as a group, for accomplishing a group task, than under other reward situations. In some research, this has been found not to be the case.

Wageman and Baker (1997) found that task interdependence is a stronger determinant of cooperation than reward interdependence. Wageman and Baker measured cooperation by examining the performance strategies the teams used and rating the cooperation of the team during the experiment. Teams in the high task interdependent situations engaged in more cooperative performance strategies than teams in low task interdependent situations. Rosenbaum et al. (1980) however, found a significant effect of reward interdependence on cooperation (i.e., turn taking). In their study, participants in the cooperative reward condition engaged in more turn taking than either the competitive or independent conditions.

While the amount of cooperation was not affected by interdependent rewards in Wageman's (1997) study, the performance increase provided by the cooperation was greater under interdependent reward conditions. Although reward interdependence did not affect the amount of cooperation, cooperation only led to greater performance under conditions of high reward interdependence. Most studies of rewards in teams used simple tasks that may not have given participants an opportunity to exhibit more cooperative behaviors. This experiment attempts to generalize the results found in previous research to more complex task situations. Although the task used in this experiment was not as complex as a task that a real project team would undertake, it was more complex than tasks used in previous research (London & Oldham, 1976; London & Oldham, 1977; Miller & Hamblin, 1963;

Rosenbaum et al., 1980; Scott & Cherrington, 1974; Wageman & Baker, 1997; Wieinstein & Holzbach, 1972).

There is significant evidence to suggest that monetary rewards increase effort (Guzzo & Bondy, 1983; Katzell, Bienstock & Faerstein, 1977; Locke, Feren, McCaleb, Shaw, & Denny, 1980; Locke, Shaw, Saari & Latham, 1981; Pritchard, Jones, Roth, Stuebing & Ekeberg, 1988). There is less evidence on how group rewards compare to individual rewards on their ability to influence effort (Johnson & Johnson, 1989). Most psychological theories on rewards support individual rewards as being more affective than group rewards. Social loafing, where there is diffusion of responsibility and members loaf while letting others do the work, may decrease the relative effectiveness of group rewards (Wageman, 1997). Social loafing theory would support individual level rewards as being more effective than group level rewards. Competitive rewards may provide more incentive for individuals to work harder individually (Johnson & Johnson, 1989), since group rewards are less influenced by individual effort (Wageman, 1995). This competition between individuals would theoretically cause individual rewards to produce better performance than group rewards. Some anecdotal evidence supports that employees would rather be rewarded individually rather than as a group (Geber, 1991; Rooney, 1995), which may also increase the effectiveness of individual rewards compared to group rewards. There is also a conflicting point of view that maintains rewards do not provide long term motivation (see, for example, Deming, 1986; Kohn, 1993). This study was not longitudinal and so cannot answer the question of the long-term effects of rewards, but this study was able to relate the type of reward with the amount of effort put forth by the participants.

Hypothesis 1a. *Individuals will exhibit more cooperation under the group reward structure (compared to other reward structures).*

Hypothesis 1b. *Individuals will exhibit more individual effort under individual rewards (compared to other reward structures).*

1.6.2. Question and Hypothesis Two

Question 2. *How will different reward structures directly effect team effectiveness variables such as performance, satisfaction, and ability to exist?*

Previous research on group and individual reward structures has found that group-level rewards improve performance when the task is interdependent (Miller & Hamblin, 1963; Wageman & Baker, 1997). These experiments, however, used unrealistic and simple tasks. This experiment used a task that was more indicative of the type of tasks teams perform, in order to increase generalizability to real project teams. Past research has also focused on differing levels of interdependence (Wageman, 1997; Wageman, 1995; Miller & Hamblin, 1963; Rosenbaum et al., 1980; Scott & Cherrington, 1974). This research focused on project teams, which are normally involved in highly interdependent tasks. As such, the task involved was interdependent for all treatments.

Other research on combinations of group and individual rewards has found that the hybrid designs result in lower performance (Wageman, 1995). These results were obtained in a field test where the control over the task was less than in a laboratory setting. The task involved was for the most part independent, where only tactical decisions were made interdependently. Other laboratory research has found similar results, but again has used simplistic tasks. This research used a more complex task in which the availability of individual rewards may serve to better motivate the individuals to higher levels of effort than with strictly group-level rewards.

Previous research has found that levels of satisfaction are greatest when the interdependence of the reward structure matches the interdependence of the task (Rosenbaum et al., 1980; Wageman, 1995). Since this research uses an interdependent task exclusively, it was expected that group rewards would provide higher levels of satisfaction than individual rewards. Conversely, it has been proposed that most people prefer individual rewards, especially in western cultures, because of the greater satisfaction in being individually recognized (Rooney, 1995; Geber, 1995).

No existing data was found on the effects of reward type on the ability of a group to exist over time. One reason may be that a longitudinal study would have to be done to actually determine a

group's ability to exist. This would require long-term changes to group-level rewards. In field research, organizations may be reluctant to continue using one reward structure for a lower performing group, when a differently rewarded group is performing significantly better. Long-term laboratory research is not usually feasible. It was expected that the effect of reward structure on ability to exist would be similar to that of reward structure on satisfaction.

Hypothesis 2a. *Group rewards will result in the highest team performance (compared to other reward structures).*

Hypothesis 2b. *Group rewards will result in the highest satisfaction (compared to other reward structures).*

Hypothesis 2c. *Group rewards will result in the highest level of team member's ability to work together in the future (compared to other reward structures).*

1.6.3. Question and Hypothesis Three

Question 3. *How will measures of autonomy preference, cohesion, and valence moderate the effects of rewards on group process?*

Autonomy preference is the degree to which an individual prefers to work independently rather than working in a group (Wageman, 1995). Wageman found that individuals with high autonomy preference experienced a greater decrease in motivation to work in group reward situations than in independent reward situations. Despite this finding, there was no significant difference in group effectiveness when autonomy preferences were taken into account (Wageman, 1995). She did find that group members with high autonomy preferences were less likely to help other group members.

Valence is the value of particular outcomes (Luthans, 1997). Each outcome has a particular valence that may be different for different individuals (Nadler & Lawler, 1977). Vroom's (1964) Valence-Instrumentality-Expectancy theory (VIE) predicts that individuals will choose to exert a high level of effort

if the effort is perceived to lead to a valued outcome. Using this model, it would be expected that an individual would work harder if the expected reward were more desirable.

Hypothesis 3a *Individuals with a high autonomy preference will not exhibit different levels of effort compared to individuals with low autonomy preferences.*

Hypothesis 3b *Individuals with a high autonomy preference will be less cooperative than individuals with low autonomy preferences.*

Hypothesis 3c. *Individuals that perceive the reward as having a higher valence will exhibit higher levels of effort under individual rewards (compared to other reward structures).*

Hypothesis 3d. *Individuals that perceive the reward as having a higher valence will exhibit higher levels of cooperation in the group-reward situation (compared to other reward structures)*

1.6.4. Question and Hypothesis Four

Question 4. How will group process (effort and cooperation) affect measures of team effectiveness?

While the relationship between group process and effectiveness was not the primary relationship being explored in this research, the effects of group process are important in order to isolate the direct effects of reward type on effectiveness.

Hackman (1973a) includes performance strategies as a factor influencing team effectiveness. In Hackman's (1973b) model of group behavior and performance effectiveness he shows performance strategies along with effort influencing performance through work behavior. Steiner (1972) formulated that the actual productivity of a group is equal to its potential productivity minus process losses. Process losses are the impediments to maximal group competence that prevent the group from combining its resources for optimal task performance (Guzzo, 1986). These process losses come from deficits of coordination and motivation. It would be expected that the performance strategy (measured as cooperation in this study) of a group would effect the coordination of group members' efforts.

Most research supports that higher levels of cooperation will result in improved performance (Tjosvold, 1988; Johnson & Johnson, 1989). Wageman and Baker (1997), however, found this not to be the case. They found that the amount of cooperation in itself did not increase performance. Only the interaction effect between cooperation and reward type increased performance. Wageman and Baker (1997) theorize that only when increased levels of cooperation are combined with increased levels of effort, brought about through rewards, did performance increase. As such, the cooperation in the group was expected to affect the group's output through an interaction effect with reward type.

Hackman (1973a) claims that in virtually all tasks, an increase in effort will result in an increase in performance, although there are some exceptions. The task used in this experiment may not have depended as much on individual effort as it did on team member cooperation. Steiner's (1972) theory of process losses also applies to the effect of effort on group performance. From this it would be expected that the team would increase its output when effort increased.

Hypothesis 4a *Higher amounts of individual effort will result in higher team performance.*

Hypothesis 4b *Higher amounts of individual effort will result in higher team member satisfaction.*

Hypothesis 4c *Higher amounts of individual effort will not effect the team's ability to exist.*

Hypothesis 4d *Higher amounts of cooperation will have no direct effect on team performance.*

Hypothesis 4e *Higher levels of cooperation will result in higher team performance in the group-reward situation.*

Hypothesis 4f *Higher levels of cooperation will result in higher team member's satisfaction.*

Hypothesis 4g *Higher levels of cooperation will result in higher levels of the team's ability to exist.*

1.6.5. Research Variables

This section describes what variables will be investigated in this experiment as previously described in the hypotheses.

1.6.5.1. Independent Variables

Independent variables are those that will be manipulated in the experiment. In this experiment one variable, reward structure, will be manipulated. The reward structure has three levels: group reward, individual reward and mixed (both group and individual reward). This was the primary variable of investigation; its effects on the dependent variables are of most importance. Table 1.1 shows the independent variable for this research.

Table 1.1 Independent Variables

Independent Variable	Definition	Levels	How Measured	Source
Reward Type	Type of reward given	Group, Group and individual, individual	Set by experiment	Wageman and Baker, 1997; Miller & Hamblin, 1963

1.6.5.2. Control Variables

Control variables are not directly manipulated in the experiment, but may influence the dependent variables. These variables are indirectly manipulated by the choice of participants. These variables will be measured to determine if they have a confounding or moderating effect on the dependent variable results. Table 1.2 shows the control variables used in this research.

Table 1.2 Control Variables

Control Variable	Definition	Levels	How Measured	Source
Autonomy Preferences	Desire to work with group vs. working individually	Likert, 1-6	Questionnaire	Wageman, 1995
Valence	Desirability of reward	Likert, 1-6	Questionnaire	Locke, 1968, Matsui et al., 1987

1.6.5.3. Dependent Variables

The dependent variables are the variables that were expected to be affected by the independent variables. The values measured determined the relationship between the independent and control variables under the conditions of this experiment. Although some of these variables were used as independent variables in some of the analysis, they were dependent in that they were not directly manipulated in the experiment. Table 1.3 shows the dependent variables being studied in this experiment.

Table 1.3 Dependent Variables

Factor	Variable	Definition	Levels	How Measured	Source
Team process variables	Cooperation	Cooperation between team members.	Likert, 1-6	Questionnaire	Campion et al., 1993; Hackman & Morris, 1975; Wageman, 1997
	Effort	Self-reported level of effort applied	Likert, 1-6	Questionnaire	Hackman & Morris, 1975; Wageman, 1997
Team effectiveness	Performance	Performance measures, individual and team	Performance score	Evaluation of Design	Hackman, 1975
variables	Satisfaction	Three types of satisfaction: Egocentric, Instrumental and Social	Likert, 1-6	Questionnaire	Gladstein, 1984; Nerkar et al., 1996
	Ability to exist	Capability of team members to work together in the future	Likert, 1-6	Questionnaire	Hackman, 1990; Pinto, Pinto, & Prescott, 1993

1.7. Premises and Delimitations

This section further defines the scope of this research by stating the assumptions, premises, and delimitations made in conducting this research. Assumptions are made by the researcher for this, and are not supported by previous research or are unique to this study. Premises are assumptions made in this study that are supported by previous research. Delimitations define areas that this research did not attempt to cover.

1.7.1. Assumptions

- The participants used in this study accurately model real project teams in organizations.
- The task used in this study accurately models the type of task done by project teams, although the scope and duration of the task had to be reduced to make the task accomplishable.

1.7.2. Premises

- Teams that work on more complex knowledge intensive problems, such as design of a product, need to have multiple perspectives and members with different functional abilities (Ancona & Caldwell, 1990).
- In a design task the quality of the output is more important than speed or quantity (Stone, 1971).
- Organizations will continue to use and implement team-based work structures (Mower & Wilemon, 1987).
- Team-based design groups produce better designs than the traditional method of sequential activities: having marketing develop design parameters, engineers producing a design, and manufacturing implementing the design (Ancona & Caldwell, 1990)
- Project teams are typically made up of cross-functional, temporary, non-dedicated members (Cohen & Bailey, 1997).

Delimitations

- This study will not investigate effects of leadership on performance changes due to reward structures.
- The teams used in this study are non-permanent, non-dedicated groups and findings may not apply to other types of teams such as management teams, or work teams.
- The task used in this study are intended to represent a design problem, and may not apply to work tasks such as those done by work teams in a manufacturing or information processing setting.

- The study will not investigate any effects of goal setting or different levels of performance goals on team performance.
- Different types or distributions of feedback are not investigated.

1.8. Desired Outputs and Outcomes

- A comparison of project team performance under different reward structures.
- A comparison of measures of cooperation and effort under different reward structures.
- A comparison of measures of satisfaction under different reward structures.
- Evidence as to the different effects of individual and team rewards in a design task.
- Better understanding of the role of cooperation and rewards in teams.

2. Literature Review

This chapter explores the research previously done on teams. Section 2.1 explains the terminology of teams and different typologies used in previous research. Section 2.2 discusses the theories of conflict and cooperation that are important to team performance. Section 2.3 describes the previous research on differential rewards, and the interaction with task interdependence. Finally, the variables, methodology, and task used in this research are justified in Section 2.4.

2.1. Team Research and Terminology

Research on teams has been prolific (Hackman, 1973, Barr & Conlon, 1994). In this research, many definitions of team and typologies of teams have been described. This section explores some of those definitions and discusses those that are most relevant to this research.

2.1.1. Definitions of Team

There have been many definitions proposed for teams and groups, as shown in Table 2.1. Hackman and Oldham (1980, Chapter 7) developed a definition that is widely used and accepted, that was adapted from the work of Alderfer (1977).

> *First the group is an identifiable (if small) social system in which members have interdependent relations with one another, in which differentiated roles develop over time, and which is perceived as a group both by members and non-members. Second, the group has a defined piece of work to do that results in an identifiable product, service, or decision for which the group can be held accountable. Third, the group has the authority to manage its own internal processes to generate the group product, with members planning and labouring collectively to get the group task accomplished.*

Other definitions differ in how they define such things as: how team members are seen as a social entity, the interaction of members, how task oriented the team is, or the responsibility of the team. The definitions also use different terminology for a team. Some use team, others use group, work group, or work team.

Table 2.1 Definitions of Team

Term	Definition	Source
Team	A distinctive class of group, which is more task-oriented than other groups, and which has a set of obvious rules and rewards for its members.	Adair, 1986
Real Team	Bounded social systems whose members are interdependent for a shared purpose, and who interact as a unit with other individuals and group in achieving that purpose.	Alderfer, 1977
Work Group	Groups of individuals that are given collective responsibility for a task on an intermittent basis do constitute a work group for that portion of their time.	Bowen, 1997
Group	A group exists when two or more people define themselves as members of it and when its existence is recognized by at least one member.	Brown, 1988
Team	Collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationships across organizational boundaries.	Cohen and Bailey, 1997
Group	two or more persons who have one or more characteristics in common; perceive themselves as forming a distinguishable entity; are aware of the positive interdependence of some of their goals or interests; interact with one another; and pursue their promotively interdependent goals together.	Deutsch, 1973
Work Team	Identifiable social system in which members have interdependent relations with one another, in which differentiated roles develop over time, and which is perceived as a group both by members and non-members…has a defined piece of work to do that results in an identifiable product, service or decision for which the group is held accountable…has the authority to manage it's own internal processes to generate the group product, with members planning and laboring collectively to get the group task accomplished.	Hackman, 1980
Real Group	Perceived to be an entity by its members and by nonmembers familiar with it; its members have some degree of interdependence; and a differentiation of roles and duties takes place in the group.	Hackman, 1982
Work Group	Intact social systems that perform one or more tasks within an organizational context.	Hackman, 1990
Team	A small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable.	Katzenbach & Smith, 1993
Group	Social aggregates that involve mutual awareness and potential mutual interaction.	McGrath, 1984
Team	A distinguishable set of two or more individuals who interact dynamically, interdependently and adaptively to achieve specified, shared and valued objectives.	Morgan, et al., 1986
Tea m	A group of individuals who work together to produce products or services for which they are mutually accountable.	Mohrman, Cohen and Morhrman, 1995
Team	A distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span membership.	Salas et al., 1992
Group	Two or more persons who are interacting with one another in such a manner that each person influences and is influenced by each other person.	Shaw, 1981
Work Teams	Small groups of interdependent individuals who share responsibility for outcomes for their organization.	Sundstrom, et al., 1990
Group	A collection of individuals who influence one another, derive some satisfaction from maintaining membership in the group, interact for some purpose, assume specialized roles, are dependent on one another, and communicate face to face.	Tubbs, 1984

Although it was beyond the scope of this research to definitively differentiate between the terms group and team, it was useful to examine how these terms are often used from the sample of definitions shown in Table 2.1. From this sample of definitions, a group was defined more broadly than a team, however, the terms group and team are often used interchangeably. As can be seen by the definitions in Table 2.1, groups are often defined as any collection of two or more people that have something in common, or that influence one another. Teams are usually more specifically defined as a group that works together toward a shared goal or to complete a task. Adair's (1986) definition that a team is more task oriented than other groups exemplifies this difference. More often a work group is defined more like a team than a group, and the terms work group and team are more synonymous than group and team. In any documentation of team research it is important to understand the specific definition of team or group the author uses in order to compare findings between studies. Further discussion of the use of these terms can be found in Hackman (1987, 1990, & 1997) and McGrath (1984 & 1986).

2.1.2. Types of Teams

There are also many categories of teams as well as definitions of team. A number of different typologies used in the literature are shown in Table 2.2. Typologies for teams are defined using criterion or dimensions like: the amount of time individuals spend on the group task, length of task, scope and type of task, relationship between team members, autonomy of the team, and type of relationships the team has with other groups and individuals in the organization.

Table 2.2 Types of Teams

Factors	Types	Source
None given	Work teams, Parallel teams, Project teams, Management teams	Cohen & Bailey, 1997
Breadth of technical expertise, degree of self-management, degree of self-leadership	None Given	Dunphy & Bryant, 1996
Type of work, Sharing of power, Duration	Parallel, Project, Work	Lawler & Cohen, 1992
None given	Embedding systems, Expedition, Standing crew, Task force	McGrath, 1986
Mission, Relationship to organizational structure, Duration	Work teams, Integrating teams, Management teams, Improvement teams	Mohrman, Cohen & Mohrman, 1995
Task interdependence, Level of supervision, Diversity of task requirements	Pooled group, Sequential team, Reciprocal team	Montemayor, 1994
Amount of work done in team, Duration of team	Permanent/dedicated, Temporary/dedicated, Permanent/non-dedicated, Temporary/non-dedicated	Saunier & Hawk, 1994
Applications of work teams	Advice and involvement, Production and service, Projects and development, Action and negotiation	Sundstrom et al., 1990
Task Interdependence, Outcome Interdependence	None given	Wageman, 1995

One issue with these types of frameworks is that they imply a clear differentiation between teams. This is not always the case. It is possible to have a team that could be defined as both a parallel and project team. In the case of Saunier and Hawk's (1994) framework, it is unclear as to the proportion time members must apply to the team task before it is labeled "a dedicated team." Cohen and Ledford (1994) even found difficulty in separating control (traditional work groups) from self-managed teams in their research (Dunphy & Bryant, 1996). This leads to the conclusion that a measurement along a continuum would better describe and allow for comparisons between groups.

This experiment studied project teams. Project teams have been defined in various ways in previous team research. Table 2.3 shows a number of definitions that have appeared in the literature. For this research Cohen and Bailey's (1997 p. 242) definition was used.

> *Project Teams are time-limited. They produce one-time outputs, such as a new product or service to be marketed by the company, a new information system, or a new plant. For the most part project team tasks are non-repetitive in nature and involve considerable application of knowledge, judgment, and expertise. The work that a project team performs may represent either an incremental improvement over an existing concept or a radically different new idea. Frequently, project teams draw their members from different disciplines and functional units, so that specialized expertise can be applied to the project at hand… When a project is completed, the members either return to their functional units or move on to the next project.*

Table 2.3 Definitions of Project Team

Term	Definition	Source
Project Team	Produce one-time outputs…Tasks are non repetitive in nature and involve considerable application of knowledge, judgment, and expertise…Frequently draw their members from different disciplines. When a project is completed, the members either return to their functional units or move on to the next project.	Cohen & Bailey, 1997
Project Team	Involve a diverse group of knowledge workers, brought together to conduct projects for a defined but typically extended period of time, apply their disparate specialties to develop innovations and fulfill customer requirements.	Lawler & Cohen, 1992
Task Force	Groups that are created by natural circumstances for a one-time performance of a delimited task. Such groups exist for and deal with only a sharply delimited band of activities-a specific task or mission-they exist only for the period of time needed to carry out that mission.	McGrath, 1996
Product Development Teams	Teams are highly interdependent in that team members must work together to complete their assignment, yet must also work extensively with nonmembers. In addition, individuals are assigned to the group because they have particular skills or experiences or because they represent a functional specialty.	Ancona and Caldwell, 1992
Project Group	Consist of employees with specialized skills who are temporarily assembled to complete a specific task on a definite time schedule, usually cross functional, complex, one-of-a-kind outputs, success may be difficult to determine	Sundstrom & McIntyre, 1995

2.2. Cooperation and Reward Interdependence

Deutsch (1949) defined a cooperative social situation, as one in which there is a positive correlation between group members' goal attainments. In order for one person to achieve his or her goal, the other members would also have to obtain their goals. More distinctly, in cooperative interdependence group members *believe* that their goals are positively related (Tjosvold, 1988). A competitive situation would then be one in which there is a negative correlation between group members' goal attainments (Deutsch, 1949).

Cooperation has consistently been found to strengthen work relationships, morale, and productivity, compared to competition (Tjosvold, 1984). Cooperation has been found to be more effective for complex tasks that require pooling of effort and sharing information (Tjosvold, 1986a). While the effect of cooperation on performance is well known, the effect of rewards on cooperation is less clear (Wageman & Baker, 1997).

Interestingly, Wageman and Baker (1997) found that cooperative behaviors were not increased by group rewards. The amount of cooperative behaviors exhibited by team members did not significantly change based on the interdependence of reward. Instead, cooperative behaviors were influenced significantly by the amount of task interdependence. Performance, however, was greatly dependent on the interaction effect between task interdependence and reward interdependence. Apparently groups in the interdependent task did not improve their performance based solely on the amount of cooperative behaviors. Instead, increased performance only came about when these cooperative behaviors were influenced by interdependent rewards. Wageman and Baker concluded that the increased performance was affected by the individuals' increased effort brought about by the reward structure. Rosenbaum et al. (1980) however, did find a significant effect of reward type on cooperative behaviors. The difference in findings may be caused by the way cooperation was defined in the two experiments, Rosenbaum et al. used turn taking on a block building task, while Wageman and Baker used a more comprehensive definition that included cooperative behaviors and strategy.

2.3. Task and Outcome Interdependence Effects on Team Effectiveness

Although there have been more than 521 research studies on cooperation (Johnson & Johnson, 1989), and despite its importance to understanding organizations (Tjosvold, 1986a), interdependence in organizations has been researched relatively little (Cheng, 1983). There are a number of different types of interdependence, with outcome and task interdependence being the most important to this study.

2.3.1. Outcome Interdependence

Wageman (1995, p.147) defines outcome interdependence as "the degree to which the significant outcomes an individual receives depend on the performance of others." Outcome interdependence exists when task accomplishment by a group yields consequences that are important to and shared by some or all group members (Shea & Guzzo, 1987). A term used to describe low outcome interdependent situations is differential rewards. Differential rewarding is when rewards are given to a group on an individual basis, with the amount determined by the individual's performance. The term differential rewarding has been used less in more recent studies. The focus has changed from examining differential rewards to interdependent rewards. Interdependent rewards are given to the group as a whole, based on the performance of the group, rather than the individual performance of the members. Interdependent rewards are more generally called interdependent outcomes, in order to differentiate extrinsic rewards from both external and internal motivational factors that affect the group. Monetary rewards are but one of many possible outcomes; public recognition, praise, or preferred work assignments could be others (Sundstrom, De Meuse & Futrell, 1990).

Differential rewarding has been often studied with the first being done in 1920 and more than thirty studies researched for this review of the literature. Most of the early studies in differential rewarding were sociological in nature. Teams in the workplace were not widespread or greatly recognized, so these studies were aimed more at finding how rewards effect different sociological groups such as friends, classes, sports teams, and partners. None of the tasks used attempted to simulate activities carried out by teams in an organizational setting. Miller and Hamblin did a review of these

early studies in 1963. They were the first to define task interdependence as a moderating factor in the effect of outcome interdependence on performance.

2.3.2. Task Interdependence

Miller and Hamblin (1963) found mixed results in 24 experiments on differential rewarding. Some results indicated differential rewards improved performance, while others found that it decreased performance. They suggested that the opposing findings could be the result of two orthogonal dimensions to cooperation. Differential rewarding was only one dimension, the other being that of task interdependence. They proposed that differential rewarding under conditions of low task interdependence may have a different effect than differential rewarding under conditions of high task interdependence.

Task interdependence is the manner in which the work contributions of individual members are integrated into team results (Thompson, 1967). Task interdependence occurs when the problem requires "a mutual exchange of ideas and information as well the give and take required to make a group decision" (Miller & Hamblin, 1963, p. 769). Non-interdependent tasks are those that can "be solved without the help of other individuals in the group" (Miller & Hamblin, 1963, p. 770).

Thompson (1967) further differentiates task interdependence as sequential, pooled or reciprocal interdependence. The three types are graphically illustrated in Figure 2.1. Sequential interdependence occurs when work is passed from member to member during completion. The lowest individual performer determines the performance of the team. Examples of sequential interdependence could be workers on an assembly-line or a football team. Pooled interdependence occurs when team members work in parallel on a task. The sum of their individual performances determines the team's performance. Examples of pooled interdependence are a sales team or batting on a baseball team. The sales team may, as a group, cover a certain area, and be held responsible as a team for their performance, but each sales person works individually. Reciprocal interdependence occurs when the work must be coordinated between all team members. A complex interaction of each member's efforts determines the team's performance. Reciprocal independence occurs in research and development teams and

basketball teams. Project team tasks are most accurately described by the third type, reciprocal interdependence.

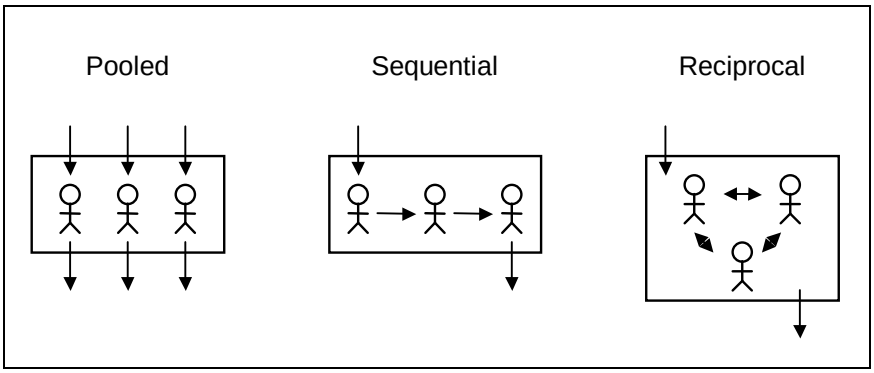


Figure 2.1 Types of Task Interdependence

(Adapted from Montemayor, 1994)

The types of task interdependence roughly equate to the amount of interdependence in a task; reciprocal relationships require the most interdependence and pooled relationships require the least. A team with pooled group interdependence is closer to what Hackman (1980) calls a coacting group. These groups have face-to-face contact and interact informally, but do not work together on a common task. It is possible to have a team that operates under the pooled group model and is a team, but most pooled group tasks are done by coacting groups. As such pooled groups have low task interdependence. Sequential interdependence could be considered a moderate level of interdependence. Each person in the team's work depends on what others do, but there is less opportunity for interaction. The reciprocal model of interdependence could be considered a high level of task interdependence.

When separated by the amount of interdependence in the task, the studies reviewed by Miller and Hamblin show strong agreement that differential rewarding reduces performance when the task is interdependent, but increases performance when the task is non-interdependent. Table 2.4 shows the

results of these studies as reported by Miller and Hamblin (1963). Since Miller and Hamblin do not differentiate the tasks used in these experiments by type of interdependence, their judgment of the amount of interdependence could include all types.

Table 2.4 Team Reward Research Conducted Before 1963

(Miller & Hamblin, 1963)

Author	Relationship*	Task	Interdependence of task
Deutsch. 1949	-	Discussion problem	High
Deutsch, 1949	-	Puzzle problem	High
Grossack, 1954	-	Discussion problem	High
Miller, 1959	-	Leavitt-puzzle	High
Mintz, 1951	-	Withdrawing cones from a jar	High
Smith, 1957	-	Discussion problem	High
deCharms, 1957	+	Arithmetic	Low
deCharms, 1957	+	Scrambled words	Low
Forlano, 1932	+	Cancellation of letters	Low
Forlano, 1932	+	Cancellation of letters	Low
Forlano, 1932	-	Cancellation of letters	Low
Maller, 1929	+	Adding numbers	Low
Maller, 1929	+	Adding numbers	Low
Maller, 1929	-	Adding numbers	Low
Maller, 1929	+	Adding numbers	Low
Moede, 1920	-	Hand grip	Low
Phillips, 1954	+	Cancellation of letters	Low
Philp, 1940	+	Transferring marbles to box	Low
Philp, 1940	+	Transferring marbles to box	Low
Sims, 1929	+	Substitution of letters	Low
Sims, 1929	+	Reading	Low
Sorokin, 1930	+	Carrying objects	Low
Sorokin, 1930	+	Sorting objects	Low
Whittemore, 1924	-	Mechanical printing	Low

* A "+" indicates a positive relationship between differential rewarding and productivity, a "-" indicates a negative relationship.

2.3.3. Conflicting Results About Task and Reward Interdependence

Two studies criticize Miller and Hamblin's findings. Weinstein and Holzbach (1972) contend that Miller and Hamblin did not include a group goal or a reason for the participants to interact. They also say that the lack of face-to-face interaction may have affected the results. Two years later, Scott and Cherrington (1974) add that Miller and Hamblin produced variations in task interdependence by manipulating reinforcement contingencies rather than task variables. Both studies attempt to disprove Miller and Hamblin's findings.

Scott and Cherrington's results, while contrary to Miller and Hamblin's, do not effectively contradict the earlier results. Scott and Cherrington used a highly independent task, where no interaction between subjects was required. Even though they found that differential rewards led to higher performance, these results, under conditions of an independent task, align with Miller and Hamblin's theory. Weinstein and Holzbach's study used a task that could be considered interdependent, but the low level of interdependency could explain their outcome. Each participant coded one response to a problem in a questionnaire that consisted of three problems. They found that differential rewarding resulted in higher productivity than group rewards, but Weinstein and Holzbach's interdependent task required that the subjects score test sheets in a sequential fashion. Each participant in the three-person groups was required to score one problem and then pass the test to the next participant. So each subject scored each test equally. This task could be considered sequentially interdependent.

Many experts on team performance (Hackman, 1997; Lawler & Cohen, 1992; Montemayor, 1994) suggest using team-based rewards only for teams that are highly interdependent. Lawler & Cohen and Montemayor specifically recommend that teams should perform a reciprocally interdependent task for team-based rewards to be effective. These recommendations would suggest that low levels of task interdependence could result in team-based reward conditions being less effective than differential rewarding.

Recent studies support that team-based rewards result in better performance under highly interdependent tasks. Wageman and Baker (1997) in a laboratory study, found that different reward structures had no significant effect on performance by themselves, but rewards did create a significant

interaction effect with task interdependence. When both task and rewards were interdependent, groups performed higher than any other combination. While both cases of interdependence used the same task, participants in the highly interdependent condition were given information and instructions that encouraged reciprocally interdependent task behaviors. The participants in the low interdependence condition acted more as a pooled group.

Wageman (1995) conducted an extensive field experiment manipulating both task and reward interdependence. In this study, pure group or pure individual rewards were found to produce higher performance than any combination of hybrid design of either task or rewards. The task in this study might be better modeled by pooled group interdependence, but as in any real world application, it is difficult to determine an absolute classification.

2.3.4. Support for Reward/Task Relationship

More recent studies have shown similar results in the relationship between task and reward interdependence, but have changed focus from sociological groups to work groups. Later studies have investigated the effects in groups of: piece-work (London & Oldham, 1976 and 1977), feedback (Stone, 1971 and Tindale, 1989), goal setting (Johnson et al., 1981 and Matsui et al., 1987), distribution of feedback (Barr & Conlon, 1994), mixed rewards (Rosenbaum et al., 1980) and group size (Stoneman & Dickson, 1989), under different conditions of differential rewarding. These studies have also begun to explore other outcomes besides productivity, including satisfaction and group processes. These studies have shown similar results to earlier studies in the relationship between differential rewarding, task interdependence, and productivity. Table 2.5 summarizes the research on differential rewards done after 1963 in the same format Miller and Hamblin (1963) used. Not all of these studies specifically looked at the relationship between task interdependence and reward interdependence, but all used differing levels of reward interdependence.

Table 2.5 Team Reward Research Conducted After 1963

Author	Relationship	Task	Type of task Interdependence
Farr, 1976	+	Sorting cards	Pooled
London & Oldham, 1976	+	Sorting cards	Pooled
London & Oldham, 1977	+	Sorting cards	Pooled
Matsui et al., 1987.	-	Numerical Counting	Pooled
Scott & Cherrington, 1974	+	Scoring tests	Pooled
Wageman, 1995	+	Machine repair	Pooled
Rosenbaum et al., 1980	-	Block building	Sequential
Stoneman & Dickenson, 1971	none	Assembly of bolt and nut	Sequential
Weinstein & Holzbach, 1972	+	Coding Questionnaires	Sequential
Barr & Conlon, 1994	-	Management decisions	Reciprocal
Miller & Hamblin, 1963	-	Number Guessing	Reciprocal
Wageman & Baker, 1997	-	Editing papers	Reciprocal

A "+" indicates a positive relationship between differential rewarding and productivity (i.e., amount, score, or number of correct answers), a "-" indicates a negative relationship.
All research except for Wageman (1995) were laboratory studies.
Assessments of task interdependence are the author's.

As can be seen, these studies generally support the theory that differential rewarding negatively impacts performance if the task is highly interdependent. The only results from these studies that do not support this hypothesis is Matsui's. He and his colleagues found that differential rewards decreased productivity even though the task was highly independent (Matsui, Kakyama & Onglatco, 1987). The results may have been affected by manipulation of goal setting. Groups set higher goals under the group reward conditions, so performance may have depended more on this than task interdependence. It can be seen that under conditions of sequential task interdependence the relationship is not clear, as one study found a positive relationship, one negative, and another found no relationship.

Wageman's (1995) study is harder to classify in this table. Although her study of Xerox repair persons attempted to create a highly interdependent situation, her manipulations may not have created reciprocal interdependence for all team activities. The teams in her study used interdependent planning, and coverage of their respective service areas that could be considered reciprocal, but continued to do

the actual work independently, better modeled as pooled. Also, while the table shows a positive relationship between differential rewarding (low outcome interdependence) and performance, she also found a positive relationship between group rewards and performance. The type of relationship was moderated by the task interdependency, where high task interdependent groups performed better under group rewards and low task interdependent groups performed better under individual rewards.

2.4. The Effectiveness of Financial Incentives

Much of the research on financial incentives has shown that they can positively influence performance (Guzzo & Bondy, 1983; Katzell, Bienstock & Faerstein, 1977; Locke, Feren, McCaleb, Shaw, & Denny, 1980; Locke, Shaw, Saari & Latham, 1981; London & Oldham, 1976 and 1977; Pritchard, Jones, Roth, Stuebing & Ekeberg, 1988, Scott & Cherrington, 1974; Weinstein & Holzbach, 1972). However most of this supporting research was done in a laboratory setting. Guzzo, Jette, and Katzell (1985) conducted an extensive review on productivity studies done in the field. Of the eleven productivity improvements that they studied, financial incentives had the greatest variability in its effectiveness. They concluded that the effects of financial incentives were greatly influenced by the circumstances in which they were applied.

Despite the experimental evidence of the positive effects of financial incentives on performance, there is an alternative view that financial incentives at best produce short term improvements, and then only for simple tasks. Kohn is perhaps the best-known proponent of this view (Kohn, 1993a, 1993b and 1998). Kohn states that “most of the research showing a positive effect of financial incentives looked only at short-term results” and “the effect was most likely to be positive when subjects were given simple, indeed virtually mindless, tasks to do.” (Kohn, 1998) This study only examines the short-term effects of financial incentives, but does use a more complex task than most other reward research experiments.

2.5. Variables, Methodology, and Task Used in This Research

This section provides a justification of variables not selected for this research, and justifies the methodology and task used in the experiment.

2.5.1. Justification of Variables

While there are many variables of interest in team research, it is only possible to measure a select few in one study. As such, it was necessary to select those variables that are believed to have the greatest effect on the dependent variables of interest. In this experiment, it was desirable to use variables that would have an effect on team effectiveness (performance, satisfaction, and ability to exist) and that are influenced by the type of reward structure. The variables selected in this study have been shown to be relevant in this chapter and in Chapter 1, but the absence of other variables is justified here.

Autonomy and leadership have been shown to be important in a team's success (see Cohen & Bailey, 1997 and Bettenhausen, 1991 for reviews). This literature review found no research that supported a relationship between type of leadership and effect of reward structure. While teams may develop a dominant or even appointed leader, it was expected that the assignment to functions would have masked any existing leadership roles.

Goal setting has been shown to be important to group effectiveness (Matsui et al., 1982; Prussia & Kinicki, 1996). Mento, Cartledge and Locke (1980) suggest that whenever goals are assigned, the acceptance of the goal should be measured. In this experiment, no goals were assigned to the participants, so it was expected that whatever goals they set are acceptable. In order to set goals, some baseline performance would have to be measured (Matsui et al., 1987). Since the teams in this experiment had no direct experience with the task assigned to them, it was unlikely they will be able to set any numerical goals. Because of time and participation constraints, multiple tests to set baseline performance and to create goals were not used.

Team composition has been included in a number of models for team effectiveness (Gladstein, 1984; Guzzo & Shea, 1992; Hackman, 1987) Although different constructs of team composition have been used to predict team effectiveness, many studies have generally shown that team diversity is negatively related to team performance (Ancona, 1992; O'Reilly, Caldwell & Barnett, 1989; Eisenhardt & Tabrizi 1995). However, diversity may be necessary in some types of teams, such as project teams (Ancona & Caldwell, 1990). While it is possible that team diversity may affect team performance, as teams of students, all of the teams used in this study had similar levels of diversity. Any significant functional diversity was set by experimental conditions by assignment to functions, effectively controlling this variable. Some other composition measures used previously, such as physical proximity and accessibility (Pinto, Pinto & Prescott, 1993) do not apply to this experimental setting.

External or boundary management has also been found to be important to team success (Ancona, 1990; Ancona & Caldwell, 1992, Gladstein, 1984). In this study, teams had no opportunity to interact with external entities during the experiment. Even if teams differ in the effectiveness of managing these relationships, the team's performance during the experiment was not likely affected.

2.5.2. Justification of Experimental Methodology

While a number of different research methods would be useful in exploring the relationship between rewards and team effectiveness, a laboratory experiment provides the best opportunity to establish causality between variables. Since relatively little is known about the relationships of reward and outcome interdependence with performance and group processes in project teams, establishing causality was the foremost goal of this study. Bowen (1995) summarized the strengths and weaknesses of a number of research methods for studying work groups, as shown in Table 2.6.

Table 2.6 Relative Strengths and Weaknesses of Standard Research Methodologies for Investigation of Work Groups

(Bowen, 1995)

Research Method	Ability to Make Causal Inferences	External Validity	Opportunity to Study a Large Number of Groups	Degree to which Cooperation of External Work Organization(s) is required	Opportunity for Longitudinal (versus cross-sectional) Studies	Theory Building
Laboratory Experiment	high	low	High	low	low	medium
Case Studies						
-Natural (i.e., no experimenter interventions)	low	medium	Low	high	medium	high
-Action Research (i.e., experimenter interventions)	medium	medium	Low	high	medium	medium
Survey	low	high*	High	medium	high	low

*assumes data sample includes multiple organizations, settings, etc.

Field studies are very rare in reward research, with Wageman's (1995) being the only known exception in the field of task/reward interdependence. Because of employees' sensitivity to any changes in their compensation, creating different reward situations is difficult in real organizations. Task interdependence is also difficult to manipulate and isolate. In real life all three types of interdependence (cooperative, competitive, and independent), exist simultaneously and continuously (Johnson & Johnson, 1989). A lab experiment allows careful control over both reward and task interdependence. Another factor prohibiting the use of field experiments was the difficulty in compensating for confounding occurrences. Most organizations are continuously making other changes and improvements that could affect a team' s performance.

It is possible to use survey research to reach enough teams under the different conditions necessary to research reward interdependency. In fact, one of the greatest strengths of survey research is the large number of possible participants. Laboratory research also makes it easy to study a large number of groups, but to a lesser extent. A problem with survey research is the inability to directly measure variables. All measurements are obtained from the person taking the survey (perception). Very few studies of teams in real organizations use objective measures of team performance, instead relying on perceptions of managers and team members (Cohen & Bailey, 1997). A laboratory experiment allows more control over the method of measuring variables.

Perhaps the most significant critique of team research is the ability to generalize findings from research usually done in the lab. A team's interaction with its environment is difficult to reproduce in a laboratory setting but has been found to be important to team success (Ancona & Caldwell, 1992). Another factor in the inability to generalize laboratory research is the task involved. Maier (1967) proposes that one of the main assets of using teams is that they are able to tackle more complex problems. Laboratory experiments typically have used simple tasks that are very different from the tasks real teams undertake. These tasks only require general knowledge and are not very complex (Bowen, 1995).

2.5.3. Justification for Task

The task used in this experiment simulated the design and planning for installation of a computer system. The team had to choose between a number of hardware and installation options. While a general knowledge of computer systems was required to understand the terms used, in-depth knowledge or computer experience was not necessary. The participants were given the performance attributes of each component (such as cost, speed and number of hours), and any formulas needed for calculating the overall system performance. It was felt that this task offered a level of complexity that more accurately models the type of tasks that real project teams undertake. Although the complexity of the task was constrained by the laboratory setting, and was not as complex as the tasks normally undertaken by a project group, the task used does offer an improvement over the traditional counting and sorting tasks used in previous research (London & Oldham, 1976; London & Oldham, 1977; Miller & Hamblin, 1963; Rosenbaum et al., 1980; Scott & Cherrington, 1974; Wageman & Baker, 1997; Wieinstein & Holzbach, 1972).

Each team member represented a functional department of an organization and was responsible for the performance of that department. As a team, they decided what components to use in the computer system requested by the customer, and how each component was procured. For example, in selecting hardware, a number of different server and workstation types were available. The team had to decide how many workstations each server supported based on the resulting performance of each

workstation. Some components had to be ordered or pulled from other projects. The manner in which these components are procured affects the hardware department's performance and the total time necessary to install the system.

Similar tasks have been used in previous research on team performance. Barr and Conlon (1994) simulated a computer production firm, with each participant being responsible for a functional area. Each participant was responsible for allocating a fixed budget among three market segments: advertising, direct sales support, and service expenses, in one of three functional areas: mainframe computers, minicomputers, and microcomputers. A reward of ten percent extra credit was offered, contingent on the team's performance, which was tested by a computer simulation.

Two studies done by Meredith (1997) and Hacker (1997) at Virginia Tech have used similar assignment to functional areas. In each of these studies, participants were asked to represent a functional area in the design and construction of a product. This product was physically tested to determine the team's performance. Hacker offered a reward of five dollars to the team member that best performed his or her role.

Bowen (1995) also used a simulated planning task to model real team work. While the participants were not assigned to a function, they were required to make decisions as a group. Bowen's task used a complex computer simulation of a production line, that utilized five different machines. Participants were students from university courses, working in teams of three, who completed the task over the course of a semester as part of their assigned work.

3. Research Methodology

The research methodology for this study consisted of a laboratory experiment. This study has attempted to answer the following questions.

Question 1. *How will different types of rewards affect measures of group process such as cooperation and effort?*

Question 2. *How will different reward structures directly effect team effectiveness variables such as performance, satisfaction, and ability to exist?*

Question 3. *How will measures of autonomy preference, cohesion, and valence moderate the effects of rewards on group process?*

Question 4. *How will group process (effort and cooperation) affect measures of team effectiveness?*

3.1. Experimental Design

This research used a three-level between-subjects experimental design. Only one independent variable, reward type, was manipulated over three levels: group reward, individual reward, and both group and individual reward (mixed). While most previous research on the relationship between reward interdependence and performance has varied the degree of task interdependence (Miller & Hamblin, 1963; Rosenbaum et al., 1980; Scott & Cherrington, 1974; Wageman, 1997; Weinstein & Holzbach), this study does not. This study used only a highly interdependent, complex task in order to simulate the type of tasks project teams undertake. Because of the complex nature of this task, a similar non-interdependent task could not be developed to investigate the effects of varying levels of interdependence.

Each team was given the task of designing a computer system based upon customer requirements. The team's output consisted of quantitative values for each design parameter. Each team member represented a different function of the organization (finance, hardware, and installation).

3.2. Sample Size

The number of teams needed for each condition was a balance between the desired power of the analysis and the practical limits on availability of participants. Similar experimental research has used 5-6 teams per treatment condition (Miller & Hamblin, 1963; Rosenbaum, et al., 1980; Scott & Cherrington, 1974; Wageman & Baker, 1997; Weinstein & Holzbach, 1972). Cohen and Cohen (1983) recommend determining sample size based on three parameters: region of rejection of the null hypothesis (α), power of the test (1-β), and the magnitude of the effect in the population (r). The effect size (degree of departure from the null hypothesis) is the most difficult component to estimate. Cohen and Cohen (1983) recommend using effect sizes generated in similar research to estimate the expected effect size. Johnson and Johnson (1989), in a meta-analysis of experiments comparing cooperative and competitive situations, found a number of effect sizes for different classifications of studies. These effect sizes were used to estimate the expected effect size for this study. A summary of the results relative to this research is shown Table 3.1.

Table 3.1 Effect Size of Various Studies of Cooperation

(Johnson & Johnson, 1989)

Type of Study	Effect Size
High quality	0.88
Medium quality	0.56
Used measures of group productivity	0.84
Lasted for one session	0.80
Used tangible rewards	0.78
Task was mathematical (analytical problem-solving)	0.60

The power of the analysis depends on what variables are being analyzed. When looking at the effect of rewards on team-level variables, the sample size is equal to the number of teams. Individual level variables, such as valence and autonomy preference, can be considered as having a sample size equal to the number of participants for that treatment.

When considering team-level variables, using similar treatment size as in previous studies (five teams), assuming an effect size of 0.70, and an α=0.05, the power would at best be 0.37. There would then be a 63% chance that the analysis would fail to reject the null hypothesis if it were true. A recommended level of power is 0.80 (Cohen & Cohen, 1983). Limitations in resources did not allow for greater than five teams per treatment; as such the power of this experiment was not high for group level measures.

When analyzing individually-measured variables, the power analysis for a sample size of five teams per treatment, assuming three persons per team, and the same effect size (0.70) and alpha (0.05) as before, results in a power of better than 0.75.

3.3. Participants

In their extensive meta-analysis of cooperation research, Johnson and Johnson (1989) found no significant differences among studies for: size of group, academic subject area, socioeconomic class of subjects, or age of subjects. Because of this, participants were not selected based on these criteria. All participants in this research were required to have the following characteristics:

Table 3.2 Participant Requirements

Attribute	Requirement for Participants in This Research
Age:	No requirements for age.
Gender:	No requirements for gender.
Education:	All participants are required to be at least at the Sophomore level. There are no requirements for major.
Team Size:	The experiment uses three-member teams.
Team Composition	Some of the team members may know and have worked with one of the other members, but as a group they will have no prior experience working together in a team.

3.4. Materials and Equipment

Each team member was given a folder of information explaining the function they represented. The pages contained in these folders appear in Appendix A, exactly as given to the participants. These sheets gave them the relative data they needed to make knowledgeable decisions. Each team member was also given a work sheet to calculate costs and fulfillment of requirements for design alternatives. Other materials available to the team members included: calculators, a white board, dry erase markers, a flip chart, permanent markers, and scrap paper.

3.5. Facilities

All experiments were conducted in the Enterprise Engineering Research Lab in 302 Whittemore Hall at Virginia Tech. The room used was a conference room, with a large table and comfortable chairs. Participants were seated at one end of the table, while the experimenter observed from the far end of the table.

3.6. Pilot Testing

Pilot testing was necessary to determine whether the task was accomplishable and whether the task was able to discriminate differences in the dependent variables. The task needed to be difficult enough to provide a challenge, and force the participants to combine their specialized knowledge, but also needed to be accomplished in a reasonable amount of time. It was also necessary for the task to allow participants enough attractive choices so that all teams did not use one obvious solution. The only way to accurately determine these dimensions of the task was to conduct a pilot test. Another important reason for pilot testing in this study was to insure that the values (i.e., costs, times) used in the experiment provide an opportunity for the teams to earn the reward. The values also needed to provide the opportunity for a balanced trade-off between choices.

An informal pilot test, using participants known by and accessible to the researcher, was conducted to determine whether the directions were clear, and the task was not excessively difficult. From this pilot test, changes in the directions were made and the difficulty of the task reduced.

The first phase of structured pilot testing consisted of two trials. From these trials, a number of problems with the values used in the experiment were discovered. Feedback from participants was solicited in order to make the instructions more clear and the problem difficulty appropriate. The questions asked by the participants during the experiment were also used to improve the directions. Data from these trials were used to scale the amount of reward earned to the performance scores. While the raw score was used in all analyses of the data, this score was converted into a dollar amount in order to determine the size of the reward given to participants. The conversion method is explained more fully in Appendix G.

The second phase of pilot testing used three teams, one in each of the three treatments. From these tests, reliability data on the questionnaire items was gathered. From this test, more refinements were made to the instructions, the reward calculation method was adjusted, and changes to questionnaire items were made to increase reliability. A method of observation that counted frequency of speaking by each participant was also introduced. Although this data was collected for all trials, the measurement did not appear to measure cooperation, as was desired. The data from this measurement was not used in the analyses but can be found in Appendix J.

The third stage of pilot testing also used three teams, one in each of the three treatments. From this stage a few minor adjustments were made in the questionnaire items to further improve reliability. Except for this, no changes were made from the final pilot testing stage to the actual experiment.

3.7. Procedure

This study used a total of 15 teams, with 5 teams in each treatment. Each team had three members. In all, the experiment used 45 participants. Each team was randomly assigned to an experimental condition by assigning a random number to each condition and sorting them by this number. The treatment order can be found in Appendix H. Each participant was also randomly

assigned to a functional discipline for the experiment by selecting an unmarked folder with the instructions for that function inside. A detailed explanation of the different functions can be found in Appendix A.

For this experiment, each team member was offered a reward of up to twenty dollars for their performance. The experiment was designed so the participants would receive an average of fifteen dollars and at least ten dollars. In actual trials, participants did better than expected and the average reward was $16.10 per participant. The reward was based on the participants' individual performance, the team's performance, or a mixture of the two depending on the experimental condition. In the mixed reward situation, team and individual performance counted equally in determining the amount of the reward.

The Institutional Review Board (IRB) assures that there is no unusual risk to participants in the experiment by approving all research done at Virginia Tech. IRB approval was obtained before starting experimental trials. Participants were required to sign an informed consent document before the experiment. This document (Appendix B) informed participants as to their rights and responsibilities during the experiment, as well as a general overview of what the experiment would involve.

3.7.1. Experimental Overview

This section briefly describes the experimental procedure; more detailed explanation can be found in the experimenter's script in Appendix C. Most participants were recruited from classes during a class period. The script and procedures used in recruiting the participants are shown in Appendix D. The experiment consisted of three phases: pre-experiment, experiment, and post-experiment.

Prior to the beginning of the experiment, participants were randomly assigned to a function and asked to sign the informed consent document. A brief introduction explaining the experiment was given to the participants. Participants were then asked to fill out the pre-experiment questionnaire (Appendix E). This questionnaire collected individual perception data (autonomy preferences and valence of the reward being offered). The reward condition the team would work under was then explained, and participants were asked if they understood or had any questions about the conditions. Each team

member was given an information sheet (Appendix A) describing his or her function, and the design problem the team was to solve. With this information, each participant also received an answer form to aid in calculating the design costs relevant to his or her function. A team answer sheet was also provided for the team to record its final decisions. After reading these information sheets participants were then given an opportunity to ask questions, which were answered provided they did not compromise the experimental conditions. The pre-experiment phase took from fifteen to twenty-five minutes depending on how quickly the participants read the instructions and documents.

Participants were then asked to begin work on the design problem. No time limit for solving the problem was given, but participants were told that the entire experiment was expected to take one and a half to two hours. The actual time participants took to solve the problem is summarized in Appendix H. At this point, the experimenter took a position at the far side of the room to observe the team's interaction.

Once the team had indicated that they solved the problem to their satisfaction, they were asked to submit their answers for scoring. The values chosen by the team were then entered into a spreadsheet and the team and or individual scores were calculated. These calculations took approximately five minutes. The team was then informed of the results and the appropriate monetary rewards were given. Participants were then asked to fill out the post-experimental questionnaire (Appendix F). This questionnaire measured constructs of: satisfaction, ability to exist, cooperation, perceived task and reward interdependence, and effort. Once the questionnaires were completed, participants were thanked for their time and were free to leave. The post-experiment phase took between fifteen and twenty minutes.

3.7.2. Task Interdependence

This research sought to study teams working on a highly interdependent task. As previously discussed, much of the research done on team-based rewards has used simplistic, independent tasks. The task used in this experiment was designed so that each individual would have to interact with the other members of the team, and would have to apply specialized knowledge to the problem. It was also

important that the performance of each team member depend on the level of performance of the other members of the team.

In order to encourage interaction between team members, each individual task (hardware, installation, and finance) required information from the other members of the team. In order to determine the total installation time, the installation team member needed information about what types of hardware components would be used. The finance function needed information about both the hardware components and installation times in order to determine costs. These information dependencies are also bi-directional. The hardware function needed information from the installation and finance function about the effectiveness of his or her hardware design. If a hardware design required more installation hours or was too expensive a different hardware design would be necessary. Likewise both the installation and the finance function needed to balance their decisions with respect to the resources and requirements of the other functions.

In order for a task to be interdependent, each member of the team must be necessary for the completion of the task. This interdependence was accomplished by giving each team member specialized knowledge about their function. Only the hardware function had information on the performance of each hardware component. The installation function had specific information about the installation times and available resources. The finance function knew the costs of the components and installation hours. By providing each individual with specialized knowledge, the task could only be accomplished if the individual team members worked together.

The final consideration when designing an interdependent task was to make the performance of each function dependent on the other functions. A truly interdependent task would behave as a system, where the performance of each component in the system depends on the performance of the other components. Making the requirements of each function dependent on the outputs of the other functions incorporated interdependence. The number of hours the installation function had to assign was dependent on the types and configuration of the hardware components. The finance function depended on the hardware and installation function to create low cost designs. The performance of the hardware

also depended on the number of overtime hours used by the installation function. Both the installation and hardware functions depended on the finance function for the available budget for the system.

Overall the level of interdependence of the task used in this experiment was high. All the individual participants had to work together closely, share knowledge, and keep in mind the requirements and performance of the other functions in order to accomplish their individual tasks. This level of interdependence is believed to be more indicative of the types of tasks undertaken by project teams.

3.8. Data Collection

This section explains how each of the variables investigated in this research were measured. For each experiment, the team was identified by a team number and the experimental conditions. Any documents that were specific to an individual, such as the questionnaires, were coded with the team number and the functional position of the participant.

3.8.1. Measurement of Variables

Two distinct stages of measurement were used in this experiment: pre-experiment and post experiment. Pre-experiment measures were gathered before the team began work on the task. These measures consisted of a questionnaire gathering individual data. Individual attributes of the team members measured on this questionnaire were autonomy preferences and valence of the reward being offered. The pre-experiment questionnaire is shown in Appendix E. Post-experimental data collection consisted of a second questionnaire, and a quantitative evaluation of the team's design. The second questionnaire evaluated satisfaction (egocentric, social, and instrumental), amount of effort, cooperation and the team's ability to exist, and is shown in Appendix F. This questionnaire also evaluated the team's perceived task and reward interdependence and gathered demographic data. The quantitative evaluation of the team's design was done by entering the values chosen by the team into a spreadsheet that calculated the team's score.

The following sections describe the method of measuring each of the variables used in this study. Questionnaire items were listed in random order on the questionnaire, and were measured with a

Likert-type scale, ranging from strongly disagree (1) to strongly agree (6). Reverse scored items are marked with an asterisk (*). All items are listed in the final form used in the questionnaires given to participants.

3.8.1.1. Autonomy Preferences

A six-item scale, developed by Wageman (1995), was used to assess individual preferences for working in teams. Wageman administered this questionnaire to 816 technicians in her study. 573 technicians completed a second survey using these questions. This scale had an internal consistency of 0.79 in Wageman's study.

- I like my work best when I do it all myself.
- I prefer tasks that allow me to work with others.*
- I would rather work alone than with other people.
- The less I have to rely on others at work, the happier I am.
- I would rather work through a work problem myself than ask for advice.
- Working in small groups is better than working alone.*

3.8.1.2. Valence

Matsui et al. (1987) used a single item, measured on a five point scale ranging from unattractive to extremely attractive, to measure the valence of the reward offered. In this experiment, three items (developed by the researcher) were used. The items used in this experiment to measure reward valence were as follows:

- The reward offered for performance in this experiment is very attractive.
- Twenty dollars is a lot of money.
- I could really use the money from this experiment.

3.8.1.3. Effort

No existing measures of effort were satisfactory for this experiment. The following four items (developed by the researcher) were used to measure effort in this experiment:

- I worked hard to perform well in this experiment.

- I tried hard to earn the maximum reward.
- I made an effort to do well in this experiment.
- I put forth my best effort during the experiment.

3.8.1.4. Cooperation

Four items on the post-experiment questionnaire measured cooperation. Campion, Medsker and Higgs (1993) developed a work characteristics survey that includes the construct of communication/cooperation within the group that seems ideally suited for measuring cooperation. The survey used a Likert scale, and was team- oriented. The internal consistency of this construct was determined to be 0.81 by Medsker and Higgs (1993). This measure was determined by a survey of 468 managers and workers. Their questions are as follows:

Communication/Cooperation Within the Work Group

- Members of my team are very willing to share information with other team members about our work.
- Teams enhance the communication among people working on the same product.
- Members of my team cooperate to get work done.

Since these questions are asked in the present tense and include some concepts not present in this experiment, some changes were made for use in this study. The questions as they were used in this experiment are as follows:

- Members of my team were very willing to share information with other team members about our work.
- Working as a team enhanced the communication among people working on this task.
- Members of my team cooperated to get work done.

Additionally an item developed by the researcher was added to the three questions above. The item was as follows:

- Members of my group worked as a team more than as individuals.

3.8.1.5. Performance

The performance score used in this research was an attempt to measure team performance in a holistic way. In most team-based projects there are many stakeholders in the team's decisions and how well they carry out their task. Rather than only measuring a single simple aspect of team performance, such as time to complete a problem, this measure took into account many different aspects of the team's decisions.

There are two opposing components to the performance measurement (Figure 3.3). The first is the department component. This component represented the organization's point of view. Maximizing their score on this component would be most beneficial to the team-member's department department. Although each team member had direct control of the factors that make up their department's score, maximizing one department's score would likely be to the detriment of the other two departments.

This first component is divided into three sub-components, each representing the departments the team members represented. The hardware department's score was made up of two factors, the number of reserved components they used and the ability of the hardware components to meet the requirements given. The installation department's score is also made up of two factors, the number of reserved hours used and the extra days used to complete the project. The finance department's score is made up of three factors, the profit made on the project, and the number of reserved hours and components used.

The second component represents the customer's point of view and is also divided into three sub-components, each representing the requirements specified by the customer. The first sub-component is the performance of the system. This is made up of two factors, the ability of the hardware to meet the system requirements and the number of overtime hours used. The installation sub-component is solely represented by the number of extra days used to complete the project. The cost sub-component is the amount over or under the bid amount charged to the customer. All of these components are summarized in Table 3.3.

Table 3.3 Performance Factors

Component	Sub-Component	Factor 1	Factor2	Factor 3
Department Components	Hardware	Reserved Components Used	Performance Requirements	Reserved Hours Used
	Installation	Reserved Hours Used	Extra Days to Install	
	Finance	Profit	Reserved Components Used	
Customer Satisfaction Components	Performance	Performance Requirements	Overtime Hours Used	
	Time	Extra Days to Install		
	Cost	Amount over bid		

The scores for both individual and group were calculated by combining these components. Because of the different range and magnitude of the numbers used to calculate the different factors, each factor was scaled when combined. A detailed description of the quantitative value of the scores and how they were scaled can be found in Appendix G. The values used to scale the factors were based on the theoretical maximum and minimum scores for each factor, and the relative magnitude of the factors.

The individual scores were based on the respective department sub-component for each role, i.e. the hardware function's score was based on the hardware sub-component. This score was then averaged with the total customer satisfaction score. The team score was an average of all the individual scores. The mixed-reward score was the average of the team and individual scores. Table 3.4 summarizes the way in which the factors were combined for each type of score.

Table 3.4 Factors Used to Calculate Individual, Mixed, and Team Reward Performance Scores

Score	Factor 1	Factor 2
Individual	Department Sub-Component	Customer Satisfaction
Mixed	Team Score	Individual Score
Team	Individual Scores	

Although individual and mixed scores were used to determine the reward given to participants in the individual- and mixed reward groups, only the team score was used in the analyses. Also, the raw scores were used in the analysis, but participants were only presented with a percentage score out of 100. This percentage was based on the maximum and minimum scores calculated from more than 140 different solutions to the problem.

3.8.1.6. Satisfaction

A number of different types of satisfaction can be measured, but only one macro level construct is used in most research. For this study it was desirable to measure different types of satisfaction. Nerkar, McGrath and MacMillan (1996) suggest three facets of satisfaction: Egocentric, Instrumental, and Social. A number of items were used to measure each type of satisfaction. These items were developed by the researcher based on the definitions of each type given by Nerkar et. al. Additionally two items from the Campbell-Hallam Team Development Survey (Hallam & Campbell, 1994) were used in the social satisfaction construct. The third item used in the Team Development Survey was dropped during pilot testing because of low inter-item correlation. The items used to measure each type of satisfaction in this study are as follows:

Egocentric Satisfaction

- I am happy with the reward I received.
- I am satisfied with my reward for this experiment.
- My reward reflected my level of performance well.
- The reward I received seemed fair relative to the reward my teammates received.

Instrumental Satisfaction

- I am disappointed that my team did not do better.*
- I am happy with my team's performance.
- I am satisfied that my team performed well on this task.

Social Satisfaction

- I am unhappy on this team.*
- I am satisfied with the way our team worked together.
- The morale of our team is good.
- I like being part of this team.
- This team has a good working relationship.

3.8.1.7. Ability to Exist

Hackman (1990) defined the ability to exist as: the degree to which the process of carrying out the work enhances the capability of members to work together interdependently in the future. This definition was used to construct a four-item scale (developed by the researcher) to measure the group's ability to exist. No other scale was found to be satisfactory for measuring ability to exist. Sundstrom's (1990) viability construct includes team member satisfaction, and Gladstein's (1984) items seemed to measure the team's affinity for one another rather than ability to work together. The items used in this research were as follows:

- If I had to choose a team to work with me on a real problem, I would choose members of this team.
- This team could effectively work together on a future task.
- I feel dislike towards some of the members of this team.*
- I would like to work with members of this team again.

3.8.1.8. Task and Reward Interdependence

These two variables are set by the experimental conditions, but it was useful to measure them in order to insure that the experimental conditions produce the desired effects.

Items from Campion's (1993) work group characteristics questionnaire were again used to measure task interdependence and reward interdependence. These constructs were determined to have an internal consistency of 0.61 for the task interdependence construct and 0.59 for the reward interdependence construct. While these internal consistency levels are low, the measures were determined in a field study where the questionnaire recipients could consider different types of tasks. In a laboratory study such as this one, the more highly controlled task was expected to produce higher internal consistencies. Campion's questions are as follows:

Task Interdependence

- I cannot accomplish my tasks without information or materials from other members of my team.
- Other members of my team depend on me for information or materials needed to perform their tasks.
- Within my team, jobs performed by team members are related to one another.

Reward Interdependence

- Feedback about how well I am doing my job comes primarily from information about how well the entire team is doing.
- My performance evaluation is strongly influenced by how well my team performs.
- Many rewards from my job (e.g., pay, promotion, etc.) are determined in large part by my contributions as a team member.

Again these questions were altered to fit this experiment as follows:

Task Interdependence

- I could not accomplish this task without information or materials from other members of my team.
- Other members of my team depended on me for information needed to perform their work.

- Within my team, work performed by team members was related to one another.

Reward Interdependence

- Feedback about how well I did on this task came primarily from information about how well the entire team did.
- The evaluation of my performance was strongly influenced by how well my team performed.
- The reward for this task was determined in large part by my contributions as a team member.

3.8.2. Summary of Questionnaire Items

Table 3.5 summarizes the survey items used in this research. Additionally the source for the questionnaire items, if there was one, is listed here with the internal consistency reported in the source study. Inter-item correlations for some constructs were lower than what is usually considered acceptable for items measuring a single construct (Cohen & Cohen, 1983). As such, some items listed above were eliminated to increase internal consistency. Two of the constructs, Reward Interdependence, and Task Interdependence were not used in any of the further data analyses, but are discussed in Chapter 5. The Valence construct consisted of three items with an internal consistency of 0.51. Inter-item correlation analysis showed that dropping one of any of the three items would not increase the Alpha (0.37, 0.46, 0.38). For this reason, the score for only one of the items was used in the analyses. The item used was: "The reward offered for performance in this experiment is very attractive." One item was also dropped from the instrumental satisfaction scale (α=0.62). Dropping this item increased Cronbach's Alpha to 0.86 for this scale. The item dropped was: "I am disappointed that my team did not do better." The Cronbach's Alpha for the cooperation scale could not be improved by dropping any one item. Dropping two items would at best result in a Cronbach's Alpha of 0.65. Since this increase was negligible, all items from the cooperation scale were retained. No other changes were made to any of the questionnaire scales. A table showing how each item changed during pilot testing appears in Appendix I

Table 3.5 Summary of Questionnaire Items and Cronbach's Alphas

Construct	Item	Cronbach's Alpha from this Study	Source	Cronbach's Alpha from Source
	I feel dislike towards some of the members of this team.	0.85	N/A	N/A
Ability to exist	This team could effectively work together on a future task.			
	If I had to choose a team to work with me on a real problem, I would choose members of this team.			
	I would like to work with members of this team again.			
	I would like to work with members of this team again.	0.76	Wageman, 1995	0.79
	I would rather work through a work problem myself than ask for advice.			
	I like my work best when I do it all myself.			
Autonomy preference	Working in small groups is better than working alone.			
	I prefer tasks that allow me to work with others.			
	I would rather work alone than with other people.			
	The less I have to rely on others at work, the happier I am.			
	Members of my team were very willing to share information with other team members about our work.	0.63	Campion et al, 1993	0.81
Cooperation	Members of my team cooperated to get work done.			
	Working as a team enhanced the communication among people working on this task.			
	Members of my group worked as a team more than as individuals.			
	I worked hard to perform well in this experiment	0.69	N/A	N/A
Effort	I tried hard to earn the maximum reward.			
	I made an effort to do well in this experiment.			
	I put forth my best effort during the experiment.			
	I am happy with the reward I received.	0.78	N/A	N/A
Egocentric satisfaction	I am satisfied with my reward for this experiment.			
	My reward reflected my level of performance well.			
	The reward I received seemed fair relative to the reward my teammates received.			
Instrumental satisfaction	I am happy with my team's performance.	0.86	N/A	N/A
	I am satisfied that my team performed well on this task.			

Table 3.5 Cont. Summary of Questionnaire Items and Cronbach's Alphas.

Construct	Item	Cronbach's Alpha from this Study	Source	Cronbach's Alpha from Source
Reward interdependence	Feedback about how well I did on this task came primarily from information about how well the entire team did.	0.49	Campion et al, 1993	0.59
	The evaluation of my performance was strongly influenced by how well my team performed.			
	The reward for this task was determined in large part by my contributions as a team member.			
Social satisfaction	I am unhappy on this team.	0.83	N/A	N/A
	I am satisfied with the way our team worked together.			
	The morale of our team is good.			
	I like being part of this team.			
	This team has a good working relationship.			
Task interdependence	Within my team, work performed by team members was related to one another.	0.46	Campion et al, 1993	0.61
	I could not accomplish this task without information or materials from other members of my team.			
	Other members of my team depended on me for information needed to perform their work.			
Valence	The reward offered for performance in this experiment is very attractive.	N/A	Matsui et al., 1987	N/A

3.9. Data Analysis

This section briefly describes how the data obtained during the experiment was analyzed. The results of the analyses are shown in Chapter 4. For all tests the level of significance was set at 0.05. For most of the variables, the average score for each team was used. Since each participant was actually a subset of the team, for most measures this provides a more accurate result. Additionally, most of the questionnaire items are phrased so that they apply to the team as a whole, rather than the individual. The autonomy preference, valence, and effort variables were analyzed on an individual basis, except when compared to a group level variable. For other variables the team average was used in the analysis.

A possible problem is the validity of using the group average for these measures. It is desirable for each member of the team to score similarly on each construct. James, Demaree, and Wolf's (1984 & 1993) within-group interrater reliability estimate was used to calculate the amount of variance between individual responses on a team. The values for each construct are presented in Table H.3 in Appendix H. From these values, it would appear as though most teams demonstrated within-group agreement in their repeated measures. Neither the experiment data nor the analyses used were altered based on the results of the within-group interrater reliability estimate.

For each hypothesis that requires a comparison of a variable between reward treatments, a simple one-way ANOVA was used to determine if any significant effects existed. Once significance was determined, a post-hoc least significant difference (LSD) test was used to determine which treatments were significantly different. The LSD test was chosen because the low number of comparisons and small sample size did not necessitate the adjusted alpha of other post-hoc tests.

For comparisons between two variables that were not constricted to a set number of levels, such as the questionnaire data, Pearson's product-moment correlation was used to determine what, if any relationship existed. The two-way significance level of this correlation was used to determine significance.

Analysis that required testing the interaction effect between three variables was done using the significance of the change between three regression equations (Montgomery & Peck, 1992). If a succeeding regression equation showed a significantly better fit, that equation was used over the simpler equation. This method is described more fully in Chapter 4 when it is applied.

4. Results

This chapter presents the results of statistical tests used in this study. A discussion of these results can be found in Chapter 5. For all tests of significance in this research, the α level was set at 0.05. Other experimental data and analysis can be found in Appendix H.

4.1. Participant Demographics

Demographic data was collected at the end of the post-experiment questionnaire. Participants were asked their age, gender, academic level, and major. The last question asked how well they knew the other members of their group. These questions can be found on the last page of the post-experimental questionnaire in Appendix F.

4.1.1. Participant's Age

The average age of participants in this study was 22.0. Ages ranged from 18 to 32, with a standard deviation of 3.18. The mode age of participants was 20 and 21. These age groups accounted for 20 of the 45 participants. The following table shows the number of participants of each age used in the study. A histogram of this data can be found in Figure 4.1.

Table 4.1 Breakdown of Participants by Age

Age	Number of Participants	Percentage of Participants
18	1	2%
19	5	11%
20	10	22%
21	10	22%
22	6	13%
23	5	11%
24	3	7%
25	1	2%
30	2	4%
31	1	2%
32	1	2%
Total	45	100%

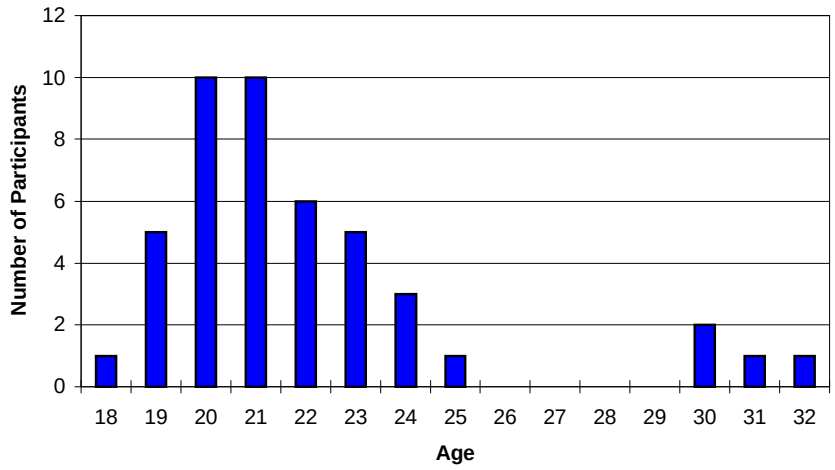


Figure 4.1 Histogram of Participant's Age

4.1.2. Participant's Gender

The study made no requirements for gender, nor restricted the mix of genders in each group. The majority of participants were male. Table 4.2 shows the breakdown of participants by gender. Further details on the mix of genders within each group are in Appendix H, Table H.1.

Table 4.2 Breakdown of Participants by Gender

Gender	Number of Participants	Percentage of Participants
Male	32	71%
Female	13	29%

4.1.3. Participant's Major Area of Study.

For this study, participants were recruited from university classes. The recruitment procedure and sign-up sheet can be found in Appendix D. The classes solicited were various management and industrial and systems engineering summer classes at Virginia Tech. Additionally a number of ISE

graduate students and friends of some of the participants were used in the study. The following classes were used:

- Mgmt 3334 Human Resources Leadership
- Mgmt 4394 Business Politics and Management
- ISE 2014 Engineering Economy (2 sections)
- ISE 3414 Probabilistic Operations Research
- ISE 3424 Discrete Event Computer Simulation
- ISE 3614 Introduction to Human Factors

These classes were approached using the method described in Appendix D. While classes from only two colleges were actively solicited, many different majors were represented in this study. The following table shows the number and percentage of participants by major.

Table 4.3 Breakdown of Participants by Major

Major	Number of Participants	Percentage of Participants
Industrial and Systems Engineering	16	36%
Accounting	4	9%
Civil Engineering	4	9%
Hotel and Restaurant Management	4	9%
Animal and Poultry Sciences	2	4%
Computer Engineering	2	4%
Mechanical Engineering	2	4%
Aerospace Engineering	1	2%
Architecture	1	2%
Biology	1	2%
Business	1	2%
Chemical Engineering	1	2%
Education	1	2%
Electrical Engineering	1	2%
Engineering Science and Mechanics	1	2%
Management	1	2%
Management Science	1	2%
Statistics	1	2%
Total	45	100%

4.1.4. Participant's Academic Level

Participant's were required to be at least at the sophomore level. Since the study was done during the summer academic session, most students taking summer classes had already completed their freshman year. No students signing up for the study had to be rejected because they did not meet the academic requirement. The largest group of students participating in the experiment was at the senior level. Table 4.4 shows the number and percentage of each level of participant, and Figure 4.2 shows a histogram of this data.

Table 4.4 Breakdown of Participants by Academic Level

Academic Level	Number of Participants	Percentage of Participants
Sophomore	7	16%
Junior	11	24%
Senior	22	49%
Masters	3	7%
Doctoral	2	4%
Total	45	100%

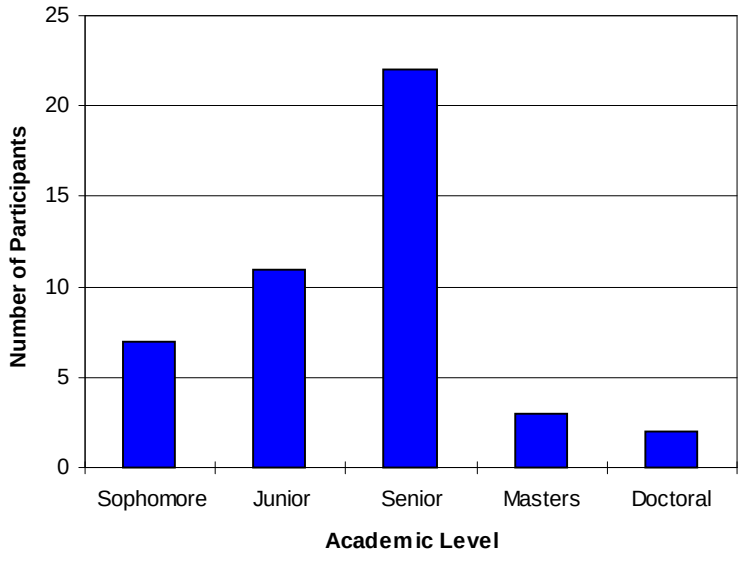


Figure 4.2 Histogram of Participant's Academic Level

4.1.5. Participant's Familiarity With Other Team Members

Participants were asked how well they knew the other members in their group by checking the item that best corresponded with how well they knew the other members. The number of responses for each familiarity statement is shown below.

Table 4.5 Familiarity of Participants

Familiarity	Number of Participants	Percentage of Participants
I have worked (homework, projects) with both before.*	12	27%
I have worked with one before, and know the other.	5	11%
I have worked with one before, and do not know the other.	6	13%
I know both from class but haven't worked with them.	7	16%
I know one from class.	7	16%
I don't know either of my team members.	8	18%
Grand Total	45	100%

* Although members of some teams had worked with each other before, it was verified before the experiment began that they had not all worked together as a team.

4.1.6. Reward Amount

There were differences in the average amount of reward each group received. Since the group and individual scores were calculated using a different scale to determine the amount of the reward, some of the difference could be attributed to the scoring method. It is possible that the amount of the reward could have affected participant responses, so the reward amount was also included in the test for differences between reward treatments as explained in the next section. The following table summarizes the average amount of reward by treatment type.

Table 4.6 Average Reward Amount by Treatment

Treatment	Average Reward Amount
Individual	$14.60
Mixed	$13.60
Group	$16.60

4.1.7. Analysis of Demographic Data by Treatment Type

The average demographic scores for each team were analyzed by treatment type to determine if there were any significant differences between treatments for any of the demographic measures. An ANOVA was conducted for each measure as a function of reward treatment. A summary of the results is shown in Table 4.6. None of the demographic measures was significantly different between treatment types.

Table 4.7 ANOVA Summary of Demographic Measures by Treatment Type

Measure	Source	df	Sum of Squares	Mean Square	F test statistic	p value
AGE	**Between Groups**	2	2.178	1.089	0.308	0.741
	Within Groups	12	42.489	3.541		
	Total	14	44.667			
GENDER	**Between Groups**	2	0.104	0.052	0.824	0.462
	Within Groups	12	0.756	0.063		
	Total	14	0.859			
MAJOR	**Between Groups**	2	0.933	0.467	0.667	0.531
	Within Groups	12	8.400	0.700		
	Total	14	9.333			
LEVEL	**Between Groups**	2	2.133	1.067	2.165	0.157
	Within Groups	12	5.911	0.493		
	Total	14	8.044			
FAMIL	**Between Groups**	2	7.748	3.874	1.457	0.271
	Within Groups	12	31.911	2.659		
	Total	14	39.659			
Reward Amount	**Between Groups**	2	23.333	11.667	0.515	0.610
	Within Groups	12	271.600	22.633		
	Total	14	294.933			

4.2. Internal Consistency of Questionnaire Items

The internal consistency of each construct measured by the questionnaires was analyzed to ensure that the items correlated highly with each other. The raw data for each item appears in Appendix H, Table H.2. Scale and Item means, with histograms for each construct are also in Appendix H. For each construct Cronbach's Alpha (Cronbach, Gleser, Nanda & Rajaratnam, 1972) was calculated. The following table shows the Alpha for each construct measured in the questionnaires.

Table 4.8 Cronbach's Alpha for Constructs Measured in Questionnaires.

Construct	Cronbach's Alpha from this Study	Cronbach's Alpha from Source	Number of Items
Ability to Exist	0.85	N/A	4
Autonomy Preference	0.76	0.79	6
Cooperation	0.63	0.81	4
Effort	0.69	N/A	4
Egocentric Satisfaction	0.78	N/A	3
Instrumental Satisfaction	0.86	N/A	2
Reward Interdependence	0.49	0.59	3
Social Satisfaction	0.83	N/A	5
Task Interdependence	0.46	0.61	3
Valence	N/A	N/A	1

4.3. Normality of Measures

A Wilkes-Shapiro test for normality was conducted to determine how closely the distribution of data approximated a normal distribution. Histograms for these measures are presented in Appendix H. For measures used in individual analysis this test was conducted on an individual basis, yielding a sample size of 45. Group level measures were tested using the average for the group, yielding a sample size of 15. Table 4.9 summarizes the results of this test.

Table 4.9 Shapiro-Wilke Test for Normality on Measures Used in Analyses

Measure	Statistic	df	p value
Ability to Exist	0.947	15	0.474
Autonomy Preference	0.956	45	0.091
Cooperation	0.950	15	0.496
Effort	0.939	45	0.010
Egocentric Satisfaction	0.830	15	0.010
Instrumental Satisfaction	0.829	15	0.010
Social Satisfaction	0.961	15	0.670
Valence	0.964	45	0.728
Team Performance	0.934	15	0.369

Measures that were significantly different from a normal distribution were used in ANOVA tests, as ANOVA is robust to non-normal distributions if the sample size is as large as 15 cases (Green, Salkind & Akey, 1997). The bivariate linear regression tests used in the comparison of regression equations for interaction analysis are also robust to violations of normality for relatively small sample sizes (Green, Salkind & Akey, 1997; Mongomery & Peck, 1992).

4.4. Test of Experimental Hypotheses

In this section, the results of testing each of the experimental hypotheses as proposed in Chapter 1 are presented. The implications of these results are discussed in Chapter 5. For most of the analysis, the average score of the team was used. Individual scores were used in some analyses, particularly for analyses using autonomy preference, valence, and effort where possible. To insure that the team averages had a high level of interrater reliability James, Demaree, and Wolf's (1984) within group interrater reliability estimate was calculated for each team on each construct. The results of these calculations (Table H.3, Appendix H) show that there was a high level of interrater reliability for most teams. Only three occurrences of low levels of interrater reliability were found. The measures for ability to exit, task interdependence and valence were found to be low in three separate teams.

4.4.1. Hypothesis 1a

H_0: The level of cooperation will not be significantly different under different reward structures.

H_1: Individuals will exhibit more cooperation under the group reward structure (compared to other reward structures).

Hypothesis 1a proposes that the group reward structure will result in higher levels of cooperation than other reward structures. Four items on the post-experiment questionnaire assessed cooperation. Cooperation scores for each group ranged from 4.83 to 5.75 with an overall standard deviation of 0.30. The average cooperation over all treatments was 5.25. In this study there are three reward treatments: group, individual, and mixed. The average score for each group was used in the analysis. Figure 4.3 shows the average cooperation score for each treatment type.

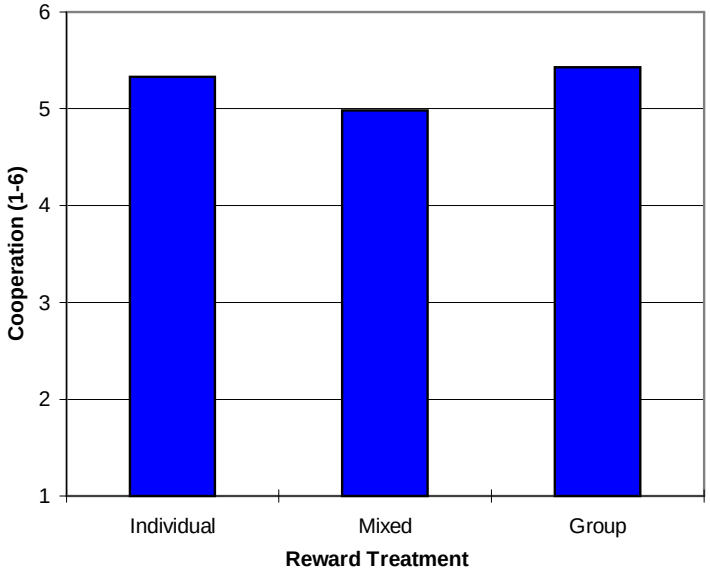


Figure 4.3 Average Cooperation by Reward Treatment

An one-way ANOVA was conducted to determine if the differences in cooperation scores could be attributed to the reward condition. The ANOVA showed a significant effect of reward treatment on cooperation scores ($F_{(2,12)}$=4.748, p=0.030). Table 4.10 shows the ANOVA summary table for this test.

Table 4.10 ANOVA Summary Table for Cooperation as a Function of Reward Condition

Source	df	Sum of Squares	Mean Square	F test statistic	p-value
Between Groups	2	0.558	0.279	4.748	0.030
Within Groups	12	0.706	0.059		
Total	14	1.264			

A Least Significant Difference test was conducted to determine which treatments were significantly different. This test showed that both the individual and group reward treatments had significantly higher cooperation scores than the mixed reward treatment (p=0.042 and p=0.013). No significant difference was found between the individual and group reward treatments (p=0.527).

In order to better display the variance of cooperation scores within each treatment, a boxplot is shown in Figure 4.4. The boxplot shows the interquartile range enclosed within the plot. The range has as its extremes the 75th and the 25th percentile. A solid line shows the median cooperation level in each treatment. Additionally, the "whiskers" show extreme observations in each treatment. A circle is used to indicate outliers. This plot better explains how apparently large differences as seen in a bar graph can result in a statistically non-significant result. In this case it can be seen that although the difference between the average cooperation in the individual treatment and the mixed treatment was nearly as large as the difference between the group and mixed treatment, the difference was not significant since the variance in the cooperation scores of the individual treatment was large.

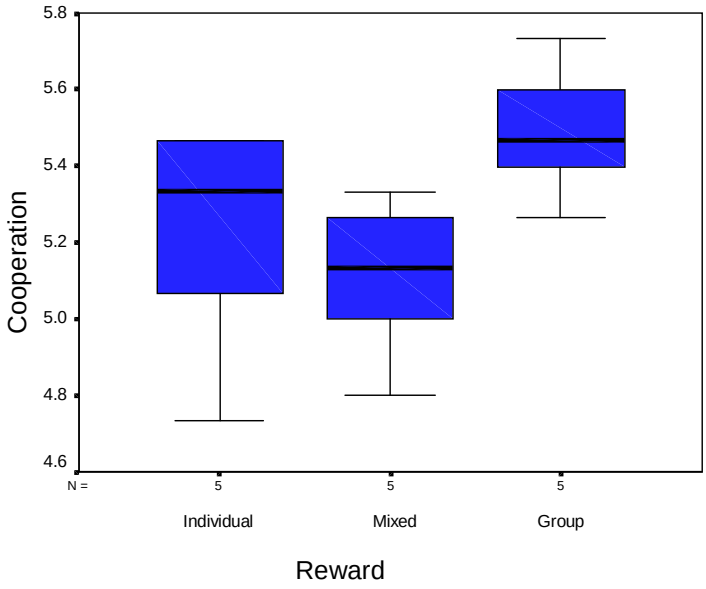


Figure 4.4 Boxplot of Cooperation vs. Reward Treatment

Hypothesis 1a was only partially supported, since the group-rewarded teams did have significantly higher cooperation than the mixed reward teams, but the group-rewarded teams were not significantly higher in cooperation than the individually-rewarded teams.

4.4.2. Hypothesis 1b

H_0: There will be no significant difference in effort levels under different reward structures.

H_1: Individuals will exhibit more individual effort under individual rewards (compared to other reward structures).

Hypothesis 1b proposes that effort will be highest under the individual reward treatment. Four items on the post experimental questionnaire measured effort. Average effort scores ranged from 3.25

to 6.0 with a mean of 5.006 and an overall standard deviation of 0.632. Individual effort scores were used in the analysis. Figure 4.5 shows the average effort score for each reward treatment.

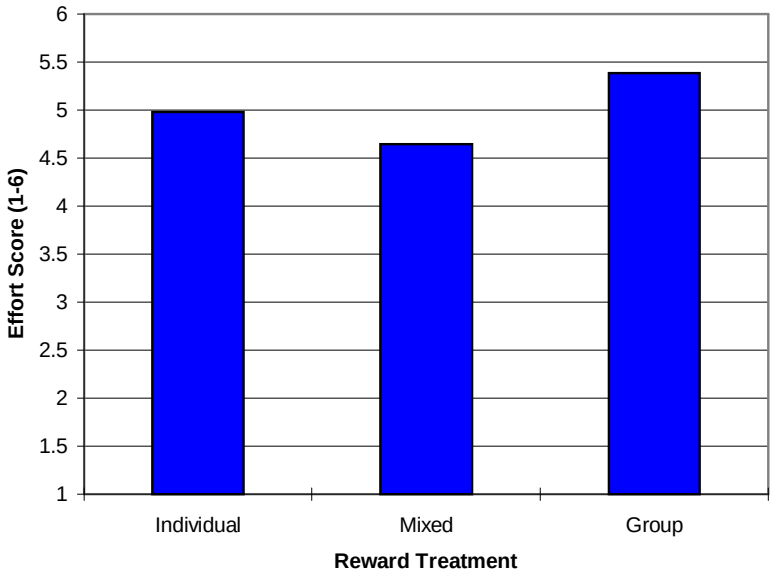


Figure 4.5 Average Effort by Reward Treatment

To determine whether reward treatment had a significant effect on effort level an ANOVA was conducted. This analysis showed a significant effect of reward treatment on effort scores ($F_{(2,12)}$=6.284, p=0.004). The summary ANOVA table is shown in Table 4.7.

Table 4.11 ANOVA Summary Table for Effort as a Function of Reward Condition

Source	df	Sum of Squares	Mean Square	F test statistic	p-value
Between Groups	2	4.044	2.022	6.284	0.004
Within Groups	42	13.517	0.322		
Total	44	17.561			

An LSD test was again used to determine if there were any differences between the three treatments. This test showed that the group reward treatment had significantly higher effort scores than

the mixed reward scores (p=0.005). No other treatments were significantly different in effort scores. Again a boxplot is shown in Figure 4.6 to better display the variance of effort within treatments.

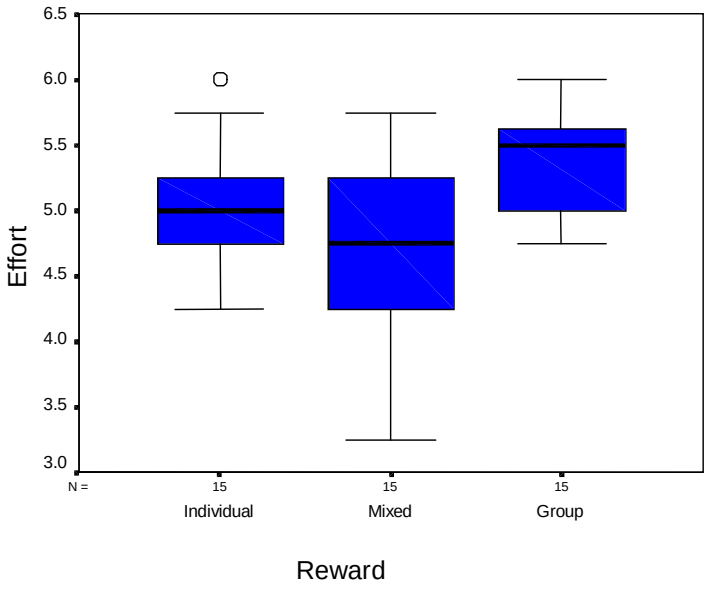


Figure 4.6 Boxplot of Effort vs. Reward Treatment

Hypotheses 1b. was not supported, since the individually-rewarded teams did not have significantly higher effort scores than either the group or mixed reward teams.

4.4.3. Hypothesis 2a

H_0: Group rewards will produce no significant performance advantage when compared to other reward structures

H_1: Group rewards will result in the highest team performance (compared to other reward structures).

Hypothesis 2a proposes that the teams in the group reward treatment will have higher team performance than the other two reward treatments. Team performance was measured by entering the values chosen by the team into a spreadsheet. The formulas used in calculating the scores can be

found in Appendix D. Because of the way the team scores were calculated, all scores are negative, with higher scores equating to higher performance. The team scores ranged from -1.889 to -0.704 with a mean of -1.249 and an overall standard deviation of 0.340. The average team score for each reward treatment is shown in Figure 4.7.

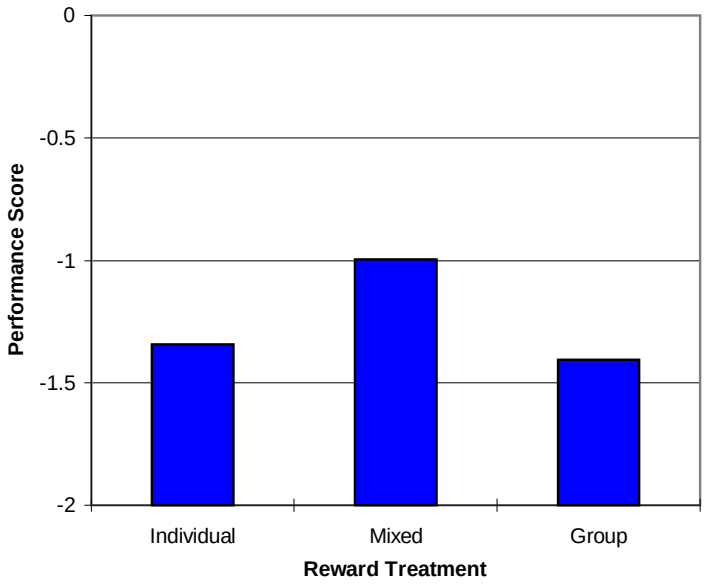


Figure 4.7 Team Performance by Reward Treatment

An ANOVA was used to determine whether reward treatment had a significant effect on team performance. The analysis showed that there was not significant evidence to reject the null hypothesis that all reward treatments resulted in equal performance ($F_{(2,12)}$=2.599, p=0.115). Table 4.8 summarizes the ANOVA results for this test.

Table 4.12 ANOVA Summary Table for Team Performance as a Function of Reward Condition

Source	df	Sum of Squares	Mean Square	F test statistic	p-value
Between Groups	2	0.488	0.244	2.599	0.115
Within Groups	12	1.127	0.094		
Total	14	1.615			

The LSD test did not show any differences between reward treatments for team performance (lowest p=0.056). The boxplot for performance by reward treatment is shown in Figure 4.8.

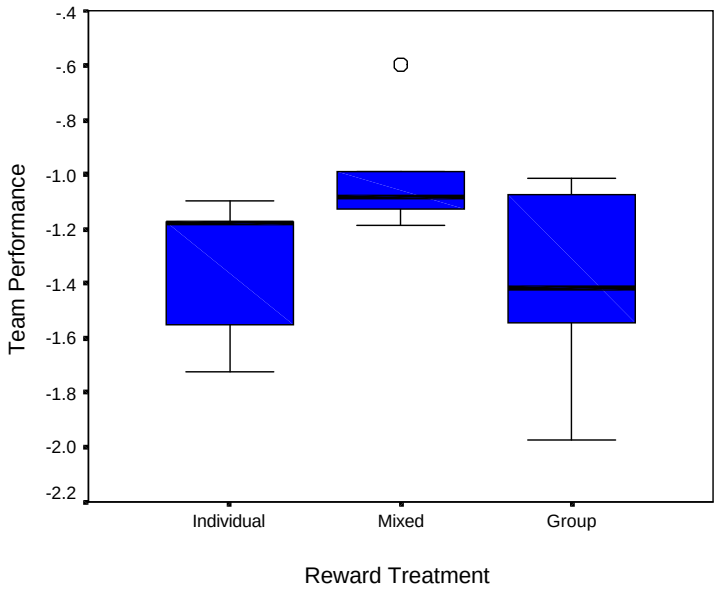


Figure 4.8 Boxplot of Team Performance vs. Reward Treatment

Hypotheses 2a. was not supported, since there were no significant differences in performance between reward treatments.

4.4.4. Hypothesis 2b

H_0: Teams in the group reward condition will not have significantly higher satisfaction than teams in other reward structures.

H_1: Group rewards will result in the highest satisfaction (compared to other reward structures).

Hypothesis 2b proposes that teams in the group reward treatment will have higher levels of satisfaction than either of the other two reward treatments. In this study three different facets of satisfaction were investigated: Instrumental, egocentric, and social. Each was assessed by four, two and five items, respectively, in the post-experiment questionnaire. Each type of satisfaction is analyzed separately here. Average satisfaction scores for each group were used in the analyses. The following figures (4.9-4.11) show the average satisfaction scores and the boxplots for each reward treatment.

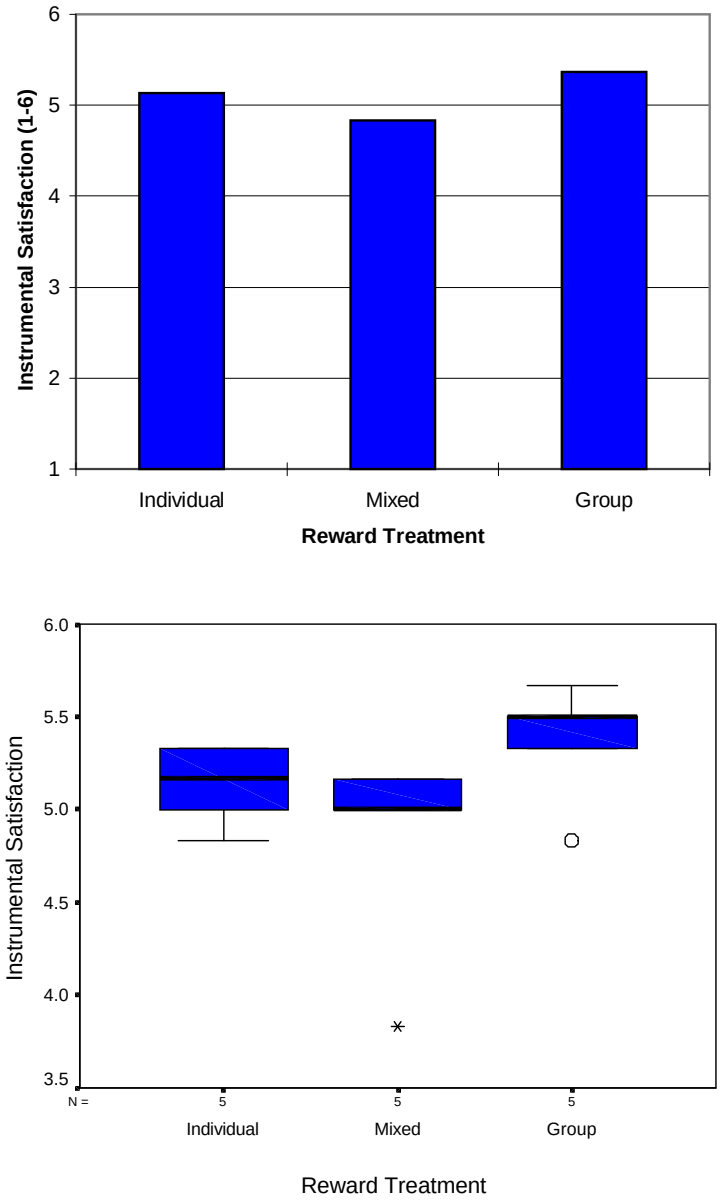
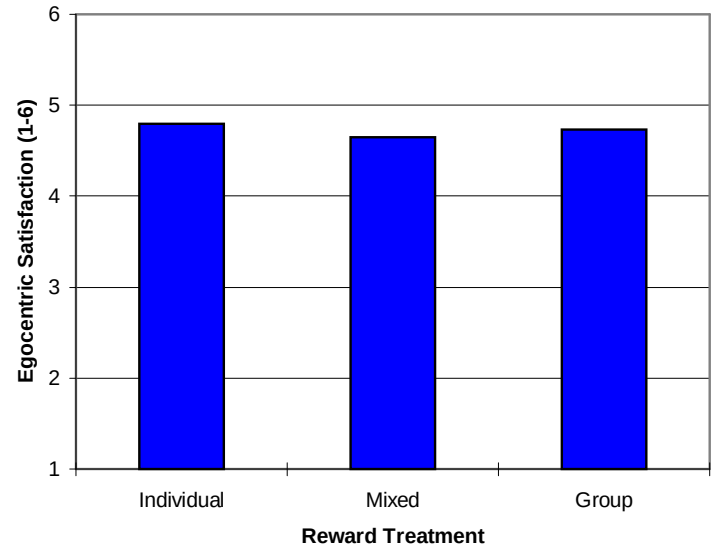


Figure 4.9 Average Instrumental Satisfaction by Reward Treatment



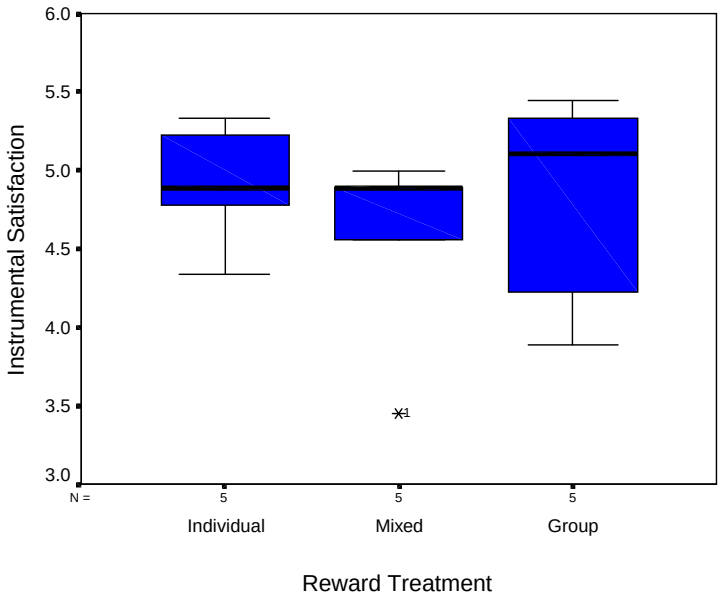


Figure 4.10 Average Egocentric Satisfaction by Reward Treatment

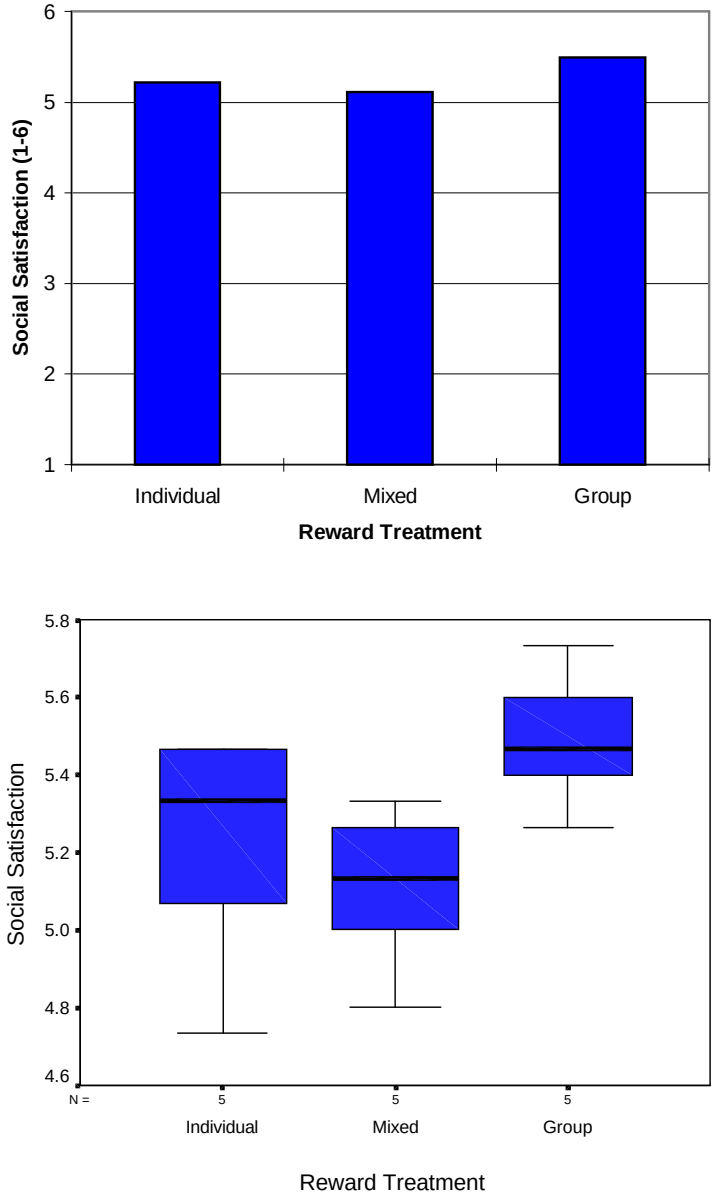


Figure 4.11 Average Social Satisfaction by Reward Treatment

For each type of satisfaction an ANOVA was conducted to determine if there were any significant differences in satisfaction among reward treatments. Reward treatment was not found to be significant in determining the level of satisfaction for any of the types of satisfaction ($F_{(2,12)}$=2.284, p=0.144; $F_{(2,12)}$=0.057, p=0.945; $F_{(2,12)}$=3.382, p=0.068, for instrumental, egocentric, and social respectively). Table 4.12 summarizes the ANOVA for each type of satisfaction.

Table 4.13 ANOVA Summary Table for Three Types of Satisfaction as a Function of Reward Condition

Satisfaction Type	Source	df	Sum of Squares	Mean Square	F test statistic	p-value
Instrumental	**Between Groups**	2	0.715	0.357	2.284	0.144
	Within Groups	12	1.878	0.156		
	Total	14	2.593			
Egocentric	**Between Groups**	2	0.056	0.028	0.057	0.945
	Within Groups	12	5.950	0.496		
	Total	14	6.006			
Social	**Between Groups**	2	0.399	0.199	3.382	0.068
	Within Groups	12	0.708	0.059		
	Total	14	1.106			

Hypotheses 2b was not supported, since there were no significant differences in any of the satisfaction measures between each of the three reward structures.

4.4.5. Hypothesis 2c

H_0: The level of the team member's desire to work together in the future will not be significantly different under different reward structures.

H_1: Group rewards will result in the highest level of team member's ability to work together in the future (compared to other reward structures).

Hypothesis 2c proposes that group rewards will result in higher ability to exist scores than the other two reward treatments. Ability to exist was measured by four items on the post-experiment questionnaire. Average scores for each group ranged from 4.42 to 5.83 with a mean of 5.261 and an overall standard deviation of 0.414. The average score for each team was used in this analysis. Figure 4.12 shows the average ability to exist score for each treatment.

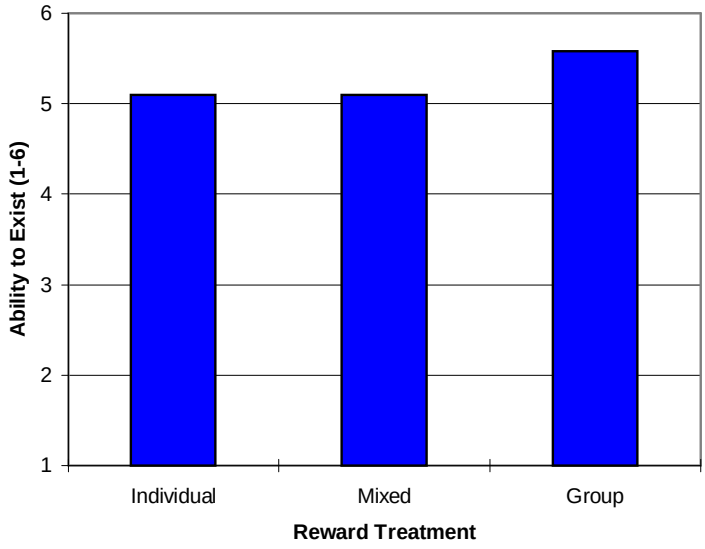


Figure 4.12 Average Ability to Exist by Reward Treatment

An ANOVA was conducted to determine whether the reward treatment had a significant effect on the groups average ability to exist. This test showed no significant difference between reward treatments for a team's ability to exist ($F_{(2,22)}$=2.880, p=0.095). The results of the ANOVA are shown in Table 4.13.

Table 4.14 ANOVA Summary Table for Ability to Exist as a Function of Reward Condition

Source	df	Sum of Squares	Mean Square	F test statistic	p-value
Between Groups	2	0.779	0.389	2.880	0.095
Within Groups	12	1.622	0.135		
Total	14	2.401			

A boxplot of average ability to exist by reward treatment is shown in Figure 4.13.

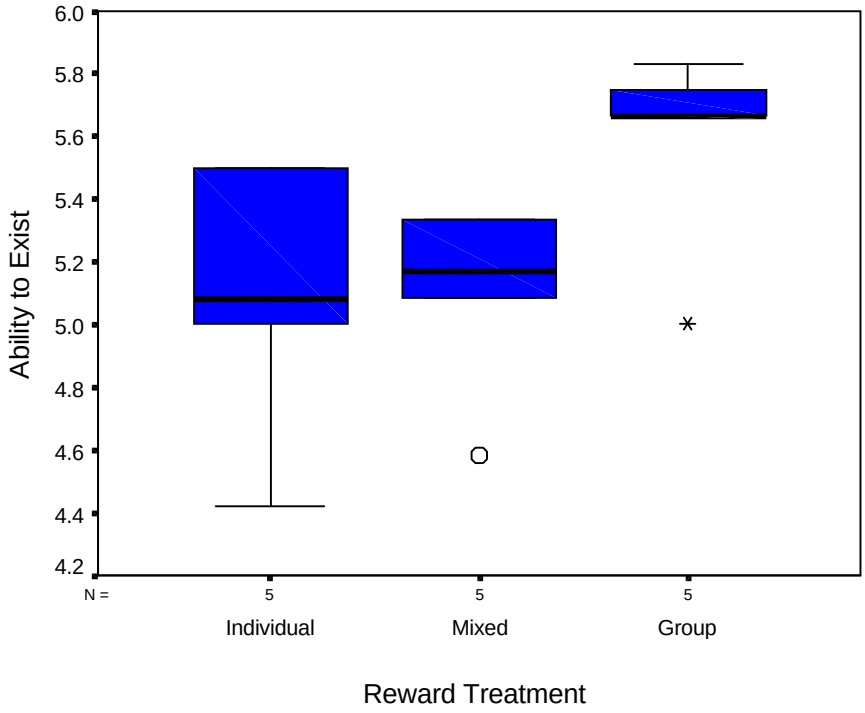


Figure 4.13 Boxplot of Ability to Exist vs. Reward Treatment

There was not enough evidence to reject the null hypothesis, so hypothesis 2c was not supported by the data in this study.

4.4.6. Hypothesis 3a

H_0: Individuals with high autonomy preferences will exhibit lower levels of effort compared to individuals with low autonomy preferences.

H_1: Individuals with a high autonomy preference will not exhibit different levels of effort compared to individuals with low autonomy preferences.

Hypothesis 3a proposes that there will not be a relationship between autonomy preference and the amount of effort exerted by participants in this experiment. Six items on the pre-experiment questionnaire measured autonomy preference. This construct measured how well the individual likes

working with groups as opposed to working individually. Effort was measured on the post-experiment questionnaire by four items. These items assessed how much effort the participant exerted in completing the task during the experiment. Autonomy preference scores ranged from 1.500 to 4.167 with a mean of 3.033 and a standard deviation of 0.708. Effort scores ranged from 3.250 to 6.000 with a mean of 5.01 and a standard deviation of 0.632. Since both the autonomy preference and effort measures were individually oriented, an individual level of analysis was used to test this hypothesis. Figure 4.14 shows the relationship between autonomy preference and effort.

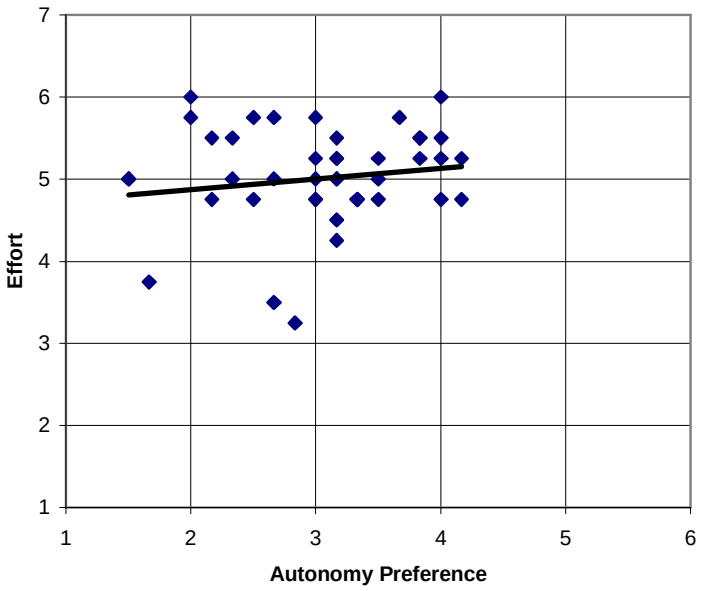


Figure 4.14 Effort vs. Autonomy Preference

(with best-fit line by linear regression)

The Pearson product-moment correlation was used to determine if a relationship exists between autonomy preference and effort. The Pearson product for these two variables across all treatments was r=0.144 (p=.347). This would indicate that there was no significant relationship between autonomy preference and effort. Hypothesis 3a was supported by the data.

4.4.7. Hypothesis 3b

H_0: There will be no significant difference in cooperation levels between individuals with different autonomy preferences.

H_1: Individuals with a high autonomy preference will be less cooperative than individuals with low autonomy preferences.

Hypothesis 3b. proposes that there will be a negative relationship between autonomy preference and cooperation. Although autonomy preference is an individual level measurement, cooperation exists between the members of a group and is a group level measurement. Since the items measuring cooperation were oriented towards the team as a whole, and not the individual, both measures will be analyzed using the team averages here. As stated above, autonomy preference was measured by six items on the pre-experiment questionnaire ($x=3.033$, $S^2=0.708$), and cooperation by four items on the post-experiment questionnaire ($x=5.250$, $S^2=.45540$). Figure 4.15 shows the relationship between autonomy preference and cooperation.

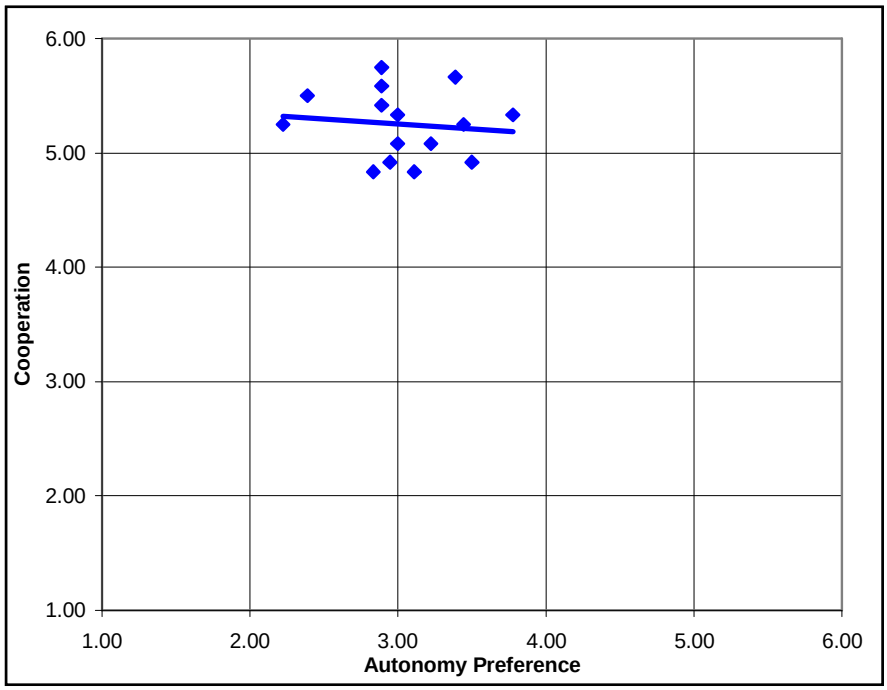


Figure 4.15 Participant's Cooperation vs. Autonomy Preference (with best-fit line by linear regression)

This hypothesis was tested using the Pearson product-moment correlation between cooperation and autonomy preference. This test did not show any significant relationship between the two measures (r=-0.117, p=0.678). As such, hypothesis 3b. was not supported by the data.

4.4.8. **Hypothesis 3c**

H_0: Valence will not significantly increase effort for individually-rewarded teams.

H_1: Individuals that perceive the reward as having a higher valence will exhibit higher levels of effort under individual rewards (compared to other reward structures).

Hypothesis 3c proposes that participants that place a higher value on the reward will exert more effort under the individual reward treatment. The reward and effort variables are discussed in previous

sections. Valence was measured by a single item on the pre-experiment questionnaire. Valence scores ranged from 2.00 to 6.00 with a mean of 4.33 and a standard deviation of 0.879. Individual scores were used in the analysis. Figure 4.16 shows the relationship between valence and effort for each of the three reward treatments. For each reward treatment a best-fit line by linear regression for the valence and effort variables is shown.

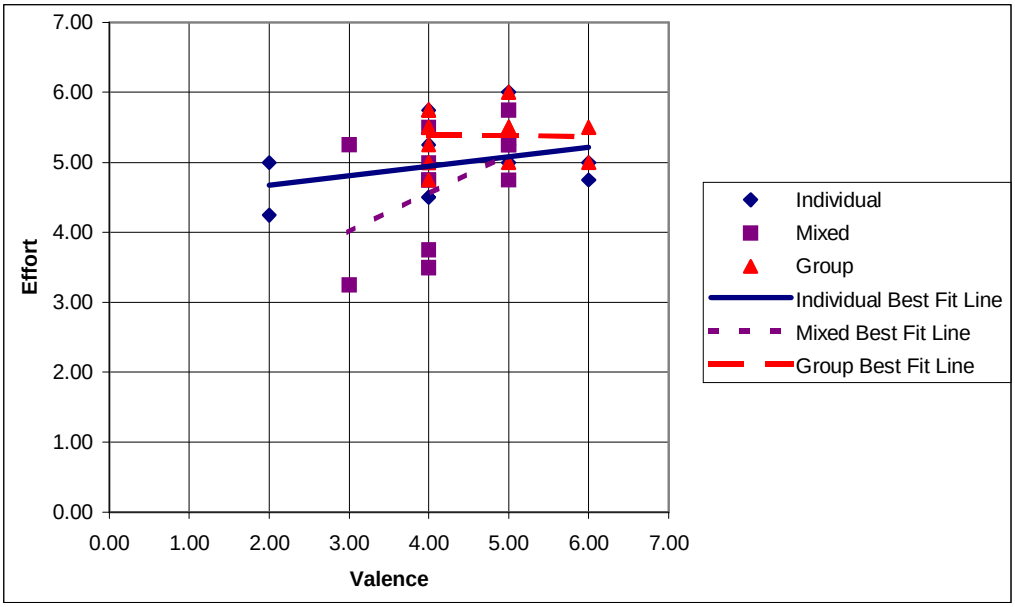


Figure 4.16 Valence vs. Effort by Reward Treatment

(with best-fit lines by linear regression)

In order to determine how the reward treatment affects the relationship between valence and effort, a determination must be made whether there is a significant difference between the reward treatments for the valence and effort relationship. To do this, three different regression models were tested. The first model only includes the valence and reward variables, so only fits one line to the data. This model would indicate that there is a significant relationship between valence and effort, but that the reward treatment has no effect on the relationship. The second model fits three lines, taking into account the reward treatment, but uses the same slope for all three lines. This second model would indicate that there are differences between reward treatment in the amount of effort, but the reward

treatment does not change the relationship (slope) between the valence and effort variables. The third model fits three lines with different slopes. This third model would indicate that there is a significant difference between effort levels in the three reward treatments and that the relationship between valence and reward is different for the three reward treatments. An ANOVA was used to determine whether each increasingly complex model provides a statistically significant better fit than the previous model. A summary of this test is shown in Table 4.14.

Table 4.15 ANOVA Summary Tables for Three Models of Valence and Effort by Reward Treatment.

Model	df1	df2	R Square Change	F Change	p value of change
1	1	43	0.098	4.695	0.036
2	1	41	0.190	5.466	0.008
3	2	40	0.117	3.575	0.037

This would indicate that a model that fits three lines of different intercepts, all having different slopes, provides the best fit for the data. As such, the reward treatment did affect the relationship between valence and effort. Figure 4.16 shows that the mixed reward treatment had the highest correlation between valence and effort. The group reward treatment had the lowest correlation between valence and effort. There was a significant difference between reward treatments for the amount of effort ($F_{(2,42)}$=6.284, p=0.004) as shown in Table 4.10. An LSD test shows that the group rewarded participants had significantly higher levels of effort than the mixed reward participants (p=.005), but no other reward treatments were significantly different. There was also a significant relationship between valence and reward over all treatments. A Pearson product-moment correlation of 0.314 (p=0.036) was found between the valence and effort variables. The reward treatment did significantly effect this relationship, but the mixed reward treatment had the highest relationship. It was proposed that the individual reward treatment would have the highest relationship between valence and effort, so hypothesis 3c was not supported.

4.4.9. Hypothesis 3d

H_0: Valence will not significantly interact with the reward structure.

H_1: Individuals that perceive the reward as having a higher valence will exhibit higher levels of cooperation in the group-reward situation (compared to other reward structures)

Hypothesis 3d proposes that participants that place a higher value on the reward will cooperate more under the group reward structure than under other reward structures. The valence, cooperation, and reward structure variables are discussed in previous sections. As in hypothesis 3b, a group level of analysis was used since cooperation was a group level measurement, although valence was an individual level measurement. Figure 4.17 shows the relationship between valence and cooperation for each of the three reward treatments. The best-fit line by linear regression is shown for each reward treatment.

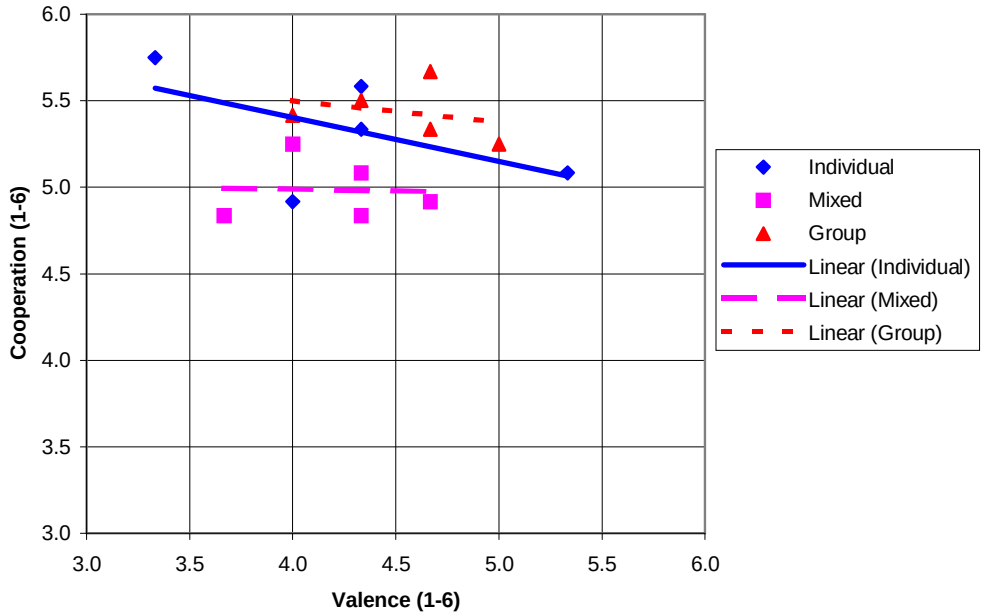


Figure 4.17 Valence vs. Cooperation by Reward Treatment (with best-fit line by linear regression)

As in the previous analysis, three regression models were fitted to the data to determine which provides the best fit. Table 4.15 shows the summary ANOVA data for the three models.

Table 4.16 ANOVA Summary Tables for Three Models of Valence and Cooperation by Reward Treatment.

Model	df1	df2	R Square Change	F Change	p value of change
1	1	13	0.017	0.227	0.642
2	2	11	0.516	6.071	0.017
3	2	9	0.022	0.220	0.807

Since the first model does not show a significant relationship, there is no significant relationship between valence and cooperation. As such, there is no change in the relationship due to reward treatment. The conclusion is also supported by the Pearson product moment correlation between

valence and cooperation, over all treatments r= -0.131 (p=0.642). Hypothesis 3d was not supported by the data.

4.4.10. **Hypothesis 4a**

H_0: Effort will have no significant effect on team performance.

H_1: Higher amounts of individual effort will result in higher team performance.

Hypothesis 4a proposes that the more effort participants exert the better their team performance will be. Both the effort and team performance variables were discussed in previous sections. Since team performance is a group level measurement, the average effort score for each team was used in the analysis. Figure 4.18 shows the relationship between team performance and average effort.

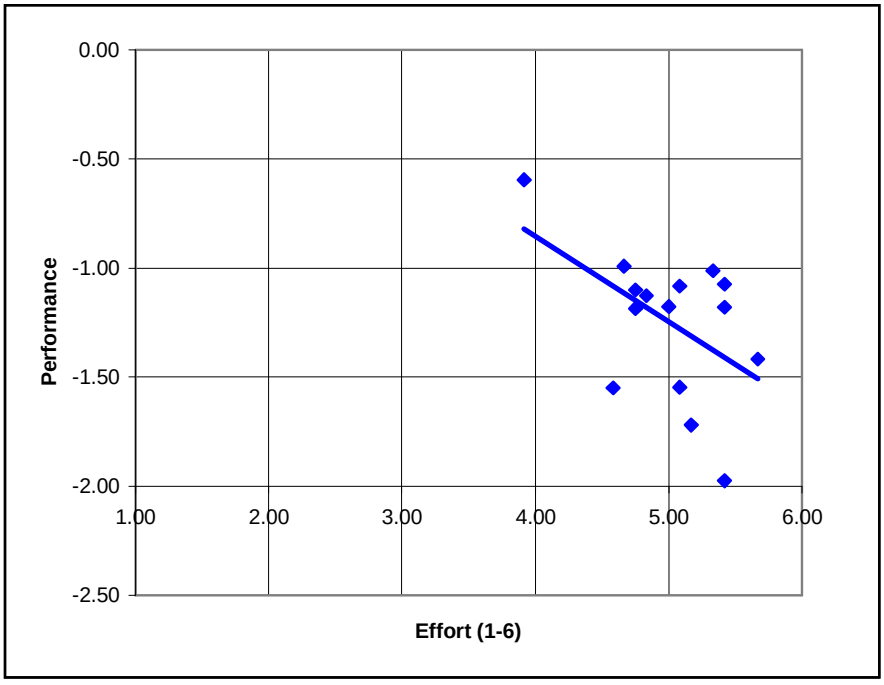


Figure 4.18 Performance of Team by Average Effort of Team Members (with best-fit line by linear regression)

Again the Pearson product-moment correlation was used to determine the relationship between effort and performance. For this relationship, r=-0.509 with a p value of 0.053. Hypothesis 4a was not supported by the data.

4.4.11. **Hypothesis 4b**

H_0: Effort will not significantly effect satisfaction.

H_1: Higher amounts of individual effort will result in higher team member satisfaction.

Hypothesis 4b proposes that higher amounts of effort will lead to higher levels of satisfaction. Both measures have been discussed in previous sections. The average effort and satisfaction for each team was used in the analysis. Figure 4.21, Figure 4.20 and Figure 4.21 show the relationship between effort and the three types of satisfaction.

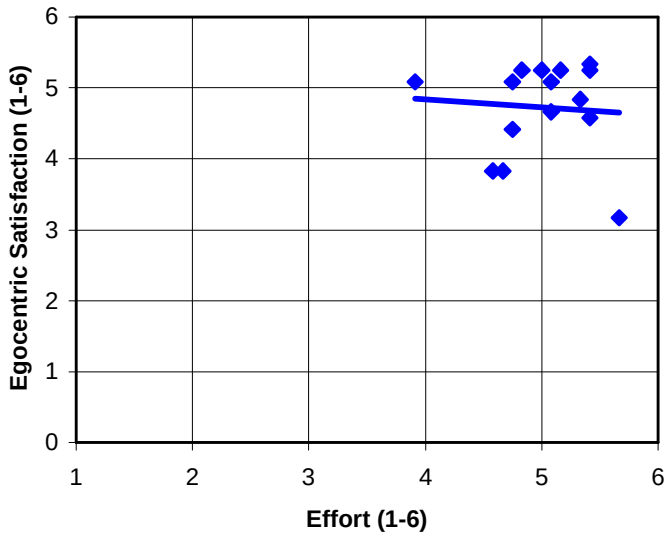


Figure 4.19 Egocentric Satisfaction by Effort Score

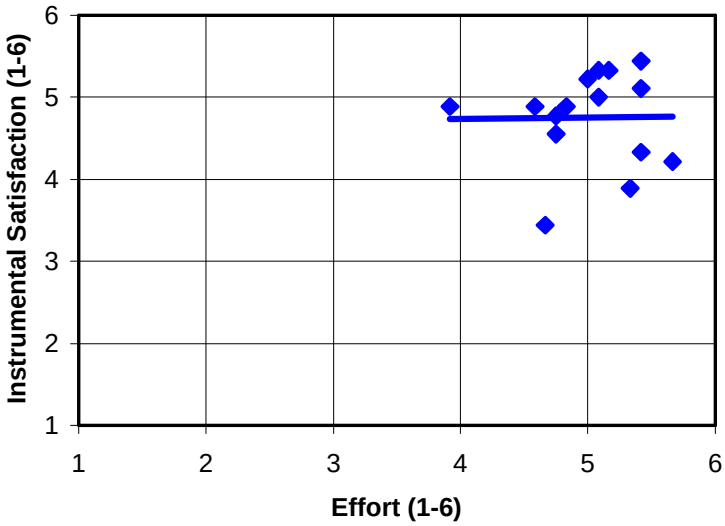


Figure 4.20 Instrumental Satisfaction by Effort Score

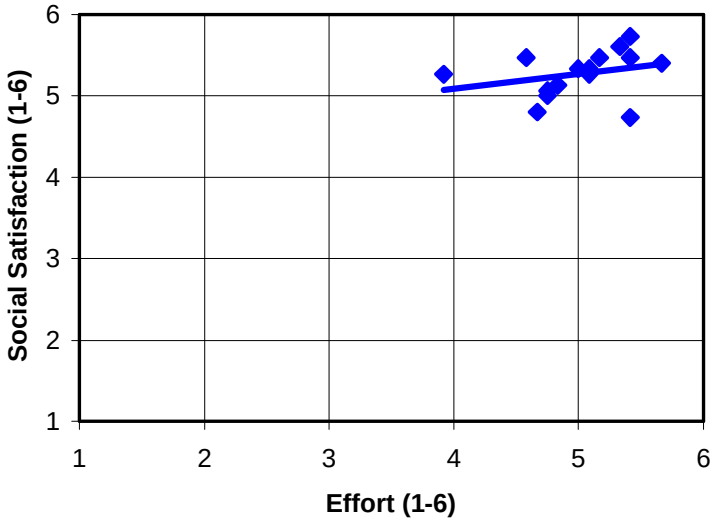


Figure 4.21 Social Satisfaction by Effort Score

Pearson product-moment correlations were calculated for effort and each type of satisfaction. Table 4.16 shows the results of these calculations.

Table 4.17 Pearson correlations for effort and three types of satisfaction

Satisfaction Measure	Pearson correlation (r)	p value
Egocentric	-0.073	0.795
Instrumental	0.289	0.296
Social	0.291	0.293

From the correlation for each type of satisfaction with effort it can be seen that hypothesis 4b was not supported.

4.4.12. **Hypothesis 4c**

H_0: Effort will significantly effect the team's ability to exist.

H_1: Higher amounts of individual effort will not effect the team's ability to exist.

Hypothesis 4c proposes that higher levels of effort will not significantly have an effect on the team's ability to exist. Both the effort and ability to exist variables were discussed in previous sections. This analysis was at the group level, with the average effort score for each group being used. Figure 4.22 shows the relationship between effort and ability to exist with a best-fit line by linear regression.

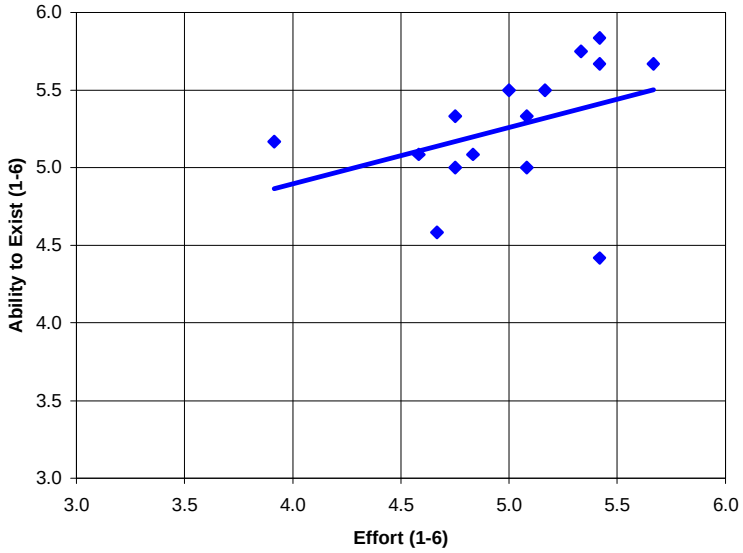


Figure 4.22 Team's Average Ability to Exist by Average Effort Score

Pearson's product-moment correlation indicates that the relationship between effort and ability to exist was not significant (r=0.388, p=0.153). Thus Hypothesis 4c was supported.

4.4.13. **Hypothesis 4d**

H_0: Cooperation will have a significant effect on team performance.

H_1: Higher amounts of cooperation will have no direct effect on team performance.

Hypothesis 4d proposes that cooperation will have no effect on a team's performance. Both the cooperation and performance variables are discussed in previous sections. Average scores for each group were used in this analysis. Figure 4.23 shows the relationship between cooperation and team performance.

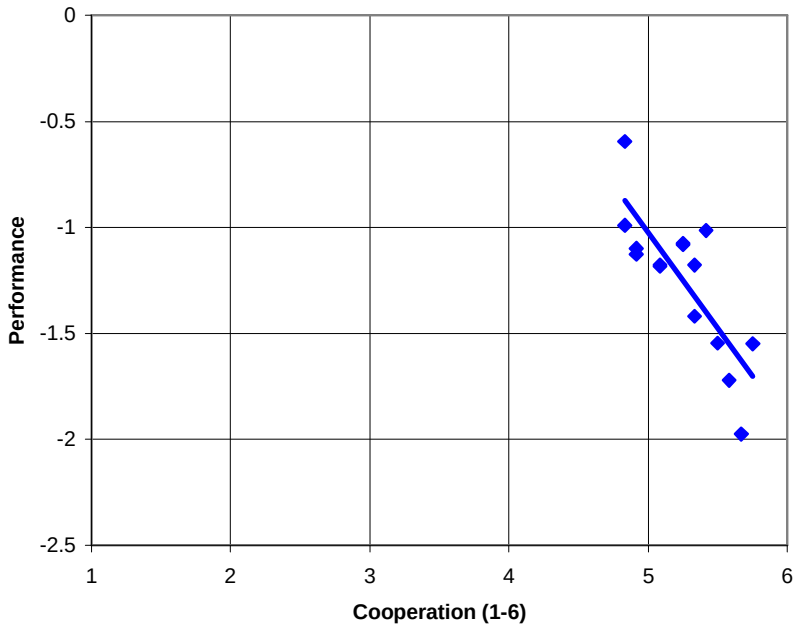


Figure 4.23 Team Performance vs. Cooperation

(with best-fit line by linear regression)

The Pearson product-moment correlation was calculated for the cooperation and performance variables to test this hypothesis. This test showed a significant negative relationship between cooperation and performance (r=-0.801, p=0.000). Teams with higher reported levels of cooperation had lower performance scores. Hypothesis 4d was not supported.

4.4.14. Hypothesis 4e

H_0: There will be no significant differences between treatments for the effect of cooperation on performance.

H_1: Higher levels of cooperation will result in higher team performance in the group-reward situation.

Hypothesis 4e proposes that group rewards will have more of an effect on the relationship between cooperation and performance. As was seen in Hypothesis 4d, however, this effect was

proposed to be positive. The relationship between cooperation and performance was negative, and is shown in Figure 4.24. This relationship is also shown in Figure 4.18, with scores broken down by reward treatment.

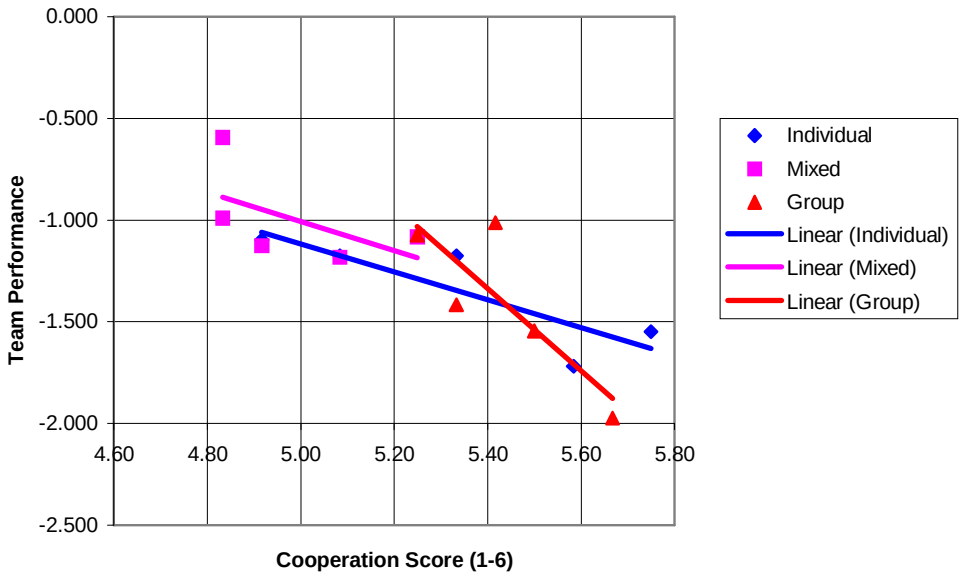


Figure 4.24 The Relationship Between Cooperation and Performance by Treatment.

As in previous hypotheses, three regression models were tested to determine which fits the data best. Average scores for each team were used in this analysis. The results of this test are shown in Table 4.17.

Table 4.18 Comparison of Three Models for the Relationship Between Cooperation and Performance by Reward Treatment.

Model	df1	df2	R Square Change	F Change	p value of change
1	1	13	0.642	23.349	0.000
2	2	11	0.002	0.033	0.967
3	2	9	0.097	1.684	0.239

As can be seen, the first model (a single regression line) provides the best fit for the data. This would indicate that there was no significant effect on the relationship between cooperation and performance due to reward treatment. Hypothesis 4e was not supported.

4.4.15. Hypothesis 4f

H_0: Cooperation will have no significant effect on team member's satisfaction.

H_1: Higher levels of cooperation will result in higher team member's satisfaction.

Hypothesis 4e proposes that cooperation and satisfaction will be positively correlated. The cooperation and satisfaction variables are discussed in previous sections. Average scores for each group were used in the analysis. Figure 4.27,Figure 4.26 andFigure 4.27show the relationship between cooperation and each type of satisfaction.

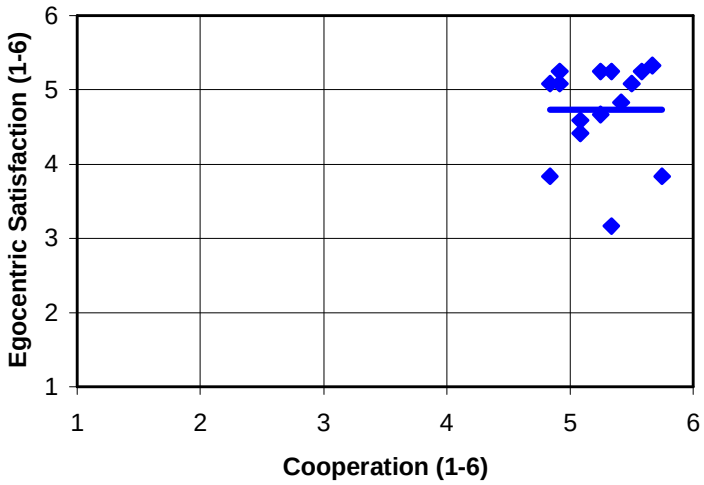


Figure 4.25 Egocentric Satisfaction by Average Cooperation Score (with best-fit lines by linear regression)

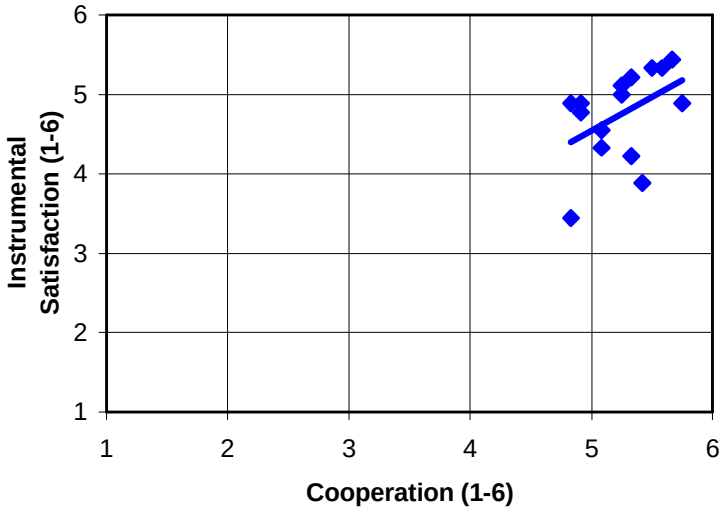


Figure 4.26 Instrumental Satisfaction by Average Cooperation Score (with best-fit lines by linear regression)

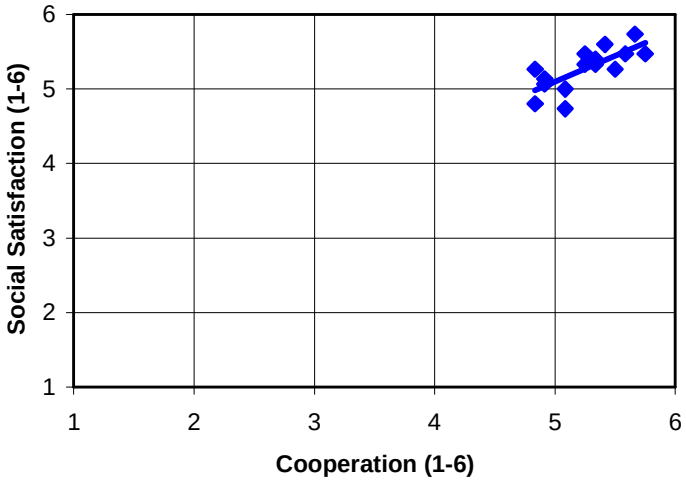


Figure 4.27 Social Satisfaction by Average Cooperation Score (with best-fit lines by linear regression)

Again the Pearson product-moment correlation was used to test this hypothesis. Table 4.19 shows the results of these calculations.

Table 4.19 Pearson correlations for cooperation and three types of satisfaction

Satisfaction Measure	Pearson correlation (r)	p value
Egocentric	0.003	0.993
Instrumental	0.614	0.015
Social	0.738	0.002

From this analysis it can be seen that both Instrumental and Social satisfaction were positively correlated with cooperation, but egocentric satisfaction was not. Hypothesis 4d was supported by this data for both the social and instrumental satisfaction measures.

4.4.16. **Hypothesis 4g**

H_0: Cooperation will have no significant effect on a team's ability to exist.

H_1: Higher levels of cooperation will result in higher levels of the team's ability to exist.

Hypothesis 4f proposes that a team's ability to exist will be positively correlated with the amount of cooperation. The cooperation and ability to exist variables are discussed in previous sections. Average scores for each group were used in the analysis. Figure 4.28 shows the relationship between cooperation and the team's ability to exist.

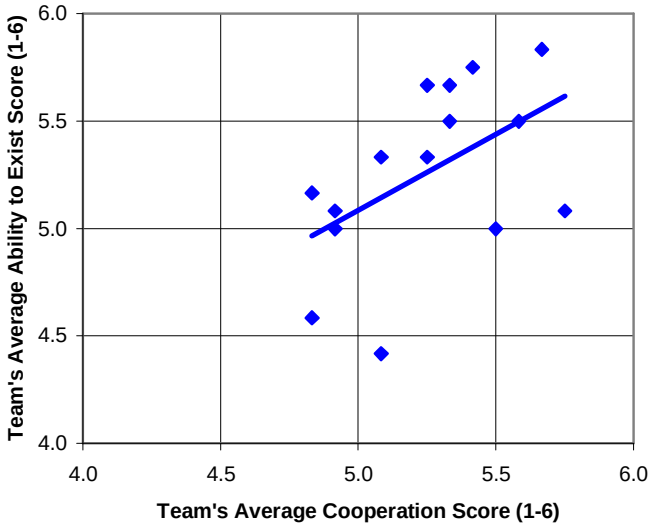


Figure 4.28 Average Team's Ability to Exist by Average Cooperation

This hypothesis was tested by calculating the Pearson product-moment correlation for cooperation and ability to exist. This test supports the hypothesis that higher levels of cooperation will result in higher levels of a team's ability to exist ($r=0.514$, $p=0.050$).

4.5. MANOVA Analysis

To determine the overall effect of reward treatment on the three team effectiveness variables (performance, satisfaction and ability to exist) a multivariate analysis of variance was conducted. The reward treatment is the independent variable with the five team effectiveness (three satisfaction measures) variables as the dependent measures. The MANOVA indicated that there are no significant differences between the reward treatments for the dependent variables (Wilks' Λ=0.448, p=0.638). Table 4.20 summarizes the MANOVA results for each of the dependent variables.

Table 4.20 Summary of MANOVA Results for Dependent Variables

Source	Dependent Variable	df	Mean Square	F test statistic	p-value.
Corrected Model	**Ability to Exist**	2	0.389	2.880	0.095
	Egocentric Satisfaction	2	0.028	0.057	0.945
	Instrumental Satisfaction	2	0.357	2.284	0.144
	Social Satisfaction	2	0.199	3.382	0.068
	Performance	2	0.244	2.599	0.115
Intercept	**Ability to Exist**	1	415.189	3071.264	0.000
	Egocentric Satisfaction	1	335.278	676.191	0.000
	Instrumental Satisfaction	1	391.852	2504.142	0.000
	Social Satisfaction	1	416.769	7068.322	0.000
	Performance	1	23.389	249.022	0.000
REWARD	**Ability to Exist**	2	0.389	2.880	0.095
	Egocentric Satisfaction	2	0.028	0.057	0.945
	Instrumental Satisfaction	2	0.357	2.284	0.144
	Social Satisfaction	2	0.199	3.382	0.068
	Performance	2	0.244	2.599	0.115
Error	**Ability to Exist**	12	0.135		
	Egocentric Satisfaction	12	0.496		
	Instrumental Satisfaction	12	0.156		
	Social Satisfaction	12	0.059		
	Performance	12	0.094		
Total	**Ability to Exist**	15			
	Egocentric Satisfaction	15			
	Instrumental Satisfaction	15			
	Social Satisfaction	15			
	Performance	15			
Corrected Total	**Ability to Exist**	14			
	Egocentric Satisfaction	14			
	Instrumental Satisfaction	14			
	Social Satisfaction	14			
	Performance	14			

4.6. Summary of Statistical Tests

Table 4.21 summarizes each hypothesis. In some hypothesis, more than one test statistic or p-value are relevant, but only one is reported for clarity. More detail is given in the proceeding sections for each hypothesis.

Table 4.21 Summary of Statistical Tests and Support for Hypotheses

Hypothesis	Test Statistic*	p value	Support for Hypothesis	Relationship Tested**
1a	$F_{(2,12)}$=4.748	0.030	Partially Supported	Cooperation significantly higher in GR vs. MR
1b	$F_{(2,12)}$=6.284	0.004	Not Supported	Effort significantly higher in GR vs. MR
2a	$F_{(2,12)}$=2.599	0.115	Not Supported	Performance NS between treatments
2b	$F_{(2,12)}$=3.382	0.068	Not Supported	Satisfaction NS between treatments
2c	$F_{(2,12)}$=2.880	0.095	Not Supported	Ability to exist NS between treatments
3a	r=0.144	0.347	Supported	Autonomy preference NC with effort
3b	r=-0.117	0.678	Not Supported	Autonomy preference NC with cooperation
3c	$F_{(2,40)}$=3.575	0.037	Not Supported	Valence-effort relationship highest in MR, lowest in GR.
3d	$F_{(2,12)}$=0.227	0.642	Not Supported	Valence-cooperation relationship NS between treatments
4a	r=-0.509	0.053	Not Supported	Effort -C with performance
4b	r=0.289	0.296	Not Supported	Effort NC with satisfaction
4c	r=0.388	0.153	Supported	Effort NC with ability to exist
4d	r=-0.801	0.000	Not Supported	Cooperation -C with performance
4e	$F_{(2,11)}$=0.033	0.967	Not Supported	Cooperation-performance score NS between treatments
4f	r=0.614, r=0.738	p=0.015, p=0.002	Supported	Cooperation +C with instrumental and social satisfaction
4g	r=0.514	p=0.050	Supported	Cooperation +C with ability to exist

* Representative values are shown, some tests used more than one F or r statistic, see section for each hypothesis for specifics
** GR=group reward treatment, MR=mixed reward treatment, IR=individual reward treatment, NS=not significant, NC=not correlated, -C=negatively correlated, +C=positively correlated

5. Discussion

The purpose of this section is to interpret the results of this study and offer an explanation for the findings. Section 5.1 gives a general appraisal of the results, and each hypothesis is discussed in detail in section 5.2. Some important findings from this study are presented in Section 5.3. Practical implications of the results for practitioners working with teams are discussed in Section 5.4. Limitations of this research are proposed in Section 5.5, and suggestions for future research in this area are proposed in Section 5.6.

5.1. Overview of Results

In general, the results of this study were disappointing in that only a few hypotheses were supported. The reward treatments had little effect on team effectiveness, and no one reward treatment seemed better overall than the others. While the lack of results may have depended on the limitations of this study (see section 5.5 Limitations of this research), it seems that the way rewards are distributed may not be as important as other factors. The way in which the group worked together, the relationships between group members, leadership within the group, and the task the group did are factors that could have influenced the cooperation and effectiveness of the team.

The results of this study do seem to support claims that financial rewards may not be the most important motivational tool for encouraging effectiveness in teams. The reward offered for participating in the experiment seemed important to the participants, but not in the traditional way rewards have been studied. The reward offered did seem to be very influential in getting people to participate in the experiment. Once the experiment was underway, however, participants seemed to focus more on the task and working with the team than worrying about how much of a reward they would get. The size of the reward the team received was seen as more feedback on their performance rather than the result of their performance. The first question most participants asked when the experiment was over was “how did we compare to other teams?” This behavior supports Deming and Kohn’s claims that it is important to pay people well, but pay in itself does not motivate increased performance.

That rewards may not be sufficient for promoting team effectiveness is also shown in comparing the results of this study to previous reward research. Previous studies have found a strong link between rewards and performance (Farr, 1976; London and Oldham, 1976 & 1977; Scott and Cherrington, 1974; Weinstein and Holzbach, 1972; Barr and Conlon, 1994; Miller and Hamblin, 1963; Wageman and Baker, 1997). This study attempted to further generalize these findings to a more complicated task. However, when challenged with a more complicated task, team members seemed to focus more on the task and less on the reward. In the more complicated tasks that real teams undertake, rewards may have even less of an influence.

5.2. Hypotheses Results

This section discusses the results of each hypothesis specifically. If the hypothesis was not supported by the data from this study, possible reasons are proposed.

5.2.1. Hypothesis 1a

> Individuals will exhibit more cooperation under the group reward structure (compared to other reward structures).

Hypothesis 1a was partially supported by the data. Participants in the group reward treatment had significantly higher cooperation scores than groups in the mixed reward treatment. There was, however, no significant difference in cooperation scores between teams in the group reward treatment and the individual reward treatment. This can easily be seen in the boxplot in Figure 4.4.

Previous research (Wageman & Baker, 1997) has found that the level of task interdependence has more of an effect on cooperation than the reward interdependence. Since only one type of task (highly interdependent) was used in this study, it is possible that the participants responded more to the task demands than they did to the reward incentives. Participants seemed to work together well and to cooperate with each other because the task required it, rather than because they were given an

incentive to do so. Wageman and Baker (1997) and Rosenbaum et al. (1980) found similar results, with no direct effect of reward structure on cooperative behaviors.

Although the group-rewarded participants cooperated more than the mixed-reward participants, this difference was small in magnitude. Also no other significant differences between reward treatments were found. While it is possible that a larger sample size would result in more significant differences between reward treatments, the small magnitude of the difference would indicate that the level of reward interdependence has little effect on the amount of cooperation team members utilize in solving this type of problem.

5.2.2. Hypothesis 1b

> Individuals will exhibit more individual effort under individual rewards (compared to other reward structures).

The levels of effort showed the same pattern as the levels of cooperation between reward treatments. There was a significant main effect for reward treatment on levels of effort, and only the group-reward treatment was significantly higher than the mixed reward treatment. However, the level of significance was higher for effort than for cooperation and the magnitude of the difference was also higher. Hypothesis 1b proposed that the individual reward treatment would result in the highest level of effort. This hypothesis was not supported.

Few other studies have attempted to measure effort directly. Scott and Cherrington (1974) and deCharms (1957) measured general arousal, but found no significant results. Terborg and Miller (1978) using three methods to measure effort, also did not find any significant results. Although their study did not manipulate reward interdependence, they were investigating the effects of rewards on groups. Wageman (1995) measured effort norms, and found that groups in the individual reward treatment had significantly higher norms promoting effort. None of the other studies of reward interdependence reviewed here used effort as a dependent variable.

It was thought that the individual reward would provide more of an incentive to exert more effort than the group reward. Group rewards often result in a diffusion of incentive, since any one person has

less of an impact on the overall group performance (Johnson & Johnson, 1989). However, it seems that in this case group rewards provided more of an incentive to increase effort than the other reward treatments. Since the groups were small (only three members) the diffusion of incentive may have had little effect.

5.2.3. Hypothesis 2a

> Group rewards will result in the highest team performance (compared to other reward structures).

The analysis of hypothesis 2a did not show any significant effect from reward treatment on the team's performance. Although the mixed reward treatment had a higher average performance than either the individual or group, this difference was not significant. The boxplot in Figure 4.8 does show that the mixed reward group was close to having significantly higher performance scores than either the individual or group reward treatments.

Although the effect was not significant, this difference is interesting since other research on team rewards has found that mixed rewards result in the lowest performance. Although not significant, these results point to a possible greater difference in light of other research findings. Miller and Hamblin (1963), Wageman (1995), and Wageman and Baker (1997) all found that mixed rewards resulted in lower performance than the group or individual reward situations. Each of these studies used a different type of interdependence (see Table 2.5). Only Wageman's (1995) field study used a complex task, but the type of interdependence in her study seems best characterized as pooled. It may be that in a complex, highly interdependent (reciprocal) situation, mixed rewards can produce an increase in performance. Some research supports this. Matsui et al., (1987) found that group and individual level feedback (linked to rewards) produced the highest level of performance. Farr (1976) suggested that results indicated that a combination of group and individual rewards would increase motivation, although he did not test this directly. None of the other research on reward interdependence reviewed here used a mixed reward treatment.

A possible factor in the lack of significant results is the complexity of the performance scores. Since the team performance scores were based on several factors, it is possible that these factors caused teams to tend toward an average level of performance. Some teams started with a very good system design, but then made poor choices in their allocation of installation hours and the amount set to charge the customer. Other teams may have had a relatively ineffective system design but increased their score by making better choices in the allocation of hours or in procuring the hardware components. Seldom did teams make good choices for all performance factors. This inconsistency in performance levels for each factor tended to drive the scores toward an average level of performance. If the participants had been given more instruction in how each factor affected their overall or individual performance, they might have made better choices as discussed in the overview in Section 5.1.

This uncertainty of how choices affect overall performance was more realistic for project teams than for other types of teams. Although project teams have specific goals and objectives, it is less likely that they have well-defined criteria for how the team is rewarded. For the most part, this is because there are many factors that affect the performance of project teams. Most other research on rewards done in the laboratory has found significant differences between reward treatments on performance. These findings were from tasks that were exclusively simple and straightforward. Since real project teams work on more complex tasks than typically studied in the laboratory, it would seem that rewards may have less of an impact on their performance than for work teams having more well defined and often less ambiguous tasks.

5.2.4. Hypothesis 2b

> Group rewards will result in the highest satisfaction (compared to other reward structures).

The reward treatment was not found to be a significant factor in determining the satisfaction of the teams. Three types of satisfaction were tested (instrumental, egocentric, and social). Instrumental satisfaction measures how satisfied the team members are with their performance on the task. Egocentric satisfaction measures how satisfied team members are with their reward. Social satisfaction

is a measure of how satisfied the team is with the other team members (the team itself). None of the three types were significantly affected by reward treatment. Social satisfaction showed the highest level of significance (p=0.068), although the magnitude of the difference was small.

This finding is supported by most other group reward research. Miller and Hamblin (1963), Rosenbaum et al., (1980), Scott and Cherrington (1974), Wageman (1995), and Wageman and Baker (1997) all found that group rewards resulted in higher levels of satisfaction. That egocentric satisfaction was not effected by reward treatment is not surprising since it seems that the amount of the reward almost exclusively accounted for different levels of egocentric satisfaction (r=0.733, p=0.002).

Instrumental satisfaction and social satisfaction were also highly correlated (r=0.678, p=0.005). The high correlation between instrumental and social satisfaction could indicate that participants did not differentiate between how satisfied they were with members of their team and how satisfied they were with how well the team went about solving the problem. A factor analysis (see Table H.6 in Appendix H) of the items for all three types of satisfaction showed that the items only loaded on two components. Instrumental and social satisfaction loaded on the same component. It is also possible that one type of satisfaction was caused by the other, although this could not be confirmed in this study.

These results would indicate, that in project teams, satisfaction is not greatly effected by the way rewards are distributed. It would seem possible that the level of instrumental satisfaction may be influenced by the team's performance, but this also was not the case (r=-0.454. p=0.089). In general, it seemed that teams that did not get along together as well (based on the researcher's observation) had lower levels of satisfaction, although this was not confirmed by any scientific testing. Satisfaction could also not be explained by how well group members knew each other, as familiarity and social satisfaction were also not highly correlated (r=0.124, p=0.660). Apparently the levels of both social and instrumental satisfaction were derived from how well the team members liked each other and not from any other external influences.

5.2.5. Hypothesis 2c

Group rewards will result in the highest level of team member's ability to exist (compared to other reward structures).

It was thought that since the task used in this experiment was highly interdependent, group rewards would result in a higher level of a group's ability to exist in the future. The data from this study did not support this hypothesis (p=0.095). As can be seen in the boxplot in Figure 4.13, the group reward treatment was close to being significantly higher in ability to exist. Only one outlying measurement prevented this hypothesis from being significant. This would indicate that further research into this hypothesis would be warranted.

None of the group reward research reviewed directly measured ability to exist, but Scott and Cherrington (1974) did measure interpersonal attractiveness, a similar construct. They found that cooperatively-rewarded groups (analogous to group rewards) had significantly higher levels of interpersonal attraction than individually- or competitively-rewarded groups.

That ability to exist was not significantly effected by the reward treatment is not surprising since ability to exist was highly correlated with social satisfaction (r=0.872, p=0.000), and social satisfaction was not significantly effected by reward treatment. This would indicate that socially satisfied groups were also more likely to desire to work together in the future. The method of distributing reward did not significantly impact how likely teams desired to work together in the future.

5.2.6. Hypothesis 3a

Individuals with a high autonomy preference will not exhibit different levels of effort compared to individuals with low autonomy preferences.

It would seem at first that individuals that preferred to work independently (high autonomy preference) would not exert as much effort when working in a group. Previous research (Wageman, 1995) has found this not to be the case, however. This hypothesis was also supported by the data in

this study. There was no significant relationship between an individual's autonomy preference and the amount of effort they exerted during the experiment (r=0.144, p=0.347).

A reason for this lack of a relationship may be that preference does not necessarily reflect ability. The autonomy preference variable measures just that, preference. Even though a participant may prefer not to work in a group, they apparently do not exert less effort when they are in a group.

5.2.7. Hypothesis 3b

> Individuals with a high autonomy preference will be less cooperative than individuals with low autonomy preferences.

Contrary to the relationship between autonomy preference and effort Wageman (1995) did find that the level of cooperation did depend on the autonomy preference of participants. A shortcoming of the cooperation measurement used in this study is that it did not measure directly how much an individual cooperated, but only measured the overall perceived cooperation in the group. Because of this, the average levels of cooperation and effort for a group were used in the analysis. From these, no significant relationship between autonomy preference and cooperation was found (r=-0.117, p=0.678).

It is possible that by using the average scores of each group, some of the effects of autonomy preference on cooperation were masked. It may be that the interdependent nature of the task used in this experiment caused participants to cooperate whether they preferred to work in groups or not. In Wageman's (1995) field study, participants had more opportunity to choose to cooperate or not. It was possible for the subjects of her study to complete their tasks individually. It would seem that the level of necessary interdependence is a factor in determining how much cooperation team members exhibit regardless of their autonomy preference. It may be that when cooperation is not strictly necessary, high autonomy preference individuals will choose not to cooperate in a group task. When cooperation is necessary for the completion of the task, individuals with high autonomy preference are apparently not any less likely to cooperate than individuals that prefer to work in groups.

5.2.8. Hypothesis 3c

> Individuals that perceive the reward as having a higher valence will exhibit higher levels of effort under individual rewards (compared to other reward structures).

The reward treatment significantly affected the relationship between valence and effort. The relationship between valence and effort was strongest in the mixed reward treatment and lowest in the group reward treatment. It was expected that under individual rewards the relationship between effort and valence would have been stronger than under group or mixed rewards. The statistical test showed that there was a significant difference between reward types for the strength of the relationship between valence and effort ($F_{(2,40)}$=3.575, p=0.037), although the expected reward treatment (individual) did not provide the strongest relationship.

It would appear that the mixed reward treatment provided the highest change in motivation for participants to exert effort, but overall the group reward led to the highest levels of effort regardless of valence. This is similar to earlier findings (Wageman, 1995, Wageman and Baker, 1997) that found the lowest levels of motivation in mixed reward treatment. It may be that for groups experiencing low levels of effort, a change to mixed rewards could increase effort if the valence of the reward was high. Overall, however, it would seem that group rewards lead to the highest levels of effort.

5.2.9. Hypothesis 3d

> Individuals that perceive the reward as having a higher valence will exhibit higher levels of cooperation in the group-reward situation (compared to other reward structures)

It was thought that valence would be more strongly related to cooperation in the group reward treatment than in other reward treatments. In other words, participants that valued the reward more highly would realize that cooperating as a group would lead to a higher group reward, and so increasing the size of their portion of the reward. If they valued the reward more, they would be more likely to not worry about their individual score and would concentrate on achieving the highest group score possible.

This was not the case, however. The comparison of regression lines showed that there was no significant relationship between valence and cooperation across reward treatments.

From observation of the teams' interaction, it appears that many participants were reluctant to sacrifice their individual scores for the good of the group. When they did, they often expected sacrifices from other members of the group as well, regardless of reward condition. It may be, that even when a person knows that lowering their individual score will improve overall group performance, they are unwilling to do this. Most other team reward research has used a task where increasing effort was the only way to increase the group's score. Few have used a task where doing worse individually could potentially improve the overall group score. It is not surprising then, that these findings supported the hypothesis that group rewards would increase cooperation in groups. In the work place, it is often necessary for a department or an individual to sub-optimize so that the larger system will be optimized (Deming, 1986). These results indicate that simply providing a group reward may not be enough to motivate individuals to avoid this sub-optimization.

It is also possible that the participants did not realize that sub-optimizing their function could potentially increase the team's performance. If this was the case, this points to a possible problem common with group rewards. Those affected by the group reward system must have a thorough understanding of how their reward is earned. Again, simply creating a group reward situation does not appear to be enough to motivate the behaviors desired in creating a group reward (i.e., cooperation).

5.2.10. Hypothesis 4a

Higher amounts of individual effort will result in higher team performance.

Hackman (1990) proposed that in most tasks increased effort brings about increased performance. It was thought that this relationship would apply to the task used in this experiment. The findings do not support this, however. There was actually a negative relationship between effort and cooperation ($r=-0.509$, $p=0.053$). Although not significant at the 0.05 level, the level of significance was high, which is noteworthy, since a positive relationship was expected.

Many tasks used in previous reward research are physical in nature such as sorting cards or building something. Others used mental tasks but ones that were repetitive, such as solving math problems or finding errors in a document. For these types of tasks, increased effort will generally lead to increased performance. The task used in this experiment was more complex and required numerous decisions. It is possible, that as the complexity of the task increases, performance is not influenced as much by effort as by ability or how the group interacts.

Another possible measure of effort could be the time the team spent working on the problem. This measure however, was also not highly correlated with performance ($r=0.066$, $p=0.816$). The problem with both of these measures is that they include the effort and time team members spent understanding the problem. Since it was complex, some teams took longer to understand what it was they had to do, and what parameters they were working with. In some cases a group might have spent a great amount of time and effort understanding the problem, but then not as much effort solving it. Other groups understood and starting working on the problem immediately, but spent more time and effort solving the problem. The specific time spent on each was not measured. Both types of teams would report a high level of effort and would have spent a large amount of time, but their level of performance might have differed.

5.2.11. Hypothesis 4b

Higher amounts of individual effort will result in higher team member satisfaction.

It was thought that team members that exerted higher levels of effort would have been more satisfied in general with their team and the way it performed. This hypothesis depended somewhat on the hypothesis that higher levels of effort would bring about higher performance. Since effort did not necessarily bring about higher performance, it is not surprising that effort also did not bring about higher levels of satisfaction ($r=0.291$, $p=0.293$ for social satisfaction; $r=0.289$, $p=0.296$ for instrumental satisfaction; $r=-0.073$, $p=0.795$ for egocentric satisfaction).

It is somewhat surprising that, despite the negative relationship between effort and performance, there was not a corresponding negative relationship between satisfaction and effort. It would appear

that teams were satisfied with their performance even when their high levels of effort did not result in high levels of performance. This may be largely due to lack of a reference point for performance and effort. Teams were told that ten dollars was the smallest reward and twenty dollars was the largest, but had no way of knowing how well they performed compared to other teams. This also points to a possible important factor in implementing a group reward system. If teams do not have a valid reference point to compare their performance and effort, they may be satisfied with the level at which they performed, regardless of whether their performance was good or poor.

5.2.12. Hypothesis 4c

Higher amounts of individual effort will not affect the team's ability to exist.

Unlike effort and satisfaction, it was not thought that the level of effort would have an effect on the team's ability to exist in the future. Although high levels of effort may cause a participant to think the team was hard working and capable, a participant may also not desire to work in a team that exerts a high level of effort. Although there was a slight positive correlation between effort and ability to exist ($r=0.388$), this correlation was not significant ($p=0.153$).

The effort measure did not differentiate between the level of effort in understanding the task and the effort exerted in solving the task, which could have masked the relationship between effort and ability to exist. Participants may desire to work with teams again that exerted effort in solving the problem, but may not desire to work with team members that exerted effort in understanding the problem.

5.2.13. Hypothesis 4d

Different levels of cooperation will have no direct effect on team performance.

Wageman and Baker (1997) found that cooperation in itself did not increase performance. Only when high levels of cooperation were coupled with group rewards, did an increase in performance occur (tested in hypothesis 4c in this study). Other research (Farr, 1976; Miller & Hamblin, 1963; Rosenbaum et al., 1980; Scott & Cherrington, 1974;Weinstein & Holzbach, 1972) did not measure cooperation, but

did attempt to manipulate it by changing the task parameters. Some of this research has found that groups in cooperative situations perform better (Miller & Hamblin, 1963; Rosenbaum et al., 1980) and some have found that groups in competitive situations perform best (Farr, 1976; Scott & Cherrington, 1974; Weinstein & Holzbach, 1972). As discussed in Chapter 2, this could be caused by the type of task interdependence. In this task, however, it would seem that cooperation (as measured in this study) in fact inhibited performance. There was a strong negative correlation between cooperation and performance ($r=-0.801$, $p=0.000$).

This negative correlation is surprising. The task was designed so that cooperation was necessary in solving the problem, and it was expected that higher levels of cooperation would facilitate higher performance. Cooperation, as measured here, may not be conducive to better performance. It may be that a certain type of cooperation is necessary for teams to perform well. For example, the installation function may ask the hardware department to use a system configuration that would reduce the number of installation hours. If the hardware department complies, he or she would be cooperating, but taking this action may or may not increase the team's performance. It seems possible that too much cooperation (in the form of making a trade-off) could harm the performance of a team. Research in this area of group-think, or diffusion of responsibility, has shown that groups can make poor choices when individuals ignore or suppress information in going along with the wishes of other members of the group.

It would appear the unique information each function was provided was not used as effectively in teams that felt they were highly cooperative. In general, it seemed that all the teams cooperated together to complete the task. Team members, in general seemed unwilling to strongly assert a particular strategy or performance consideration based on their individual knowledge as provided in the handouts. As such, the cooperation variable may not have measured productive cooperation toward the team's goal, but only how willing team members were to agree with the group's wishes. The measure of cooperation used here may be too broad, subject to different interpretation by the participants.

5.2.14. Hypothesis 4e

Higher levels of cooperation will result in higher team performance in the group-reward situation.

As stated in the previous hypothesis discussion, Wageman and Baker (1997) found that only a combination of high levels of cooperation and high levels of reward interdependence resulted in an increase in performance. In this study, no change in the relationship between cooperation and performance was found due to reward treatment ($F_{(2,11)}$=0.033, p=0.967). Additionally an overall negative relationship (r=-0.801) between cooperation and performance was found.

Again, it appears as though teams cooperated to complete the task regardless of how the reward was distributed. None of the interaction effects that Wageman and Baker found was apparent in this experiment. The different type of task used in this experiment could cause this lack of interaction. Wageman and Baker used a simpler editing task. The type of interdependence also varied, depending on how the participants worked together. As discussed previously, rewards could have less of an effect on groups involved in more complex tasks then in simpler tasks. Additionally, performance on mental tasks such as the one used in this experiment may not benefit as much from cooperation as more physical tasks commonly used in reward research.

5.2.15. Hypothesis 4f

Higher levels of cooperation will result in higher team member's satisfaction.

It was expected that cooperation and satisfaction would be highly correlated. This was the case for both instrumental satisfaction (r=0.614, p=0.015) and social satisfaction (r=0.738, p=0.002). Egocentric satisfaction was not correlated with cooperation (r=0.003, p=0.993).

It appears that teams that had high levels of cooperation were also more satisfied. It is impossible to tell in this experiment whether cooperation caused satisfaction or satisfaction with the team caused cooperation. It is likely that the two constructs are related in a reciprocal fashion; they build on one another. Possibly initial cooperation caused team members to be satisfied with the group, which

caused team members to be more willing to cooperate. This increase in cooperation may cause more feelings of satisfaction, leading to more cooperation. Another factor of this relationsip may be the aspect of cooperation measured in this study, as discussed in Section 5.2.14. It is possible that the construct of cooperation as measured in this study overlaps the constructs of instrumental and social satisfaction.

It is questionable, however, whether high levels of cooperation (as measured in this study) are desirable in groups of this nature. Given the negative correlation between cooperation and performance, lower levels of cooperation may produce higher levels of performance. From these findings, lower cooperation would also produce reduced satisfaction (instrumental and social), and reduced ability for the team to exist in the future. Hackman (1973b) mentions that, depending on the nature of the group, different team effectiveness measures (performance, satisfaction and ability to exist) have different levels of importance. He specifically mentions that, in project teams, performance is likely to be more important than either satisfaction or ability to exist. As such, it may be necessary to encourage performance over satisfaction in teams of this type. Since project teams are temporary and typically meet on an intermittent basis, a reduction in satisfaction or ability to exist may be less harmful to the team members over long periods of time than in other types of teams, such as work teams.

5.2.16. Hypothesis 4g

Higher levels of cooperation will result in higher levels of the team's ability to exist.

Since cooperation and ability to exist were expected to be positively correlated, it was also expected that cooperation would correlate with ability to exist in the same way cooperation correlates with satisfaction. A significant positive correlation between cooperation and ability to exist was found ($r=0.514$, $p=0.050$).

It is not clear, however, whether increased cooperation causes both higher levels of ability to exist and satisfaction or whether an increase in cooperation increases satisfaction, which in turn increases the team's ability to exist. In other words, both ability to exist and satisfaction may be caused by cooperation, or satisfaction may be a mediating variable between cooperation and ability to exist. When social satisfaction is controlled in a partial correlation, cooperation and ability to exist were not

highly correlated (r=-0.397, p=0.167). This indicates that cooperation is not highly correlated with ability to exist, but is correlated because cooperation is highly correlated with social satisfaction. However, cooperation and social satisfaction remained highly correlated when ability to exist is controlled (r=0.689, p=0.006). This would indicate that cooperation was highly correlated with satisfaction, but ability to exist was only highly correlated with cooperation because it was correlated with satisfaction. It would seem that high levels of cooperation are not necessary for a team to have a high ability to exist, but high social satisfaction may be necessary for a team to continue to exist.

This causation could be important in teams that are required to work together for long periods of time, or when team members are required to work together on a future project. Since lower levels of the type of cooperation measured in this study may be desirable, this reduction in cooperation will not automatically cause a decrease in a team's ability to exist. Lower levels of satisfaction may be unavoidable when cooperation is reduced, but ability to exist may be effected by other factors that can be controlled, such as team member selection or structure of team interactions.

5.3. Review of Findings

The findings from this research are very different from many of the findings of previous team reward research. Some of the most important findings, and possible factors for these findings are discussed here.

5.3.1. Task Complexity

Perhaps the most significant factor is the more complex task used in this experiment. Most other studies have used a very simplistic task (see Tables 2.4 and 2.5 for examples). Although few significant relationships were found in this research, these findings may be more representative of the effects of different reward structures on these types of teams. The reward structure may not have as much of an effect on real teams as is implied by the research findings of other studies.

The more complex task allowed teams to have more choices and created more uncertainty in the outcomes of these choices. In the more simplistic tasks commonly used, it was clear to participants how they could go about increasing their reward. Particularly in an experimental situation, where there are few other motivating factors, participants have little reason not to perform better to increase their reward. The task used in this experiment forced participants to consider other factors besides just increasing their output to get a higher reward.

Since the complexity of the task used in this experiment was constrained by the experimental setting and the length of time participants were able to participate, it was necessarily less complex than a task that a real project team would perform. The only known study comparing team and individual rewards that did use a more complex task is Wageman's (1997). Wageman did find significant effects of reward type on performance scores, although it is questionable whether the groups used in her study worked together as a team as much as a project team normally would. It seems that as task complexity increases, team members tend to focus more on the task and less on the way the reward is distributed. Comparing the results of this study to previous findings indicate that, in the more complex tasks that project teams perform, the way rewards are distributed may be less important than the how the task and teams are structured.

5.3.2. The Effects of Cooperation and Effort on Performance

Two unexpected and unusual findings are the negative relationships between cooperation and performance, and effort and performance. While these findings differ from the findings of previous research, they may be indicative of the changing roles and tasks that teams undertake.

Cooperation is generally cited as a reason for the use of team-based reward systems. It was thought that by rewarding teams as a group, they would be less likely to compete with each other and to cooperate to complete their task. While the findings of the research do not refute this assumption, they do show that cooperation alone does not lead to greater team performance in all cases. When working on a complex task, teams must not only cooperate, but must also effectively use the resources of the team. The task used in this research required that the team members use their individual knowledge

effectively. By being cooperative, they may have ignored their individual strengths, and become victims of group-think.

It is usually accepted that higher levels of effort will lead to better performance. Hackman (1973a) generalizes that in virtually all tasks, increased effort will lead to better performance. He does allow that there are some exceptions to this. When he wrote this, team research focused more on work teams and less on knowledge teams such as project teams. With the increase in the number of knowledge workers and the corresponding increase in teams engaged in knowledge type tasks, it may be that effort plays a different role in the success of today's teams.

5.3.3. Performance and Satisfaction

Another important finding in this research is of the possibility that performance and satisfaction could be negatively related. At the team level, instrumental satisfaction was negatively correlated with team performance ($r=-0.502$, $p=0.056$). Although not significant at the 0.05 level, there is evidence that the group rewarded teams had lower levels of performance ($p=0.115$) but the highest levels of social satisfaction ($p=0.068$), and mixed-rewarded teams had the highest level of performance and the lowest levels of social satisfaction. It could be that either performance or satisfaction would need to be emphasized depending on which is more important to the team. Further research will be necessary to test this hypothesis.

5.3.4. The effects of reward treatment on valence and effort

This research also found that mixed rewards provided the greatest change in motivation to exert effort with respect to valence. Although in this task effort was negatively correlated with performance, other tasks where effort could provide an increase in performance could benefit from using mixed rewards.

5.4. Practical Implications

The findings of this research may have important implications for practitioners working with project teams. Although much previous research has found a positive link between group rewards and performance on some types of tasks, the more realistic task used in this study indicates that this link may not be universal. It seems that for the mental, complex tasks that project teams typically undertake, group rewards may not have the effect found in previous research.

Unlike the teams in this study, real project teams often have difficulties cooperating effectively. The teams in this study, being students in a laboratory setting, seemed very willing to cooperate due to task demands. Real project teams, usually composed of members from different departments, may need to compete for resources and rewards with other departments. This competition may create a less cooperative group than the ones used in this study. In that case, group rewards may be necessary to increase cooperation to a level where the team is able to accomplish its task. In cases where the team is highly cooperative, possibly due to a lack of competition between departments, individual rewards may be necessary to reduce the type of cooperation measured in this study.

Alternatively, it may be that the method of communicating the reward, the manner in which it was linked to performance measures, and the understanding of the team as to what performance factors lead to overall success are more important than the way in which the reward was distributed. Any of these factors could have contributed to the lack of a relationship between cooperation and performance. Further study will be necessary to determine the effect of these factors on reward structure and performance.

Another important finding for practitioners, is the lack of a strong relationship between reward structure and many of the constructs thought to be important to performance, as well as performance itself. Since project teams typically have a long time between the start of a project and the measurement of actual results, and because project teams work with that team only once, a change in reward structure may not produce measurable changes in performance or team effectiveness. When reward structures are changed, such as the introduction of team-based rewards, managers typically expect rapid results.

This study indicates that a change in reward structure may not be sufficient to realize an increase in team effectiveness for project teams over the course of one project, which in a real setting may take place over many months. Although very few significant differences between reward structures were found, it is possible that further iterations of the task would have produced more significant results. Unfortunately this is not always possible in project teams. The relatively long duration of projects, and the changing members of a project team may cause any changes due to reward structure to not appear for a long period of time. Few managers are willing to wait years before a possibly expensive intervention shows results.

5.5. Limitations of this Research

While all research seeks a better understanding of the truth, there also always exists factors that limit the ability of the research to do so. A number of characteristics of this research limit the generalizability and validity of these findings. This section discusses these limitations and how they may have impacted the findings.

This study found little difference in the effectiveness of teams under different types of reward systems. There are some possible reasons for this. Factors present in this study may have limited the sensitivity of the measures so that differences between the groups, if present, were not revealed. More generally it may be that experiments of this type are not effective in studying the phenomenon of group rewards in work groups. Another possibility is that the participants used in this experiment were not representative of a real project team. It is also possible that there are, as found in this study, no significant differences between the reward treatments used. This last possibility has been discussed in Section 5.3 of this Chapter. The other limitations of this research are discussed here.

5.5.1. Experimental Factors

There were a number of factors unique to this study that may limit the generalizability of these findings. These limitations could be overcome in subsequent research, and should be taken into consideration along with the specific recommendations presented in the next section.

The first factor was the small sample sizes and limited pool of participants for this study. Since only five teams were used in each treatment, this small number may not have been enough to achieve significant results on some of the statistical tests. Small sample sizes are common in team reward research because of the resources necessary. In general, reward research requires more funding than other types of participant-based experimental research, since a large enough reward must be offered to participants to achieve the desired effect. Using teams increases this effect, since more than one participant was required for each team. While this does not invalidate or limit the generalizability of the findings, it may have prevented some real relationships between the variables from being statistically significant.

Another factor is that the task used in the experiment may not be entirely representative of a real project team task. The task used in this experiment did attempt to create more realism than most tasks used in laboratory team reward research. However, to make the study feasible with the resources available, the task was necessarily made more simplistic and of a shorter duration than a real project team task. It is likely that the group dynamics would change over time as the team worked together. Whether this change would intensify or moderate the findings of this research is impossible to say

Two important measures used in this study proved to be less than ideal, and could indicate a problem with the experimental design. The constructs of reward and task interdependence were both measured by three items on the post-experiment questionnaire. These measures were intended to confirm that the experimental conditions created different levels of reward interdependence, but not different levels of task interdependence. Both scales proved unreliable, however (reward interdependence α=0.49, task interdependence α=0.46). Removing any one item also did not result in an acceptable alpha (at best α=0.48). A one-way ANOVA was conducted using only one item from each scale to determine if any significant differences between reward treatments existed. No one item

showed a significant difference between reward treatments (highest p=0.29). These scales, both from previous research, were not effective in measuring reward and task interdependence.

Although not an internally consistent measure, the means for both task and reward interdependence were high (5.24 and 4.64 respectively). There were no significant differences between reward treatments for either measure (p=0.52 for task and p=0.28 for reward interdependence). There was also no significant difference between treatments for any single item from these measures. Although no significant difference in task interdependence was expected between treatments, the reward interdependence was expected to be highest in the group reward treatment.

It is possible that not enough was done to emphasize the method of earning the reward to participants. While many of the groups acted in a manner that would be expected under the different reward types, others did not seem to pay much attention to how their reward would be calculated. For example, some teams in the individual reward treatments bargained with each other over who had to give up the most, and some group-rewarded teams did not worry about their individual scores, but concentrated on achieving a high group score. Many teams, however, seemed to concentrate on the problem and not on how they should solve it to earn the maximum reward. This may be an inherent problem with extrinsic monetary rewards (see Section 5.3). Some people may not be as influenced by them as they are by intrinsic rewards or group norms.

The reward given might also have been seen by the participants as one based on completion more than performance (Cameron & Pierce, 1997). Since the participants were guaranteed some level of reward, no matter what their performance, their reward may not have been linked closely enough to their level of performance to illicit the desired effects. A larger difference between minimum and maximum reward amounts may have created a larger effect. Unfortunately, organizations typically only allocate one percent of their payroll to rewards (Cacioppe, 1999). The differentiation in rewards sizes given in this experiment would seem to be much greater than is typically used in the typical organization, and may be reflective of the expected performance results when applied to real-world settings.

Another possible effect of the experimental procedure was that teams were given little guidance as to what the best choices were. This was done purposefully, since in project teams, there is often no

concrete right or wrong answer. In this experiment, teams had to decide such things as whether to use more over time hours, which harms customer satisfaction, or to use reserved hours, which harm individual performance. They may even decide that neither was desired and a different system design was necessary. In most other studies on rewards, there was a clearly defined way to earn a larger reward: sort more cards, solve more math problems, or find more errors, for example. It is possible that the results found in this study are more valid for how these types of teams actually work. In a work team, where the team may be rewarded for producing more products, there is a clearly defined path to earning the reward. In such a case, previous team reward research would indicate that group rewards can be effective for an interdependent task and individual rewards are usually superior in an independent task. In a project team, where the output is less concrete and many factors influence the success of team output, a reward based on the team's performance may not yield the same results.

The timing of when the post-experiment questionnaire was given may also have affected some measures. Since the questionnaire was administered after the teams knew of their performance score and received their reward, they may have retroactively altered their perceptions of some of the constructs. For example, a team might have performed poorly and so may have responded with lower scores on the effort questionnaire items.

Another factor that could have impacted the results was the possibility of a Hawthorne effect during the experiment. A Hawthorne effect occurs when a change in behavior of the participants is caused by the presence or observation of the experimenter, rather than by the experimental conditions (Martin, 1996). The experimenter was present during the experiment for all groups. Although the level of presence and interaction between the experimenter and participants was the same for all treatments, this presence could have suppressed or encouraged certain behaviors. For example, all teams might have tried harder to cooperate because of the experimenter' s presence. This effect could have been more pronounced in one treatment than others, i.e., an interaction effect could have been present.

The final element of this experimental design that may have caused the results to differ from previous research was that the teams only performed the task once. Most other reward research used multiple trials to determine the effect of rewards on the performance of the team. In this experiment,

teams were given little opportunity to learn what decisions would best increase their reward. In project teams, each new task is for the most part unique and often the team members will work with a new team each time. In real project teams there is little opportunity for the teams to learn to perform best through iterations of feedback and rewards. It was desirable to see if a promised reward would be effective in bringing about improved performance without allowing participants multiple attempts to earn the reward.

5.5.2. Research Method Factors

A first possible research method factor is the inherent complexity of teams and how they interact. Numerous variables impact how effective a team is, and in any given situation different variables may have more or less effect. In this study no attempt was made to control for, or to alter the leadership, goal setting, or the ability of the participants. Any of these may have significantly affected the outcomes.

Perhaps the greatest limitation to this research, is that it was done in a laboratory setting. There is much debate whether laboratory research is at all representative of real life situations. The situation set up in this experiment was not unlike situations that the student participants are involved with on a daily basis. So, it is likely that the students did not react differently in this situation than they do normally. This does not necessarily mean that the experimental setting is representative of a real project team setting, however.

In a real setting, teams would have much more interaction with outside entities, including the customer and other teams. Some of the parameters set up in the experiment would not be as concrete in a real situation. Teams would have more leeway in the manner in which they solved the problem and in how the solution was implemented.

An argument has been made that work team research needs to expand out of the laboratory setting (Ancona, 1992; Hackman, 1997; McGrath, 1986; Wageman, 1997). The basis for these arguments is that the complex nature of teams and their interaction with the rest of the organization cannot be successfully recreated in a laboratory setting. It is difficult to assemble groups that can be considered real teams (see section 5.5.3 for a discussion of this) in a laboratory. It is more difficult to

create a realistic working environment for these teams. Given this, it would greatly increase the validity, or possibly negate the findings, of this experiment if it were done using real teams in an organization.

5.5.3. Team Factors

A factor that is shared with much of academic research, was the use of college students as subjects in this study. Ideally real teams in an actual business environment would provide the greatest level of external validity for these results. This experiment used students as subjects, which may not be entirely representative of the real project teams at which the research was aimed. While university students are increasingly asked to work in teams, and so have some team experience, these teams may not work together in the same manner as real project teams. However, these students will likely be on project teams soon after entering the work force. The question is whether these students will have changed significantly before they are on an actual project team from when they participated in an experiment. It is also unlikely that any project team would consist of members that were all recent college graduates. The underlying factor that may determine whether these students were representative is the demographics of a real team. A real team would more likely consist of both new and experienced employees, whereas the teams used in this experiment better represent new employees.

It is impossible to determine how the use of students could have impacted the findings. Only a study that used both university students and real project teams could determine if differences between these two groups exist. One possible effect proposed in earlier discussion is that the teams in this study cooperated more than real work teams might. The valence of the reward might also be different in real work teams, as could the effect of other influences such as working relationships and differences in position or seniority of team members. The intrinsic factors that may have altered the effects of the monetary reward would likely be different in real teams than in the teams used in this experiment. Even though the reward offered in the experiment had a high valence for the students, there are obviously differences between earning some extra money in an experiment and how your performance may influence your career and income. University students also may be more accustomed to group rewards

than teams working in an organization. Students often work on teams where there is a group reward (a grade).

One way to characterize the teams used in this study is by their group development. One of the most popular models of group development is Tuckman's (1965) four-phase model. This model describes the development of a group in terms of group norms, roles, and status. The first phase, forming, is the initial period in which members become acquainted with one another and start to establish a basis for membership in the group. The second phase, storming, is when group members try to establish influence and status within the group. In the third phase, norming, group members establish norms related to tasks and relationships in an effort to resolve conflicts from the previous stage. Performing is the fourth stage and occurs when group members come to understand their roles, norms and group goals. While each of these stages is not distinct, and groups frequently regress to previous phases, an overall assessment of how far a group has progressed in the hierarchy can be made. For the most part the teams in this study remained in the forming stage. A few groups seemed to move rapidly into the storming and possibly the norming phase. Since some of the teams were made up of members that all knew one another, these teams spent less time in the forming phase. Although no technical analysis of the group development of the teams was made, from the researcher' s observations, most of the groups had not reached the upper stages of team development by the end of the study. Cacioppe (1999) suggests, however, that project teams universally move through all of these stages as the deadline for project completion approaches. This reinforces previous discussion that the results of this study may best characterize newly formed groups.

Hackman and Oldham's (1980) definition of a team was used in this study. While the study was designed so that the teams and the experimental situation would support this definition, there are some areas where the teams used might not strictly meet the definition of teams. There are three main parts to Hackman and Oldham's definition of a team. First the group is an identifiable social system. Second the group has a defined piece of work. Finally the group has authority to manage it own internal processes. Overall the teams used in this experiment were fairly representative of a team as defined by Hackman and Oldham.

Three characteristics of an identifiable social system are included in this definition: members have interdependent relations with one another, differentiated roles develop over time, and the team is perceived as a group by both members and non-members. The team members did have interdependent relations with one another. The groups worked together to solve the problem given them and depended on each other to for information to solve their individual portions. The perceived level of cooperation was high (5.25 on a six point scale) indicating that the teams felt they worked together to solve the problem. While differentiated roles were created in the experiment by assigning team members to functional roles, a key part of the definition is that the roles develop over time. It is unlikely that over the course of a two hour experiment that the teams could have developed significant role differentiation. In many cases the teams allocated resources for each function as a group rather than sharing information about their function with other group members and allocating resources individually. This would indicate that the functional roles where not highly differentiated. High scores on the ability to exist, cooperation and satisfaction scales indicate that the teams worked together, were satisfied with the team and desired to work together again in the future. Team members also seemed to view the problem in terms of the group rather than only focusing on their part of the problem. Although no direct quantitative evaluation of the team member's perception of being a group was made, the teams did seem to view themselves as a group.

The group did have a defined piece of work that resulted in an identifiable decision. The teams filled out a final answer sheet indicating how they desired to allocate the available resources. All of the teams seemed to understand the task given to them and focused their efforts on completing this task.

The final part of Hackman and Oldham's definition is that the teams manage their own internal processes. In this study, teams were allowed to solve the problem the way they felt was best. Although there were constraints on the types of decisions the teams were able to make they could manage the process of completing their task in any way. For example, the teams could only allocate the available components and workers, they could not choose to out-source a part of the project or hire additional workers. The teams were able to use any method of reaching a decision. Some teams bartered over resources, some looked for consensus, and in a few an emergent leader finalized decisions. Teams

also differed in how they solved the individual portions of the problem. Some teams worked as a group on each part, in others each individual focused on their function and shared information as needed.

All of these factors limit the generalizability of these findings. They do not necessarily invalidate them, however. By piecing together findings over multiple studies, a more complete understanding of the relationship between the variables studied here can be determined. It is hoped that the findings in this study can add to the greater knowledge that is pursued in academic research.

5.6. Future Research

From this study, it is clear that further research into the area of team-based rewards is necessary. This research is apparently the first experiment to use a project-type task in investigating the effect of reward structure on teams. Results from this study would indicate that these types of tasks are very different from those used in previous reward research, which more accurately represent tasks done by work teams. Since the importance of project teams has become apparent, and the use of project teams is increasing, it is necessary to specifically investigate these types of teams in order to find the best method of rewarding their performance.

Areas that could be explored in future studies are: ability of participants, goal setting and acceptance, method of specifying how the reward will be distributed, different methods of measuring cooperation and effort, and different levels of task interdependence. Additionally, different types of participants should be recruited to determine their effect on these results. Previously established or existing teams could be used to determine if newly-created teams significantly differ from those that have experience working together. Different types of effort could be included such as frequency, or duration in addition to the intensity of effort studied here. Some researchers (Kanfer, 1990 for example) have advocated that the typical intensity of effort measurement is not necessarily indicative of the types of effort required in business settings. She argues that duration of effort is often more important when multiple tasks compete for the time of the worker. Improved measures of cooperation and interdependence would also be important for future research in this area.

Some of the results from this study, while not significant at the α=0.05 level, did have a high level of significance considering the small sample size. It seems possible that group rewards increase both social satisfaction and ability to exist. Further study of these two variables under similar conditions would seem warranted. The average performance of the teams in the mixed reward condition, though not significant, was higher than either of the other two reward treatments. When compared to other studies of team performance under different reward conditions, this difference may be more important. Most other studies in this area have found that mixed rewards lead to lower performance. That effort and cooperation had a negative effect on performance also seems unusual. Other studies of these variables under different conditions would be valuable to determine whether these effects are typical to project teams or unique to this study.

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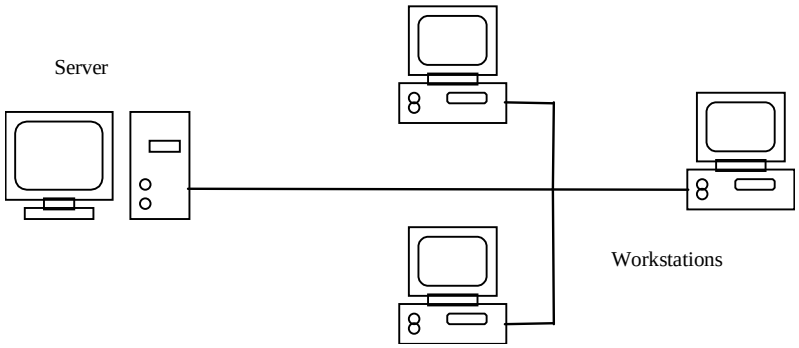
Appendix A -- Information Sheets

A.1. General Instructions

You work for Technology Systems Integration Inc. (TSI). Your company specializes in the installation of computer systems. All of your systems consist of servers with attached workstations. All workstations must be attached to a server, and more than one server/workstation set is usually necessary to provide enough workstations. The servers will also be connected, but this is routine and does not affect your design. A diagram of a server/workstation set using three workstations is shown below:



Each server and workstation has a performance rating. The customer requirements for workstations are expressed as the number of workstations needed at a given performance. For example the customer may require five workstations each with a performance rating of 90. You may use a server/workstation set with three workstations that achieves a performance rating of 90 and two other workstations attached to a different server with a combined performance of 94 to meet the requirements.

Additionally your company installs the hardware at the customer's site. TSI's installation department handles all installation.

TSI has just been awarded an important project from a major grocery distribution chain. Your team's assignment is to design a computer system from the components your company uses. The team's design will be recorded on the design parameters form that the marketing department head has.

A marketing representative has assessed the project requirements and has submitted a bid for the project. This bid is what the customer has agreed to pay for the system, but can be increased if necessary. The cost of the system and the amount charged will determine the profit TSI makes on the job. The customer's system requirements are provided on the next page.

Each of you will have an area that you are responsible for, but it is up to the team to make final decisions. You will have to share the specialized information you have so that the team can best design the system.

Your team's first step will be to come up with a preliminary hardware design. The hardware department has the specialized knowledge needed to calculate what server/workstation combinations will be able to meet the design specifications. From this, the installation department can calculate the expected installation hours needed to install the system and the finance department can calculate the costs to make sure the design is profitable. The hardware department's first design may not be the best possible when cost and time are taken into account. Your team should be prepared to reiterate the procedure in order to create the best possible design.

The customer's satisfaction with the system is determined by how well the system performs, how quickly it is installed, and the final cost of the system. The marketing department has informed you that the customer is most interested in the system's performance, and places the least amount of emphasis on the cost. Your individual functions each have unique performance measures that are explained later.

Customer Requirements

TSI's bid for this project is $245,000.

The customer wants the system installed 15 days from now. The system must be completed by the end of day 15 or it will be late.

The customer requires 19 workstations of varying performance levels as shown in the table below. Each workstation must meet or exceed the performance requirement or customer satisfaction will decrease.

Workstations Needed	Actual Performance Needed
4	90
5	85
10	70

A.2. Design Parameters

Use this sheet to record the final design decisions of your team.

Amount Charged:_____

Hardware Components: For each server you use, put the name of the server in the server column, the type of workstations connected to it, and the number of workstations connected to it (not more than five). Each line should only have one server.

Server	Workstation Type	# of workstations

Number and type of components ordered or reserved components used:

Components Ordered	Reserved Components Used

Installation: For each day put the number of each type of installation hours used.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

A.3. Finance Function

You are the head of the finance department at TSI Inc. As department head it is your responsibility to balance the costs and revenue of the project to ensure profitability for the company. Each component and hour of labor used in the system cost TSI money. A bid has already been made on the project, but can be increased, although customer satisfaction may suffer. TSI expects to make a profit of 20% on every job.

Your department's performance is based on the profit the company earns on the project. If you don't make at least 20% profit on the project, your department's performance will suffer. Your job is to try to keep costs down by not allowing the other department heads to make decisions that will result in exorbitant costs, and to determine the final amount charged to the customer.

You can charge the customer whatever you think is necessary except:

- You must charge at least as much as the system costs TSI
- The customer's contract prohibits the cost from exceeding 300,000.

One way the other department heads sometimes meet the requirements for a project is to pull people off other TSI projects. While doing this meets the requirements of this project, it places other projects at risk of not being finished on time, driving up costs and forcing you to offer discounts to customers. When department heads pull people off other projects your department's performance suffers since other projects will make a lower profit.

The following tables show the costs for each component and the wages for employees. Every component used, whether in stock, reserved, or ordered must be included when calculating costs.

Servers	**Cost**
S100	20000
S80	15000
Workstations	
W100	5000
W80	1000

Wages and Benefits	**Regular ($/Hour)**	**Overtime ($/Hour)**
Installer	100	150

This table shows every combination of servers and workstations that TSI uses. The cost of each set is shown in the cost column.

Server	Workstation	Number of workstations	Cost
S100	W100	1	25000
S100	W100	2	30000
S100	W100	3	35000
S100	W100	4	40000
S100	W100	5	45000
S100	W80	1	21000
S100	W80	2	22000
S100	W80	3	23000
S100	W80	4	24000
S100	W80	5	25000
S80	W100	1	20000
S80	W100	2	25000
S80	W100	3	30000
S80	W100	4	35000
S80	W100	5	40000
S80	W80	1	16000
S80	W80	2	17000
S80	W80	3	18000
S80	W80	4	19000
S80	W80	5	20000

When your team is making decisions about which hardware to use, you need to calculate the costs to make sure the design will be profitable. Use the tables provided to help in calculating the costs of each proposed design. Remember your department's performance is judged by the profit TSI makes on the project. You want the total cost to be less than the amount bid divided by 1.2 or you can raise the amount charged so that it is 1.2 times the cost.

Component	Cost	X Number of Units	= Total Component Cost
S100 Server S80 Server	20000 15000		
W100 Workstation W80 Workstation	5000 1000		
Regular Installer Hours Overtime Installer Hours	100 150		
		Total =	

Component	Cost	X Number of Units	= Total Component Cost
S100 Server S80 Server	20000 15000		
W100 Workstation W80 Workstation	5000 1000		
Regular Installer Hours Overtime Installer Hours	100 150		
		Total =	

Component	Cost	X Number of Units	= Total Component Cost
S100 Server S80 Server	20000 15000		
W100 Workstation W80 Workstation	5000 1000		
Regular Installer Hours Overtime Installer Hours	100 150		
		Total =	

Component	Cost	X Number of Units	= Total Component Cost
S100 Server S80 Server	20000 15000		
W100 Workstation W80 Workstation	5000 1000		
Regular Installer Hours Overtime Installer Hours	100 150		
		Total =	

Component	Cost	X Number of Units	= Total Component Cost
S100 Server S80 Server	20000 15000		
W100 Workstation W80 Workstation	5000 1000		
Regular Installer Hours Overtime Installer Hours	100 150		
		Total =	

Component	Cost	X Number of Units	= Total Component Cost
S100 Server S80 Server	20000 15000		
W100 Workstation W80 Workstation	5000 1000		
Regular Installer Hours Overtime Installer Hours	100 150		
		Total =	

A.4. Hardware Function

You are the head of the hardware department at TSI Inc. As department head it is your responsibility to balance the availability of components, and the ability of the components used, to meet the system requirements. Your department's performance is judged on the ability of the hardware components to meet the customer requirements.

You must choose the components used for this system from the available components based on their capabilities. There are three ways of procuring components. The safest and least costly is to choose from the components in stock. There are also components that are available but have been reserved for another project. Using these components will cause your department to come up short on another project, and will hurt your department's performance. You may also order components if needed, but these will take time to procure. The components, their performance, number in stock, number on reserve, and order lead times are shown in the table below.

Servers	**Performance**	**Available**	**Reserved**	**Order Time (in days)**
S100	100	4	4	5
S80	80	6	8	5
Workstations				
W100	100	8	12	4
W80	80	16	20	4

All hardware must be acquired before any installation can begin. For example: if an S100 Server must be ordered, installation cannot begin until day 5.

Each server can support at most 5 workstations, and the performance of each workstation decreases with the number of workstations per server.

Only one type of workstation can be connected to each server.

A lower performing workstation than needed will reduce customer satisfaction, but you don't think the customer will notice if a workstation performs better than required.

The following table shows all the possible combinations of servers and workstations, with the resulting performance of each workstation. Each row is one server/workstation set. The number of workstations shows how many workstations are attached to the server.

Server Performance	Workstation Performance	Number of workstations	Actual Workstation Performance
100	100	1	100
100	100	2	95
100	100	3	91
100	80	1	90
80	100	1	90
100	100	4	87
100	80	2	86
80	100	2	86
100	100	5	83
100	80	3	82
80	100	3	82
80	80	1	80
100	80	4	78
80	100	4	78
80	80	2	76
100	80	5	75
80	100	5	75
80	80	3	73
80	80	4	70
80	80	5	67

For example: you need 8 workstations with a performance of 70. The following combinations can be used to meet the requirement.

Two S80 Servers (80) each with 4 W80 (80)Workstations, or

One S80 Server (80) with 5 W100 Workstations (100) and 1 S80 Server (80) with 3 W80 Workstations (80), or

One S100 Server (100) with 5 W80 Workstations (80) and 1 S100 Server (80) with 3 W80 Workstations (80).

You will need to create a preliminary hardware design before the other functions can begin to calculate cost and installation times. You may be able to calculate every reasonable combination of servers and workstations for each required number of a certain performance. For each workstation required look in the actual performance column to decide what server/workstation combinations will meet that requirement. Depending on the number of workstations required you may need to create multiple server/workstation sets to get enough workstations of a given performance. After costs and installation time is calculated, you may find that your first design doesn't meet these performance criteria. Be prepared to create a new design taking these factors into account. You may also have to order or use reserved components to meet the customer requirements. Alternately, your team may decide that the best design may not meet all the customer requirements. Remember that your department's

performance is determined by the systems ability to provide the customer with the number of workstations needed at each performance level and your use of reserved components.
To find the performance of a server/workstation, look up the value in the provided table. Use this table to calculate the number of workstations of a given performance you have, to compare to the number of workstations of a given performance you need.

Server	Workstation Type	# of workstations (max. 5)	Performance

Server	Workstation Type	# of workstations (max. 5)	Performance

Server	Workstation Type	# of workstations (max. 5)	Performance

Server	Workstation Type	# of workstations (max. 5)	Performance

Server	Workstation Type	# of workstations (max. 5)	Performance

Server	Workstation Type	# of workstations (max. 5)	Performance

A.5. Installation Function

You are the head of the installation department at TSI Inc. As department head, your main responsibility is to balance the available installer hours and the necessary hours of installation required by the system. Your installation team will install the hardware at the customer's site. Your department's performance is determined by the amount of time necessary to install the system.

You determine the amount of time it will take to install the system by allocating the number of available installation hours each day. You have three choices when allocating installer hours to this project. The first option is to use the installer hours available. You have a limited number of available hours per week; specifically, you have four installers who each work ten hours a day. By only using the available hours the time to finish the installation may extend the total time to finish the project longer than you would like. You may also require your installers to work overtime, but because of your employee contract there is a limit to the amount of overtime work they can do. Since your installers work hard already, working overtime frazzles their nerves, and makes them tired, resulting in errors that decrease the customer's satisfaction. Although you have 40 hours each day of installation time available, some of these hours are already devoted to other projects. Your third option is to pull installers working on other TSI projects to work on this one. Doing so puts other projects behind schedule and will hurt your department' s performance. Installation cannot begin until all hardware components are acquired. The following table shows the time it takes to install each component.

Hardware	Installation Hours
Servers	
S100	30
S80	40
Workstations	
W100	8
W80	10

The following table shows all the installation times for every server/workstation combination used by TSI.

Server Performance	Workstation Performance	Number of workstations	Time
S100	W100	1	38
S100	W100	2	46
S100	W100	3	54
S100	W100	4	62
S100	W100	5	70
S100	W80	1	40
S100	W80	2	50
S100	W80	3	60
S100	W80	4	70
S100	W80	5	80
S80	W100	1	48
S80	W100	2	56
S80	W100	3	64
S80	W100	4	72
S80	W100	5	80
S80	W80	1	50
S80	W80	2	60
S80	W80	3	70
S80	W80	4	80
S80	W80	5	90

The following table shows the current allocation of installation hours. The available hours represent installers who are idle and are available to work on this project. The overtime available shows how much overtime you can assign each day. The other projects row shows the number of hours your installers plan to spend working on other projects. You can pull them off those projects to complete this one, but your department's performance will suffer when the other projects get behind schedule.

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours	20	20	10	0	0	0	10	20	20	40	40	40	40	20	20	20	20	10	20	30
Overtime Hours	8	8	8	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Hours on Other Projects	20	20	30	40	40	40	30	20	20	0	0	0	0	20	20	20	20	30	20	10

You need to determine the amount of time your installers will devote to this project. You may draw upon each of the three types of hours. The total number of hours it will take to install the system will depend on how many of each type of hardware component is used in the system. Once hardware creates an initial system design you can calculate the number of hours it will take to install the system. You may have to work with the hardware department to come up with a new design if the system will take more hours to install than your installers can handle.

Use these tables to calculate the total number of installation hours you will use. Make sure the number of hours of each type you use do not exceed the available hours of that type. The total number of hours you assign should equal the number of hours necessary to install the hardware selected by your team. Installation cannot begin until all ordered hardware has arrived. To determine when installation will be completed, find the last day that a number of hours greater than 0 was entered. The system will be considered complete on that day.

Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Available Hours																				
Overtime Available																				
Hours on Other Projects																				

Appendix B -- Informed Consent

Informed Consent for Participants of Investigative Projects

Title of Project: The Impact of Reward Structure on Project Team Performance.
Research Investigator: Brian Cunningham

I. Purpose of this Research

This research will investigate the impact of three different reward structures on the performance of project teams. About 15 teams are expected to participate in this experiment. The results will be posted in PDF format to Virginia Tech's Electronic Theses and Dissertations web page at: http://scholar.lib.vt.edu/theses/theses.html

II. Procedures

Participants will work with other team members in designing a computer system. Each participant will be assigned to a functional discipline, such as marketing, finance or hardware. The experiment is expected to take approximately two hours.

III. Risks

There are no unusual risks involved in this experiment.

IV. Benefits of this Research

Although teams have become highly used in organizations, organizational support for this different structure has lagged. This research attempts to determine the optimum reward structure for use in project teams. You will also be compensated as explained under Compensation.

V. Extent of Anonymity and Confidentiality

Data from this study will in no way be linked to you individually. The data you provide will be identified only by a number, which is not linked to your name. The results of the study may be published, but any published data will be in no way linked to your name.

VI. Compensation

You will be given the opportunity to earn up to $20 for participation in this experiment. You will receive this compensation before the conclusion of the experiment. The actual amount could depend on your performance, the performance of your team, and or the experimental conditions to which you are randomly assigned. No guarantee of earning the maximum amount is made, but you will receive some compensation regardless of the outcomes.

VII. Freedom to Withdraw

You are free to withdraw from this study at any time without penalty. If you withdraw from the study before it's conclusion you will receive the minimum reward amount.

VIII. Approval of Research

This research has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University and by the Department of Industrial and Systems Engineering.

IX. Participant's Responsibilities

I voluntarily agree to participate in this study. I agree to abide by all of the rules of the experiment, until the completion of the experiment, or a decision to withdraw. I also agree to not discuss any aspect of the research with others, except my teammates, after the conclusion of the research.

X. Subjects Permission

I have read and understand the Informed Consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this research. If I participate I may withdraw at any time without penalty. I agree to abide by the rules of this project.

_____ _____

Signature Date

Should I have any questions about this research or its conduct, I will contact:

Brian Cunningham Research Investigator	540-552-6647	bcunning@vt.edu
Dr. Eileen Van Aken Faculty Advisor	540-231-2780	evanaken@vt.edu
Dr. Tom Hurd Chair IRB, Research Division	540-231-5281	

Appendix C -- Experimenter's Script

As participants arrive, the experimenter will introduce himself and seat the participants at a table. The experimenter will then distribute the consent form (Appendix A).

Thank you for coming. Before we begin the experiment you need to read and sign a consent form.

When all participants finish reading and have signed the consent form, the experimenter will collect the forms.

Now I need you to fill out a short questionnaire, before we actually begin working on the problem.

Distribute pre-experiment questionnaire. Wait till all participants have finished, and then collect the questionnaire.

Now we can start the experiment. Today we are going to do a little role-playing. You work for Technology Systems Integration Inc. (TSI). Your company specializes in the installation of computer systems. TSI has just been awarded an important project from a major grocery distribution chain. Your team's assignment is to design a computer system from the components your company uses. You will now choose the function you will represent by selecting a folder with your functions information in it.

Allow participants to select functions. Distribute information sheets (Appendix E).

Each of you should have information sheets explaining your function. Please read over these sheets and ask any questions that you may have, afterwards I will explain how you can earn your reward. Take your time, but don't actually begin working on the problem. You can write on the sheets if you wish.

Wait until all participants have read the information sheets and answer questions. Depending on which reward condition was randomly selected for the team one of the following is read.

[Group Reward Condition]

TSI has just implemented a new performance incentive plan. Under this new plan your team will be rewarded as a group based on your performance. Your team will receive up to $60 dollars, depending on how well you do, to be divided equally among the group. Your performance will depend on how satisfied the customer is with the design you come up with, and how well you manage your individual departments as a whole. When you finish your design I will calculate your team's performance and you will receive your reward. Remember that you will receive an equal share of the reward based on the entire team's performance.

[Individual Reward Condition]

TSI has just implemented a new performance incentive plan. Under this new plan, each of you will receive a bonus based on how well your department performs. This bonus can be up to $20 depending on your performance. The factors that effect each of your department's performance are explained in your information sheets. When you finish your design I will calculate your team's performance and you will receive your reward. Remember that the size of your reward will only depend on how well your department performs, and not on the performance of other members of your group.

[Mixed Reward Condition]

TSI has just implemented a new performance incentive plan. Under this new plan, each of you will receive a bonus based partly on how your team performs and partly on how your department performs. Up to $10 will be given based on your individual department's scores, and $30 will be given to the team, to be distributed evenly, based on your team score. The factors that effect each of your department's performance are explained in your information sheets. Your team's performance will depend on all the departments' performance and how satisfied the customer is with the design you come up with. When you finish your design I will calculate your team's performance and you will receive your reward. Remember that both your team's performance and your individual performance will affect your reward.

Do you have any questions at this time?

Answer Questions. Give design parameters form to team.

You may now start working on the problem. You may ask questions if you need to. Use this sheet to record your final design. You may want to look over this sheet to better understand exactly what parameters your team will need to define. When you have finished your design, please put your answers in the appropriate places on the design parameters sheet, and let me know you are finished. You can work together in any way that you feel is best to solve the problem. There are no restrictions on how you can communicate, what information you can share or how you share the work. You have as long as you like to complete the problem, but most team's have taken 1.5 to 2 hours to complete the entire experiment.

> *The experimenter will remain in the room with the participants to make observations The time that the team starts working on the problem will be noted.. The experimenter will answer any questions the team has during the experiment. When the team indicates that it is done, the team answer sheet is collected and the completion time noted.*

Good, now I ask that you wait a few minutes while I calculate your score. When I finish you will get your reward and be asked to fill out another questionnaire.

> *The experimenter will leave the room and calculate the teams score by entering the design parameters into a spreadsheet. When finished, the scores will be reported to the team and rewards distributed. The post experiment-questionnaire will then be handed out.*

This is the final part of the experiment. Please answer all questions as best as you can. When you are finished you will be free to leave.

> *The experimenter will collect the post-experiment questionnaire as participants finish and thank them for their time and cooperation. All documents used by the team will be coded with the group number and function of each participant.*

Appendix D -- Recruitment of participants

D.1. Recruitment of Participants.

I'm Brian Cunningham and I'm a graduate student in Industrial and Systems Engineering. I'm looking for people to participate in an experiment I am doing for my masters thesis. It should be fun and you may learn something about how consulting or design teams work. The best part is that you will have the opportunity to earn up to $20 during the experiment, although the actual amount will depend on your team's performance. It should take approximately two hours, but the actual time will be mostly up to you. The experiment will be held in 302 Whittemore, which is the old ISE main office. I need three people for each trial, but you can sign up individually and I will find other people to work with you. I am going to pass around a sign-up sheet with times for the experiment. If you are interested in participating put your name, email and telephone number down so I can get hold of you. My phone number and email are on the sheet. It's important that you show up and come on time if you sign up, since two other people will be counting on you and we can't conduct the experiment without all three people. If you are interested in doing the experiment, but can't make any of these times, put your information at the bottom, with times you are available. I will try to find other people to do the experiment at that time.

> *The sign-up sheet is then passed around and collected either by the instructor at the end of class or by the researcher when it has gone around to everyone. Subjects were called the night before the experiment to remind them of the time and place.*

D.2. Sign-up Sheet

If you are interested in participating in the experiment please put your name and phone or email in the chart.

I need three people to work together as a team for each time. During the experiment you will be given the opportunity to earn up to $20.

The actual amount will depend on your performance during the experiment, but you will get some payment regardless of the outcome.

Please call or email me if you will not be able to come at your scheduled time, as two other people will be relying on you to be there.

We can only do the experiment when all three people show up, so it is also important to be on time.

Brian Cunningham bcunning@vt.edu 552-6647

Day	Time	Name	Email	Phone
Wednesday, July 8	1:00			
Wednesday, July 8	3:00			
Thursday, July 9	1:00			
Thursday, July 9	5:30			
Friday, July 10	11:00			
Other Times?				

Appendix E -- Pre-experiment Questionnaire

Please respond to the following statements by indicating how much you agree or disagree with them.

Circle the response that most closely corresponds to how you feel about the statement.

1. I would rather work through a work problem myself than ask for advice.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

2. I like my work best when I do it all myself.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

3. Twenty dollars is a lot of money.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

4. Working in small groups is better than working alone.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

5. I prefer tasks that allow me to work with others.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

6. The reward offered for performance in this experiment is very attractive.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

7. I would rather work alone than with other people.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

8. I could really use the money from this experiment.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

9. The less I have to rely on others at work, the happier I am.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

Appendix F -- Post-experiment Questionnaire

Please respond to the following statements by indicating how much you agree or disagree with them. Circle the response that most closely corresponds to how you feel about the statement.

1. I am happy with the reward I received.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

2. I worked hard to perform well in this experiment

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

3. I am unhappy on this team.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

4. I feel dislike towards some of the members of this team.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

5. Feedback about how well I did on this task came primarily from information about how well the entire team did.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

6. Members of my team were very willing to share information with other team members about our work.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

7. I tried hard to earn the maximum reward.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

8. This team could effectively work together on a future task.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

9. I am satisfied with my reward for this experiment.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

10. I am disappointed that my team did not do better.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

11. Members of my team cooperated to get work done.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

12. I am satisfied with the way our team worked together.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

13. Within my team, work performed by team members was related to one another.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

14. The morale of our team is good.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

15. I am happy with my team's performance.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

16. The evaluation of my performance was strongly influenced by how well my team performed.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

17. I made an effort to do well in this experiment.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

18. If I had to choose a team to work with me on a real problem, I would choose members of this team.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

19. Working as a team enhanced the communication among people working on this task.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

20. I could not accomplish this task without information or materials from other members of my team.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

21. The reward for this task was determined in large part by my contributions as a team member.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

22. My reward reflected my level of performance well.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

23. I like being part of this team.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

24. I would like to work with members of this team again.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

25. Other members of my team depended on me for information needed to perform their work.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

26. I am satisfied that my team performed well on this task.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

27. This team has a good working relationship.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

28. I put forth my best effort during the experiment.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

29. The reward I received seemed fair relative to the reward my teammates received.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

30. Members of my group worked as a team more than as individuals.

Strongly Disagree	Disagree	Tend to Disagree	Tend to Agree	Agree	Strongly Agree

What is your age? _____

What is your gender? _____

What is your major? _____

What is your academic level? _____

How well do you know the other members of your team?

I have worked (homework, projects) with both before. __

I have worked with one before, and know the other. __

I have worked with one before, and do not know the other. __

I know both from class but haven't worked with them. __

I know one from class. __

I don't know either of my team members. __

Appendix G -- Performance Calculations

The team's total score is an average of the individual scores. The individual scores are each based on factors that are specific to each department (department score), along with a customer satisfaction score. The department scores are internal measures within the company that measure how well the department performs. The customer satisfaction score is an external measure of how well the team meets the customers requirements for the project.

G.1. Department Scores:

Each department is scored based on the factors that the department directly controls. These scores do not take into account how well the design satisfies the customer requirements, but does reflect how the team's decisions will affect the company itself. When used to calculate individual performance for the purpose of determining the reward given, each score is averaged with the total customer satisfaction score.

G.1.1. Hardware:

The hardware score is based on two factors: how many reserved components are used and how well the system meets the performance requirements. For each reserved component used, one point is subtracted from the hardware score. For each computer that doesn't meet the performance requirement one tenth of a point is subtracted for each point below the necessary hardware performance.

Example:

Hardware decides to pull one component from reserves and two computers have a performance rating of 87 when the customer required them to be at 90. One

point is subtracted for the reserved component and 0.6 (0.1 X 3 X 2) is subtracted for the lower performing computers. This would result in a total hardware score of -1.60.

G.1.2. Installation:

The installation score is also based on two factors: how many reserved hours are used and how many extra days are taken to complete installation. For each reserved hour used, one twentieth of a point is subtracted from the installation score. For each extra day taken to complete installation one point is subtracted from the installation score.

Example

Installation uses 20 reserved hours and takes one extra day to complete installation. The 20 reserved hours are divided by 20 to give a reduction of 1.0 points to the installation score. The one extra day results in a further one point reduction in the score. This scenario would result in a total installation score of -2.00.

G.1.3. Finance:

The finance score is based on three factors: the difference between the cost of the system and the amount charged to the customer, the number of reserved components used, and the number of reserved installation hours used. For each dollar of profit twenty-five one-hundred-thousandths of a point is added to the finance score. For each reserved component used one quarter of a point is subtracted and for each reserved hour seventy-five-thousandths of a point is subtracted.

Example

The total system cost is $250,000. Finance charges the customer $300,000 for the system. Two reserved hardware components and 25 reserved installation hours were used. The $50,000 profit is divided by 20000, adding 1.25 points to the finance score. The one reserved component is divided by four to give a reduction of 0.25 to the finance score. Finally the 20 reserved hours used are multiplied by .0075 to reduce the

finance score by a further 0.15. This results in a final score of 1.25 for the finance department.

G.2. Customer Satisfaction:

The customer satisfaction score is based on three factors: the performance of the system, the time to install the system, and the amount charged for the system relative to the bid. Each factor is weighted differently. Performance counted for half the total satisfaction score, time made up one third, and cost was one sixth. These weights were explained to the teams by telling them that performance was most important and cost was least important to the customer.

G.2.1. Performance:

The performance satisfaction score is based on two factors: the performance of the installed components compared to the desired performance by the customer, and the number of overtime hours used by installation. For each computer that doesn't meet the performance requirement one tenth of a point is subtracted for each point below the necessary hardware performance. For each hour of overtime installation hours used one twentieth of a point was subtracted from the performance satisfaction score.

Example:

Two computers have a performance rating of 87 when the customer required them to be at 90. A total of 0.6 (0.1 X 3 X 2) is subtracted for the lower performing computers. Additionally, 20 overtime installation hours were used, so one point (20 divided by 20) is subtracted from the performance satisfaction score. These two factors would yield a total performance satisfaction score of -1.60.

G.2.2. Time:

The customer requirements specified that the project was to be done in fifteen days. For each day scheduled for installation over the fifteenth day, one point is subtracted from the time satisfaction score. If the project is scheduled for completion before the fifteenth, one point for each day is added to the time satisfaction score.

Example:

Installation decides to use one extra day to install the system. One point is subtracted from the time satisfaction score to produce a total score of -1.0.

G.2.3. Cost:

The cost satisfaction score is entirely based on the difference between the amount charged for the system and the amount bid. In all cases the amount bid was set at $245,000. Each dollar difference added or subtracted one twenty-thousandth of a point from the total cost satisfaction score. If the amount charged was over the amount bid, a negative satisfaction score resulted. If the amount charged was lower than the bid it positively influenced the satisfaction score.

Example:

The total amount charged is $300,000, a $65,000 increase over the amount bid. This results in a total finance satisfaction score of -2.75.

G.2.4. Total Customer Satisfaction:

To calculate the total customer satisfaction score each factor score is multiplied by a weight factor and the three scores are added. The performance satisfaction score is multiplied by 0.6, time by 0.4, and finance by 0.2.

Example:

Using the above examples and multiplying them by the appropriate weight yields the total customer satisfaction score.

Table G.1 Example Customer Satisfaction Scores

Factor	Score	Weight	Contribution to Final Score
Performance	-1.60	0.6	-0.96
Time	-1.00	0.4	-0.40
Cost	-2.75	0.2	-0.55
		Total Score	-1.91

G.3. Final Performance Scores:

The final scores for individuals are calculated by averaging the appropriate department score with the total customer satisfaction score. The team score is calculated by averaging all three individual scores. The mixed reward treatment uses both scores with each determining half of the total reward. The scores as reported to the participants were scaled to a 1-100 point range.

Example:

Using the above examples, the individual and team scores would be calculated as follows.

Table G.2 Example Final Performance Scores

Department	Department Score	Satisfaction Score	Final Score
Hardware	-1.60	-1.91	-1.76
Installation	-2.00	-1.91	-1.96
Finance	1.25	-1.91	-0.33
Team			-1.35

G.3.1. Reported Scores:

Since the raw scores would be meaningless to participants, the scores are scaled to a 1-100 point range. Because of the slight differences in the possible range of scores different scaling factors are used for each department and for the team score. To convert the scores, a theoretical minimum score is subtracted from the actual score then the total is divided by the theoretical maximum minus the theoretical minimum. The following are the theoretical minimums and maximums used in scaling the scores.

Table G.3 Theoretical Minimum and Maximum Scores

Score	Min	Max
Hardware	-13	0
Installation	-10	0
Finance	-6	0
Team	-7	0

Example:

From the above example for the hardware department, the raw score is -1.76. From this -13.0 is subtracted to give 11.24. The theoretical minimum is subtracted from the theoretical maximum to give 13. 11.24 is divided by 13 to give 0.86 or a score of 86%.

G.3.2. Reward Calculations:

In order to determine the amount of reward each individual would receive, the reported score was checked against a table that gives an amount for each score. For the team and individual rewards the same amount was used for each score, but either the individual department score or the team score was used as appropriate. For the mixed condition an amount approximately equal to half of the individual/team amount was given, but the amount was given for both the individual and team score to each participant. The following table shows the amounts given for each reported score.

Table G.4 Rewards Given Based on Performance Scores

Score	Team or Individual	Mixed
0%	$10	$5
55%	$11	$5
60%	$12	$6
65%	$13	$6
70%	$14	$7
75%	$15	$7
80%	$16	$8
85%	$17	$8
90%	$18	$9
95%	$19	$9
100%	$20	$10

Example:

From the above example the hardware department received a score of 86%. In the individual reward treatment he or she would receive $17. Also from the above examples, the team score would be 81%. In the group rewarded situation each individual on the team would receive $16. In the mixed reward situation the hardware department head would receive $8 for their individual score and $8 for their team score for a total of $16.

Appendix H -- Experiment Data

H.1. Additional Team Data

Table H.1 Treatment, Gender Mix, and

Team Number*	Reward Treatment	Gender Mix (No. of Males)	Time to Finish Task (min.)
7	Mixed	2	72
8	Individual	2	79
9	Individual	2	82
10	Mixed	3	92
11	Group	2	121
12	Individual	2	95
13	Mixed	1	92
14	Group	1	59
15	Group	2	73
16	Mixed	2	109
17	Group	3	79
18	Mixed	3	65
19	Individual	3	70
20	Individual	3	78
21	Group	1	75

* Team Numbers 1-6 were pilot tests

H.2. Questionnaire Responses

Table H.2 Questionnaire Data

Team*	Function	Q1V1	Q1V2	Q1V3	Q1V4**	Q1V5**	Q1V6	Q1V7	Q1V8	Q1V9	Q2V1	Q2V2	Q2V3**	Q2V4**	Q2V5	Q2V6	Q2V7	Q2V8	Q2V9	Q2V10*	Q2V11	Q2V12	Q2V13	Q2V14	Q2V15	Q2V16	Q2V17	Q2V18	Q2V19	Q2V20	Q2V21	Q2V22	Q2V23	Q2V24	Q2V25	Q2V26	Q2V27	Q2V28	Q2V29	Q2V30	Age	Gender	Major	Level***	Famil
7	H	5	3	4	3	2	4	2	2	3	5	5	6	6	4	6	4	4	4	3	5	5	6	5	5	5	5	4	5	6	5	4	5	4	6	5	4	5	5	6	23	M	ISE	5	1
7	I	2	2	1	3	3	4	3	4	3	2	3	4	5	3	5	4	4	2	3	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	3	4	4	21	F	HTM	3	1
7	F	5	6	2	3	3	5	2	5	3	5	5	5	5	4	6	6	5	5	2	5	6	3	6	4	4	6	5	5	6	5	3	5	5	6	3	5	6	3	3	20	M	ACCT	3	1
8	H	5	5	4	2	4	4	4	4	5	6	6	6	6	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	20	M	CPE	2	3
8	I	3	4	4	3	3	4	3	5	3	6	5	5	5	3	5	4	4	5	4	5	5	4	5	5	4	4	5	5	2	4	4	5	5	5	5	5	5	5	5	20	M	ESM	2	3
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9	H	4	3	2	3	2	4	3	5	3	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	4	5	5	5	5	21	M	HTM	4	2
9	I	3	4	4	2	2	5	3	6	5	5	5	6	6	5	6	5	6	5	6	6	6	5	4	5	6	5	5	6	6	5	5	5	6	5	5	6	5	5	5	22	M	HTM	3	5
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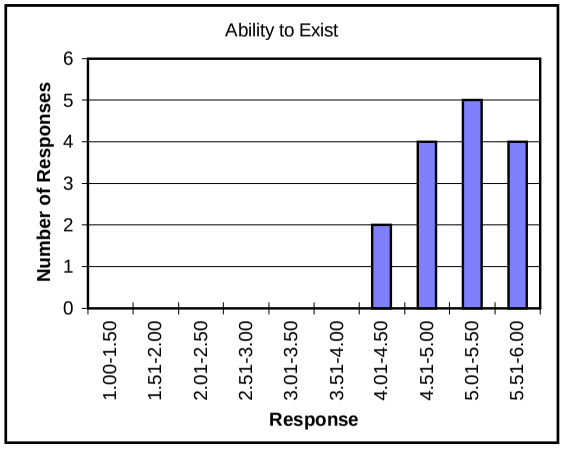
21	F	1	2	4	2	1	5	2	4	1	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	4	5	6	4	4	5	5	5	5	5	5	5	22	F	EDU	4	6

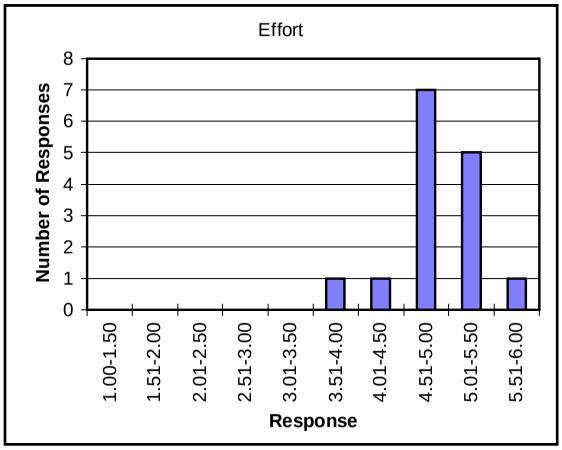
* Team numbers 1-6 were pilot tests
** Reverse coded items have been reversed in this table
*** Numbers correspond to grade level 1=freshmen…4=Senior, 5=Masters, 6=PhD

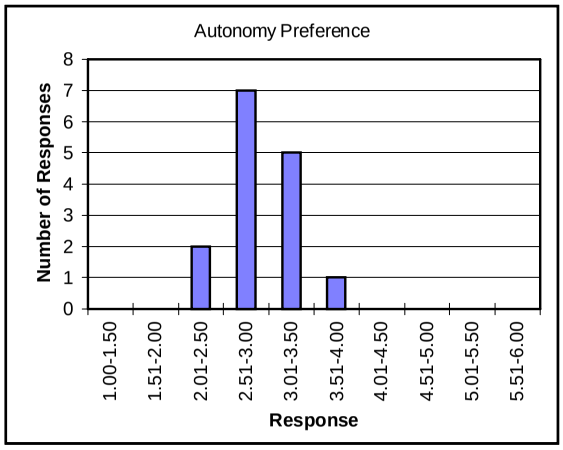
H.3. Scale and Item Means

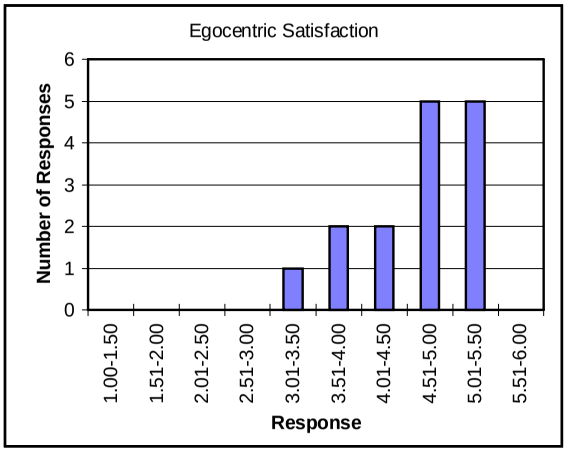
Table H.3 Scale and Item Means

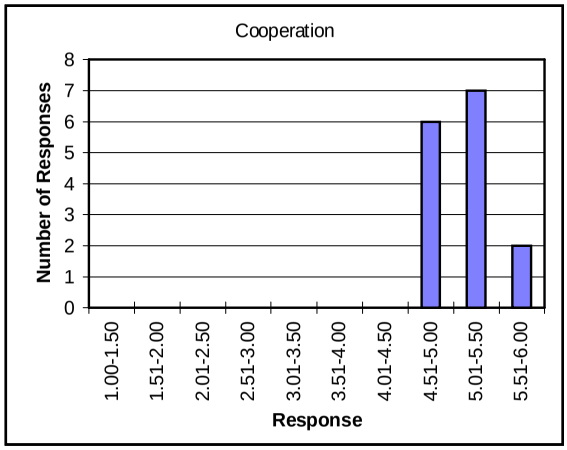
Construct	Item Number	Item	Item Mean	Scale Mean
	Q2V4	I feel dislike towards some of the members of this team.	5.56	
Ability to exist	Q2V8	This team could effectively work together on a future task.	5.24	5.26
	Q2V18	If I had to choose a team to work with me on a real problem, I would choose	5.11	
	Q2V24	I would like to work with members of this team again.	5.13	
	Q1V1	I would rather work through a work problem myself than ask for advice.	3.07	
	Q1V2	I like my work best when I do it all myself.	3.67	
Autonomy	Q1V4	Working in small groups is better than working alone.	2.49	3.37
Preference	Q1V5	I prefer tasks that allow me to work with others.	2.62	
	Q1V7	I would rather work alone than with other people.	2.87	
	Q1V9	The less I have to rely on others at work, the happier I am.	3.49	
	Q2V6	Members of my team were very willing to share information with other team	5.40	
Cooperatio	Q2V11	Members of my team cooperated to get work done.	5.31	5.25
	Q2V19	Working as a team enhanced the communication among people working on	5.20	
	Q2V30	Members of my group worked as a team more than as individuals.	5.09	
	Q2V2	I worked hard to perform well in this experiment	4.87	
Effort	Q2V7	I tried hard to earn the maximum reward.	4.89	5.01
	Q2V17	I made an effort to do well in this experiment.	5.31	
	Q2V28	I put forth my best effort during the experiment.	4.96	
	Q2V1	I am happy with the reward I received.	4.89	
Egocentric	Q2V9	I am satisfied with my reward for this experiment.	4.89	4.73
Satisfaction	Q2V22	My reward reflected my level of performance well.	4.33	
	Q2V29	The reward I received seemed fair relative to the reward my teammates	4.80	
Instrumenta	Q2V15	I am happy with my team's performance.	5.18	5.11
Satisfaction	Q2V26	I am satisfied that my team performed well on this task.	5.04	
Reward	Q2V5	Feedback about how well I did on this task came primarily from information	4.27	
interdep-	Q2V16	The evaluation of my performance was strongly influenced by how well my	4.96	4.64
endence	Q2V21	The reward for this task was determined in large part by my contributions as a	4.69	
	Q2V3	I am unhappy on this team.	5.44	
Social	Q2V12	I am satisfied with the way our team worked together.	5.31	
satisfaction	Q2V14	The morale of our team is good.	5.27	5.27
	Q2V23	I like being part of this team.	5.20	
	Q2V27	This team has a good working relationship.	5.13	
Task	Q2V13	Within my team, work performed by team members was related to one	5.13	
interdep-	Q2V20	I could not accomplish this task without information or materials from other	5.36	5.24
endence	Q2V25	Other members of my team depended on me for information needed to	5.22	
Valence	Q1V6	The reward offered for performance in this experiment is very attractive.	4.33	4.33











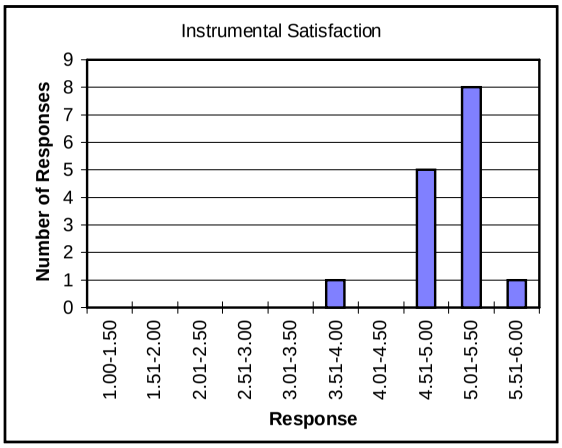
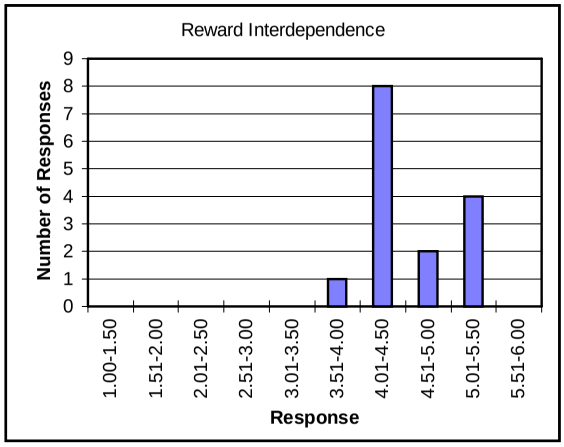
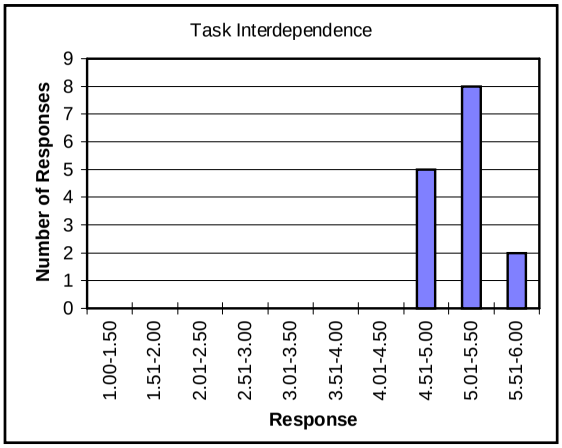
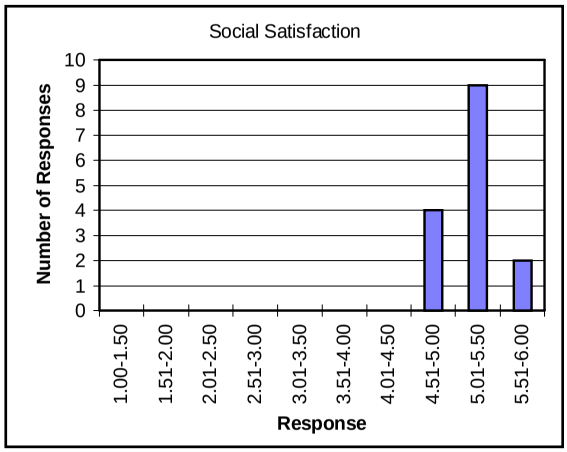


Figure H.1 Histograms of Questionnaire Constructs







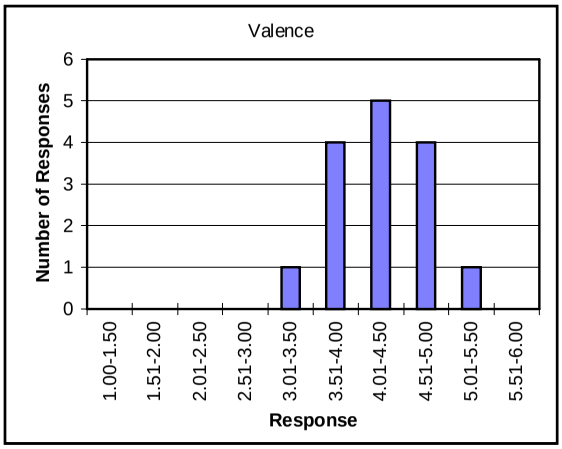


Figure H.1 Cont. Histograms of Questionnaire Constructs.

H.3. Variation of Questionnaire Responses Within Groups

James, Demaree, and Wolf's (1984 & 1993) within-group interrater agreement measure was used to estimate the amount of variance between scores of the individuals in a team. This measure compares the variance between scores to a theoretical variance based on random answers. For this reason, the estimate can vary outside of the normal zero to 1.00 range when the true variance is greater than the variance of the theoretical random answers.

Table H.3 Within-Group Interrater Agreement

Team	Ability to Exist	Aut. Pref.	Coop.	Effort	Ego. Sat.	Inst _Sat	Rew. Int.	Soc. Sat.	Task Int.	Valence
7	0.97	0.88	0.91	0.79	0.75	0.75	0.96	0.91	0.69	0.89
8	0.99	0.94	0.99	0.95	0.99	1.00	0.96	0.99	0.62	1.00
9	0.94	0.96	0.97	0.97	0.98	0.87	0.97	0.96	0.96	0.89
10	0.88	0.83	0.95	0.84	0.94	0.87	0.30	0.97	0.89	0.89
11	0.97	0.63	0.98	0.98	0.40	0.94	0.91	0.96	0.91	0.89
12	-1.00	0.57	0.96	0.97	0.83	0.87	0.94	0.84	1.00	0.89
13	0.98	0.97	0.97	0.81	0.97	1.00	0.97	0.96	0.87	0.89
14	0.98	0.98	0.96	0.98	0.97	0.94	0.94	0.97	0.97	0.66
15	0.99	0.86	0.97	0.98	0.98	0.94	0.91	0.97	9.00	0.54
16	0.91	0.97	0.92	0.91	0.88	0.87	0.87	0.97	0.97	0.66
17	0.99	0.95	0.98	0.95	0.99	0.87	0.96	0.99	0.96	1.00
18	0.98	0.97	0.94	0.98	0.83	0.94	0.87	0.96	0.78	0.89
19	0.97	0.91	0.95	0.97	0.95	0.94	0.85	0.97	0.96	-0.49
20	0.96	0.94	0.98	0.79	0.98	0.97	0.93	0.98	0.48	0.54
21	0.98	0.92	0.97	0.98	0.98	0.94	0.97	0.97	0.96	0.89

H.4. Performance Scores

Table H.4 Team Performance Scores

Team Number	Hardware	Installation	Finance	Customer Satisfaction	Team
7	-0.965	-1.315	-0.696	-0.930	-0.992
9	-1.110	-1.110	-1.079	-2.220	-1.100
10	-1.548	-1.998	-1.616	-3.096	-1.721
11	-1.335	0.165	-0.615	-0.670	-0.595
12	-1.092	-1.942	-1.220	-2.184	-1.418
13	-1.476	-0.976	-1.083	-1.952	-1.178
14	-1.325	-1.375	-0.853	-1.650	-1.184
15	-0.993	-1.468	-0.764	-0.986	-1.075
16	-2.704	-1.104	-2.118	-2.208	-1.975
17	-1.923	-0.923	-0.400	-1.846	-1.082
18	-1.080	-1.080	-0.880	-2.160	-1.013
19	-0.809	-0.809	-1.763	-1.618	-1.127
20	-1.320	-1.420	-0.792	-1.640	-1.177
21	-1.507	-2.007	-1.132	-2.014	-1.548
22	-1.037	-2.637	-0.962	-1.073	-1.545

H.5. Factor Analysis of Satisfaction Constructs

Table H.5 Rotated Component Matrix for Satisfaction Constructs

Satisfaction Construct	Item	Factor 1	Factor 2
Egocentric	Q2V1	.000	.870
	Q2V9	.206	.897
	Q2V22	.009	.785
	Q2V29	.226	.766
Instrumental	Q2V15	.671	.481
	Q2V26	.781	.166
Social	Q2V3	.670	.008
	Q2V12	.802	.139
	Q2V14	.658	.104
	Q2V23	.738	.106
	Q2V27	.878	.006

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Appendix I -- Questionnaire Item Changes

Table I.1 Changes to Questionnaire Items From Pilot Testing

Code	Construct	Original Items	Items Used in Experiment
Q2V4	Ability to exist	I feel dislike towards some of the members of this team.	I feel dislike towards some of the members of this team.
Q2V8	Ability to exist	This team could effectively work together on a future task.	This team could effectively work together on a future task.
Q2V18	Ability to exist	If I had to choose a team to work with me on a real problem, I would choose members of this team.	If I had to choose a team to work with me on a real problem, I would choose members of this team.
Q2V24	Ability to exist		I would like to work with members of this team again.
Q1V1	Autonomy Preference	I would rather work through a work problem myself than ask for advice.	I would rather work through a work problem myself than ask for advice.
Q1V2	Autonomy Preference	I like my work best when I do it all myself.	I like my work best when I do it all myself.
Q1V4	Autonomy Preference	Working in small groups is better than working alone.	Working in small groups is better than working alone.
Q1V5	Autonomy Preference	I prefer tasks that allow me to work with others.	I prefer tasks that allow me to work with others.
Q1V7	Autonomy Preference	I would rather work alone than with other people.	I would rather work alone than with other people.
Q1V9	Autonomy Preference	The less I have to rely on others at work, the happier I am.	The less I have to rely on others at work, the happier I am.
Q2V6	Cooperation	Members of my team were very willing to share information with other team members about our work.	Members of my team were very willing to share information with other team members about our work.
Q2V11	Cooperation	Members of my team cooperated to get work done.	Members of my team cooperated to get work done.
Q2V19	Cooperation	Working as a team enhanced the communication among people working on this task.	Working as a team enhanced the communication among people working on this task.
Q2V30	Cooperation		Members of my group worked as a team more than as individuals.
Q2V2	Effort	I worked hard to perform well in this experiment	I worked hard to perform well in this experiment
Q2V7	Effort	I attempted to represent my function to the best of my abilities.	I tried hard to earn the maximum reward.
Q2V17	Effort	I didn't put forth much effort in completing the assigned task.	I made an effort to do well in this experiment.
Q2V28	Effort		I put forth my best effort during the experiment.
Q2V1	Egocentric Satisfaction		I am happy with the reward I received.
Q2V9	Egocentric Satisfaction		I am satisfied with my reward for this experiment.
Q2V22	Egocentric Satisfaction		My reward reflected my level of performance well.
Q2V29	Egocentric Satisfaction		The reward I received seemed fair relative to the reward my teammates received.
Q2V10	Instrumental Satisfaction		I am disappointed that my team did not do better.

Table I.1 Cont. Changes to Questionnaire Items From Pilot Testing

Code	Construct	Original Items	Items Used in Experiment
Q2V15	Instrumental Satisfaction		I am happy with my team's performance.
Q2V26	Instrumental Satisfaction		I am satisfied that my team performed well on this task.
Q2V5	Reward interdependence	Feedback about how well I did on this task came primarily from information about how well the entire team did.	Feedback about how well I did on this task came primarily from information about how well the entire team did.
Q2V16	Reward interdependence	The evaluation of my performance was strongly influenced by how well my team performed.	The evaluation of my performance was strongly influenced by how well my team performed.
Q2V21	Reward interdependence	The reward for this task was determined in large part by my contributions as a team member.	The reward for this task was determined in large part by my contributions as a team member.
Q2V3	Social satisfaction	I am unhappy on this team.	I am unhappy on this team.
Q2V12	Social satisfaction		I am satisfied with the way our team worked together.
Q2V14	Social satisfaction	I am proud to be part of this team.	The morale of our team is good.
Q2V23	Social satisfaction	I like being part of this team.	I like being part of this team.
Q2V27	Social satisfaction		This team has a good working relationship.
Q2V13	Task interdependence	Within my team, work performed by team members was related to one another.	Within my team, work performed by team members was related to one another.
Q2V20	Task interdependence	I could not accomplish this task without information or materials from other members of my team.	I could not accomplish this task without information or materials from other members of my team.
Q2V25	Task interdependence	Other members of my team depended on me for information needed to perform their work.	Other members of my team depended on me for information needed to perform their work.
Q1V3	Valence	Twenty dollars is a lot of money.	Twenty dollars is a lot of money.
Q1V6	Valence	The reward offered for performance in this experiment is very attractive.	The reward offered for performance in this experiment is very attractive.
Q1V8	Valence	The Reward offered in this experiment is hardly worth the effort.	I could really use the money from this experiment.

Appendix J Additional Data

A measure of frequency of speech was introduced in an attempt to measure the construct of cooperation. It was determined that this did not measure the intended construct during the experiment, but the data was collected for all trials. The measure was made by counting the number of time each participant spoke. The length of time, nor what the comment was did not influence the count. A normalized frequency (number of times speaking divided by time) for each individual and the standard deviation of the normalized frequency for each team was calculated. This measure was not used in this study in any way, but is provided here for completeness.

Table J.1 Frequency of Speech Data

Team	Function	Time	Speak	Normalized Frequency	Standard Deviation
7	Finance	72	121	1.681	0.278
7	Hardware	72	101	1.403	0.278
7	Installation	72	81	1.125	0.278
8	Finance	79	103	1.304	0.236
8	Hardware	79	125	1.582	0.236
8	Installation	79	88	1.114	0.236
9	Finance	82	96	1.171	0.256
9	Hardware	82	73	0.890	0.256
9	Installation	82	115	1.402	0.256
10	Finance	92	102	1.109	0.438
10	Hardware	92	182	1.978	0.438
10	Installation	92	133	1.446	0.438
11	Finance	121	57	0.471	0.145
11	Hardware	121	92	0.760	0.145
11	Installation	121	73	0.603	0.145
12	Finance	95	115	1.211	0.108
12	Hardware	95	95	1.000	0.108
12	Installation	95	109	1.147	0.108

Table J.1 Cont. Frequency of Speech Data

Team	Function	Time	Speak	Normalized Frequency	Standard Deviation
13	Finance	92	36	0.391	0.907
13	Hardware	92	196	2.130	0.907
13	Installation	92	157	1.707	0.907
14	Finance	59	59	1.000	0.191
14	Hardware	59	66	1.119	0.191
14	Installation	59	44	0.746	0.191
15	Finance	73	91	1.247	0.234
15	Hardware	73	58	0.795	0.234
15	Installation	73	67	0.918	0.234
16	Finance	109	115	1.055	0.423
16	Hardware	109	185	1.697	0.423
16	Installation	109	202	1.853	0.423
17	Finance	79	135	1.709	0.170
17	Hardware	79	156	1.975	0.170
17	Installation	79	160	2.025	0.170
18	Finance	65	70	1.077	0.032
18	Hardware	65	66	1.015	0.032
18	Installation	65	67	1.031	0.032
19	Finance	70	110	1.571	0.336
19	Hardware	70	136	1.943	0.336
19	Installation	70	157	2.243	0.336
20	Finance	78	78	1.000	0.351
20	Hardware	78	113	1.449	0.351
20	Installation	78	59	0.756	0.351
21	Finance	75	97	1.293	0.154
21	Hardware	75	120	1.600	0.154
21	Installation	75	107	1.427	0.154

Appendix K Vita

Brian Cunningham was born in Dayton Ohio on September 23, 1972. He has lived most of his life in the Washington DC area, except for a five-year stay in Redlands, California. Brian graduated from Centreville high school in 1991 and started at Virginia Tech in the fall. He received a Bachelor's of Science in Industrial and Systems Engineering in the spring of 1996. Finding Virginia Tech's ISE department ideally suited to his interests, he stayed to study for his Masters in Industrial and Systems Engineering with a concentration in Management Systems. Brian currently lives in northern Virginia with his wife Susan and their Akita. Brian is a consultant with Accenture, where he has been working since defending his master's thesis in the fall of 1998.